

Smart Campus Challenge Project: Empirical Analysis on Closing the Digital Division Through Smart Solutions

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Abstract. This study is an empirical analysis of bridging the digital divide through smart solutions. It was based on a demonstration of the “Smart Venue Project Group” among the consortiums selected for the “2021 Smart Campus Challenge Project,” which was organized by the South Korean Ministry of Land, Infrastructure and Transport. Previous studies have only been focused on the status of the digital divide in terms of accessibility, capability, and utilization. This study is meaningful as it explored data from actual facilities that provided digital devices, education, and digital information in the selected project site. For analysis, the data on the smart venue was divided into three timeframes: pre-experience, active-experience, and post-experience. Users had the opportunity to experience various smart devices. Moreover, with an on-site smart coordinator, the users felt comfortable using the devices. This is considered to be a major result in terms of actual users in terms of which aspects of the business to focus on to bridge the actual digital divide. Before designing the space, a living lab was operated in advance, and the utilization methods for the space were identified based on the variables refined. Consequently, five factors were extracted: the status of smart city information awareness, the status of a city and regional problems, smart venue satisfaction, resolution for digital information gap, and service satisfaction. Based on this, the space was built, and hardware, software, and applications were developed. The analysis showed that the awareness level for information about the smart city increased over time. With information access, people’s interests in their urban and regional problems increase. Satisfaction with the space was enhanced from the improved reliability and convenience due to the app developed for the space. It is judged that the above results can be used as basic data for the implementation of the smart city project in the future, and since this project is ultimately based on empirical evidence rather than diffusion, it is necessary to consider scalability based on this.

Keywords: Digital divide, smart solution, smart campus challenge, digital equity, smart city

1. Introduction

South Korea is seeking ways to resolve the growing information gap along with the super-aged population (Kang et al., 2012). As more complex and sophisticated information technologies are driven by the 4th industrial revolution, informatization, and the developing digital economy, the ability to adapt to these technologies is essential (Lee et al., 2016; Kim et al., 2021). The lack of adaptability is bound to be observed among the marginalized, and the gap continues to grow over time (Lee et al., 2017). The youth or people living in large cities acquire advanced information through a naturally-created learning field, but the elderly or people in small and medium-sized cities tend to be alienated in general (Datta et al., 2018; Lee et al., 2021). This trend is called the digital divide, and it is recognized as a critical issue for social integration (Ministry of Land 2021) (Jeong et al., 2018). Thus, various types of studies have been actively carried out in academia (Hu et al., 2020). However, the studies conducted so far have only investigated the status of the gap in accessibility, competence, and ability to use in terms of the digital divide. In addition, before and after comparisons for the utilization of digital devices have not been sufficiently verified. In particular, the change in technological development related to the current 4th industrial revolution is a trend that cannot be denied anywhere in the country, and is being considered at the global level beyond the national level.

The South Korean Ministry of Land, Infrastructure and Transport (MOLIT) announced “the 2021 Smart Campus Challenge Project” in accordance with Articles 9-2 and 27 of the “Act on the Promotion of Smart City Development and Industry.” The project was designed to demonstrate and commercialize the convergence of university research and new and innovative smart solutions for campuses and regions through industry-academia collaboration. In other words, it aimed to solve the digital divide, as well as problems in small and medium-sized cities, and secure an ecosystem to create a foundation for a smart city by comparing and analyzing before and after the introduction of smart solutions and building a database. In particular, the target sites for this project are Asan and Yesan-gun, which are small and medium-sized cities in Korea, and reflect regional characteristics. The purpose of this study is to provide smart solutions through the Smart Campus Challenge project carried out by the Smart Venue Project Group (SMART VENUE PROJECT GROUP, here after referred to as “smart venue”) among the selected consortiums. Based on how much the digital gap was closed and demonstrations verified by the project group, various policy implications could be identified such as suggestions on which measure to adopt for the operation, how to further enhance and spread smart city solutions, how the perception changed before and after, and so on.

2. Contents

2.1. Project Group Formation

The project group consists of a consortium of five institutions. Looking at the plans for each institution in detail, Kongju National University, the host institution, plans to continuously analyze the effectiveness and discuss how to expand it further with the local government. To do that, the university will monitor the project for an appropriate period and provide tailored consulting by supporting to train personnel and build local governance and a living lab. Yesan-gun will lay the groundwork for a smart city and support residents to enjoy the service by establishing a smart venue based on a top-ranked smart city plan. Chungcheongnam-do Development Corporation (CNDC) will share data collected through an empirical project with Kongju National University to improve the quality of residents' lives, health, and education. The CNDC will also introduce the venue in the future public rental housing to provide more opportunities for residents and locals to access information. AkiQ Plus and First Mile will commercialize the smart venue by building a framework for service and space and an Information and Communication Technology (ICT) solution, respectively. The detailed demonstration plan is as follows Figure 1.

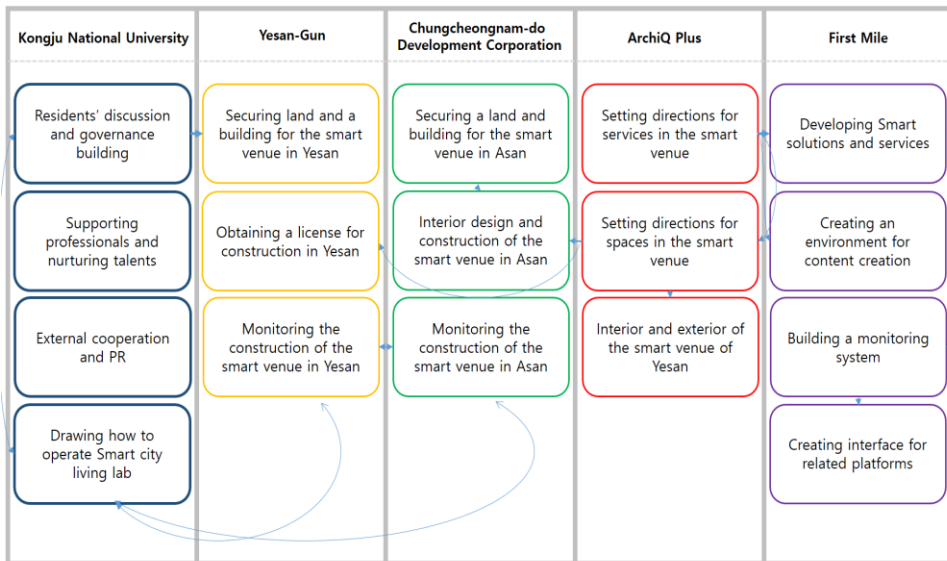


Fig. 1: Demonstration plan of each institution

2.2. The Status of the Project Sites for Demonstration

After considering various factors, Yesan-gun and Asan-si in Chungcheongnam-do, small and medium-sized cities in South Korea, were selected for the demonstration of smart solutions for urban aging and urban decline. This was because the cities were experiencing accelerated population loss, aging population, and digital divide, which

were different from the problems large cities were facing. In Yesan-gun, the number of businesses that played a key role in economic activities, such as production, distribution, and services, was sharply decreasing due to accelerated population outflow, increasing aging index, and continuous population decline. An increase in the number of stores closing and decaying infrastructure have exacerbated the issues of small cities such as economic decline. However, Yesan has good geographic accessibility as Kongju University’s College of Engineering is located within 1 km of the site. Asan-si, adjacent to the college of Engineering, selected Chungnam Public Rental Housing for newlyweds, the youth, and the marginalized as the initial project site and plans to build a smart venue in the housing district. The smart venue will serve as a hub for the smart city utilized by both the residents and the locals, becoming the central part of the smart city expansion in Chungnam. Table 1 shows the general status of the local governments selected as the demonstration sites.

Table 1: The general status of the local governments as the demonstration sites

Category	Yesan-gun, Chungnam	Asan-si, Chungnam
Size of the economy	736.1 billion won	1602.7 billion won
Population	81,488 (M:41,379/F:40,109)	333,074 (M:174,133/F:158,941)
Business	7,087	22,321
Housing	37,131	123,673
Household	38,290	135,159
Conditions	Solutions for various urban issues such as the aging population, the outflow of youth, rising number of empty infrastructure are needed.	The first city to provide public housing in Chungnam and a hub serving as a starting point for the growth of the smart city in Chungnam

Yesan-gun built a smart venue in the “Yesan Cultural Center” operated by the local government, and Asan-si developed a smart venue in the Chungnam Public Rental Housing district. Residents of various classes use the Yesan Cultural Center, which has excellent accessibility. Chungnam Public Rental Housing was built for newlyweds, the youth, and the marginalized and is suitable as a starting point to expand smart cities in the area as an urban hub. Demonstration contents for the project sites such as scope and location are as follows [Table 2].

Table 2: Summary of demonstration by project site

Demonstration Location	1st Project site: 3, Cheonbyeon-ro 90beon-gil, Yesan-eup, Yesan-gun, Chungcheongnam-do 2nd project site: 1873, Buksu-ri, Baebang-eup, Asan-si, Chungcheongnam-do
Demonstration contents	- Implementation of smart venues (solutions) for improving the living convenience of the residents of the target area and solving problems

	- Education to bridge the digital information gap, facilitate the use of venues, etc.
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Table 3: Location map of Yesan county


Location map	Yesan Cultural Center 2nd floor
	

Table 4: Asan City site location map

Location map	Chungnam-type happier house
	

2.3. Empirical Analysis

Through data on the level of the reduced digital gap and demonstrations, this study was designed to draw conclusions for suggestions on the operation type and plan, how to further enhance and expand smart city solutions, and how the perception changed before and after. For analysis, the data on the smart venue was divided into three timeframes: pre-experience, active-experience, and post-experience. Users had

the opportunity to experience various smart devices. Moreover, an on-site smart coordinator helped to make the users feel comfortable using the devices. Before designing the space, a living lab was operated in advance, and utilization methods were identified based on the variables refined. Consequently, five factors were extracted: The status of smart city information awareness, the status of a city and regional problems, smart venue satisfaction, resolution for digital information gap, and service satisfaction. The analysis showed that the awareness level for information on the smart city increased over time. As people have access to their urban and regional problems, their interests in the issues increase. In particular, satisfaction with the space was enhanced as the reliability and convenience were improved due to the app developed for the space. Residents' opinions were collected at each timeframe and various conclusions regarding the layout of the space, training course development, and so on were drawn based on their opinions. Fig. 2 below is a gray zone in which private data of personal space and public data of urban space in the smart venue are mixed and compromised, as described above. Gray Zone is designed to enable future big data analysis by sharing private data in the data hierarchy of Smart Venue and transforming it into administrative data.

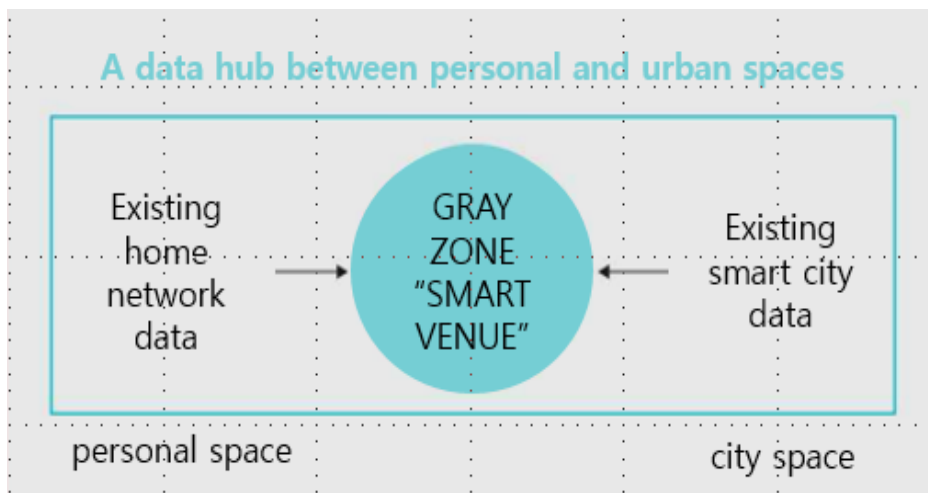


Fig. 2: A data hub between personal and urban spaces

2.4. Software/Hardware for each Space Derived from the Analysis

Software/hardware (SW/HW) for each space were built based on the analysis results. The space on the second floor of Yesan Cultural Center was turned into a smart venue and divided into four zones. For Zone 1, a book café was created and filled with technologies such as a dashboard, smart bulbs, a gateway, Artificial-Intelligence (AI) speakers, and AI CCTV. Zone 2 was designed for smart healthcare, arranged with a folding door, BMI analyzers, blood pressure monitors, height measuring scales, a Zwift and its monitor, and AI CCTVs. Zone 3 is a multi-purpose studio, with

broadcast recording facilities, a computer for recording, cameras, and a chroma key. Zone 4, the last zone, is a personal study space where distance learning is possible. The application developed in conjunction with the venue allows users to book a clinic appointment, inquire about health information, and get notifications.



Fig. 3: The layout of Yesan cultural center

Asan-si used a communal space in the Chungnam Public Rental Housing to create a smart venue, dividing it into three zones. Zone 1 is a space for smart healthcare, arranged with BMI analyzers, blood pressure monitors, height measuring scales, a Zwift and its monitor, personal computers (PCs), and servers. Zone 2 was designed to create content with PCs, cameras, chroma keys, lights, microphones. Zone 3 is a virtual classroom equipped with tablets, an electric projector screen, PCs, a projector, cameras and microphones for video conferencing. Other areas were furnished with TVs for the dashboard, tablets for controlling smart devices, AI CCTVs, and so on.

2.5. Curriculum

The analysis showed a meaningful result that training was desperately needed for using the venue, smart devices, and amenities. The digital divide happens due to the lack of accessibility and training; thus, it was difficult to overcome the gap only through the venue itself.



Fig. 4: The layout of Chungnam public rental housing

In the end, the technological realization of the global territorial spatial system is oriented towards a smart city. Through spatial change at the national level, it will be possible to bring about balanced development between cities and an alternative effect that can overcome the crisis of local calling. Therefore, training courses of 30 lectures were developed to support residents to conveniently use the SW/HW and to better understand the smart venue. There are three training courses as follows: a) the training for service coordinators, b) smart venue leadership training, and c) smart venue general education. The training was conducted in consideration of the participants' characteristics. The total courses consisted of 30 lectures in total, 10 lectures each, and aimed to improve the use of the smart devices and support residents to be able to use the venue by themselves for sustainability by empowering them through tailored courses. The entire curriculum consisted of virtual courses and was conducted online.

First, the training for service coordinators involves a 10-step course, intending to nurture professionals by improving the understanding of the overall project and providing better service to residents. The service coordinators consisted of local residents and students of Kongju National University. Second, smart venue leadership training aims to help the representative of the residents better communicate with the residents and lead by example as a citizen..

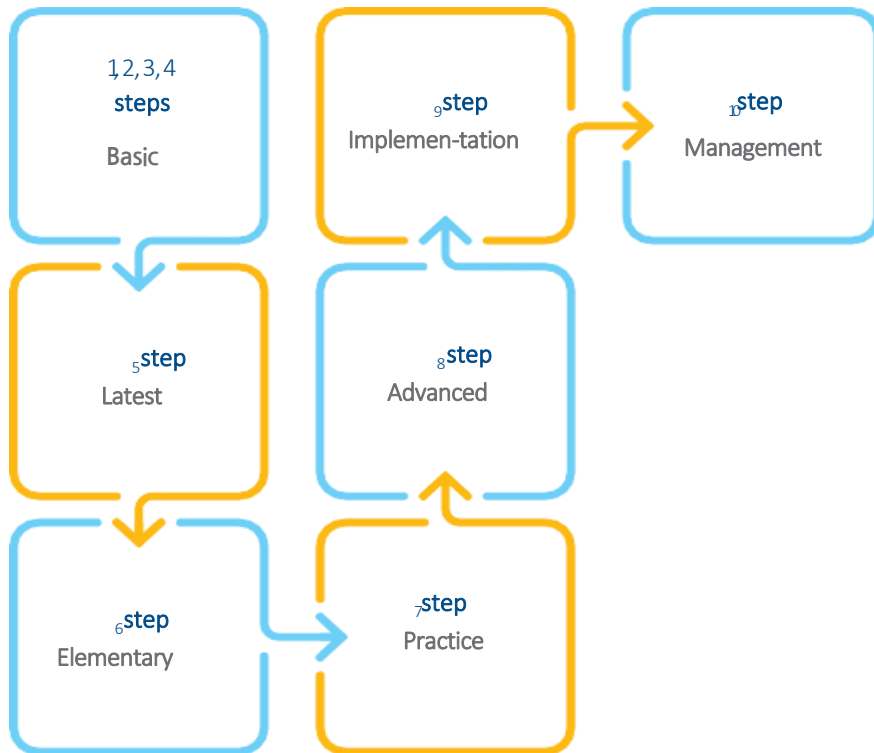
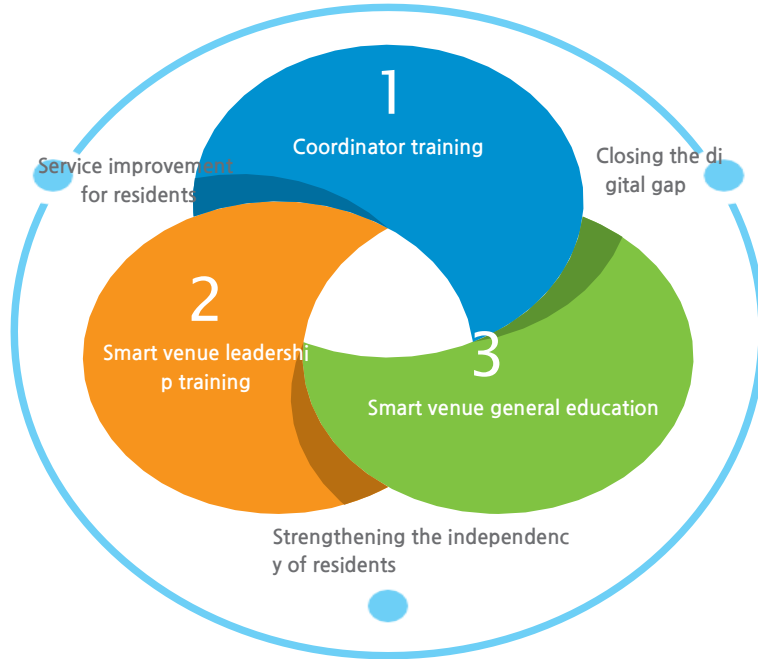


Fig. 5: Curriculum and steps

Third, smart venue general education was promoted to secure the consistency of education and to seek sustainable development plans. Based on this, each curriculum was defined as follows.

Table 5: Service coordinator training curriculum

Step 1, 2, 3, 4 (basic)	4th industrial revolution and changing land-use policies	<ul style="list-style-type: none"> ▶ Understanding the current policy for land use <ul style="list-style-type: none"> ▶ New tech for metaverse land: the government’s promotion of proptech to respond to the new market demand ▶ Laying the economic foundation for property data
	Proptech: future innovative growth. understanding of the leading industry	<ul style="list-style-type: none"> ▶ Introducing the 13 major innovative growth engines: learning outlook for the new and promising industry <ul style="list-style-type: none"> ▶ The 8 core business areas, proptech: Keywords for innovative changes in the Korean economic and social structure ▶ Introducing the national core businesses: Learning the national smart city trial project
	Smart city Overview and theories	<ul style="list-style-type: none"> ▶ Smart city concept: Basics regarding the concept, background and vision <ul style="list-style-type: none"> ▶ Smart city cases: Global advanced cases and Korean smart city models ▶ Progress of smart city in Korea: Roadmap for smart city services
	Big data analysis and smart consulting	<ul style="list-style-type: none"> ▶ Market research for consulting: reports search <ul style="list-style-type: none"> ▶ Big data analysis for properties ▶ Practice for preparing a smart consulting report
Step 5 (elementary)	Understanding of Smart Campus Challenge project	<ul style="list-style-type: none"> ▶ Introducing the smart campus challenge <ul style="list-style-type: none"> ▶ Introducing the smart venue: Project overview including its background and goal ▶ Smart venue user analysis: analyzing major users
Step 6 (practice)	How to use smart venue solutions	<ul style="list-style-type: none"> ▶ How to operate the smart venue solution: Understanding smart device arrangement and each solution <ul style="list-style-type: none"> ▶ Major user analysis for each smart venue solution ▶ How to manage and use the devices in smart venue

Step 7 (practice)	How to use the app	<ul style="list-style-type: none"> ▶ How to use the app installed on the device in the venue: Making a clinic appointment ▶ How to use the app installed on the device in the venue: Inquiring health information ▶ How to input data for digital notification in the app
Step 8 (advanced)	Smart venue and living lap	<ul style="list-style-type: none"> ▶ Living lab 101: concepts, etc. ▶ Living lab and service coordinator: Increasing engagement in the project and the use of the smart venue ▶ Smart venue and living lab: Living smart with residents
Step 9 (advanced)	AI-based smart housing service	<ul style="list-style-type: none"> ▶ Status and outlook for smart housing technology ▶ Smart housing business model ▶ Pleasant indoor environment and smart venue services
Step 10 (advanced)	Service-minded training	<ul style="list-style-type: none"> ▶ How to serve the smart venue users ▶ Service quality training ▶ Service quality system model: Overview of AI smart housing system service

Table 6: Smart venue leadership training

Step 1, 2, 3, 4 (common)	Understanding smart campus challenge project	<ul style="list-style-type: none"> ▶ Introduction of the smart campus challenge project ▶ Introduction of the Smart venue including the background and goals ▶ Use of the smart venue
	Understanding the status and policies of Yesan	<ul style="list-style-type: none"> ▶ Understanding the status of Yesan : The current demography and key industries ▶ Drawing the future of Yesan: Expecting what the future Yesan would look like based on the current status ▶ Introduction of policies and directions of Yesan
	Overview and principles of smart city	<ul style="list-style-type: none"> ▶ Introduction of the project site: Yesan Cultural Center ▶ Introduction of the layout of the smart devices: Smart health devices/smart self-learning/studio ▶ Introduction of amenity rules: Opening hours, etc.
	Big data analysis and smart consulting	<ul style="list-style-type: none"> ▶ Learning theories of smart city: Overview of the smart city including the definition ▶ Future cities, smart cities: Drawing the future smart city

		<ul style="list-style-type: none"> ▶ Sharing advanced cases: Learning advanced cases of smart cities and smart villages
Step 5 (elementary)	Integration of AI technologies Smart home	<ul style="list-style-type: none"> ▶ Smart home changing the quality of life of citizens <ul style="list-style-type: none"> ▶ AI-based smart housing services ▶ Smart venue: Where smart technologies are applied
Step 6 (latest)	Roles of smart venue leader	<ul style="list-style-type: none"> ▶ Governance changing the quality of life of citizens: Defining roles of smart venue leader ▶ Governance changing the quality of life of citizens: Furbishing the smart venue ▶ Governance changing the quality of life of citizens: Creating a sustainable community
Step 7 (advanced)	Building a relationship for communication	<ul style="list-style-type: none"> ▶ Communication and exchange between venue communities: Communication skills ▶ Communication and exchange between venue communities: Conflict resolution ▶ Communication and exchange between venue communities: “Together, our culture,” how to build a harmonious community
Step 8 (developed)	Exploring community	<ul style="list-style-type: none"> ▶ Reflecting on how I cooperate and communicate in a community: What is my leadership style? ▶ How to proceed a meeting, basic and procedures: The importance of active listening ▶ Understanding of expression, acceptance, and tools of opinions and how to apply to each type of community meeting
Step 9 (Practice)	Ways to vitalize community	<ul style="list-style-type: none"> ▶ Ways to boost the use of Smart venue: Developing ideas ▶ How to organize a community and assign roles including opening community clubs in Smart venue: Finding ways to increase active participation of users of the venue ▶ Discussing how to utilize a communal space in the venue
Step 10 (completed)	Understanding community and communication	<ul style="list-style-type: none"> ▶ Caring and examples in a community: Conflicts and how to deal with them ▶ Caring and examples in a community: How to improve vitality in a community ▶ Understanding Smart venue community of Yesan:

		Identifying user characteristics and setting the future direction of the venue community
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Table 7: Smart venue general education

Step 1, 2, 3, 4 (common)	Understanding smart campus challenge project	<ul style="list-style-type: none"> ▶ Introduction of the smart campus challenge project <ul style="list-style-type: none"> ▶ Introduction of the Smart venue including the background and goals ▶ Use of the smart venue
	Understanding the status and policies of Yesan	<ul style="list-style-type: none"> ▶ Understanding the status of Yesan: The current demography and key industries ▶ Drawing the future of Yesan: Expecting what the future Yesan would look like based on the current status ▶ Introduction of policies and directions of Yesan
	Overview and principles of smart city	<ul style="list-style-type: none"> ▶ Introduction of the project site: Yesan Cultural Center ▶ Introduction of the layout of the smart devices: Smart health devices/smart self-learning/studio ▶ Introduction of amenity rules: Opening hours, etc.
	Big data analysis and smart consulting	<ul style="list-style-type: none"> ▶ Learning theories of smart city: Overview of the smart city including the definition <ul style="list-style-type: none"> ▶ Future cities, smart cities: Drawing the future smart city ▶ Sharing advanced cases: Learning advanced cases of smart cities and smart villages
Step 5 (latest)	Drawing a smart city in Yesan	<ul style="list-style-type: none"> ▶ Introduction of the current status of Yesan, cultural and medical facilities ▶ Introduction of services realized in Smart venue combined with Yesan ▶ Drawing the future Yesan to be changed by the use of Smart venue
Step 6 (elementary)	Smart venue and smart home	<ul style="list-style-type: none"> ▶ Concept of smart home ▶ Domestic and global technology trends in the smart home market ▶ Industry trends in the smart home market: The Smart Budget
Step 7 (basic)	New housing, Smart housing	<ul style="list-style-type: none"> ▶ Status and cases of smart housing services <ul style="list-style-type: none"> ▶ AI housing service for a safe and comfortable living environment ▶ AI-based smart housing status and best practices

<p>Step 8 (practice)</p>	<p>How to use a smart venue solution tailored for Yesan</p>	<ul style="list-style-type: none"> ▶ How to use workout machines and devices in content creation room (1) ▶ How to use workout machines and devices in content creation room (2) ▶ How to use the app: <p>Learning how to install and use the app on my mobile</p>
<p>Step 9 (advanced)</p>	<p>Living lab of The Smart Budget</p>	<ul style="list-style-type: none"> ▶ Living lab created with citizens: Explaining the overview of the living lab, including its definition, and sharing cases where capacity as an active citizen was strengthened ▶ Living lab created with citizens: Glancing at our venue ▶ Living lab created with citizens: Getting to know our community
<p>Step 10 (completed)</p>	<p>How to exchange opinions on a regular basis</p>	<ul style="list-style-type: none"> ▶ How to exchange opinions through discussion with the venue community ▶ How to resolve conflicts through internal discussion within the village community ▶ Understanding the process of how residents' opinions are accepted through surveys, etc.: The feedback process

2.6. App Development

The developed app has three main functions. The first one allows users to make a clinic appointment. After clicking clinic appointment on the app, users get to choose the type of clinic they want to have an appointment with. The app also checks whether the user wants to see a doctor in person or online, and the user can select a date and time to visit. When the user makes an appointment at a clinic, the clinic receives a notification through a system tied to the app and check the appointment status in real-time. The second one is health consultation. When the consultation is enabled on the app, the user can directly talk to someone from a public health center through a video call. This can be useful for someone who does not have time to see a doctor due to other schedules or work. The last one is notification. Once users select information in which they are interested, they receive a notification about the information through a popup on the app. The notification will inform the users about the current issues in the area, such as the weather. The development of the app, which the analysis showed is highly needed, helped reduce the digital divide of the residents and made the residents better at using smart devices. In the end, the efficiency of using the hospital or medical system through the app can be maximized, and unnecessary procedures have been simplified. If this is spread to the entire city in the future, it is judged that the AI can select the appropriate treatment and establish a system that allows consultation or reservation without visiting a hospital.

id	hospitalid	type	bookdate	booktime	subject
972	1003	20000	2021-10-27	10:30:00	2004
973	1003	20000	2021-12-09	17:00:00	2004
834	1003	20001	2022-02-14	13:30:00	2004
... skip ...					
808	1003	20001	2021-10-20	18:00:00	2004
809	1003	20001	2021-12-03	11:00:00	2004
893	1003	20001	2022-03-02	08:00:00	2004
(324 rows)					

Fig. 6: Record actual service usage log

3. Conclusions

This study is an empirical analysis of bridging the digital divide through smart solutions. The analysis was based on a demonstration of the “Smart Venue Project Group” among the consortiums selected for the “2021 Smart Campus Challenge Project,” which was organized by the MOLIT. The previous studies have only focused on the status of the digital divide in terms of accessibility, capability, and utilization. This study is meaningful in that it explored data from actual facilities that provided digital devices, education, and digital information in the selected project site.

For analysis, the data on the smart venue was divided into three timeframes: pre-experience, active-experience, and post-experience. Users had the opportunity to experience various smart devices. Moreover, an on-site smart coordinator helped the users feel comfortable using the devices. Before designing the space, a living lab was being operated in advance, and the utilization methods for the space were identified based on the variables refined. Consequently, five factors were extracted: the status of smart city information awareness, the status of a city and regional problems, smart venue satisfaction, resolution for digital information gap, and service satisfaction. Based on this, the space was built, and hardware, software, and applications were developed. The analysis showed that the awareness level for information about the smart city increased over time. With information access, people’s interests in their urban and regional problems increase. Satisfaction with the space was enhanced as the reliability and convenience were improved due to the app developed for the space.

The satisfaction level for the smart venue was very high as the venue provided services enjoyed by all residents regardless of age or income. Moreover, the local government and the public sector supported the smart venue; thus, the residents were satisfied with the services from the venue. In terms of convenience for the community, this venue was different from other models in that it provided cultural and medical services unavailable in small and medium-sized cities, and an on-site coordinator was present to help residents use the services that they need. The analysis proved that the services provided by the existing shelters and community centers could be diversified

by incorporating smart technologies. In addition, those technology-converged spaces can serve as a hub that bridges a city and a space and allow the smart solutions integrated with cutting-edge ICT and AI technologies to be easily available. Further, it demonstrated that building an open innovation platform is feasible through the implementation of an open API for fast services.

Considering the analysis and the implication of the study, knowing how to operate and manage the venue after the demonstration would also be critical. This can be divided into four aspects in general. The first is the operation's sustainability. It is essential to create a maintenance team, considering that smart devices need proper care, and build a system where the maintenance team can provide remote solutions through management, operation, server maintenance, the organization and operation of local governance, and the introduction of remote solutions. The second is a clarification of maintenance cost and management subject. After the project is completed, it is suggested that Yesan Cultural Center and Chungnam Public Rental Housing vest in the local government of Yesan and the CNDC, respectively, and the management subjects remain the same as they vest in. The third is to establish a sustainable cooperative system among the participating organizations. Each organization of a consortium should make a continuous effort in spreading smart city solutions, building a framework for service and space, creating ICT solutions, and constructing governance and living labs. These efforts should be accompanied by continuous monitoring and consulting on the effectiveness of the smart venue. The fourth is the utilization of the data collected from the empirical analysis. The health care data gathered through the demonstration should be stored and analyzed in the server operated by the management subject and used in a way to give customized guidance for residents' health, exercise pattern, and convenience. Especially data on the environment, which has emerged as a serious social issue, should be used as the basic data to improve the living environment of residents, and AI CCTV footage data should be used for the safe and pleasant life of residents.

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