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The role of the living lab in smart city projects: A comparative case study of two Northeast Asian cities*

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Abstract

Extant literature has emphasized the role of citizen participation in creating a successful smart city. However, previous works are lacking in a systematic analysis of the specific mechanisms by which citizen participation makes a positive impact on smart city projects. We attempt to bridge the gap by focusing on the role of the living lab, a citizen-driven mechanism that has used innovative ideas, new technologies, and cooperation with various participants to address local problems. As co-creation is the common ground for smart cities and living labs in terms of citizen participation, we provide a theoretical framework in which the notion of co-creation mediates smart cities and living labs. To examine the living lab's effect of co-creation on smart cities, we conduct a comparative case study of two Northeast Asian cities: Taipei and Busan. We explore (1) the factors behind the different outcomes in these two cities, despite many similarities that might affect smart cities' effectiveness, and (2) the relationship between smart cities and living labs and how to systematically understand the interaction between the two. We find that living labs have played a key role in making Taipei's smart city projects effective and successful, which allows the city to keep showing a high level of performance. In contrast, citizens could not find channels to participate in such projects

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in Busan. We conclude that the living lab explains why the smart cities in Busan have been less successful than in Taipei.

Keywords
Smart City, Living Lab, Citizen Participation, Co-creation, Northeast Asia

Ⅰ. Introduction

Cities around the world are getting smarter in coping with various urban problems, enhancing citizens' quality of life, and becoming more sustainable and resilient. Using information and communication technologies (ICT) and conducting big data analysis, cities are being designed and transformed to optimise transportation flows, minimize energy use, increase efficiency of health care services, produce less waste, and bring about a host of economic and social benefits. The cities that have so transformed, or are going through such transformation, are known as smart cities (SCs). In an SC, city functions are optimised and citizen welfare improved by using smart technologies and data analysis.

Previous studies on SCs have emphasized the role of citizen participation in making such projects effective and successful. Citizens understand urban problems in the local context better than other project participants and can therefore offer useful information and opinions for the progress of SC projects. They are also the users of innovative technologies created for these SC projects, which are important only if they improve services for the citizens. Therefore, citizens' engagement and their partnership with other actors such as government, firms, and specialists are important components of SCs (Castelnovo, Misuraca&Savoldelli 2016; Dameri&Rosenthal-Sabroux 2014; Hollands 2008; Kusumastuti&Rouli 2021; Mellouli, Luna-Reyes&Zhang 2014). Nevertheless, existing studies are lacking in systematic analyses of the specific mechanisms by which citizen participation makes a positive impact on SC projects; the causal connection between citizen participation and effectiveness of SCs has attracted little academic attention so far.

This study attempts to bridge this gap in the literature by focusing on the role of the Living Lab (LL) in SC projects. The LL is a citizen-driven

(user-driven) mechanism for innovation, in which citizens (local residents) attempt to address their local problems by creating innovative ideas, developing new technologies, and cooperating with various participants. We show that co-creation provides the common ground for SCs and LLs to meet in the context of citizen participation. We provide a theoretical framework in which the notion of co-creation mediates SCs and LLs to explain how the latter can enhance citizen participation. To examine the LLs' effect of co-creation in SCs, we conduct a comparative case study of two smart city projects in Northeast Asia: Taipei in Taiwan and Busan in South Korea. Specifically, we ask the following two research questions:

1. Why, despite many similarities that might affect the effectiveness of SCs, do the two cities show different outcomes? In other words, why are the SC projects in Taipei more effective than those in Busan?
2. What is the relationship between SCs and LLs? How can we systematically understand the interaction between the two? What is the key overlapping component between the two, and how does it mediate the relationship theoretically and empirically? Specifically, how do LLs contribute to the effectiveness of SCs?

We find that the LL has played a key role in making Taipei's SC projects effective and successful, allowing the city to keep showing high level of SC performance. In contrast, the Busan SC lacks LL components, and almost no LL experiments have been attempted during the whole SC process, meaning that citizens could not find channels to participate in such projects. Therefore, we conclude that the Busan SC has been less successful than the Taipei SC, and the LLs explain the different outcomes. This article contributes to the existing literature on SCs and LLs both theoretically, by suggesting a framework for analysis that connects SCs to LLs, and empirically, by comparatively analysing the two SC case studies.

In the next section, we review the literature and provide a theoretical

framework for an analysis focused on co-creation. In the third section, we give an overview of the two cities and show that they fit the method of the “most similar system design,” in which common characteristics are controlled for and key differences are considered explanatory variables (Przeworski&Teune 1970). In the fourth section, we compare the two cases and illustrate how LLs play a role in making SC projects effective and successful. For this section, we conducted an online interview with TPMO members in July 2021 and an offline meeting with a senior official who oversaw the Busan Eco Delta City project in August 2021. We also asked some follow-up questions to our interviewees via email to get additional information on the two SCs. The final section presents conclusions and implications.

II. Literature Review and a Theoretical Framework

SCs are systems of people interacting with and using flows of energy, materials, services, and financing to catalyse sustainable economic development, resilience, and a high quality of life. These flows and interactions are rendered smart by the strategic use of information and communication infrastructure and services in a process of transparent urban planning and management that is responsive to the social and economic needs of society (European Commission, 2013). SCs can be implemented in both top-down and bottom-up styles (Coenen et al., 2014; Simonofski et al., 2019). Therefore, SCs can involve citizen participation in theory, although it is not a prerequisite. Some studies have explicitly specified citizen participation as one of the key characteristics of an SC. Caragliu et al. (2011) define SC as a city in which investments in human and social capital and traditional and modern communication infrastructure fuel sustainable economic growth and a high quality of life (Lee 2020), with wise management of natural resources, through participatory governance (Caragliu,

Del Bo&Nijkamp 2011). However, there is a range of variation within participatory SCs in terms of the degree and type of participation. Moreover, whether participatory SCs produce better outcomes than top-down SCs and how citizens' participation is implemented on the ground remain relatively unexplored.

The existing literature has focused on the technology aspect since most SC projects are centred on technology-based solutions. In particular, ICTs, Internet of Things (IoT), sensors, artificial intelligence (AI), and blockchain are the key technologies considered essential to building a smart city. Big data and algorithm technologies can be used to quickly respond to unpredictable crises in a city, such as disasters and pandemics (Yao&Wang 2020). According to a classification of the existing literature on SCs, about 78%, from 2011 to 2020, relates to technologies, followed by legal systems (14%), and human beings (8%) (Myeong, Park&Lee 2022).

Nevertheless, a few studies have shown how citizen participation can play a role in making SCs effectively meet their objectives. Simonofski et al. (2019) present a framework for evaluating citizen participation in an SC by showing three main methods of participation bundled into three categories: citizens as democratic participants, citizens as co-creators, and citizens as ICT users. Importantly, LL is one of the three techniques/platforms by which citizens can play a role in SCs as co-creators. Preston et al. (2020) illustrate how citizen engagement can help SC development through co-creation with a focus of energy in the built environment. They analyse a specific case of SC focusing on the role of citizen participation measured by "Arnstein's Ladder of Citizen Participation." Levenda (2019) describes the role of LL experimentation in SC projects focusing on local energy transition.

Based on the literature's emphasis on the notion of co-creation, we focus on the role of LL in enhancing citizen participation in SC, with co-creation as a key defining characteristic (Puerari et al. 2018) so that there can be a common

ground in which LLs are connected to SCs in terms of citizen participation. LL is a user-centric approach for problem solving, based on co-creation mechanism in which local residents, universities, firms, governments, and various organizations cooperate for joint value creation, rapid prototyping, or validation to scale up innovation and businesses. In an LL, the role of citizens is not limited to providing consultation; they also lead the process of designing and implementing experiments by which they can acquire data and knowledge and therefore find solutions. Thus, LL, by its own nature, reinforces citizen participation in SC. Although a growing number of research documents the role of LL in SCs (Alam&Porras 2018; Baccarne et al. 2014; Paskaleva et al. 2015; Preston, Mazhar&Bull 2020), the relationship between SC and LL has not yet been fully revealed. To understand the relationship theoretically, we must first compare and contrast the two mechanisms.

LLs and SCs are different in several aspects. First, an SC is a city transformed as a result of SC projects, whereas an LL can only be a part of the SC projects. In other words, an LL is a specific mode of operation by which SC projects are conducted. It is a user-driven innovation mechanism, meaning that residents (citizens) lead the process of social innovation and value creation; in this sense, if an SC is a purpose, LL is a method of achieving it. Similarly, an SC can be understood as a system and the LL as a methodology. Second, an SC is basically plan-oriented, while an LL is experiment-oriented. An SC is an object for planning and designing, and it is considered a test-bed for experiment for LL participants. Therefore, the LL is much more flexible than an SC because every experiment either succeeds or fails; in case of a failure, participants can come up with a new idea and attempt a new experiment to test it. Third, an SC is designed and implemented on a macro level, while an LL is conducted on a micro level; in other words, the size and scope of SC projects are greater than those of LL projects. In general, an SC is designed in a way to transform the whole city or a specific area/function of a city, while an LL experiment often aims to cover a neighbourhood, street, region in a city, or

even a college campus. Therefore, SC is a long-term project, while LLs are short-term. Fourth, the goal of an SC is the optimisation of a city, while that of the LL is problem solving. An SC seeks to optimise city functions, while an LL is basically a problem-solving mechanism that allows for innovation and value creation. Nevertheless, the ultimate goal for both SCs and LLs is to make a sustainable and resilient city. The comparison is summarized in Table 1.

〈Table 1. Smart Cities and the Living Lab〉

	Smart City	Living Lab
Definition	Project or result of a project (purpose)	A specific mode of operation in a project (method)
Orientation	Plan (city as an object for planning)	Experiment (city as a test-bed)
Level, Size, Scope	Macro, large, long-term projects	Micro, small/medium, short-term projects
Goal	Optimisation of city functions	Problem solving

Despite these differences, SCs (especially inclusive SC) and LLs share a key characteristic: citizen participation. In LLs, citizen participation means co-creation—a collaborative process of citizens (residents), central and local governments, businesses, universities and research institutes, and social activity groups together attempting to solve a problem and create social innovation. It is a process where a partnership of the public and private, including people, is formed. Specialists suggest five key principles for LLs: (1) *continuity* based on trust among participants; (2) *openness* to different perspectives and stakeholders; (3) *realism* for generating results for uses and real markets; (4) *empowerment of users*, especially utilizing their creative power; and (5) *spontaneity* of users in finding problems and generating ideas (Bergvall-Kareborn&Stahlbrost 2009). Indeed, the spirit of co-creation permeates these five principles, meaning that it

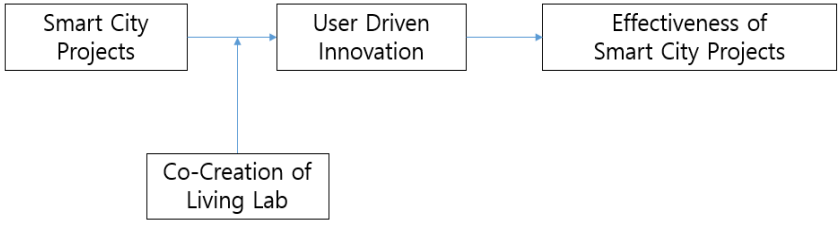
is a key characteristic that embraces all other LL characteristics.

Moreover, co-creation is also a key component in every stage of an LL. Table 2 summarizes the five major stages and role of citizens (residents) in each stage. An LL starts with identifying local problems, followed by generating the main idea for solutions, designing and implementing experiments, testing prototypes and applying them to real settings, and finally evaluating the project and seeking more market value creation. Citizens (residents) play a role in identifying their local problems, generating various solutions, participating in the experiment processes such as collecting and creating local data and testing and evaluating the results. Therefore, the whole process involves co-creation, although actual LL practices show a variation in the degree of participation.

〈Table 2. Five stages of the Living Lab and the role of citizens〉

	Stages	Role of Citizens (Residents)
1	Identification of problem	Citizens present local problems in their neighbourhood and discuss them with other participants.
2	Idea generation and selection	Citizens exchange their idea with professors, researchers, and other specialists. They express their opinions in the final decision making.
3	Design and implementation of experiments	Citizens conduct research, investigations, data creation, and interviews for opinion survey, and therefore involve themselves in the process of citizen science.
4	Prototype testing and application	Citizens test the prototypes and express their opinions on the applicability of the prototypes in their environment.
5	Evaluation and further market orientation	Citizens evaluate the living lab project in the context of problem solving and democratic process of political participation.

〈Figure 1. A Framework for Analysis〉



Focusing on the notion of co-creation as a common ground connecting LLs to SCs, we suggest a framework for analysis in Figure 1, in which LL plays a role in SC projects as an intervening variable making SCs user-driven—and therefore effective—projects. Based on the literature review, we hypothesize that citizen participation and co-creation make SCs effective in that co-creation helps people correctly identify problems, provide appropriate technological and social solutions, optimise city functions systematically, and therefore, transform the city into a more sustainable and resilient one.

Next, we provide an overview of the SC projects in Taipei and Busan and examine LLs' role in these projects.

III. The case studies: Taipei and Busan

Although it is not easy to trace the historical origin of SCs, the first instance was arguably the creation of a virtual digital city in Amsterdam in 1994. As Cisco and IBM launched separate SC initiatives in the mid-2000s and the first Smart City Expo World Congress (in Barcelona) was held in 2011, one can say that Europe (and to some extent, North America) led the introduction and promotion of SCs. However, as the use of ICTs increased rapidly, SCs quickly

caught on around the world. Today, Europe and Asia are the two leading regions implementing SCs. Table 3 shows the regional distribution of the 118 SCs listed in the Smart City Index 2021 published by the International Institute for Management Development (IMD) in collaboration with Singapore University of Technology and Design. Europe has 41% of the SCs ranked in the index, and Asia approximately 31%.

〈Table 3. Regional distribution of 118 smart cities〉

Continent	Cities (countries)
Asia (36)	Beijing (China), Bengaluru (India), Hong Kong (China), Chengdu (China), Hangzhou (China), Nanjing (China), Chongqing (China), Zhuhai (China), Tianjin (China), Guangzhou (China), Shanghai (China), Seoul (South Korea), Busan (South Korea), Taipei (Taiwan), Tokyo (Japan), Osaka (Japan), Singapore (Singapore), Tel Aviv (Israel), Dubai (United Arab Emirates), Kuala Lumpur (Malaysia), Hanoi (Vietnam), Bangkok (Thailand), Istanbul (Turkey), Shenzhen (China), Ho Chi Minh City (Vietnam), Abu Dhabi (United Arab Emirates), Medina (Saudi Arabia), Ankara (Turkey), Jakarta (Indonesia), Mumbai (India), Makassar (Indonesia), Medan (Indonesia), Hyderabad (India), Manila (Philippines), Riyadh (Saudi Arabia), and New Delhi (India)
Africa (6)	Abuja (Nigeria), Lagos (Nigeria), Cape Town (South Africa), Nairobi (Kenya), Cairo (Egypt), and Rabat (Morocco)
Australia/New Zealand (5)	Brisbane (Australia), Sydney (Australia), Newcastle (Australia), Melbourne (Australia), and Auckland (New Zealand)
Europe (49)	Bologna (Italy), Milan (Italy), Rome (Italy), Bordeaux (France), Paris (France), Lyon (France), Lille (France), Marseille (France), London (United Kingdom), Birmingham (United Kingdom), Glasgow (United Kingdom), Manchester (United Kingdom), Leeds (United Kingdom), Amsterdam (Netherlands), Rotterdam (Netherlands), The Hague (Netherlands), Copenhagen (Denmark), Berlin (Germany), Munich (Germany), Dusseldorf (Germany), Hanover (Germany), Kiel (Germany), Lausanne (Switzerland), Zurich (Switzerland), Geneva (Switzerland), Vienna (Austria), Stockholm (Sweden), Goteborg (Sweden), Zaragoza (Spain), Oslo (Norway), Helsinki (Finland),

	Madrid (Spain), Barcelona (Spain), Bilbao (Spain), Dublin (Ireland), Lisbon (Portugal), Prague (Czech Republic), Brussels (Belgium), Tallinn (Estonia), Warsaw (Poland), Krakow (Poland), Bratislava (Slovakia), Budapest (Hungary), Moscow (Russia), Saint Petersburg (Russia), Bucharest (Romania), Athens (Greece), and Sofia (Bulgaria), Kyiv (Ukraine)
South America (7)	Santiago (Chile), Buenos Aries (Argentina), San Jose (Costa Rica), Bogota (Colombia), Rio de Janeiro (Brazil), Sao Paulo (Brazil), and Medellin (Colombia)
North America (14)	New York (USA), Los Angeles (USA), Chicago (USA), San Francisco (USA), Washington, D.C (USA), Boston (USA), Phoenix (USA), Denver (USA), Philadelphia (USA), Seattle (USA), Toronto (Canada), Montreal (Canada), Mexico City (Mexico), and Vancouver (Canada)

Source: https://www.imd.org/smart-city-observatory/home/#_smartCity

In East Asia, SCs are generally considered government-centred, top-down, and hardware-driven projects that use cutting-edge technologies principally for economic competitiveness (Höffken&Limmer 2019). This is because all the countries of this region, especially Japan, Singapore, Taiwan, and South Korea, have had similar experiences of rapid and successful economic development led by strong state initiatives. SCs here are often considered part of the governments' new development strategies based on their high-tech industry strength. The governments' interest might be based on their desire to not fall behind in the age of the Fourth Industrial Revolution (Joo&Tan 2020). According to its own economic capacity and regional characteristics, the South Korean government encourages local governments to lead city diplomacy in an attempt to share policies and solve urban problems with foreign partners (Lee 2023). However, not all SCs in East Asia might be equally top-down, and there are variations among them with regard to governance style (top-down or bottom-up) and degree of citizen participation.

Taiwan and South Korea share many similar conditions that motivated them to initiate SC projects. They experienced rapid and successful economic

development under an authoritarian rule in the 1970s and 1980s, in which the strategic concerns of the United States played some (at least partial) role (Cumings 1984). After an unprecedented economic growth, both countries suffered from industrial pollution, especially in urban areas, and began to manage their environment in the 1990s (Rock&Angel 2005). They still share political, economic, and institutional similarities. The countries' per capita GDPs are close to each other, even though Busan's GDP per capita is higher than that of Taipei. Both economies are (mostly) free, as measured by the Heritage Foundation's Index of Economic Freedom. Politically, both are liberal democracies with a presidential system, and their degrees of democracy measured by the Freedom House Index are similar. Local leaders (mayors), with a four-year term, are elected by citizens directly (Matthew&Bae 2022), with similar degrees of fiscal autonomy for local governments, as measured by subnational expenditure as a share of GDP, and similar urbanization rates, measured by urban population as a percentage of total population. However, some indicators show that South Korea is in a more favourable condition for SC project implementation than Taiwan. In 2021, South Korea's Internet penetration rate was 97%, compared to Taiwan's 90%, and it ranked fourth in the number of ICT patents (N = 5,458) during 1981–2019, while Taiwan ranked 13th (N = 378). The national similarities are presented in Table 4.

〈Table 4. Profiles of the two countries (cities)〉

	Taiwan (Taipei)	South Korea (Busan)
GDP[1] (USD Billion) (Dec 2020)	668	1,631
GDP per capita[1] (USD) (Dec 2020)	28,407	31,265
GDP growth rate[1] (%) (Dec 2021)	1.8	1.2
City's GDP per capita[2]	18,668	27,426

(USD) (2020)		
City Population (2022)[3]	2,591,750	3,468,139
Economic Development	Government-led (mostly under authoritarian regime)	Government-led (mostly under authoritarian regime)
Regime Type	Liberal Democracy	Liberal Democracy
Degree of Democracy[4] (measured by Freedom House Index)	Free: 94 (Political Rights: 38) (Civil Liberties: 56)	Free: 83 (Political Rights: 33) (Civil Liberties: 50)
Economic Freedom[5]	Free (80.1)	Mostly Free (74.6)
Form of Government	Presidential System	Presidential System
Local Election for Mayor	Citizen election	Citizen election
Mayor's Term	4 Years	4 Years
Urban Population (% of Total Population) (2019)[6]	78.5	81.4
Subnational Expenditure as a Share of GDP[7] (%)	16.65 (2021)	14.18 (2018)
Number of ICT Patent[8] (1981–2019)	378	5,458
Internet Penetration[9] (%) (2021)	90	97

Note:

1. https://tradingeconomics.com/
2. https://invest.taipei/pages/E_TaipeiHeighlights.html, https://kosis.kr/statHtml/statHtml.do?orgId=101&tblId=DT_1C86&conn_path=I2&language=en
3. https://worldpopulationreview.com/world-cities/taipei-population, https://worldpopulationreview.com/world-cities/busan-population
4. https://freedomhouse.org/countries/freedom-world/scores
5. https://www.heritage.org/index/ranking
6. https://www.worldometers.info/demographics/taiwan-demographics/, https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=KR
7. https://www.dgbas.gov.tw/public/data/dgbas01/110/110Btab/110B歷年各級政府淨支出對國內生產毛額之比率.PDF; https://www.oecd-ilibrary.org/sites/c6217390-en/index.html?itemId=/content/component/c6217390-en#countryli_container2
8. https://www.nationmaster.com/nmx/ranking/number-of-patents-in-the-ict-sector
9. https://datareportal.com/reports/digital-2021-south-korea, https://datareportal.com/reports/digital-2021-taiwan

Furthermore, government initiatives propelled SCs in both countries. In Taiwan, the government proposed a series of SC initiatives, such as Electronic Taiwan (2002), Mobile Taiwan (2005), Ubiquitous Taiwan (2007), Intelligent Taiwan (2009), Wireless Taiwan (2010), Digital Taiwan (2012), and Smart Taiwan (2015) (Ji et al. 2021). Similar national projects were conducted in South Korea in the 2000s and 2010s, and some of the names, such as Ubiquitous City, overlapped with those used in Taiwan. The most recent and representative national proposal was the National Smart City Strategic Project in 2018 (Yang, Kwon&Kim 2020). The SCs selected for this case study, Taipei and Busan, emerged out of the history of central initiatives and support.

Despite these similarities, however, the results show a remarkable gap between the two. In the IMD Index mentioned above, Taipei was ranked fourth (with A rating) and Busan 37th (with BB rating) among the 118 SCs in 2021; this gap has been present for some time. To explain the different levels of SC performance in the two cities, we use the Most Similar System Design, in which a key difference (as an independent) explains the differences in the dependent variable while similar characteristics are controlled. We focus on the role of the LL in strengthening citizen participation in SCs and hypothesize that LLs might have contributed to the different performances of the two SCs.

We selected Taipei and Busan mainly because they represent current SC projects in the two countries. While Seoul and Songdo are also representative South Korean SCs, we excluded them in the following reasons. First, Seoul enacted the Law on Smart City Construction and Industrial Promotion in 2018 and initiated to build up the system for SCs in six major fields in 2019. However, due to the abrupt death of the mayor in 2020, the SC projects were temporary stopped or delayed, and resumed after the inauguration of the new mayor in 2021. Therefore, it is still early to analyse the effectiveness of SC projects in Seoul. Second, Songdo, contrary to expectations, has not shown good performance as a smart city. It aimed to develop as a ubiquitous city with smart

technologies but ended up with a new town with new apartments and public parks. Songdo is not even in the IMD Index ranking.

Table 5 summarizes the cases. SC in Taipei was initiated in 2016, when the city's government set up the Taipei Smart City Project Management Office (TPMO) as a key agency to design and implement the city's SC projects. Taiwan's central government had long been interested in promoting SCs under different slogans in the 2000s and 2010s, and accordingly, local governments began to set up their own SC strategies. Taipei began the work when Ko Wen-je was elected mayor in 2014. Ko placed smart technology and the smart city agenda at the forefront of his election campaign and of his eventual administration's governance strategy (Chang, Jou&Chung 2021). Establishing the TPMO was indeed a turning point for the Taipei SC, which has been implemented in a way that the city provides a platform in which citizens, firms, and other local actors can exchange, test, and apply their innovative ideas and technologies. They first propose their ideas, and if selected, they can be further investigated and experimented, and some of them do end up as SC projects. These projects bring about smart solutions for various urban challenges such as transportation, health, security, environment, and education. Therefore, the Taipei SC is basically a project-based mechanism in which both top-down and bottom-up style projects are being experimented with and implemented. The whole city is a test-bed for experiments and new business opportunities, and smart urban solutions are created as a result of successful SC projects.

〈Table 5. Profiles of Taipei and Busan, case studies〉

	Taipei	Busan
Initiation	2016	2018
Planned and Implemented by	Local government	Central government
Involved Actors	Local businesses and citizens	Busan city government, big

		firms, and K-Water
Location	The whole city	Some part of the Eco-Delta City area in Gangsuh District (11.77 km2/2.2 km2)
Budget	5.35 million USD (5 Years)1)	2 billion USD
Type	Top-down + bottom-up	Top-down
Implementation	The local government provides a platform in which firms can test their innovative ideas and technologies	The central government designates a specific area and build SC town in that area
Citizens' Participation	Active	Less active
Current Status	The first collection of SC projects in 2021 have been completed and another set of projects are under way	The SC town village is completed

In 2018, the Korean government designated Busan SC as one of the two National Demonstration Smart Cities (NDSC). Throughout the 2000s and 2010s, more than 50 local governments set up and implemented various types of SC projects in Korea. However, the NDSC was an upgraded version, in that the central government planned and led the whole process of SC construction. Indeed, SCs became a new driving engine for economic development during the Moon government that took over in 2017. They were on the main agenda for discussion in the Fourth Industrial Revolution Committee, also created by the central government. Busan SC was particularly focused on water circulation (smart water supply system, smart sanitation, and use of rainwater system) and new water-related industry development. Approximately 2 billion USD of investments, both private and public, have been made to date. As of April 2022, 54 households had moved into a smart town village completed in December 2021. The village was constructed without citizen participation, but the newly moved-in residents are supposed to experience the LL and evaluate and (partially) correct the system. In

other words, the whole SC infrastructure is designed and implemented without citizen participation, and residents have an opportunity to experience, evaluate, and suggest improvements after construction is finished.

IV. The role of the Living Lab in smart cities

1. The LL and co-creation in Taipei's SC

The spirit of co-creation is well reflected in the case of Taipei SC. Mayor Ko's strategies for promoting SCs were: (1) transforming SCs from central government initiatives into local government initiatives, (2) increasing transparency and participation in SC governance, and (3) changing the main focus of SC from infrastructure construction to problem solving. The LL is the key operating mechanism through which the Taipei city government promotes these strategies and implements co-creation in SC projects. More specifically, TPMO created a proof of concept (POC) as the key implementing mechanism for the LL. POC is a series of processes of proposing, designing, implementing, and evaluating LL experiments; it can be planned and conducted top-down style as part of the city governments' projects and proposed and implemented bottom-up style, as suggested by local firms. In both cases, citizens and firms (especially start-ups and small- and medium-sized enterprises) play a critical role as they not only design and implement the experiments, but also evaluate prototypes and participate in making decisions, whether they would further develop the experiments or not. From 2016 to 2019, more than 100 POC proposals were made. Among them, only one-third were realized into POCs, and some of them finally turned into real SC projects. Therefore, Taipei SC is not a plan-based but an experiment-based mechanism. Even a top-down POC is not a finally approved government project with a certain amount of budget secured, but undergoes testing and evaluation.

The city government set up a 1+7 framework for SC promotion in 2019, with smart governance as the pivotal area and encompassing seven major SC areas, comprising smart transportation, smart building, smart security, smart healthcare, smart environment, smart economy, and smart education. Table 6 shows the number of projects in each key area. To date, these areas have not shown a major imbalance in terms of projects. Table 7 shows the progress status of such projects. About 78% of total projects are bottom-up, of which about 52% have not been started. Even in the case of top-down projects, four out of 59 were unfinished. Examples of top-down projects include the Smart Taipei Main Station project, which has established an integrated smart application system providing users with indoor navigation, emergency escape, parking, tourism information, the smart disaster and rescue information provider, and the visual 119 emergency rescue system. Examples of bottom-up projects include the autonomous bus test-bed, smart waste management and recycling system, sharing transportation system, and smart AI street lighting system.

〈Table 6. The key areas of a smart city and the number of projects (as of April 2022)〉

1+7 Key areas	Number of Projects
Smart Government	31
Smart Transportation	53
Smart Healthcare	48
Smart Building	35
Smart Education	23
Smart Economy	36
Smart Environment	38
Smart Security	27
Total	291

Source: https://smartcity.taipei/projects/3

〈Table 7. SC Projects in Taipei (as of April 2022)〉

Top-Down (59)	In progress (38)
	Finished (17)
	Incomplete (4)
Bottom-Up (215)	In progress (26)
	Finished (78)
	Incomplete (111)

Mayor Ko's promotion of SCs were combined with his campaigns in the 2014 and 2018 elections. In the 2014 election, he won support as he suggested a participatory SC blueprint radically different from the earlier versions of the Cyber City (by Ma Yin-Jeou) and Intelligent City (by Hau Lung-Bin) promoted in the context of the developmental state. As a non-affiliated mayor without partisan support, he secured an electoral base with his own strategies and "a city for ordinary citizens" as a key slogan, which positively affected voters' choice. He established not only the TPMO, but also Taiwan Smart City Solutions Alliance in 2015 to cultivate local start-ups and recruit talented individuals and small firms around the world to collaborate on SC projects in Taipei city. He also set up the Global Organization of Smart Cities (GO Smart) in 2019 as a platform for domestic and international networks for cities and industries to cooperate on SC projects. Both Taiwanese and global cities can seek to collaborate on an "inter-city POC" in this platform. As the Taipei SC has become the representative SC for Taiwan and led the development of other projects, the initiative of implementation has shifted from central to local

governments and from governments to citizens. At the same time, beneficiaries of Taipei SC have become the major electoral base of Mayor Ko (Chang, Jou&Chung 2021).

2. The limited LL in Busan SC

Unlike Taipei, Busan SC is basically a product of central planning rather than local volunteerism; however, it does not necessarily mean that an inclusive and participatory SC is not possible under central supervision. The central government can promote an SC project with a channel of citizen participation such as the LL. Much of the LLs in South Korea are organized and implemented as a form of contests held by the central government, and Busan SC has also had them as a key component from its initial phase of planning and design. Moreover, a budget of maximum 5 million USD was allocated just for LLs in the initial plan. Nevertheless, LLs were never planned in Busan SC, and they are now being implemented as a kind of post-hoc evaluation by the residents who will live in the apartment town (a small demonstration village build as part of the Busan SC projects), test the smart components, and make suggestions for improvement. This is not a typical LL in which co-creation is the key factor; specific plans for a post-hoc LL have not yet been established.

Busan SC was planned in 2018 as a project to address various urban issues by using Industry 4.0 technologies, such as big data, IoT, 5G, blockchain, and AI. The plan included and emphasized the LL as a specific tool for SC implementation from an early stage. All the documents published by the Ministry of Land, Infrastructure, and Transport (MOLIT) explicitly mention the LL as a mechanism for public participation in SC projects. They refer to SC cases in the United States, Canada, Netherlands, Great Britain, and Denmark as the model based on LL experiments. Busan SC was one of the initial attempts by the Moon regime, after former president Park was impeached and jailed for large-scale corruption in 2016, to emphasize citizen-centred administration and

policies. The MOLIT designed an “inclusive SC” based on the core concept. It designated two cities—Busan and Sejong—as national demonstration sites and assigned budgets and key government organizations to implement SC projects. In Busan, K-Water became the main contractor, and a master planner was also appointed to oversee the whole SC process that adhered to the basic MOLIT design. The two cities would become model SCs in Korea and a reference point for further projects.

Busan SC focused on 10 key components, including robots, healthcare, transportation, water (energy), and security. For example, it planned to use the heat in rivers as a key renewable energy source and introduced a smart water management system for the whole circulation of rain, river, tap, sewer, and reused water. It also planned a world-class robot city in which robots could be used for household support, delivery, and parking. A village in which residents could experience future technologies beforehand and test the prototypes was to be built. Here, the LL was not a co-creation but merely a procedure of post-hoc tests, and citizens could thus participate only at the final test stage. Table 8 gives a list of the robots in Busan SC, many of which were not functional as of April 2022.

〈Table 8. Robots in Busan SC〉

Robots for Human Life • Home secretary • Shopping assistant • Teaching assistant • Coding and programming • Entertainment (robot pet)	Robots for Logistics • Food and commodity delivery • Valet parking • Recycling
Robots for Social Security • Patrol • Clean up and maintenance • Disaster relief	Robots for Healthcare • Psychological support for elders • Physical support for the disabled • Gym trainer

Source: Busan Eco Delta City Smart City Master Plan (2018.12.26) (*in Korean*)

Moreover, given that the LL is a social innovation mechanism for citizens aiming to solve problems in their neighbourhood, the Busan SC project creates a new neighbourhood (a 2.2-sq. km village) where problems are already fixed. While this could represent an alternative model for future generation SCs, one concern is that such a model might avoid the real problems of a city. Although Busan is the second largest city in South Korea, just like any other city outside the Seoul metropolitan area, it suffers from a declining population (migration to Seoul's metropolitan area), a hyper-aging population, diminishing local jobs, unemployment, and disruption of the local higher education system. In other words, Busan is not a case in which rapid industrialization and urbanization cause urban problems such as pollution (Shin, Kim&Kang 2022), dense population, traffic jam, and lack of housing. On the contrary, the city has been suffering from structural problems and needs a new solution for urban revitalization. If robots and blockchain technologies can address these structural problems effectively, Busan could be a possible model for a futuristic SC; if not, it might become a smart city that is not smart in tackling real urban problems.

V. Conclusions

Based on a comparative study of the Taipei and Busan SCs, this study finds that a LL, as a mechanism of co-creation, can play a key role in building a successful and effective SC. It can be a channel for citizen participation in SCs, thereby igniting a process of user-driven innovation to build an SC. As citizens are the main participants in all the five stages of a LL, an inclusive model of SC where the co-creation mechanism works systematically can be established, as has happened in the Taipei SC. The POC is the key mechanism of both top-down and bottom-up SC projects and is essentially a process of experiment,

trial and error, and co-creation for successful innovation. In contrast, Busan SC is lacking in LL components not because it was planned and led by the central government but because it aimed to create a smart city without problems. As a result, while Taipei has become a leader in smart city development in East Asia, Busan has fallen behind. The real problem in Korean SCs is that political leaders still consider cities as an object of planning rather than a test-bed for experimentation. Although they are confident in both the nation's smartness and successful experiences of city planning and urban renewals, they seem to have overlooked the global trend of citizen participation in creating successful SCs. The LL is highly active in Korea, and in theory, a key component of their SCs. However, government leaders still tend to think that an SC is a present given to citizens by the government to help them enjoy a quality life.

As cities are increasingly becoming pivotal agents in addressing global problems such as climate change, pandemics, and disasters, they are required to equip themselves with a systematic problem-solving mechanism to effectively address such challenges. This mechanism should be inclusive, flexible, and creative enough to effectively respond to rapidly changing urban problems. In this context, a participatory SC with LL as a key co-creation mechanism will play a more important role globally in the future. This study shows that to develop a participatory SC, the tradition of interventionist states might be one of the biggest hurdles that some East Asian countries must overcome. Although it was the main driving engine for rapid and successful economic development in the past, it can jeopardize the future by delaying the development of participatory SCs.

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No potential conflict of interest was reported by the authors.

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