연구논문 「환경정책」 제27권 특별호 2019. 12: 17-49
DOI http://dx.doi.org/10.15301/jepa.2019.27.S.17
ISSN 1598-835X

Are Smart Cities Growing Smartly and Sustainably?: Smart and Sustainable Growth Evaluation of Each Plan of Two Smart Cities in South Korea*

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Abstract: A smart city (SC) should be planned and constructed based on Urban Growth Management. There is insufficient research to assess whether projects designed for the creation of SCs are in-line with both Smart Growth and Sustainable Growth practices, which are the foundation of Urban Growth Management. The purpose of this study is to assess whether the projects designed for the creation of SCs in Korea have been conducted using Smart Growth and Sustainable Growth practices. We selected the Sejong 5-1 Neighborhood and Busan Eco Delta City as case study areas. We evaluated the SC plans based on both Smart Growth principles and Sustainable Growth indices. As a result, we found that SC plans in both case study areas have primarily focused on economic growth opportunities that have followed some technological indicators. The indicators for equitable approval processes, efficient development patterns, and resiliency to hazards, but, were all found to be lacking in the urban planning considerations for these cities. This article proposed that Urban Growth Management such as Smart Growth and Sustainable Growth is important for environmental policy.

Key Words: Smart City, Smart Growth, Sustainable Growth, Plan Evaluation

I. Introduction

The era of smart cities (SCs) has arrived. Over the past few years,

* This work is financially supported by Korea Ministry of Land, Infrastructure and Transport (MOLIT) as 「Innovative Talent Education Program for Smart City」.

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global SC development projects have flourished, such as the United States' (U.S.) SC Team Challenge Project, India's SC 100 Construction Project, and so on (Lee and Lim, 2017). In January 2018, the Korean government selected Sejong 5-1 Neighborhood (Sejong 5-1N) and Busan Eco Delta City (Busan EDC) as the locations for pilot SCs. This project is a prototype for SCs in Korea to create a leading model for future SC-building businesses.

For a long time, urban planners agonized over Urban Growth Management to solve problems caused by indiscriminate development and urban sprawl. Among the proposed solutions, Smart Growth became a major agenda in the field of urban planning in the late 1980s and is still a growth management ideology and strategy adopted by many cities today. SCs and Smart Growth are similar in that they both stem from the need to solve urban problems, but Smart Growth is largely rooted in Urban Growth Management, while SC is an urban planning concept that have emerged as opportunities to incorporate new innovations in modern technologies like information and communication technology (ICT).

The trajectory of changes in Urban Growth Management reveals the values and planning/design elements that should be oriented toward sustainable urban development. However, while SCs seem to be following the direction of Urban Growth Management, it is not certain whether they should be included in the trajectory of Urban Growth Management. The reason we question this is because SCs emerged among a tendency to solve urban problems with modern technology like ICT.

Are SCs growing smartly and sustainably? This study sought to find answers to this question by evaluating two plans for pilot SCs in terms

of smart and Sustainable Growth. We conducted this research in the following order. First, we explored the links between Urban Growth Management and SCs through a literature review, and then we formulated the research questions. Second, we compared the basic characteristics of the two pilot SCs in Korea and analyzed the evaluation results and the SCs' planned self-evaluation methods. Finally, based on the results of the analysis, we argue that Urban Growth Management, such as smart and Sustainable Growth, is a priority for SCs.

Ⅱ. Smart Growth and Sustainable Growth on the Trajectory of Urban Growth Management

Modern metropolises suffer from a lot of urban problems such as traffic congestion, environmental pollution, lack of open spaces, housing supply imbalances due to polarization between classes, urban decline, and natural disasters due to climate change. Urban Growth Management has developed in different ways. U.S. local, regional, and state growth management policies can be largely divided into four major waves from the 1950s to the present, which can be represented by a single trajectory. Capitalist countries with institutionalized urban planning can be said to follow this trajectory, even if the timing and indicators vary slightly between countries. The main theoretical background of this study is Chapin's (2012) discussion of the waves of Urban Growth Management.

The trajectory of Urban Growth Management has been formed through four waves. The first wave on the trajectory of Urban Growth

Management is the era of growth control in which suppressed urban growth or planned expansion such as urban growth boundary development stop lines, the rate of growth ordinance, growth caps, and so on. The second wave is the era of comprehensive planning, in which urban growth and development are managed rather than merely suppressed or planned expansion. In the 1980s and 1990s, communities across the U.S. began campaigns against urban sprawl that is related to above problems, focusing policies and programs on creating a more compact and livable community. At the same time, the New Urbanism movement took place, and city landscape design was incorporated into Urban Growth Management programs (Chapin, 2012).

〈Table 1〉 Eras of urban growth management

	Era of growth controls	Era of comprehensive planning	Era of smart growth	Era of sustainable growth
Defining issues	Environmental degradation, loss of pristine lands, exurban development	Environmental degradation, infrastructure costs, infrastructure provision, professionalization of planning	Environmental degradation, infrastructure provision, placemaking, urban economic development	Economic development, environmental degradation, climate change, energy demand and supply
Basic approach	Strict limits on the amount of growth, boundaries delineating the preferred locations of new development, planned expansion	Regulation of development, comprehensive planning, infrastructure planning	Incentives and public infrastructure investments to support desirable development outcomes	A combination of incentives and regulations that promote development outcomes appropriate to urban, suburban, and rural locations
Era's implied motto	Growth needs to be managed aggressively	Plans, regulations, and budgets are the solution to the problem of growth	Growth is an opportunity for strengthening urban communities	Growth is inevitable and essential, but must be balanced against the long-term goal of sustainability

Source: Chapin, 2012

While private participation in the public sector is expanding, the era of Smart Growth, a third wave, has emerged due to the recognition of the limitations of comprehensive planning-oriented Urban Growth Management and discussion of ways to improve it. With the Smart Growth movement, numerous cities have embraced many of the core concepts of the movement and are incorporating these ideas into their plans (Chapin, 2012; Ye, Mandpe and Meyer, 2005). In the era of Smart Growth, urban growth is regarded as an opportunity to improve the community rather than a matter of controlling and managing it. The U.S. state of Maryland, which institutionalized Smart Growth in its urban planning, established the Smart Growth Act in 1997 to facilitate new developments in priority funding areas (PFAs). In this way, the state tried to revitalize existing communities by creating landscape designs that incorporated activity centers and high-density architecture. Unlike UGBs and USAs, local governments could receive compensation for most of the state infrastructure costs and were offered various incentives for brownfield maintenance, redevelopment, and job creation through PFA tax credits (Cohen, 2002).

Smart Growth models aim to develop placemaking, streetscape design, and lively activity centers in the community as well as emphasize the importance of image and landscaping in Urban Growth Management. In addition, Smart Growth models enhance partnerships between public, private, and non-profit organizations for existing comprehensive planning models (Crane, 2008).

The fourth wave is the era of Sustainable Growth, which incorporates and advances the concept of Smart Growth in every city that has adopted Urban Growth Management. In the era of

Sustainable Growth, planners should deal with the issues that the Urban Growth Management of Smart Growth has failed to address or neglected (Chapin, 2012):

(1) Local economic and community issues, such as the recession and high unemployment rate, housing problems such as plummeting housing prices and redevelopment demolition workers, and the lack of new development in many states that rely on real estate development;

(2) Climate change issues that have a significant impact on communities in coastal areas, such as rising sea levels and changes in ecosystems;

(3) Growing energy demand and associated problems; and

(4) Sustainable and self-sufficient food systems for healthy communities.

Planners should take a close look at Smart Growth and Sustainable Growth, which views growth and development as an opportunity and takes into account long-term issues such as economic recovery, community restoration, climate change, and energy supply. Cooperation among major institutions is paramount for Sustainable Growth.

Urban Growth Management has evolved forming a single trajectory rather than staying at a certain time. The concepts that distinguish 'Urban Growth Management' longitudinally are the era of Urban Growth Control, the era of Comprehensive planning, the era of Smart Growth, and the era of Sustainable Growth. For example, in the era of Sustainable Growth, urban planners would mange urban growth with perspective of Sustainable Growth. They would focus on issues

such as adapt to climate change, energy demand and supply. But, they could manage growth using urban growth boundary with perspective of Sustainable Growth. The eras of them are not the concepts of disconnection, but dominant.

Ⅲ. ICT: Distinguishing SCs from Other Cities

The acronym SC was first introduced in 1994 (Dameri and Cocchia, 2013), but it still does not have a clear definition (Angelidou, 2015; Caragliu, Del Bo and Nijkamp, 2011; Chourabi et al., 2012; Hollands, 2008; Marsal-Llacuna, Colomer-Llinàs and Meléndez-Frigola, 2015; Wall and Stravropoulos, 2016). However, a comprehensive definition of SC can be built by distinguishing between the technology component (ICT), which combines various features derived from SCs, and the methods and scope of its use. 〈Table 2〉 explores the various definitions of SCs.

As shown in 〈Table 2〉, the definition of an SC varies between researchers and institutes. Keywords found in SC definitions include ICT, communication, intelligence, and information (26%); environment and sustainability (17%); infrastructure and services (17%); and people, citizens, and society (12%; Lee and Yoon, 2018). The environment and sustainability are the second most important factors behind ICT and intelligence. But even before the emergence of the concept of SCs (including digital cities, Ubiquitous-cities, etc.), there was interest in the environment and sustainable development. The same is true of infrastructure, services, people, and society. In other words, what distinguishes SCs from previous urban concepts is whether ICT is used.

〈Table 2〉 Various definitions of SCs

Source	Definition
Lombardi et al. (2012)	Cities that actively utilize modern technology to bring innovative transportation systems, infrastructure, and green efficient energy systems to everyday urban life
Marsal-Llacuna et al. (2015)	Cities that use data and information technology to deliver more efficient services to citizens and to monitor and optimize their existing infrastructure
Lee and Yoon (2018)	Cities that can achieve continuous economic development and improvement in quality of life by investing in human resources, social infrastructure, transportation, and advanced ICT
Navigant Research (2016)	Cities applying technology to strategic planning to achieve sustainable development, improved quality of life, and economic development
Hamblen (2015)	Urban areas that use different types of electronic data collection sensors to provide the information needed to efficiently manage assets and resources
Deakin (2013)	Cities that utilize ICT to meet the demands of its citizens, requires community participation in the process, and implement technology in a way that has a positive impact on the community
Northstream (2010)	Cities that connect people with things and utilities without interruption using ubiquitous technology to enrich life within the urban environment of the 21stcentury
Albino et al. (2013)	Cities that are more intelligent and interconnected by using smart computing technology to create key infrastructure components and urban services, including efficient urban management, education, health care, public safety, real estate, transportation, and utilities
European Commission (2019)	Cities that utilize digital technology to provide better public services for citizens, use resources efficiently, and minimize the impact on the environment to improve the citizens' quality of life and enhance urban sustainability

Sources: Albino, Berardi and Dangelico (2013); Lee and Yoon (2018)

SCs can be divided into hard smartness and soft smartness depending on the degree of smartness, which is deeply related to the utilization of ICT. Hard smartness refers to actively utilizing ICT to improve the physical parts of cities, such as offices and residential buildings, infrastructure, etc., most of which are tangible assets. In soft smartness, ICT plays a more passive and limited role in driving urban change. For example, intangible assets, such as encouraging communication between local governments and citizens through

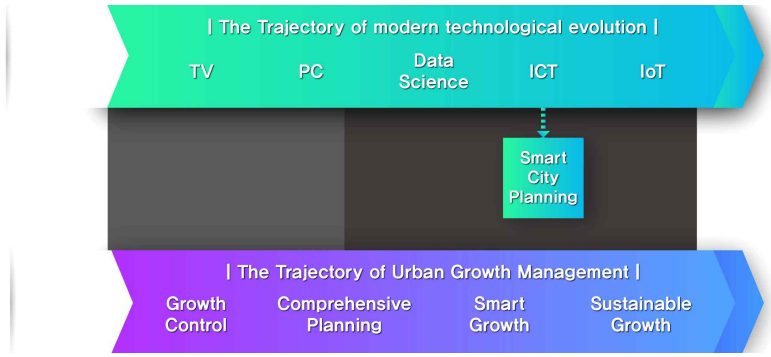
e-governance, exchanging instant feedback between users and providers in the development of a product, or creating a living lab that allows multiple stakeholders to participate in the urban planning process, all belong to soft smartness.

Different countries and regions have different perspectives and approaches to SCs. Even cities that solve problems smartly without using digital science, digital technology, or ICT can be referred to as SCs. But SC technologies must be deeply embedded and integrated into the urban fabric. To do this, the planner must take full advantage of the technological factors and demonstrate concern for community problems, creative thinking, thorough research, good planning, and persistence to achieve bold action (Barlow and Levy-Bencheton, 2018). In other words, technology is not the only requirement for an SC, but SCs would not be possible without modern science and technology.

Ⅳ. Links Between Urban Growth Management and Smart Cities

Are SCs an extension of the trajectory of Urban Growth Management? There have been quite a few studies directly comparing SCs with the concept of sustainable development. These studies focused on how the diverse concept of the SC embraces the agenda of sustainable development. In other words, rather than utilizing a diachronic understanding of the apparent background of SCs according to the trajectory of changes in Urban Growth Management, most of these studies viewed SCs and the concept of sustainable development as synchronous.

〈Figure 1〉 Smart city planning derived from the evolution of modern technologies and the trajectory of Urban Growth Management including Smart Growth and Sustainable Growth



Some scholars have sought to combine sustainable development with the definition of SCs to achieve various urban planning goals. Global institutions emphasize sustainable development and smart urban transformation to fix urban problems (D'Auria, Tregua and Vallejo-Martos, 2018). As such, there has been lively discussion on how SCs can secure sustainability, which has recently emerged as a new concept called the smart sustainable city (Ahvenniemi, Huovila, Pinto-Seppä and Airaksinen, 2017; Akande, Cabral, Gomes and Casteleyn, 2019; Bibri and Krogstie, 2017; Bifulco, Tregua, Amitrano and D'Auria, 2016; Houvila et al., 2019; Yigitcanlar and Kamruzzaman, 2018). Smart sustainable cities are innovative urban areas that meet the economic, social, environmental, and cultural needs of current and future generations, while utilizing ICT and other means to improve efficiency, competitiveness, and quality of life in terms of urban services (ITU, 2016).

Cities change as they respond to opportunities provided by new tools and technologies such as ICT as well as new challenges arising

from the needs of society (Zhang et al., 2016). Digitalization processes are inherently based on technology infrastructure and innovation systems. The smarting process, however, considers all aspects of regional growth and daily life, from the support of sustainability to ICT (Caragliu et al., 2011).

Previous studies on the link between SCs and sustainable development have often simply compared the two concepts without considering the trajectory of Urban Growth Management. Some scholars have defined SCs as an umbrella concept that includes numerous sub-topics, such as smart urbanism, smart environment, sustainable and smart technology, smart energy, smart mobility, and smart health (Gudes et al., 2010; Lara et al., 2016). Other researchers have viewed the smarting process as a means of sustainable development (Lytras et al., 2018; Trindade et al., 2017).

Park et al. (2017) stated that smart city has an urban management function that effectively solves urban problems using information and communication technology. Developing countries, in particular, have the potential to create a variety of urban problems due to rapid population growth and urbanization. In developing countries, the need for planned urban development is greater than that of developed countries, and growth management is more directly included in the smart city concept. This is the same context in which the need for growth management was raised in the United States to prevent sprawl in the 1980s. Growth management plays an especially important role in resolving spatial inequality, which is in line with the importance of providing housing type and community in consideration of various incomes and classes in Smart Growth. Smart cities are related to growth management in the sense that growth management based on

Smart Growth eventually creates a sustainable city.

There is still a lack of research on what the relationship between the two concepts is and what should be prioritized in the planning and policy-making process. The following research questions were created based on the literature review:

RQ1: In terms of Urban Growth Management, is the region in Korea currently being developed as an SC planning for smart and Sustainable Growth?

RQ2: Is the concept of an SC located on the trajectory of Urban Growth Management? If it is not, how can the relationship between SC planning and Urban Growth Management be explained?

V. Methods and Results

1. Basic Conditions of the Two Case Study Areas

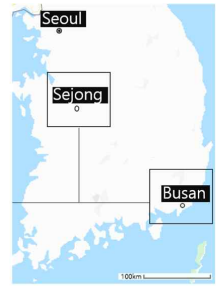
We selected Sejong 5-1N and Busan EDC, which are pilot SCs, as the case study areas and assessed their SC plans. The two cities announced their plans to implement SC projects in February 2019 (Korean Ministry of Land, Infrastructure and Transport, 2019). Busan EDC has determined indicators for managing its performance to create a continuously "new smart growing city (Busan Metropolitan City, 2019, p.21)." In addition, the city includes plans for improved quality of life, economic security, sustainable urban space models, and energy self-reliance. Sejong 5-1N has set the goal of creating a sustainable city for future generations by focusing on sustainable development, including eco-friendly energy, data-based innovation ecosystems, and citizen-centered participation systems.

Busan EDC is part of Gangseo-gu, Busan.. The Busan EDC SC plan was designed to fit the concept of a future waterfront city where innovative ecosystems will be created by fostering industries such as robotics. The 10 main themes were water management, utilization of robotics, learning-day play, intelligent urban management, smart water, zero energy, smart education and living, health, mobility, smart safety, and smart parks. Sejong 5-1N is in Sejong City (also known as Sejong-si). The Sejong 5-1N SC plan is an artificial intelligence-based city with seven major innovation elements, including mobility and health care, education, environment, governance, culture and shopping, and jobs.

Gangseo-gu, Busan has long been one of the least developed area in Busan Metropolitan City due to its low population density and geographical features, such as the Nakdong River Estuary Bank, which is a migratory bird habitat. However, Gangseo-gu recently received attention as a new growth engine of Busan, and the Busan Metropolitan City (2019) plans to develop western Busan into a global city with EDC in mind. Currently, various developments have been made in EDC, such as in the Busan-Jinhae Free Economic Zone, Sinpyeong-Jangrim Industrial Complex, National Industrial Complex in Noksan, and Smart Valley in Sasang. Also, developments in the selected area are expected to continue because it has good access to Gimhae International Airport, the second South Sea Expressway, Busan Station, and the Busan New Port (Busan Metropolitan City, 2019).

〈Figure 2〉 The location of (a) South Korea and (b) Sejong City and Busan Metropolitan City. The plans for (c) Sejong 5-1N and (b) Busan EDC

(a) Location of South Korea



(b) Locations of Sejong City and Busan Metropolitan City

(c) A Smart city of Sejong5-1

(d) A Smart city of Busan EDC

Sources: (a) and (b) : Google Maps,
(c) https://www.happycity2030.or.kr/plan/?act=sub5,
(d) https://www.kwater.or.kr/busi/popMapPage07Page.do

Sejong City was constructed in July 2012 as a single-story metropolitan government that does not have a basic local government. Sejong City has been carrying out its administrative-centered multi-city project since 2005, which is intended to create a sustainable model city that leads to balanced national development. The relocation of central government agencies and the establishment of an early growth hub have been completed, and it is currently in the process of expanding its self-sufficiency function and improving

its urban infrastructure. Sejong City also has the advantage of access to the Korean Train Express (Osong Station), various highways, and Cheongju Airport, as well as being within two hours of the country's major cities (Sejong City, 2019). The pilot SC of Sejong 5-1N is linked to other neighborhoods in the administrative city, including the central administrative region, cultural and international exchange areas, and high-tech industrial function areas. There are plans to implement future high-tech technologies in to the SC by taking advantage of the site's blank status.

〈Table 3〉 General characteristics of Sejong-si and Busan Gangseo-gu

Characteristic	Sejong-si	Gangseo-gu
Area (km^2)	464.89	181.49
Population (persons)	284,225	123,079
Open space as a percentage of total land use (%)	69.01	55.81
Number of development permits	2,777	573
Local tax per capita (million won/population)	2.34	0.78
Number of people employed (persons)	99,827	116,770
R&D expense (million won)[1)]	7,553	–
Number of patents	307	304
Disaster damage (million won)	3.24	4.60
Working age population (persons)	194,460	82,937

Sejong City has a higher population density and more development than Busan City's Gangseo-gu, with a larger per capita local tax, research and development (R&D) spending budget, and number of people available for production. However, Gangseo-gu has more employees in business than Sejong City. Knowledge and information-related economic data, such as R&D expenditure and the number of patents, is important for estimating the growth potential

1) Note: R&D = research and development. [a]According to the Gangseo-gu Statistical Yearbook (2019, p. 209), the R&D of this area was 0 won.

of SCs. Although Sejong City has greater potential to implement SC development compared to Gangseo-gu, the latter has contact with numerous existing communities in Busan.

2. Plan Evaluation Based on the Smart Growth Principles and the Sustaining Places Scoring Matrix

According to Sun-Ho Park, the vice minister of the Ministry of Land, Infrastructure and Transport, the pilot SC plans are the results of project developers', ministries', and experts' efforts (Korean Ministry of Science and ICT, 2018). The pilot SC plan serves as the basic framework of the city.

In order to determine whether the SC plans contain adequate Urban Growth Management categories, Smart Growth principles and the Sustaining Places scoring matrix were used in this research (Godschalk and Rouse, 2015; Smart Growth Network and International City/County Management Association, 2003). The Smart Growth principle serves as a guideline used by many cities in the U.S. The Sustaining Places scoring matrix was developed to assess the sustainable development of an urban comprehensive plan, but we used this as an evaluation index because the SC plan is a master plan. Indicators that were not covered by the Smart Growth principles were supplemented by the Sustaining Places scoring matrix. In 〈Table 4〉, Categories 1 to 10 are Smart Growth indicators (based on Smart Growth principles), and 11 to 14 are Sustainable Growth indicators (based on the Sustaining Places scoring matrix). It is expected that the Smart Growth rate of the SC plan and the level of Sustainable Growth can be evaluated separately. Since Smart Growth principles are more elaborate than the Sustaining Places scoring matrix, the two

indicators were integrated to establish a new index.

Compared to Sustainable Growth, Smart Growth focuses on issues related to land use in cities and surrounding areas. For that reason, Smart Growth oriented toward placemaking and streetscape design neglected to deal with 4 issues that were mentioned upfront, local economic and community issues, climate change issues, growing energy demand problems and self-sufficient food systems for healthy communities. To consider these issues, indicators that were not covered by the Smart Growth principles were supplemented by the Sustaining Places scoring matrix. In addition, indicators that are deemed inappropriate or unnecessary to evaluate and analyze the two smart city implementation plans were excluded. Categories from 1 to 10 in 〈Table 4〉 are selected to evaluate Smart Growth in each plan. We excluded indicators that are not proper for evaluating plans especially in South Korea and reconstituted them that are close or sharing similar values. Smart Growth indicators were used as the main content of our evaluation indicators because they are more specific in terms of urban planning compared to sustainable ones. Sustainable Growth indicators are categories 11 to 14, and the indicators to be used in the evaluation have been selected and reconstructed from Sustaining Places scoring matrix.

The plan evaluation methodology has been used extensively in urban planning since the late 1990s (Kang, Hyun and Park, 2014). The plan evaluation methodology was used in this study to derive the indicators for evaluation and then provide scores on a sequential scale (Baker, Peterson, Brown and McAlpine, 2012; Kang et al., 2014; Tang and Brody, 2009). Quantitative scoring systems derived from these methods can help facilitate communication between different

stakeholders as well as between-plan comparisons (Berke et al., 2000; Kang et al., 2014).

We reconstructed evaluation criteria except for the contents that are not covered by the master plan (eg. policy content), which are not suitable to the actual conditions of Korean cities. Smart Growth principle has various policies, concepts, and goals, so it is difficult for all of this to converge on the plan. For example, real estate industry education is not suitable for entering the contents of Korean cities' master plan, even if it is a necessary principle for Smart Growth. Therefore, we reconstructed the indicators with focus on the planned contents and values for the purpose of assessing smart city plans regarded as the master plans.

To increase reliability in plan evaluation, the protocol was pretested as follows. Members of the research team (the four authors) reviewed all indicators and independently applied the protocol to the same plan and compared results. The team evaluated the plans, each time comparing results, resolving differences in interpretations, and refining the protocol. This process was continued until the team was satisfied that interpretations of results could be evaluated consistently (Berke et al., 2000).

Specific details on how the plans were assessed are as follows. The evaluation results were analyzed using two aspects, the coverage score and the depth score (Brody, 2003a, 2003b; Fu and Tang, 2013; Kang et al., 2014; Tang and Brody, 2009). The coverage score was calculated to determine if the plan addressed a particular indicator. If an indicator was not addressed, a score of 0 was given, and if it was addressed, a score of 1 was given. The depth score was assessed using a three-point ordinal scale to determine how detailed the plan

was regarding the indicator in question (0 points if the indicator was not included, 1 point if the indicator was included but not specified, and 2 points if the indicator was specified for implementation in the region; Kang et al., 2014).

〈Table 4〉 Smart and sustainable growth evaluation protocol incorporated in the SC plans

Category	Evaluation criteria (Indicators)
1. Housing choice	1.1 Secure housing for below-median-income households 1.2 Variety of housing opportunities for home buyers to choose from
2. Walkable neighborhoods	2.1 Creating space for walkable communities 2.2 Safety and mobility for bicycle users and pedestrians 2.3 Public services near jobs and transit 2.4 Providing seniors and people with disabilities easy access to public and private services 2.5 Connections between walkways, parking lots, greenways, and waterways
3. Participatory planning	3.1 Education and promotion that stimulate participation of various stakeholders 3.2 Various materials and programs that activate citizen participation 3.3 Cultivation of relationships with schools, universities, and colleges 3.4 Establishing collaborative relationships with non-governmental organizations
4. Community image	4.1 Planning that encourages adaptive reuse of historic or architecturally significant buildings 4.2 Active and secure open spaces 4.3 Programs for interchange between community residents 4.4 Programs for streets, buildings, and public spaces that coincide to create a sense of place
5. Equitable approval process	5.1 Rational and cost-effective urban development guidelines 5.2 Development of a self-evaluation program for Smart Growth projects 5.3 Use of specific means of expression to visualize the results of developments
6. Integrated land use	6.1 Programs that create a balance between jobs and housing 6.2 Mixed-use development
7. Resource conservation	7.1 Programs that preserve open spaces 7.2 Planning for green infrastructure 7.3 A network of trails and greenways
8. Multi-model transportation	8.1 Variety of transportation choices 8.2 Connection between transportation modes 8.3 Transit-oriented development 8.4 Programs that address parking needs and opportunities

9. Efficient urban infrastructure	9.1 Community-centered public facilities plan 9.2 Differentiating the cost of infrastructure according to the distance from urban core to suburban areas 9.3 Accessible and quality public services and facilities
10. Efficient development patterns	10.1 Efficient developments that ensure ready access to public open space 10.2 Programs that match building scale to street type 10.3 Various programs to encourage high density development
11. Responses to climate change	11.1 Policies to reduce carbon emissions 11.2 Encouraging climate change adaptation
12. Reasonable energy consumption	12.1 Implementing green building design and energy conservation 12.2 Providing for renewable energy use 12.3 Providing for solid waste reduction
13. Resilience to hazards	13.1 Discouraging development in hazard zones 13.2 Protecting and managing streams, watersheds, and floodplains 13.3 Planning for post-disaster economic recovery 13.4 Protecting vulnerable populations from natural hazards 13.5 Reducing exposure to toxins and pollutants in the natural and built environment
14. Healthy community	14.1 Planning for increased public safety through the reduction of crime and injuries 14.2 Planning for physical activity and healthy lifestyles 14.3 Planning for access to healthy, locally grown foods for all neighborhoods

* This Protocol was made by extracting and reconstructing indicators from Smart Growth principles and sustaining places scoring matrix

3. Results and Analysis

Certain smart and Sustainable Growth indicators were well-addressed in both regions, while others were given insufficient attention. This is because the two regional SC plans focused on SC themes, such as artificial intelligence, robotics, smart education, smart energy, and smart mobility. In other words, the plan was developed based on various SC indicators rather than developing an Urban Growth Management strategy after fully analyzing the environmental and topographical characteristics of the case area and the conditions in the surrounding area.

In both areas, high depth scores and coverage scores were obtained

for the categories of walkable neighborhoods, integrated land use, and multi-modal transportation. These specific categories are primarily related to transportation, which is the easiest ICT to utilize in the urban planning approach. For example, transit-oriented development in the field of multi-modal transportation is related to job-housing proximity and integrated land use. It is also very closely related to the walkable neighborhood environment in terms of reducing reliance on cars.

Additionally, both regions achieved high depth scores and coverage scores in the Sustainable Growth categories of reasonable energy consumption and healthy community. The Sejong 5-1N presented specific alternatives, including smart energy structure and strategies, with the aim of creating a "sustainable eco-friendly future energy city (Sejong City, 2019)." The Busan EDC pilot city set a target of "production of 100% of the energy consumed with renewable energy to create a sustainable energy self-reliance city (Busan Metropolitan City, 2019)." Thus, unlike Sejong 5-1N, Busan EDC has included a rational energy consumption strategy within the specific category of renewable energy. Both areas received high overall scores for healthy community by including plans to create spaces that promote a safe neighborhood environments, healthy lifestyles, and healthy local food. However, Sejong 5-1N designated indicators such as culture, shopping, and healthcare among the seven major innovation elements of pilot cities and described the related information in more detail than the Busan EDC plan.

The two regional SC plans lacked detailed proposals in two major Urban Growth Management areas. First, there was a lack of consideration for the categories of equitable approval process,

efficient development patterns, and resilience to hazards. An equitable approval process is a rational and cost-effective urban development program that uses a self-assessment system to facilitate Smart Growth projects and evaluate the development results. Although the Busan EDC SC plan provided details for the creation of a cost-effective urban development program (including the application of a regulation sandbox), its plan to develop key performance indicators to "ensure the sustainability of cities (Busan Metropolitan City, 2019)" did not include specific sustainability considerations, details regarding the 27 key performance indicators, or an assessment system for Smart Growth projects.

〈Table 5〉 Results of the smart and sustainable growth evaluation

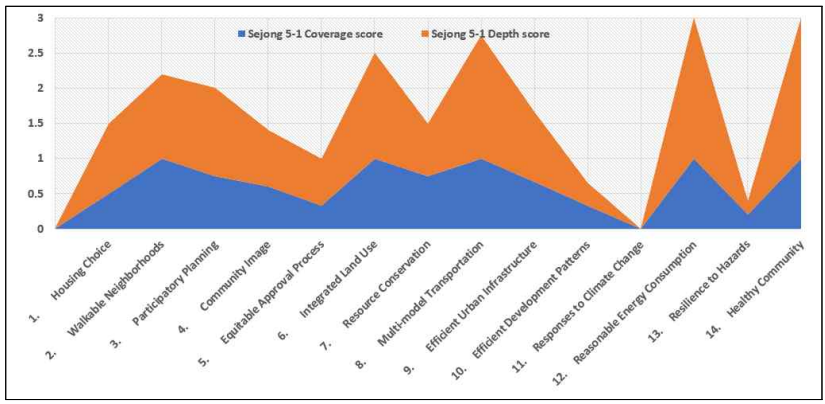
Category	Sejong 5-1N		Busan EDC	
	Coverage score	Depth score	Coverage score	Depth score
1. Housing choice	0.50	1.00	1.00	1.00
2. Walkable neighborhoods	1.00	1.20	1.00	1.60
3. Participatory planning	0.75	1.25	0.50	0.75
4. Community image	0.60	0.8	0.75	1.50
5. Equitable approval process	0.33	0.67	0.33	0.67
6. Integrated land use	1.00	1.50	1.00	1.00
7. Resource conservation	0.75	0.75	0.75	0.75
8. Multi-modal transportation	1.00	1.75	0.75	1.25
9. Efficient urban infrastructure	0.67	1.00	0.67	0.67
10. Efficient development patterns	0.33	0.33	0.33	0.67
11. Responses to climate change	0.50	0.50	0.50	0.50
12. Reasonable energy consumption	1.00	2.00	0.67	1.00
13. Resilience to hazards	0.20	0.20	0.60	0.80
14. Healthy community	1.00	2.00	0.67	1.33

If the Busan EDC SC paln had laid out specific strategies for Sustainable Growth, there would have to be strategies for responding to natural disasters due to climate change, strategies for reducing

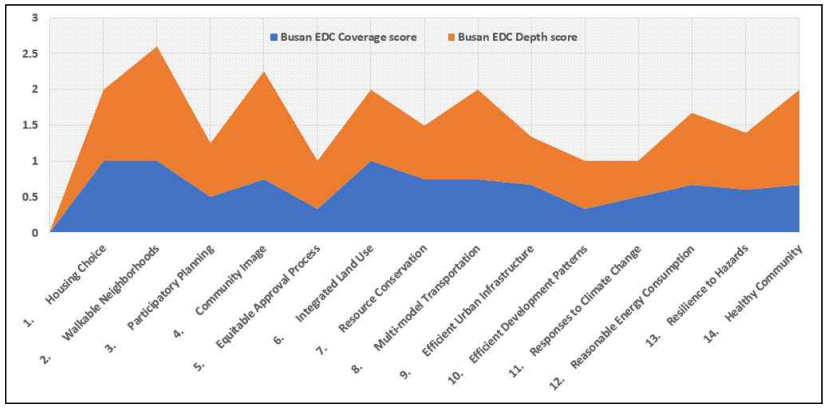
energy consumption, strategies for improving community rigidity that occur after disasters, and strategies for self-sufficient, and healthy community. The Sejong 5-1N SC plan contained the categories of the regulatory sandbox, but it was hard to say that it was only for urban development programs especially in terms of Urban Growth Management. The Sejong 5-1N SC plan introduced these regulatory sandbox for using test-bed of new technologies and easing the data-related regulations. However, Sejong 5-1N contained some indirect details on cost-effective urban development by describing the progression of laws pertaining to innovative cities as well as regulations for each category.

Second, both regions lacked plans to protect their legacy against hazards. There were no plans for natural disaster response or economic recovery after a disaster. The Busan EDC included details on the prevention of development in hazard zones and protections for floodplains, watersheds, and streams, but these lacked specificities. The Sejong 5-1N SC plan only focused on climate resilience improvement, which is aimed at protecting the environment from pollutants.

〈Figure 3〉 Evaluation results for the Sejong 5-1N SC plan



〈Figure 4〉 Evaluation results for the Busan EDC SC plan



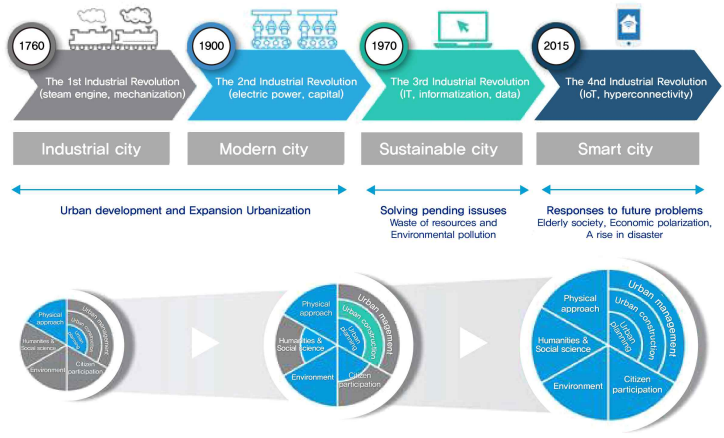
The category of efficient development patterns has a total of three detailed indicators. Both case areas lacked details on strengthening the link between the width and size of buildings to improve the landscape and the walking environment (Indicator 10.2). In the case of Busan EDC, efficient development patterns primarily focused on the development of public open space, and in the case of Sejong 5-1N, the only programs that fell in this category were those designed to encourage high-density development. It seems that the Busan EDC SC strategy is to secure the skyline by limiting the number of floors. This could be the result of the limitation of Smart Growth indicators, since high-density development is not the best choice for all regions.

Next, there was a lack of detailed strategies for urban planning alternatives in terms of Smart Growth. The Busan EDC pilot city presented a "New Smart Growing City (Busan Metropolitan City, 2019)" space plan and expressed an awareness of urban issues such as urban sprawl, downtown decline, and inequality. However, the suggested solutions did not utilize enough urban planning. For example, they said, "instead of simple zoning in existing communities

there should be creative complex land use and minimum area for location regulation in SC," but the details of the plan fell. The Sejong 5-1N SC plan tended to focus more on indicators than the Busan EDC plan, but it did not formulate sufficient strategies that fully considered the characteristics of the space, and surrounding areas. The layout of Sejong 5-1N was built around the transportation infrastructure. there simply wasn't enough room in the proposal to discuss all indicators of growth management.

Public officials of the Busan Metropolitan City created a pilot SC plan that classified the urban model into distinct industrial revolutions, with smartness separate from sustainability (〈Figure 5〉). This demonstrates that an SC is an advanced form of sustainable city and not a separate concept. 〈Figure 5〉 also demonstrates that they view a physical approach as a requirement of urban planning. They even show urban planning as a lower-level concept than urban construction and urban management. Urban management (not growth management) and urban construction are not higher concepts than urban planning. Urban planning should be the top priority when addressing urban issues, unless these are not relevant to national security or national land planning.

〈Figure 5〉 Changes in spatial planning according to the Busan Metropolitan City.



Sources: Busan Eco-Delta City smart city plan

Ⅵ. Conclusion: Urban Growth Management as a Priority for SC Planning

The concept of SCs does not fully include all indicators of Urban Growth Management and is thus a separate entity from the Urban Growth Management trajectory. Urban Growth Management has a priority about SC planning. Simply put, Sustainable Growth is an ideology and goal that all cities should pursue, but not all cities need to be planned SCs. SCs are not the extension of the trajectory of Urban Growth Management. Therefore, Smart City planning should be discussed based on Urban Growth Management.

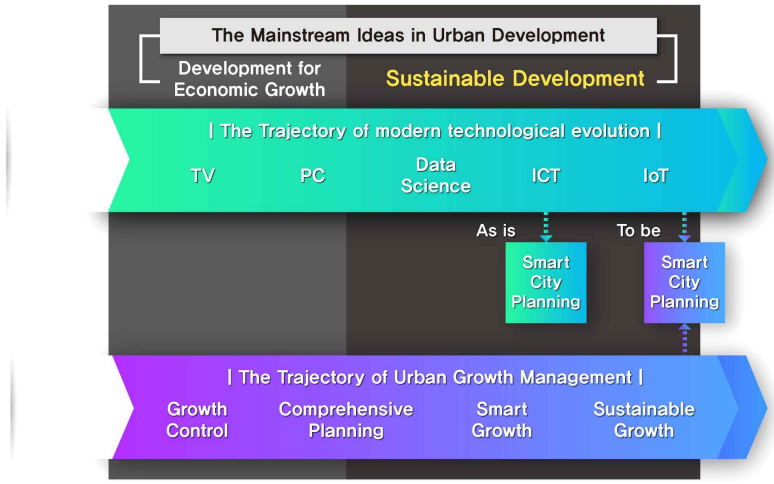
Some SCs are planned and constructed sustainably, even if planners don't recognize the global paradigm of sustainable development. Sustainable Growth is a concept based on the popular trend of sustainable development. Many scholars have sought to find the links

between sustainable development and SCs and to create an integrated concept, like smart sustainable cities. However, sustainable development and SCs do not have a horizontal relationship and should not be used as an alternative to urban planning.

If SCs are not discussed in terms of urban planning access and Urban Growth Management, only sustainable development will be incorporated into SC planning, which could result in the risk of missing out on the numerous solutions addressed by Urban Growth Management. For example, from the perspective of Sustainable Growth, coastal and lowland development should be planned very carefully, with special attention given to the issues of the environment, climate change, and disasters. For example, Busan EDC belongs to a cultural heritage area with migratory bird-watching sites and special coastal control sea areas that are in decline or predicted to collapse. Nearby, there is a wetland protected area that is deemed to be particularly valuable for conservation.

The planners who created the Busan EDC SC need to focus on this situation more carefully. If the city continues to increase its housing development in the form of suburbs to unnecessarily fill open spaces and stabilize the housing market, the costs of building public facilities will be higher in the long run and the city will have failed to maintain Sustainable Growth.

〈Figure 6〉 The mainstream ideas in urban development and the trajectories related to smart city planning



As is: SC planning that does not include Urban Growth Management
To be: SC planning based on Urban Growth Management

Sustainable Growth, as described in Urban Growth Management, was established based on the trend of sustainable development. Sustainable development that is especially significant to environmental policy can be found in general corporate management philosophy, comprehensive urban plans, civic group slogans, and so on. Sustainable development is an ideology but not an alternative to urban planning programs. However, there is no such thing as sustainable zoning. In other words, sustainable development only provides us with an ideology and a balanced view.

When planning SCs, all aspects of Urban Growth Management should be carefully examined. While the concept of sustainable development has been absorbed into SC planning, the impact of climate change also needs to be considered. There is a lack of planning that accounts for new zoning programs or compact

development that is specifically designed to reduce disasters, environmental protection and adapt to climate change. There are few specific urban planning alternatives, such as living lab contents. This is because the concept of an SC has absorbed the agenda of sustainable development while ignoring Urban Growth Management. Therefore, to create a sustainable SC, it is necessary to recognize the importance of Urban Growth Management and plan accordingly.

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Received: 08 November 2019
Revised: 22 November 2019
Accepted: 17 December 2019