A study on setting the direction of digital twin implementation for urban regeneration business

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A B S T R A C T

In Korea, after the period of urban development, many cities entered a period of decline. Accordingly, the market for urban businesses such as urban regeneration, redevelopment, and reconstruction is expanding. However, even though these businesses are large businesses that generate a lot of added value, there is a high risk that it is difficult to accurately predict the direction of the business and the profit and cost of the business. However, if a city digital twin is established from the perspective of an urban digital business, any reasonable market participant can promote urban regeneration, redevelopment, and reconstruction projects as an urban digital business. Therefore, in this study, from the perspective of urban digital business, the purpose of constructing a digital twin for urban regeneration digital business was to be presented by analyzing the case of establishing a digital twin of the urban regeneration project by the town as a case. As a result of analyzing the case site through public DB and on-site surveys, a total of 237 parcels and 156 buildings were analyzed. As a result, a total of 54 public Databases and actual cases were found to be inconsistent. Therefore, in this study, four directions were suggested for the establishment of a digital twin for urban regeneration digital business at the village level. The first is to secure consistency between the current government's public ledgers (public DB). The second is to improve the problem that it is difficult to check information such as empty houses. Third, it is a regular and detailed field survey to improve books that are inconsistent with various current conditions, such as when buildings are actually destroyed, but there are buildings on the ledger or buildings without a building register (most of them are expected to be illegal buildings). Fourth, the government's cost and time to develop and apply digital twin technology for the old cities, which are most cities in Korea, is a step away from what is currently being built/developed around pilot cities such as new towns and smart cities at the government level. It is commitment.

1. Introduction

After post-war reconstruction in the 1960s and 1970s in Korea, the government had been leading urban development and growth due to rapid urbanization since the 1980s. Since the 2000s, however, private-led reconstruction and redevelopment initiatives started to come into the picture. Since the 2010s, private participation in urban regeneration projects has become popular. This represents a transition from a public-led to a private-led approach in urban business areas and markets.

A digital twin, a digital replica of a physical object or system that collects real-time data using sensors, is a technology allowing effective operation and prediction through the analysis and simulation based on the data (Chang and Jang, 2021). IDC (International Data Corporation) predicted that by 2020, 30% of the world's top 2,000 companies would implement and utilize digital twins with productivity gains of up to 25%. Accordingly, urban business is expected to be digitalized. Since the target of the business is cities, it can be predicted that digital twin technology will be actively used.

Considering the deterioration of Korean cities, the most expandable urban business is urban regeneration, redevelopment, and reconstruction. Urban redevelopment projects target an area where detached houses and apartment buildings are mixed with deteriorating infrastructure. Reconstruction projects are mostly conducted for the apartment complex whose infrastructure is not in poor condition. In contrast, urban regeneration targets broader areas, a city or village. The goal of the urban regeneration project is not limited to renewing facilities, buildings, or houses of an area. It aims to achieve an urban 'renaissance' of a declining city considering the people, culture, education, and ecosystem of a city altogether.

Against this backdrop, we will examine how to implement digital twin technology for urban regeneration business that has the biggest market potential and needs to compromise between complicated concepts of urban digital businesses. To this end, we will derive the directions for implementing digital twin technology from the cases of urban regeneration businesses for towns. It is hoped that our findings will help to predict how the digital twin technology will be integrated into Korea's urban business and how it will develop in the future.

2. Literature review

2.1. Digital twin technology

To better understand digital twin technology, it needs to be compared with the concept of Cyber-Physical System (CPS). The two concepts are similar, but the definitions should be clarified by comparing them with each other. In CPS, physical and software components are connected and real-world information can be delivered to the virtual space, visualized for the managers to see and use for operation. The definition of a digital twin is more varied. It is generally defined as a technology used to predict results through creating a computer-based digital twin of an actual object existing in the real world and using a computer to simulate situations to predict what will happen. It is also defined as a technology to gain precise information about real assets by building a model of a physical object in the digital space and creating simulations (KICTA, 2021; Weekes, 2019). In short, CPS connects cyber and physical systems to deliver information to each other. It is widely accepted that CPS is a conceptual model whereas a digital twin is an applied or advanced technology. For instance, CPS is considered a system in a comprehensive sense where virtual control factors are physical systems are operated in connection, and digital twin technology is an advanced version of the CPS (Chang and Jang, 2021).

Digital Twin supports the diversification of the product development process, testing, and optimal operating environment of the smart factory, Smart City, and realistic representation of the city in construction and real estate transactions. Digital twins are particularly valuable in terms of description, analysis, diagnosis, and prediction (Dohrmann et al., 2019). It is known that when applied to business performance improvement, creativity, innovative ability, efficiency improvement, marketing sales, customer-based service, and management, etc., it is known to have a great effect. Deloitte predicts that the global market for DT will grow 38% annually to reach \$16 billion by 2023. In particular, in relation to spatial information, can be a very innovative way to understand problems or trends related to the customer base. Business, society, environment, smart city, agriculture, autonomous driving, drone mapping, etc. will become the main contents that can be implemented through the digital twin of spatial information.

In Korea, a government-led initiative is underway to build a digital twin of the Sejong national pilot smart city. Also, Korea's Electronics and Telecommunications Research Institute (ETRI) uses digital twin technology to effectively manage national infrastructure, applying it to the Cheongju City Public Facilities Service Corporation in North Chungcheong Province. In addition to the development of a pilot city (or a new town) or facility management, digital twin technology allows urban regeneration businesses to set the direction of regeneration, operate and manage the city after regeneration, and predict the cost and profits of the city through simulations. Due to these abilities, urban planners are able to do business by controlling a number of risks, preventing the situation where unpredictable risks hamper business generating huge profits for some actors while causing gentrification or economic loss for other actors. It is expected that the advance of digital twin technology will provide an opportunity to change the landscape of urban business where a handful of actors with large capital and power monopolized the market.

Korea is developing digital twins in an array of areas: in the area of cities, buildings, land, and geography, LX and Korea Land and Housing Corporation are providing digital twin services related to smart city projects; Electronics and Telecommunications Research Institute (ETRI), Korea Institute of Civil Engineering and Building Technology(KICT), Telecommunications Technology Association(TTA), Korea Rural Community Corporation (KRC), and National IT Industry Promotion Agency (NIPA) establish digital twin masterplans, design, mid- and long term roadmaps for businesses; and National Geographic Information Institute (NGII) and Korea Rural Community Corporation are promoting services and research related to digital twin-based topographic information and 3D spatial information production. The city of Seoul and Sejong plan to build and provide digital twins for "Virtual Seoul" initiative and smart city pilot project, in collaboration with ETRI (Lee, 2021).

2.2. Urban regeneration digital business by village

Village regeneration projects are expanding nationwide in Korea as small cities in rural areas decline. Unfortunately, most projects have been conducted top-down using trendy urban business items not related to the village resources. This has been the cause for weakening the self-sustainability of the village and the destruction of the community. Urban regeneration business for villages, more than anything else, should be conducted in a way to regenerate the village or city in the truest sense by systematically collecting and organizing the resources about human and society, urban planning, and architecture in the region.

In other words, while existing urban businesses are rather unsystematic and unpredictable with high risks, participated by a limited number of actors, a new business area will be created as digital twin technology enables the digitalization of spatial and value information. This new business area will become part of the digital business. Just like we produce, manage, and transact goods and services on digital platforms, urban businesses will be able to be digitally based.

3. Case analysis

3.1. Basic directions for building a digital twin

It is crucial how precisely a physical object (or a world) can be digitalized and implemented in a virtual space to create a digital twin. To achieve this, we need to build the data of property with different values along with the information of physical space. In 2009, the Ministry of Land, Transport, and Maritime Affairs of Korea promoted the 3D spatial information building project but did not pass the preliminary feasibility assessment conducted by the government based on legal standards for the project. As this case shows, this kind of project takes a huge amount of cost and time. Digital twins, with sophisticated physical details, are now under planning and preparation by the government and expected to be implemented in the foreseeable future. However, the interest of this study is not only the digitalization of physical space, but the valuable information that should be created for urban regeneration business—for example, ownership, development potential, and occupancy relationship, including lease, of urban spaces. In particular, for the village-level urban regeneration business, it can be a critical information asset to capture vacancy information, as well as a physical-digital twin, in digital urban business. For this purpose, we conducted a case study on a selected case site where an urban regeneration project was being carried out at the village level in Yesan-gun, Chungcheongnam-do, Republic of Korea. For the analysis, public data DB analysis, required for a digital twin, case paper analysis, field investigation, and analysis were performed. The investigation and analysis were performed for a month in June 2020.

3.2. Analysis of the case site

3.2.1. General status of case site

From the perspective of urban business, we intend to derive the items that should be given value through digital twin technology to the physical space element in the village-level urban regeneration project through the case analysis. The case site, consisting of a total of 237 lots, is one RI (administrative unit of a city in Korea), located in Yesan-gun, Chungcheongnam-do, South Korea. The site is not a large-scale apartment complex, but a village with a great number of households and a large population, located in the heart of the shopping district but at the same time having elements of a natural village everywhere.

The case site is inhabited by 610 households, 1,344 people, including 687 males and 647 females. In terms of space, there is a total of 156 buildings as of June 2020, with 104 houses, accounting for the largest share at 66.67%of the total.

3.2.2. Status of the residential environment in case site

There are 21 neighborhood living facilities and housing (13.46%), 15 neighborhood living facilities (9.62%), and 10 storehouses and warehouses (6.41%). The current state of the buildings is shown in Table 1.

Table 1: Buildings in the case site

Use	No. of buildings	Ratio (%)	Use	No. of buildings	Ratio (%)
Factory	1	0.64	Accommodation	1	0.64
Factory facilities and housing	1	0.64	Greenhouse	1	0.64
Neighborhood living facilities	15	9.62	Storehouse And Warehouse	10	6.41
Neighborhood living facilities and housing	21	13.46	House	104	66.67
Facilities for the elderly and children	1	0.64	Garage	1	0.64
Total	156	100.00%		As of June 2020	

There is a total of 55 business facility buildings in the case site, of which retail stores (18) take the largest share, followed by offices (16) and restaurants (11). There were six village communities at the case site: A village association, a development association, a women's association, a senior citizen's association for males, a senior citizen's association for females, an elderly people's association (female), and a co-operative. Also, there was a social enterprise, the Asian food market cooperative. As for the road, the Janghang Line (railroad) passes to the west of the site, Chungseo-ro (Daero 3, 25m) is located 200m to the west, and the Yeokjeon-ro (Jung-ro 3, 12m) passes through the south and north. Yesan-ro (Jung-ro 3, 12m) and Jugyo-ro (Jung-ro 3, 12m) pass to the south and the east, respectively. In addition, there are four small roads width 8~10m), including Yeokjeon-ro 70-Gil, Yeokjeon-ro 46-Gil, Jugyo-ro 33-Gil, and Yesan-ro 37-Gil.

The deterioration of the housing in the case site becomes the data to determine the deterioration of the buildings on the site. Table 2 shows the results of a sample survey on the deterioration of houses on the site.

Table 2: Deterioration of the houses in the case site

Div.	Responses(persons)	Ratio	Rank
10 years or less	7	16.7%	2
20 years or less	3	7.1%	5
30 years or less	7	16.7%	2
40 years or less	7	16.7%	2
50 years or less	10	23.8%	1
60 years or less	3	7.1%	5
70 years or less	3	7.1%	5
80 years or less	2	4.8%	8
Total	56	100%	

Note: 4 households that answered, "I don't know" and 10 households with no response were excluded from the analysis

The result of the sample survey and analysis confirmed that 42.9% of the houses were considerably deteriorated as they are 50 years old or more since construction. In Korea, houses 15 years old or longer after completion can be remodeled, and houses 30 to 40 years after completion can be reconstructed due to deterioration. Also from these legal standards, the buildings in the case site are considered significantly deteriorated.

The distribution of the residential area of the case site survey sample is shown in Table 3. As a result of the analysis, it was found that the largest number of dwellings was between 60m² and 85m² and 85m² to 100m², the size of the national housing in Korea.

The results of the survey on the satisfaction of urban space and residential environment in the case site are as follows (Table 4): As a result of the analysis, most answered that they were average (55.4%), but they were generally satisfied (satisfied (25.0%)+very satisfied (5.4%)=30.4%).

On the other hand, the results of the residential environment satisfaction survey on the ease of access to medical facilities are shown in Table 5. In the case of the case site, as is the case in most local cities in Korea, the proportion of the elderly is very high. Elderly people have various chronic diseases

and are often difficult to move, so access to medical facilities is more important than other young people. However, because of the survey, it was found that the neutral or dissatisfied ratio was similar to the satisfactory ratio. Across the survey results, it is worth comparing what respondents indicated as being highly satisfied with the city they live in. We can find that the satisfaction with access to medical facilities was not relatively high.

Table 3: Case site housing area

Div.	Frequency (Number of people)	Ratio	Rank
Under 60㎡	3	6.3%	6
60㎡~85㎡	13	27.1%	1
85㎡~120㎡	13	27.1%	1
120㎡~150㎡	8	16.7%	3
120㎡~180㎡	4	8.3%	4
180㎡~210㎡	1	2.1%	8
210㎡~240	4	8.3%	4
Over 240㎡	2	4.2%	7
Total	48	100.0%	-

Table 4: Ease of access to commercial facilities

Div.	Frequency (Number of people)	Ratio	Rank
Very Dissatisfied	2	3.6%	6
Dissatisfied	3	5.4%	3
Moderate	31	55.4%	1
Satisfied	14	25.0%	2
Very Satisfied	3	5.4%	3
No response	3	5.4%	3
Total	56	100%	-

Table 5: Ease of access to medical facilities

Div.	Frequency (Number of people)	Ratio	Rank
Very Dissatisfied	2	3.6%	6
Dissatisfied	13	23.2%	2
Moderate	21	37.5%	1
Satisfied	13	23.2%	2
Very Satisfied	3	5.4%	5
No response	4	7.1%	4
Total	56	100%	-

The answer to the question about whether the roads around your residence are safe to walk on is shown in Table 6. As a result of the analysis, the ratio of 'dissatisfied' and 'very dissatisfied' (8.9%+19.6%=28.5%) was higher than that of 'satisfied' and 'very satisfied' (12.5%). As mentioned earlier, in the case of small rural towns, the proportion of the elderly is higher than in large cities. We can find that most of the elderly have difficulty walking.

Table 6: Road conditions around the residence

Div.	Frequency (Number of people)	Ratio	Rank
Very Dissatisfied	5	8.9%	3
Dissatisfied	11	19.6%	2
Moderate	29	51.8%	1
Satisfied	4	7.1%	4
Very Satisfied	3	5.4%	6
No response	4	7.1%	4
Total	56	100%	-

Nevertheless, the feeling that the roads around the residence are not safe to walk on shows the direction of improvement in Korea's aging cities. However, it is not possible to judge by simply looking at a two-dimensional map to suggest a direction in which road should be improved and how much. In other words, if the three-dimensional visualization using the digital twin presented in this study is performed, such inconvenient roads can be easily improved, and related decisions can be made efficiently. We can find that the application of digital twin technology is the most necessary point in the urban regeneration business.

Then, the results of examining the accessibility of public institutions are shown in Table 7. Most of the respondents also answered that the accessibility of public institutions was average (48.2%). However, the proportion of respondents who said they were generally dissatisfied (dissatisfied+very dissatisfied) (16.1%+3.6%=19.7%) and those who answered that they were generally satisfied (satisfied+very satisfied) (17.9%+5.4%=23.1%) were similar. In general, the response that they were satisfied was slightly higher.

Table 7: Ease of access to public institutions

Div.	Frequency (Number of people)	Ratio	Rank
Very Dissatisfied	2	3.6%	6
Dissatisfied	9	16.1%	3
Moderate	27	48.2%	1
Satisfied	10	17.9%	2
Very Satisfied	3	5.4%	5
No response	5	8.9%	4
Total	56	100%	-

The results of the satisfaction survey on the accessibility of cultural facilities are shown in Table 8. As a result of the survey, dissatisfaction (28.6%+17.9%=46.5%) was found to be very high in old cities because there are few cultural facilities.

Table 8: Ease of access to cultural facilities

Div.	Frequency (Number of people)	Ratio	Rank
Very Dissatisfied	10	17.9%	3
Dissatisfied	16	28.6%	2
Moderate	18	32.1%	1
Satisfied	5	8.9%	4
Very Satisfied	2	3.6%	6
No response	5	8.9%	4
Total	56	100%	-

In most countries, including Korea, demand surveys are conducted when installing cultural facilities. As a method of measuring the amount of demand, a method of measuring the number of potential consumers such as the population size of an existing city is typically used. The same is true in Korea. If a large number of people do not live in an old city, it is not considered feasible to install new cultural facilities. However, there is a kind of dilemma as to whether the absence of such cultural facilities is the cause of the currently small number of residents, or whether the cultural facilities should not be installed because of the small number of residents. If digital twin technology can be used to

identify the floating population of a city and simulate changes in demand following the establishment of new facilities, a new paradigm for urban development can be presented.

Satisfaction with parks and green areas was also found to be generally high (26.8%+5.4%=32.2%). Parks and green spaces need to be understood in the same context as cultural facilities. Table 9 shows the ease of access to park greenery.

Table 9: Ease of access to park greenery

Div.	Frequency (Number of people)	Ratio	Rank
Very Dissatisfied	3	5.4%	5
Dissatisfied	15	26.8%	2
Moderate	24	42.9%	1
Satisfied	7	12.5%	3
Very Satisfied	2	3.6%	6
No response	5	8.9%	4
Total	56	100%	-

Korea has been thinking for a long time about the problem of population density in Seoul and the metropolitan area. However, to newly install cultural facilities or parks, there must be a large number of people living in the background. In the same way, as now, good infrastructure can be installed only where many people live. Then, because everyone wants to live in a place with a lot of good infrastructures, the problem of population concentration in Seoul and the metropolitan area cannot be solved. At this point, it is necessary to suggest a rational decision-making direction using digital twin technology.

Regarding the accessibility of public transportation, the ratios of generally dissatisfied (14.3%+3.6%=17.9%) and generally satisfied (17.9%+5.4%=23.3%) were similar, except for cases where they answered that they were average (51.8%). However, it was found that the percentage of respondents who were generally satisfied was higher. Table 10 shows the ease of public transport access.

Table 10: Ease of public transport access

Div.	Frequency (Number of people)	Ratio	Rank
Very Dissatisfied	2	3.6%	6
Dissatisfied	8	14.3%	3
Moderate	29	51.8%	1
Satisfied	10	17.9%	2
Very Satisfied	3	5.4%	5
No response	4	7.1%	4
Total	56	100%	-

Older cities have relatively low population density. Therefore, there will be relatively little movement of vehicles and the problem of parking facilities will not be significant. However, as a result of the survey, the number of respondents who answered that they were generally dissatisfied (32.1%+16.1%=48.2%) was found to be very high. Table 11 shows the convenience of using parking facilities. This is a problem that most Korean cities are struggling with, and aging cities are no exception. Korea achieved rapid economic growth after the Korean War. However, at the time of designing cities or facilities, all these rapid economic growths could

not be predicted and reflected. That is why, as in many cities, parking is scarce. These are the results described. Then, if we use digital twin technology to streamline the flow of vehicles in the city or provide information by distributing available vehicles for each parking lot, a certain part of the parking problem can be solved. Accordingly, smart parking is the fastest spreading and most popular among smart city pilot projects in Korea.

Table 11: Convenience of using parking facilities

Div.	Frequency (Number of people)	Ratio	Rank
Very Dissatisfied	9	16.1%	3
Dissatisfied	18	32.1%	1
Moderate	17	30.4%	2
Satisfied	6	10.7%	4
Very Satisfied	2	3.6%	6
No response	4	7.1%	5
Total	56	100%	-

3.3. Analysis of public database

To create a digital twin for village-level urban regeneration business, it is needed to analyze the public database of the country. In Korea, public cadaster is provided in a digitized form. The Real Estate Register, of Korean public DBs, is a public ledger in which the rights and status of real estate are recorded, including lot number, title, structure, and area, and whether or not rights such as ownership, mortgage, cheonsei right, and provisional seizure have been established. The real estate register consists of the land register and building register and includes a title section, Gap-gu, and Eul-gu. The title section shows the location and the current state of the real estate. In Gap-gu, the relationship between ownership and ownership-related rights is displayed while the relationship of rights other than ownership is shown in Eul-gu. The Building Standards Register is a book that clearly records the condition of a building, including the location, number, type, structure, area, and the address and name of the owner. It is stored in local governments and can be used as basic data for taxation.

Also, buildings are registered based on the contents of the building standards register, and the information related to the real estate in the register provides the basis for the indication of the real estate or the registered holder of the right. Therefore, if there is any change in the condition of the building, the building standard register must be changed first before applying for the registration change. When the indication of the real estate on the register is not consistent with that of the building standards register, the owners of the real estate cannot apply for registration if he or she registers the change in the indication of the real estate. The Land Use Planning Confirmation is a document based on Korea's Framework Act on the Regulation of Land Use. It is the most basic document that confirms regulations and permissible uses of the land for real estate development. The land-use planning confirmation certificates are issued by the head of local governments but are currently open to the public through the land use regulation information service website.

The public cadaster, related to the urban regeneration business, includes certified copies of the register, building and land register, and land registration map. A certified copy of the register shows the ownership of the space; the building and land register the physical state of the space; and the registration map the exact boundaries and shape of the land. In principle, the information from these public DBs must match. For example, the area of the building on the copy of the register must be consistent with that of the building register, at least to some extent. In addition, it should match the actual condition of the urban space. The current state of Korea's public cadaster (public DB) is as follows (Table 12).

However, in the analysis of the case site, consisting of 237 lots and 156 buildings, through the on-site investigation, there were 9 buildings in the register, but not on the building register. In addition, there were 10 cases where there was a building register, but without a certified copy of the register (building). Furthermore, there were 10 cases where there was neither copy of the register nor a building register. A total of 6 buildings were found not to exist even though there was a copy of the register (building) and the building register. Additional 25 buildings did not exist although they do on the registered copy. 5 buildings seem to be vacant, but there was no public DB to confirm the fact and need to be investigated through the actual condition investigation survey.

Table 12: Public cadaster (Public DB) of Korea

Public cadaster, Public DB	Number of buildings
Certified copy of the Register (land)	Title, land area, landowner
Certified copy of the Register (building)	Building use, structure, area, owner
Building standard register	Building area, gross floor area, building-to-land ratio, floor area ratio
Land use planning confirmation	Use in urban planning

4. Future directions for creating a digital twin for urban business

Based on the case analysis, we were able to identify the directions for establishing a digital twin for doing urban digital business. First, it is necessary to ensure consistency between the current public cadaster (Public DBs) of the government. Korea's legal system related to real estate does not presume or guarantee consistency between ledgers and integrity. All public cadasters must be consistent with reality to be recognized as truth, for it simplifies the administrative process of public officials, such as registration, and clarifies the limits of their

responsibilities. However, it is becoming an obstacle in building a digital twin. In order to ensure consistency, it should be first identified how inconsistent it currently is. It can be as simple as building big data in texts, instead of the image in the current system, and comparing them between the ledgers, but it can cost a large amount of administrative time and cost, requiring determination and interest at the national level.

Second, it is difficult to verify information such as vacant houses. Vacant houses, if it is defined as uninhabited houses, can be divided into two types: First, it is a case where there is a resident on the resident registration but in reality, no person lives there. The next case is the case where there is no resident on the resident registration or in reality. The vacant house with the resident on the resident registration can only be confirmed through the field investigation. However, if there is no resident-on-resident registration, it can also be verified by cross-checking different public DBs of the government. This information also needs to be indicated in spatial information, such as GIS and connected to a digital twin. In addition, the DBs should be connected continuously to create a digital twin. In other words, the DB connection should be updated constantly. For an automatic update, the same property connection between the frame DB relation and the linked DB relation must be maintained (Yng, 2021). It should also be considered and carefully studied how to give registration numbers to space objects.

Third, detailed on-site investigations should be conducted regularly to improve the registers that are inconsistent with actual conditions- such as the case where the building is actually destroyed but there is a building on the register or the building without a building register (most of which must be an illegal building). There is a limit to flying a drone over the area every time and attaching sensors to all areas and buildings which are private property, to create a digital twin. Then the answer lies in building a system that enables regular and detailed checks, etc. For an urban digital business, such as village-level urban regeneration, it can be a way to use organizations at the village level. Villages have an autonomous administrative organization, including the head of the village. It is required to establish a system that can utilize these organizations.

Lastly, the digital twins, currently under development, are centered on pilot projects for new towns or smart cities. However, the majority of Korea's cities are deteriorating cities. With a few exceptions, they are all small or medium-sized cities. This means there would be much bigger market potential for regenerating these deteriorating, small and medium-sized cities through digital technologies. Therefore, the government should pay attention and lend to the development, application, and construction of digital twins for deteriorating cities at the village level as this requires an enormous amount of cost and time at the government level.

5. Conclusion

As many Korean cities are starting to decline, the market for urban business—urban regeneration, redevelopment, and reconstruction, is expanding. Although they are high-value adding businesses, there are a lot of risks that are difficult to predict, including the business directions, profits, or costs of the business. Therefore, they used to be monopolized by a handful of big businesses or public actors. However, if a digital twin of a city can be created from the urban business perspective, anyone can be engaged in the urban digital business, conducting urban regeneration, redevelopment, or reconstruction projects.

In this study, we tried to suggest a direction for creating a digital twin for urban regeneration digital business by analyzing the case of the urban regeneration project case by the village from the perspective of urban digital business.

However, in the analysis of the case site, consisting of 237 lots and 156 buildings, through the on-site investigation, there were 9 buildings in the register, but not on the building register. In addition, there were 10 cases where there was a building register, but without a certified copy of the register (building). Furthermore, there were 10 cases where there was neither copy of the register nor a building register. A total of 6 buildings were found not to exist even though there was a copy of the register (building) and the building register. Additional 25 buildings did not exist although they do on the registered copy. 5 buildings seem to be vacant, but there was no public DB to confirm the fact and need to be investigated through the actual condition investigation survey.

To sum up, we suggested four directions for creating a digital twin for the village-level urban regeneration digital business: First, it is necessary to ensure consistency between the public cadasters (public DBs) of the government; Second, we need to improve the difficulty of confirming vacancy information; Third, regular and detailed filed investigations are required to improve the inconsistency between the register and actual conditions, including the case where the buildings are destroyed but exist on the register or without the register (most of which are assumed to be illegal buildings); Fourth, the government needs to expand the digital twin projects that centered around pilot projects for new towns or smart cities and to put more effort and time to develop and apply the digital twin technology for deteriorating cities—which takes account the majority of Korean cities.

Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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