

SPACE & ENVIRONMENT

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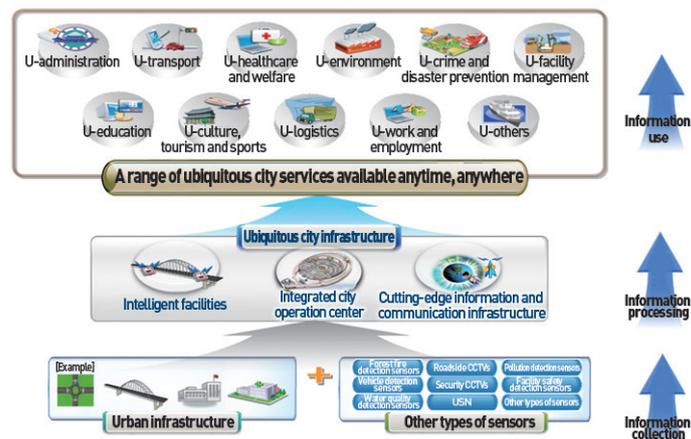
Direction of the Smart City Strategy in Korea

Jaeyong Lee

1. Changes in Korea's Smart City Policy

In the early 2000s, Korea built a world-leading information network across the country and introduced the concept of information technology-based cities based on the belief that doing so would empower them to ensure more efficient urban management and operation. However, the information technology-based city concept of that time was different from the current smart city concept. Its focus was on concurrently building the new infrastructure of information and communication networks, and services thereon would be in the form of integrated services that the state has to offer, for example transportation and crime prevention. As shown in Figure 1, the ubiquitous city primarily focused on building cutting-edge urban infrastructure.

Figure 1. The Ubiquitous City Concept



Source

The First Ubiquitous City Comprehensive Plan, 2009.



KRIHS (Korea Research Institute for Human Settlements) was established in 1978 with a mission of creating a beautiful and pleasant living environment. To achieve the mission, KRIHS has been committed to enhancing the quality of life and well-being of the people in the nation with its spatial planning studies and policy suggestions.

Since its foundation, KRIHS has carried out a variety of studies on the efficient use, development, and conservation of territorial resources. Its research areas range from sustainable and balanced territorial development and conservation of the territory to the provision of housing and infrastructure.

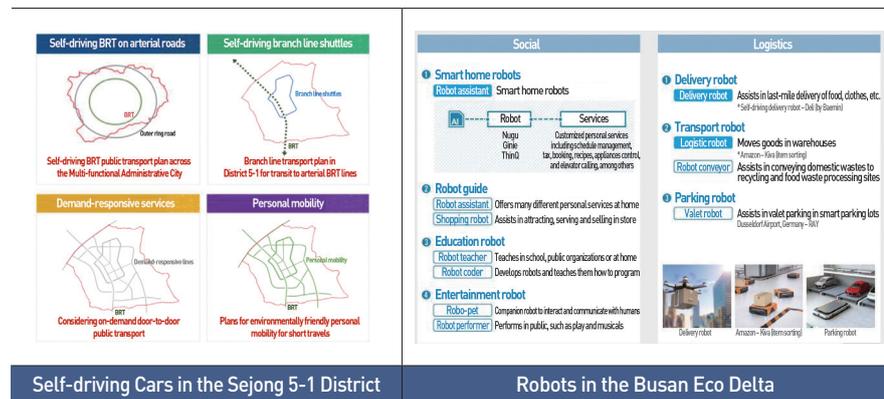
In 2010, the smart city started emerging globally as a new model of a city underpinned by information and communication technologies (ICT). The smart city concept in other countries, unlike that of Korea, aimed to maximize innovation in urban spaces to solve problems in the city. This led the Korean counter-party to understanding the limitations of the ubiquitous city concept that merely focused on construction projects and served as momentum for them to make rapid changes in the ubiquitous city policy towards smart city policies in 2017 and onwards.

2. Types of Smart Cities by Urban Space and Tailored Strategies

In 2018, the Presidential Committee for the Fourth Industrial Revolution announced the Smart City Strategy. What differentiated the strategy from the previous strategies was that it aimed to categorize smart cities depending on the types of urban spaces available and implement tailored strategies accordingly. The key to doing so was empirical actions to drive innovation, and the urban spaces subject to the strategy were categorized into newly built urban spaces, existing urban spaces, and deteriorated urban spaces.

Newly built urban spaces' advantages included freedom in building up-to-the-minute infrastructure and making spatial plans suitable for new solutions and more funding sources available given that these projects would be more of urban development projects in nature. Accordingly, the approach taken for the newly built urban spaces was designating them as national smart city pilot cities and providing state budgets and other financial sources to design and construct smart cities on blank sites. The national smart city pilot cities are exempted from location and new industry regulations to allow for free urban design and the introduction of up-to-the-minute solutions, presenting new smart city models never seen before.

Figure 2. Example of Solutions Introduced to National Smart City Pilot Cities



Source

Sejong and Busan Implementation Plans of National Smart City Pilot Projects. 2019.

For existing cities, a range of projects are pursued where municipalities compete with each other with multi-faceted ideas to demonstrate novel smart city models. These include: the national smart city strategy R&D demonstration project that highlights data interconnections between the public and private sectors and aims to validate the platform and solutions; the thematic smart city demonstration project that concentrates technologies and solutions from many different areas with the aim to solve specific urban problems such as transportation, safety, environment, tourism, and so on; and the smart city challenge project where the public and private sectors join hands to design and implement policies to solve problems and create new industries.

Lastly, for deteriorated cities, smart city urban regeneration projects are pursued with the aim to identify new solutions to solve their problems in a more efficient way.

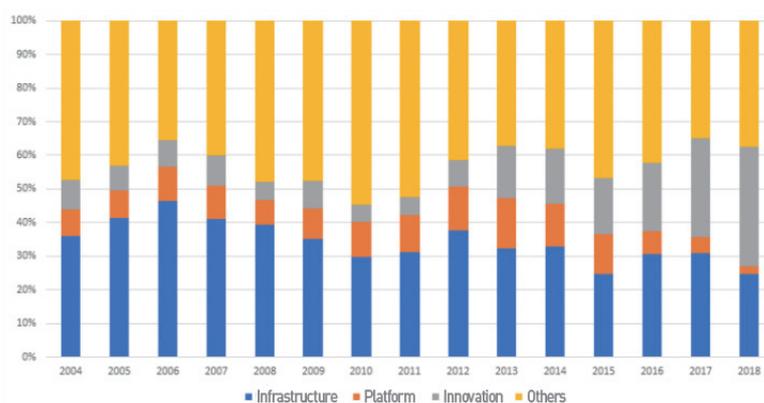
In 2017, the Korean government up-scaled its smart city policy and made a shift towards empirical demonstrations to identify new smart city models that fit individual urban spaces. It is also pursuing providing institutional support, for example introducing smart city indices to support the demonstrations, pursuing the legislation of a 'regulatory sandbox,' and introducing public-private cooperative special purpose companies (SPCs).

The ubiquitous city policy focused on building the same high-tech infrastructure and solutions when building new towns, meaning not much of a difference between all ubiquitous city projects nationwide. However, the government recognized that given the convergent nature of cutting-edge information technology and data industries it would no longer be able to succeed in building smart cities with a straightforward, top-down approach to policy making and implementation and made a shift in its smart city policy towards a bottom-up approach whereby many different players such as municipalities, the private sector and citizens make suggestions on policies that fit their communities and the central government focuses on empirical demonstration thereof by providing financial and institutional support. These changes are well accepted by those involved in the smart city policy.

3. Future Orientations for the Smart City in Korea

An analysis of keywords from news articles about smart cities, from 2004 when the nation introduced the concept of the smart city to date, revealed that keywords about physical infrastructure, for example "construction" or "building," dominated at the beginning but declined later on, driven out by ones related to innovativeness such as "innovation" and "citizens" (Figure 3).

Figure 3. Smart City Keywords Analysis in Korea



Source
KRIHS, 2018.

Following such a transition of keywords in the smart city policy towards innovation, the nation is pursuing a changeover of its smart city policy from unilaterally setting the image of what the smart city should look like and merely providing policy measures to reach the goal to a tool to create urban setting to empower innovative ideas, solutions, and players therein.

Changes are also happening in how municipalities, which are responsible for the implementation and operation of smart city projects under the law, see the smart city. A survey of 162 cities and counties in Korea in 2018 showed that 66 cities and counties were planning or working on smart city projects. Among them, 43% described their smart city project inclined to building cutting-edge infrastructure, 5% creating innovative spaces. However, when they were asked about their future orientations, only 20% answered that they would pursue building cutting-edge infrastructure while 23.3% focusing on creating innovative spaces. The most common type of smart cities was a data-based, platform-centered smart city, which accounted for 51.6% in their then-current smart city projects, or 56.7% in their prospective projects.

Table 1. Municipalities' Current and Future Smart City Projects

		Type of smart city projects slated in 5 years			
		Building cutting-edge infrastructure	Platform-centered	Creating innovative spaces	Total
Current smart city type	Building cutting-edge infrastructure	15.00 %	18.33 %	10.00 %	43.33 %
	Platform-centered	5.00 %	38.33 %	8.33 %	51.67 %
	Creating innovative spaces	0.00 %	0.00 %	5.00 %	5.00 %
	Total	20.00 %	56.67 %	23.33 %	100.00 %

Source
KRIHS, 2018.

Given the central government’s policy, the results of the analysis of smart city keywords, and the types of smart cities pursued by municipalities, smart cities in Korea will rapidly change towards empirical demonstrations of new smart city models. Orientations for the smart city policy in Korea include demonstrating cutting-edge technologies, for example citizens’ involvement-oriented living lab-type demonstrations, public-private data interconnections and urban platform demonstrations, testing pros and cons of regulation postponement, and piloting public-private cooperative policy development, and creating urban spaces to solve urban problems and develop new industries based on multi-faceted demonstrations within the urban space, be it social or institutional. However, demonstration projects themselves are not all it takes to effectively solve urban problems and create new industries. In this sense, the next challenge of the smart city will be to develop policy measures to ensure successful demonstration projects are further developed and up-scaled.

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Strategic Implementation of the 'Urban Regeneration New Deal' Program in Korea

Minho Seo, Yujin Bae and Kyusang Kwon

1. Background and Significance

Nationwide Urban Regeneration New Deal Program in Full Swing

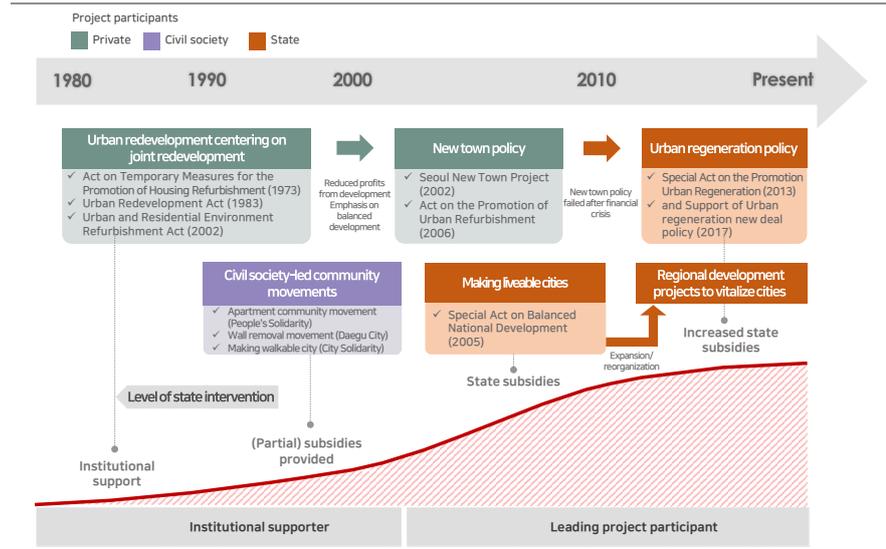
In 2017, Korea included the 'Urban Regeneration New Deal Program' which aims continuous innovation in the city led by the local community, in its national agenda. The key strategies of the Urban Regeneration New Deal Program are building compact network spatial structure-based hubs, revitalizing the city, alleviating urban deterioration by refurbishing residential areas, improving old and low-rise residential areas and quality of life, and pursuing community-led urban regeneration, among others. Compared to past urban regeneration initiatives pursued in 15 destination sites with a state budget of \$134 million dollars (KRW 150 billion) per year, the program has been significantly expanded to 100 sites with a budget of \$89 billion dollars (KRW 10 trillion) including \$17.8 billion dollars (KRW 2 trillion) of government subsidies per year.

Necessity for Strategic Implementation for a Successful Urban Regeneration New Deal Program

Recently Korea is facing population decreases, worsening crises in regional areas, and continued urban deterioration. Given these circumstances, how the Urban Regeneration New Deal Program is implemented should be more strategically refined and the roles of the state and other players involved should be further clarified in order to achieve the policy objectives.

There have been insufficient efforts to systemically manage deteriorating regions in the state level, and municipalities have insufficient funds and resources. Given the recent worsening of population decreases in regional areas and regional bipolarization, recklessly distributing program resources might do nothing but yield zero-sum effects. In this sense, the trade-off relationship between many different players involved in urban regeneration and different projects should be taken into consideration so that the government and other players take a strategic approach of 'selection and concentration,' under which they concentrate their finance, human resources and assets on subjects that have competitive edges.

Figure 1. Development of Urban Regeneration Policy and Changes in State Roles



Source

Minho SEO et al., 2018. KRIHS.

2. Conditions for Urban Regeneration New Deal Program and Fact-finding Analysis

Demonstrating Potential to Build a Compact-Network Spatial Structure and its Effectiveness

Building the Compact-Network city is the key strategy of the Urban Regeneration New Deal Program, which aims to concentrate populations and functions on the regional hub city and strengthen connections with neighboring regions, thereby establishing an innovative foundation of scale to revitalize the region. However, whether Korea's territory and urban spatial structure fits the compact network spatial structure has never been validated. The empirical analysis in this study revealed that there are 17 functional urban communities suitable for building a compact network city. It also showed that spatial density and complex land use has positive effects on labor productivity rather than the size of the city population. Specifically, it is estimated that labor productivity would increase by 0.05% per unit increase in urban spatial density and 0.12% per unit increase in complex land use. In this sense, intensive space use and hub city development under the Urban Regeneration New Deal Program seems to be an effective strategy for economic foundation building and job creation.

Validating the Appropriateness of the Urban Regeneration Program to Overcome Nationwide Deterioration

The ultimate goal of the urban regeneration new deal policy is to control the ever-worsening urban deterioration. Urban deterioration across the country has worsened in the past three years from 64.5% (2013) to 65.9% (2016). Eighty point two percent of eup, myeon and dong (basic municipalities) in Korea are experiencing chronic demographic and social regressions, and the deterioration rate in metropolitan cities is as high as 85.0%. Despite such extreme deterioration, 821 eup, myeon and dong have been isolated from the existing urban regeneration projects (23.5% of the total municipalities in Korea, 1.8 times more than the number of target sites included in the existing projects). Furthermore, these municipalities are primarily in cities of which population is less than 200 thousand people (25.9%,

128 municipalities) or rural counties (28.2%, 219 municipalities). This implies that target sites under the existing urban regeneration projects were chosen based on their community compositions or viability of project implementation, rather than the level of deterioration in these municipalities. In this sense, a separate support system should be developed for urban regeneration new deal projects that target small regional cities and the state directly takes the initiative in pursuing projects in municipalities experiencing an extreme level of deterioration.

Figure 2. Functional Urban Communities in Korea (2015)

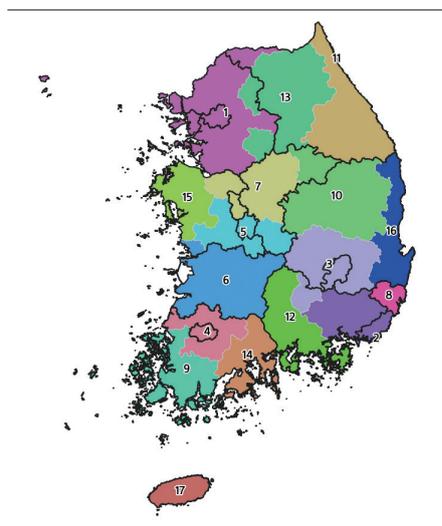
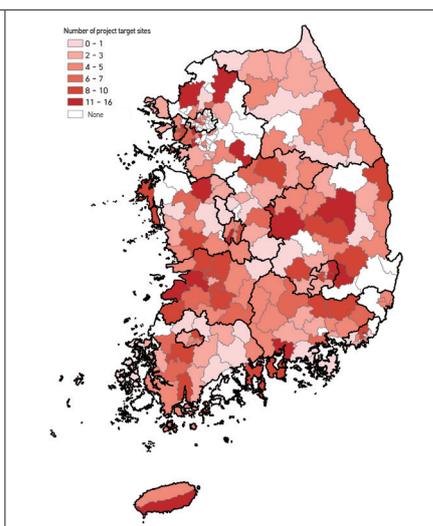


Figure 3. Isolation from Urban Regeneration Programs in Comparison to Level of Deterioration (2016)



Note

Bold borderlines denote borders between metropolitan cities or provinces. Analysis based on total destined travelers data from the national transportation database (2015).

Source

Minho SEO et al., 2018. KRIHS.

Note

Figures represent numbers of eup, myeon and dong that are experiencing more severe deterioration than other municipalities but have been excluded from existing programs. Level of inconsistency represents unit conversions to the number of project target sites.

Source

Minho SEO et al., 2018. KRIHS.

Validating Municipality-initiative in Securing Funding Sources and Running Urban Regeneration New Deal Projects

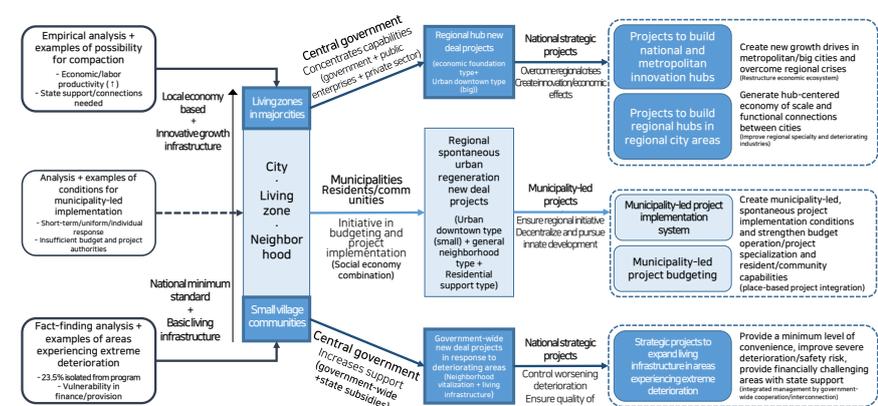
The budget for the urban regeneration new deal has been expanded to KRW 10 trillion per year. However, the availability of funding sources depends on municipalities' financial conditions, collaboration with relevant government ministries, and other funding sources provided by state-run corporations and public funds, save for \$7.1 billion (KRW 800 billion) directly invested by the Ministry of Land, Infrastructure and Transport. Specifically, central government ministries have challenges related to inflexibility in using funding sources caused by insufficient tax revenues, lack of specific assistance for major projects, and partitioning of budgets and organizations that hinders collaboration between government ministries. Local governments have poor financial conditions hence may be unable to provide matching funds, which may force them to give up on projects. In addition, funds invested by municipalities are not linked with mid-term local government fiscal plans, which makes it uncertain whether they would be able to secure budgets for the projects. In neighborhood-type urban regeneration projects that primarily focus on projects closely associated with citizens' daily living, the majority of funding sources relies on state subsidies, affecting the viability of local government-led project implementation. In this sense, it is needed to develop an integrated funding system to ensure stable implementation of the urban regeneration new deal. It is also needed to raise state subsidizing rates in consideration of local governments' financial circumstances and apply differential subsidies and establish a new working-level organization in charge of budgeting and ensuring substantial collaboration between government ministries.

3. Strategic Implementation of the Urban Regeneration New Deal Program

Clarifying the Roles of Players Involved in Urban Regeneration Based on the 'Selection and Concentration' Principle

To effectively achieve the policy objectives of the urban regeneration new deal, it is overarching to clarify areas in which each player involved in urban regeneration has competitive edges in terms of project implementation and finance based on the 'selection and concentration' principle. In particular, the state should focus on developing strongholds to expand economic foundations in the metropolitan and conurbation level and building basic living infrastructure and making physical improvements in areas experiencing extreme deterioration that have been isolated from the existing policy and projects.

Figure 4. Strategic Orientations and Project Areas by Urban Regeneration New Deal Project Type



Source

Minho SEO et al., 2018. KRIHS.

Government-led Strategic Implementation: Building Regional Hubs and Answering to Areas Experiencing Extreme Deterioration

- ① National and metropolitan innovative hub building project: To build innovative districts connected to metropolitan cities and major regional cities or promote innovation projects in combination with university town, smart city and railroad station area development. In deteriorating industrial cities, to pursue projects designed to restructure the economic ecosystem to generate new growth drives.
- ② Strategic project to build regional hubs in regional city areas: To build a hub that covers neighboring small cities, urban-rural consolidated cities and rural living areas in the city area level; and to build a hub to ensure the economy of scale (more than 300,000 people) capable of competing and cooperating with neighboring large cities and establishing functional systems for sharing public, living, cultural and welfare services.
- ③ Strategic project to answer to areas experiencing extreme deterioration: To increase basic living infrastructure in order to refurbish poor buildings and fire roads that are threats to residents' safety and ensure the minimum level of quality of life; and to pursue state-led projects that specifically focus on physical improvement and expanding basic living infrastructure given that these areas have been excluded from the existing projects due to their poor financial conditions and social indifference.

4. Policy Recommendations

For strategic implementation of the urban regeneration new deal based on the aforementioned 'selection and concentration' principle, a few institutional improvements are needed in the national level. First, institutional development is needed in relation to innovation district projects designed to take advantage of under-used state-owned land and encourage private investment in order to build metropolitan and regional hubs, introduce anchor facilities to generate proactive effects and ensure swift project implementation. Second, spontaneous inter-city agreements should be encouraged in the basic municipality level so that the metropolitan and regional hubs are established beyond administrative districts and public services can be interconnected between them. Third, there are many areas experiencing extreme deterioration across the country and their demands are related to overall social overhead capital for residents' living, which cannot be addressed solely with the urban regeneration new deal. Therefore, a government-wide organization should be established to focus on improving residential and living environments in these areas and run and execute relevant budgets in an integrated manner, and state subsidy rates should be further raised to 70-80% for municipalities with poor financial conditions. Lastly, for local-led, place-based implementation of the urban regeneration project and relevant projects across the government ministries, the substantial operation of comprehensive subsidy programs that offer more choices to municipalities should be ensured, and multi-year inter-ministry projects should be established using the planning contract system. In particular, special accounts for urban regeneration and tax increment financing should be established for municipalities' autonomous and stable financing.

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How to Develop Smart Mobility in Small and Medium-sized Cities

Jong-Il Park

1. Background and Purpose

The development of cutting-edge technologies has led to the emergence of smart mobility that represents convergence between 'sharing' 'autonomous vehicles', and 'battery' technologies. Smart mobility has potential to improve the efficiency of urban transportation systems and contribute to the improvement of public transportation systems. However, discussions over the application of smart mobility have focused on large cities. Application of smart mobility to small and medium-sized cities will help improve the efficiency of their transportation systems and the quality of residents' lives.

2. Necessity of Application of Smart Mobility to Small and Medium-sized Cities

Smart Mobility

Smart mobility is defined as transportation modes and services that have emerged following the development of advanced technology. In this study, its scope is limited to bike sharing, shared personal mobility, ride sharing, car sharing, demand-responsive transport, and autonomous shuttles that are likely to be introduced in the near future. Smart mobility can serve as a supplement or substitute for traditional transport modes, improving user' convenience and saving travel time and costs.

Small and Medium-sized Cities

A small and medium-sized city is defined as a city outside the Seoul metropolitan area with population under 500 thousand people. There are 43 small and medium-sized cities in Korea, serving as home to approximately 7,930 thousand people, 15% of the nation's total population. Many small and medium-sized cities are experiencing sluggish population growth or decline, hence perishing. Decreases in tax revenues have resulted in poorer financial conditions, and an increasing number of them are struggling to merely maintain their transportation systems, rather than improving them.

Necessity of Application of Smart Mobility to Small and Medium-sized Cities

In small and medium-sized cities, passenger cars have much higher shares in the overall transportation system compared to large cities, hence better chance to yield significant effects by smart mobility. It will also lower the share of passenger cars and raise the share of public transports by complementing access to public

transportation and substituting for passenger cars in short-distance travels. Furthermore, vitalizing small and medium-sized cities by smart mobility will contribute to balanced national development. Small and medium-sized cities have been relatively less highlighted in national policy that has focused on developing major cities and assisting rural villages. Given their financial conditions, it is not viable for small and medium-sized cities to make major investment in improving their transportation systems.

3. Characteristics of Small and Medium-sized Cities and Appropriate Smart Mobility

Selecting Subject Cities

Most of small and medium-sized cities are categorized into either rural or urban cities, and some of them have new urban centers. In this study, three cities (Naju, Gimcheon, and Jinju) were chosen for analysis as they have rural areas, an old urban center, and a new urban center.

Results of Analysis

In the rural area, it is appropriate to introduce demand-responsive transportation. Very poor access to bus services needs to be improved, but given that there are a large number of aged people, making substitutes for buses is more appropriate than improving accessibility to bus services. The use of smart mobility that requires users drive themselves is not suitable. The old urban centers have favorable environments to introduce bike sharing, shared personal mobility, ride sharing, and car sharing services. They have relatively better public transport conditions and feature a very high proportion of intra-regional travelers. They also feature a higher proportion of young people (in their 20s to 40s) and partially have relevant infrastructure. The new urban centers have very good environments for bike sharing, shared personal mobility and ride sharing services and also have good environments for car sharing and autonomous shuttles. They have relatively better public transportation conditions and feature a very high proportion of intra-regional travelers. A high proportion of young people and a very high population density mean favorable conditions for smart mobility underpinned by well-developed infrastructure.

Survey Results

A survey of 465 citizens in small and medium-sized cities was carried out. Their current modes of travel included passenger cars (53%), buses (19%), walk (18%), and bicycles (10%). Among them, 76% said that they would be willing to use smart mobility services, and their preferences included ride sharing (27%), car sharing (22%), and demand-responsive transportation (19%). People in the rural areas had stronger preference for demand-responsive transportation (36%) and ride sharing, while those in the old urban centers preferred car sharing (27%), demand-responsive transportation (24%), and ride sharing (21%). People in the new urban centers preferred ride sharing (29%) and car sharing (21%) and showed stronger preference for bike sharing (19%) and shared personal mobility (14%) compared to those in other areas.



Suggestions for Appropriate Smart Mobility in Small and Medium-sized Cities

In rural areas, it is needed smart mobility to substitute for existing transportation rather than complementing it. In this sense, demand-responsive transportation would be the ideal smart mobility. Accessibility to bus services needs to be improved as many people travel to and from the old urban center by bus, but given the higher proportion of aged populations, it would be appropriate to substitute for it by introducing demand-responsive transportation. In old and new urban centers, bike sharing and shared personal mobility would be the most appropriate as supplements and ride sharing as a substitute. In particular, new urban centers feature a higher proportion of intra-regional travelers, a shorter travel distance, a higher population density and a higher proportion of young populations. Accordingly, introducing bike sharing and shared personal mobility would yield substitution effects. Introducing bike sharing, shared personal mobility and ride sharing to new urban centers and demand-responsive transportation to rural areas would be effective and ensure stable operations.

4. Policy Recommendations

The government should establish a long-term vision and detailed strategies to introduce smart mobility to small and medium-sized cities. Many advanced countries are supporting a range of studies designed to establish smart mobility strategies. It is also needed to make legislative and institutional improvements in relation to smart mobility, which may be considered illegal under the current legislation or in the blind spot due to absence of relevant legislations. In particular, conflicts surrounding ride sharing, which is in fierce confrontation against the taxi industry, should be addressed. In addition, guidelines to the introduction of smart mobility should be developed and distributed to municipalities to help them better understand smart mobility and work on relevant projects. Lastly, pilot projects need to be pursued to establish a smart mobility model suitable for small and medium-sized cities and private enterprises should be encouraged to take part in.

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Development of Smart Cities and Spatial Information

Siyeong Lim

1. Background and Objectives

The Government Pushes Forward the Smart City Agenda in Response to the 4th Industrial Revolution.

In 2018, the Presidential Committee on the Fourth Industrial Revolution announced its smart city innovation strategy to develop 'people-centered, sustainable, open, tailored, interactive, connected and converged smart cities as innovative growth engines.' To this end, the government proclaimed to introduce proper technologies by classifying smart cities as test beds, new cities as regional growth centers, theme-based special complex, and ones for urban regeneration. In particular, the government chose Busan and Sejong City as the venues for the pilot smart cities to develop a comprehensive success case with deregulation and new technologies, including data hub and participative open platform.

The Role of Spatial Information for the Development of Smart Cities is Very Important.

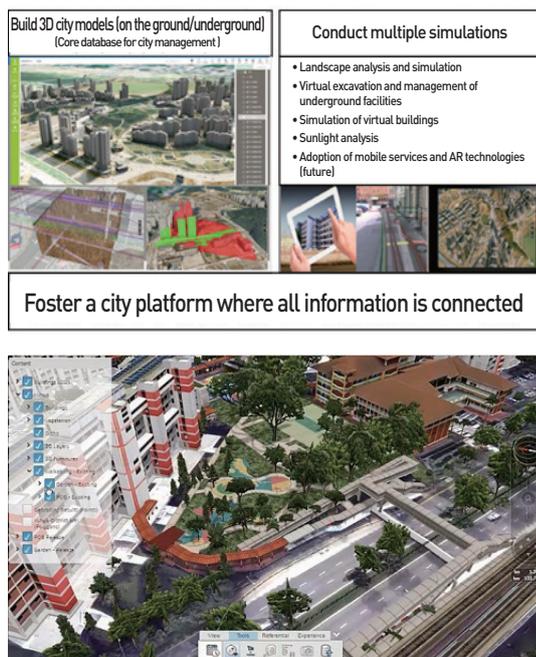
Cyber-Physical System (CPS)¹ has emerged along with the development of technologies that collect and analyze data such as IoT and big data. Currently, CPS is mainly used and focused on facility management and smart factory. However, the system will be applied to cities in the end. The smart city development is centered on activities to connect and integrate various data generated in cities up until now. In the future, efforts to predict and analyze data in a virtual space will lead such development and that is the essence of CPS. The first step to apply CPS to cities is to create a virtual space. The spatial information by itself represents a virtual space of a city. Considering that the spatial information has served as a base of data integration as well as a venue where such data is shared by many, it is time that the role of spatial information is all the more important.

2. Status of Use and Expectations on Smart Cities Spatial Information

Currently, the spatial information is recognized as the core infrastructure and smart city projects are being developed based on this. As for Sejong City, for instance, the entire city and its underground facilities are realized as a 3D spatial data. The city also plans to develop a digital twin platform to support urban administration, collect various data on the city and simulate such data on the platform. Singapore intends to utilize a 3D city model to integrate semantics-embedded information with a space, instead of a simple map, through Virtual Singapore project so that it can be used not only in urban planning, but also virtual experience, testbed, game business, etc.

1. A Cyber-Physical-System (CPS) is a concept that creates a virtual space same with the reality, and analyzes and simulates actual data in the virtual space to control the reality.

Figure 1. 3D DB in Sejong, 3D in Virtual Singapore



Source

Korea Land & Housing Corp. (LH). 2018. Implementation directions on smart city pilot project [Sejong 5-1 Life Zone]. Smart City Conference.

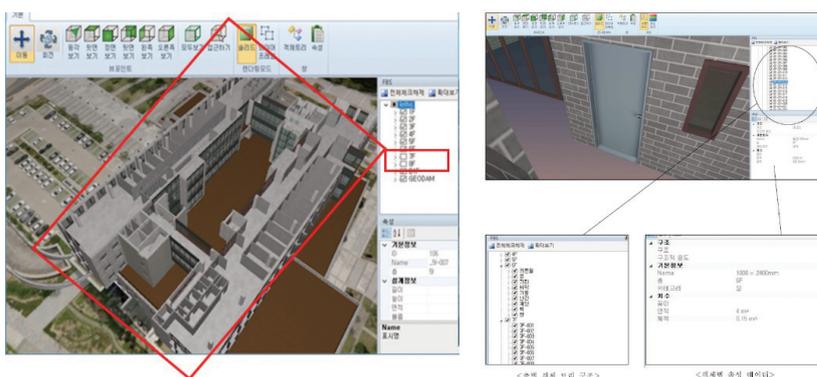
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<https://www.nrf.gov.sg/programmes/virtual-singapore> [dated on November 14, 2018].

3. Object-oriented Testing and Limitations

In order to apply CPS to the smart city, a virtual space must be identical to the reality. There are numerous objects and they are intertwined with each other in a real world. The current spatial information technology only reflects a virtual space by object and is insufficient to realize their relations. Hence, this study explored the possibility of unit-level realization of a space for the development of smart city by developing an object-oriented testing model.

Figure 2. Testing Models in This Research



Source

Author

About four limitations were found while developing such model. First obstacle was a lack of data libraries and standards in developing objects in reality as separable data and integrating each piece to create a virtual space. Second, a lack of diverse data for developing a model was pointed out so CAD drawings are solely utilized in architectural design. Therefore, there is a need to actively use Building Information Modeling (BIM) data. Third, developing an object-oriented testing model demanded a lot of manual tasks. Lastly, speed degradation in loading while combining spatial data with building information occurred. Hence, efforts to overcome such limitations with technological breakthroughs and policy measures are needed.

4. Policy Directions

The spatial information technology should be advanced first in order to pursue smart cities. To be specific, we should be able to develop an objectified 3D spatial data. Then, modular modifications and data renewal of such objectified data should be available like putting Lego bricks together. Also, data in reality needs to be connected and synchronized in an objectified space in real-time so that spatial analysis techniques for smart city services can be applied based on this. To make this happen, governance by multiple stakeholders who produce and manage data is required.

In this respect, multiple pilot projects should be implemented in terms of spatial information to promote the development of smart cities. Most of all, it is urgent to develop technologies and standards based on pilot projects to create a small virtual space that is identical to the real world and synchronizing with it.

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