Smart management services for high-rise apartments in Beijing, China

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**ABSTRACT**
High-rise apartments are one representative form in the era of urbanization. However, the management of the high-rise apartment is not easy because of large household densities and the complex structures. Advanced technologies have permeated our daily lives and management services are becoming more intelligent. The aim of this study is to explore the smart management service model of high-rise apartments by investigating the current state of management services and residents’ consciousness of it, as well as to identify necessary management services. A survey was conducted in two apartment complexes with a focus on the actual users’ demands and preferences. The results show that the characteristics of the common space would be decided by considering residents’ diverse needs for these common spaces. Further, residents of high-rise apartments lack awareness and experience of technologies for smart management. This suggests that smart management services should be developed in consideration of the perspectives of the residents to satisfy their psychological and safety needs. Virtual social spaces would be provided to create a sense of neighborhood among the residents. In a human-centered approach, this study would be a basis for the development of smart management services supporting the quality of residential life in high-rise apartments.

**1. Introduction**
Housing management services in China have a short history of about 30 years, and their development has been concentrated in coastal areas and large cities (Luo 2002). Apartment management services in China consist mainly of “outsourcing” to professional management companies as apartments become larger and more complex. This gives rise to many problems related to conflicts between consignment companies and residents. China’s management services do not consider detailed facility management and focus on commercial aspects, with resulting deficiencies in human-centered management. Recently the purpose of such management has been changing from physical management to human-centered management by adopting a model that operates in pursuit of advanced technology (Xie 2010).

The development of information and communication technology (ICT) has triggered social changes and increased individuals’ dependence on the use of technologies for their domestic wellbeing. Further, many digital platforms that can be managed more efficiently have been developed and provided by consignment companies but have not been implemented to ensure the residents’ positive experience. Such management includes financial management, resident information management, complaint filing, and expense payment system management (Zhang et al. 2008). Therefore, the current management method lacks system development and application in consideration of the residents’ perspectives, even though this management is purportedly provided for the convenience of the residents (Cho, Chae, and Kim 2012).

The aim of this study was to provide basic information for the development of a promising management service model, considering the perspectives of the residents of a high-rise apartment complex in Beijing, China. The perceptions and the use of common space by the residents of high-rise apartment complexes were investigated and analyzed. In addition, based on the evaluation of the comprehensive management services in the complex, the need for smart management services associated with advanced technologies was proposed.

**2. Related work**

**2.1. Common space in high-rise buildings**
Chinese culture generally values communalism; thus, common spaces in apartment complexes are considered important. Community education began in China in the 1980s, when the role of common spaces was emphasized in residential areas to promote a sense of community among members (Wang 2006; Yao 2019). In recent
years, the role of common spaces in strengthening the sense of community has attracted increasing attention, under the influence of management policies for the community in urban residential areas (Zhang and Li 2017). In a high-rise apartment with complexity and high-density, common space that supports community activities is important for residents’ quality of life.

Common space is a transitional area and supporting community activities through common spaces can significantly improve the lifestyles of apartment complex residents (Lei 2013). As Chinese residential areas are highly concentrated around apartments, the interactive aspect of common spaces that can induce natural interaction between residents is emerging as a factor of importance (Lei 2013; Huang, 2009). The external environment within the apartment complex, in particular, the green space, can directly affect the quality of life of the residents living in the city (Kim and Kim 2001). The outdoor common space in the complex can be divided into three elements: circulation, spatial composition, and facilities (Kong and Kim 2009).

2.2. The definition and status of management service

Management services in China have developed gradually since the early 1980s, starting as an after-sales service in which buildings and environments were managed after houses were sold. From 1993 onwards, as the economic development picked up pace, not only did the physical demand for housing increase, but also the requirements for convenience, safety, and comfort. Increasing attention has been paid to apartments with various functions for improved quality of life, beyond the conception of the house as merely a physical living environment (Luo 2002; Xie 2010). China’s real estate market has developed rapidly and the apartment management service in China is defined as “property management.” This property management is commercially operated for safety, convenience, comfort, and a clean environment; thus, professional management enterprises are entrusted to provide maintenance, infrastructure management, and repair services to building users in the relevant area (Li 2015). Although the property management sector has developed quickly as part of the real estate market, research on property management in China has dealt with management and operation only in a broad sense (Jiang 2007). In other words, the research on the provision of management services at a user level was found to be insufficient (Yu and Chen 2014).

2.3. Smart management services

Since the 2000s, the real estate market in China has been pursuing a living environment that fosters convenience and quality of life by applying smart technology (Xie 2010). Smart management systems, including the Internet of things (IoT), exist to optimize and operate buildings by applying ICT, remote monitoring, and remote control (Jiang 2007). In particular, smart management services in China have been extensively supported by the government and recently cloud computing, big data and AI are applied (Fan 2020). Smart management services can be characterized as networks that are intelligent and human centered. Eco-friendly technologies that save energy and technological interventions for convenient living are included (Chen 2009). According to Wei (2018), there are two approaches to the smart management. First, the safety of the complex is secured with a facial recognition system, a vehicle recognition system, a CCTV surveillance system, and a crime prevention system at the entrance. In terms of convenience, managers’ works should be made more efficient through the automation of maintenance and information communication (Wei 2018). Convenience services for the community facilities are also proposed (Xia 2020). Smart management systems are mostly employed for efficiency and information processing, emphasizing convenience in the management and safety of housing.

3. Research methods and scope

First, we extensively reviewed previous studies on common spaces and management services for high-rise apartment complexes.

Second, we conducted a survey of two high-rise apartment complexes located in Daxing District, Beijing, China. Complex A was a large-scale apartment complex constructed in 2010, close to a subway station and located in an area where department stores, and convenience facilities, were concentrated. This apartment complex was equipped with community facilities and was being managed to revitalize the community and ensure environmental friendliness. Complex B was a large-scale apartment complex with a total of nine buildings with over 1,000 households, constructed in 2008. This complex showed community facilities and management problems similar to those of Complex A. There are reasons why these complexes were selected as survey targets. Daxing District is located in the southern part of Beijing, China, where apartment construction is increasing every year. Daxing District is an area where high-rise apartments have more than 1,000 households, built at the same time, and management statuses are similar among these apartment complexes (Table 1).
Table 1. Apartment complexes.

|                | Complex A                      | Complex B                      |
|----------------|--------------------------------|--------------------------------|
| Residence      | 2010                           | 2008                           |
| Complex        | Separate commercial space      | Mixed commercial space         |
| composition    | from housing space             | and housing space              |
| Households     | 2,757                          | 1,319                          |
| Complex area   | 24 blocks (162,000 m²)         | 9 blocks (170,000 m²)          |
| Building area  | 458,000 m²                     | 100,000 m²                     |

The common spaces in the two apartment complexes, which were similar in size, included parking spaces, pedestrian roads, garbage disposal units, resting spaces, and green spaces. In Complex A, mixed grounds comprising underground parking and a typical garbage collection point were adopted, while only underground parking was available in Complex B, where automated garbage collection was utilized. At the block level within each complex, we inspected the status of security, lighting, and management at the main entrance, the elevator, and the stairs, which were selected as the common spaces most used by residents. The inspection revealed that maintenance was insufficient, with advertisements encroaching on common spaces, and poor cleaning. In addition, even though stairs are an important space in high-rise buildings, in these cases, they reflected insufficient management in terms of security and lighting, as shown by their low frequency of use. In terms of the residential characteristics of the surveyed subjects, there were 42 single-person residences (26.3%); 39 two-person households (24.4%); 68 three-person households, including children (42.5%); and 11 households with four or more people living with their parents or children (6.9%). 124 people (77.5%) owned their apartments, 32 were paying monthly rent (20%), and four were temporary residents (2.5%).

Third, the survey was conducted from January 18 to 30 January 2019 among the residents of the complexes. The questionnaire consists of 80 questions regarding common spaces, consciousness of community and management services. The full list of questions used for the survey can be referred to tables in chapter 4 where the analysis results are presented. A total of 220 copies of the questionnaire were distributed; 180 copies were collected, and 160 copies were finally analyzed using the SPSS Statistics 23.0 statistical program, excluding some questionnaire with missing answers. The proposed method has the advantage of identifying actual users’ needs for the housing management services. However, there is a limitation in terms of generalizing the survey result, since two complexes were investigated in the survey.

4. Analysis results

4.1. Evaluation of apartment common spaces

4.1.1. Evaluation of common spaces at the block level

To ascertain the current status and satisfaction with the use of the common spaces at the block level, a survey was conducted of three common spaces: the common entrance, the elevator, and the staircase.

Most (78.8%) of the main entrances to the residence had access restrictions. The most common method of access to the entrance was with an access card (61.9%), followed by use of password (16.3%). When the anxiety levels among respondents who did not have access restrictions were measured, 29.4% of them selected “no anxiety,” and 70.6% chose “neutral.” In particular, in China, since the apartment complex itself is completely closed, non-residents cannot freely enter the complex; hence, the importance attributed to the security feature that restricts access to the residential building was not significant (Table 2).

The elevator was the common space with the highest utilization rate at the block level. The inconvenience of the waiting time for the elevator was investigated using a Likert scale with a range from one point (very uncomfortable) to five points (not at all uncomfortable). Residents did not complain much about waiting for an elevator but felt somewhat uncomfortable when actually using it. The reasons were “slow speed” (9.4%), “lack of cleanliness” (8.1%), “small space” (5%), “slow response” (3.8%), and “insufficient availability” (3.1%). In answer to the question as to whether they had experienced the elevator passing the floor on which they needed to exit it, half of the participants answered “yes” (Table 3).

Table 2. Common space at the block level: entrance.

| Content | N (%) |
|---------|-------|
| Restricted access | 26 (16.3) |
| Password | 99 (61.9) |
| Card | 1 (0.6) |
| Other | 126 (78.8) |
| Total | 160 (100) |

Table 3. Common spaces at the block level: elevator.

| Item | Content | N (%) |
|------|---------|-------|
| Average usage per day | 1–2 times | 46 (28.7) |
| | 3–5 times | 92 (57.5) |
| | 6–9 times | 18 (11.3) |
| | More than 10 times | 4 (2.5) |
| Experience of accident(s) | Yes | 52 (32.5) |
| | No | 52 (32.5) |
| Total | 104 (65%) |

Total | 160 (100) |
Through the survey, it was found that the actual utilization rate of the staircases was not high, and that the residents felt anxious there. The staircase is an important passage in an emergency, and so should be managed to remain vacant at all times. However, residents used the staircases as warehouses for storing bicycles, strollers, and other equipment (25.6%), or as a place to discard garbage (15.6%), thus reflecting insufficient awareness of the importance of the staircase.

4.1.2. Evaluation of common spaces at the complex level

For essential spaces, such as parking spaces, roadways, pedestrian roads, green spaces, and garbage spaces, residents generally showed more than average levels of satisfaction, as shown in Table 4. Essential common spaces are important spaces supporting the everyday living of residents because if the environment is not managed properly, accidents or great inconvenience may be caused.

The common spaces with low occupancy rates of residents were a rest area for older adults (41.3%), a dance space for adults (40.6%), and a children’s playground (36.9%). Results of the analysis of the satisfaction with common spaces that supported community activities are given in Table 5. The results reveal that the common spaces with which residents expressed low levels of satisfaction were infrequently occupied and used, implying that the usage rates of and satisfaction with the space are related. The cases of the children’s playground, the elders’ rest area, and the adult dance area show that entertainment spaces for specific residents did not sufficiently cater to the needs of the target residents.

In January 2018, a “Circular on Accelerating the Classification of Domestic Waste in Certain Key Cities” was issued and Beijing’s waste separation method was officially established accordingly (China 2018). The status of the separate collection of garbage in the complexes was investigated and is shown in Table 6.

In terms of satisfaction with the garbage disposal space, less than 40% were satisfied – that is, more than half were not satisfied. Regarding the cause of dissatisfaction, the reasons included “smell,” “not able to properly separate collection,” “the collection interval time is relatively long,” “there is no separation effect,” “there are small trash bins,” and “scrap-pickers are active.”

4.2. Management service conditions in the complexes

We investigated the noise levels, the problem of smoking, and the lifestyle management services in the complexes. The results of the survey of noise between floors showed that 54.4% of residents (87) felt uncomfortable because of (from most irritating to least) “the sound of children’s playing,” “the noise from the corridor,” “the sound of TV, music, etc., from next door,” “the sound of walking,” “the sound of flowing tap water,” and the “elevator operation sound.” Regarding smoking in the complex, 44.4% (71) of respondents feel uncomfortable, whereas 33.1% (53) of responses stated that smoking was “not inconvenient.” The most common places where smoking was considered a problem were the “elevator,” “staircase,” and “hallway.” Notably, 71.9% of respondents who felt uncomfortable about the noise and 64.4% who felt uncomfortable about the smoking did not complain about these problems to the management office at all. It seems that there was not enough communication between managers and residents, furthering the distrustful relationship between them. Accordingly, a virtual communication space would be a good way for residents to report management problems easily at anytime and anywhere, resulting in interactive communication between managers and residents.

Residents expressed overall satisfaction with the management costs, but the results show that the communication, announcement and opening of the residents’ conferences were not enough. The most common reasons for the absence of residents’ meetings included “no residents’ committee,” “not receiving notice of the meeting,” “not interested at all,” and “the meeting time is not relevant (weekdays, working hours).” Regarding the question of their willingness

| Table 4. Essential common spaces at the complex level. |
|-----------------|-----------------|-----------------|
| Item            | N = 160         | Satisfaction (M) | Std. deviation |
| Parking space   | 3.09            | 1.101           |
| Driveway        | 3.19            | 1.067           |
| Pedestrian road | 3.53            | 1.121           |
| Green space     | 3.52            | 1.138           |
| Garbage disposal| 3.25            | 0.997           |

| Table 5. Common spaces supporting community activities. |
|-----------------|-----------------|-----------------|
| Outdoor community space | N = 160 | Satisfaction (M) | Std. deviation |
| Plaza           | 3.46            | 0.815           |
| Trail           | 3.61            | 1.047           |
| Nature park     | 3.48            | 0.931           |
| Grass space     | 3.37            | 1.062           |
| Children’s playground | 3.12     | 1.018           |
| Rest space for the elderly | 3.21 | 1.066           |
| Adult dance space | 3.21            | 1.006           |
| Fitness facility | 3.41            | 1.129           |
| Public garden   | 3.44            | 1.086           |

| Table 6. Garbage disposal. |
|-----------------|-----------------|-----------------|
| Item            | F(%)            |                |
| Current status of waste |                |                |
| No separate collection | 38 (23.8) |                |
| Notified of separate collection but unsure whether it was implemented | 56 (35.0) |                |
| N = 160         |                |                |
| A manager or system separates the waste | 22 (13.8) |                |
| Waste is directly sorted before being thrown away | 44 (27.5) |                |
to participate in safety training (e.g., firefighting, energy-saving), 68.8% of respondents (110) showed their intent to participate “if the time is right,” and 14.4% (23) answered that they would attend “because it is very important.” This result implies that most residents would be willing to participate in activities such as meeting residents and safety education but may be unable to be involved because of lack of notice and time constraints. Thus, managers should provide more time options and communication methods to ensure residents’ participation. In addition, community activities, such as fire, safety, and energy-saving training, could be provided through networks and the virtual community, and thus, would not be limited by time and space.

For a comprehensive evaluation of the management services provided within the complex, a survey was conducted to measure the expectations, importance, and necessity of the services. The average score for the management service currently being received was 3.38. When examining the reasons for dissatisfaction, the answers included “complaints about managers,” “complaints about management status,” and “complaints about current public facilities in the complex.” Regarding services that needed to be improved, “the responsibility of the manager” (59.1%), the “facility defect servicing” (53.5%), “diverse management services” (52.8%), and “cleanliness of the maintenance service (52.8%)” were given in this order (Table 7). The findings show that the services that required improvement for residents were consistent with the reasons for the complaints about the current management. The quality of services that can be provided by managers will have a direct impact on residents’ service satisfaction. That is, managers’ responsibility is the most influential factor on the satisfaction of residents with services.

(Group A: The monthly average cost of living is less than 4000 RMB; Group B: The monthly average cost of living is between 4000 RMB and 6000 RMB; Group C: The monthly average cost of living is over 6000 RMB)

The result of the analysis of the management service according to the monthly average cost of living showed a significant difference (Table 8): Group B was more dissatisfied with the management service than Groups A and C. Regarding management expenses, Group B said that management expenses were not adequate. Meanwhile, the high cost of management was not burdensome for Group C, which nonetheless rated the quality of service as not satisfactory. While Group A was satisfied with the quality of service, thinking the cost reasonable for it, Group B seemed to think the quality of service was not sufficient for the cost of living. The results suggest that the cost of living affected residents’ expectations about quality of life; thus, the higher the cost of living, the more they expected their quality of life to be improved.

### 4.3. Consciousness of community and the environment

Regarding neighborhood communication, only 4.4% of respondents chose “1–2 times a week.” When asked, “Which people do you think of as neighbors in the apartment complex?” the most frequent reply was “all residents in the apartment complex” (47.5%); 23.1% of respondents said, “people who live on the same floor,” whereas 21.9% of residents said, “people who live in the same building” (21.9). For the question, “If your neighbor asks you to spend time with them, how much are you willling to interact with them?” only 17.5% of respondents said they would “never” interact with their neighbors. That is, most residents were willing to communicate with their neighbors, and this was not consistent with the current state of non-communication in real life. This implies that the residents lacked opportunities for communication with their neighbors; thus, more channels for communication should be provided to enhance the quality of community life (Table 9).

We investigated the differences in the residents’ understandings of energy saving in their homes and complexes (Table 10); 53.7% of residents (86) considered saving energy in their homes, while 18.2% (29) did not consider energy conservation in relation to the complex. For example, 13.8% of respondents (22) were unwilling to save energy for the use of heating in common spaces; further, 4.4% of respondents (7) claimed that “the energy use in common spaces doesn’t matter [to] me.” This result shows that unnecessary use of energy in common spaces still exists in the apartment complexes.
Table 9. Occupants’ consciousness of community.

| Item                                                      | N = 160 | N (%) |
|-----------------------------------------------------------|---------|-------|
| Neighborhood communication                                | No at all | 38 (23.8) |
|                                                          | No interest | 56 (35.0) |
|                                                          | 1–2 times a month | 59 (36.9) |
|                                                          | 1–2 times a week | 7 (4.4) |
| Neighborhood intimacy                                     | Only my house | 12 (7.5) |
|                                                          | People who live on the same floor | 37 (23.1) |
|                                                          | People who live in the same building | 35 (21.9) |
|                                                          | All residents in the apartment complex | 76 (47.5) |
| Willingness to communicate with neighbors                 | Never | 28 (17.5) |
|                                                          | Occasionally | 76 (47.5) |
|                                                          | Often | 45 (28.1) |
|                                                          | Every time | 11 (6.9) |

Table 10. Occupants’ consciousness of eco-friendly practices.

| Item                                                      | N = 160 | N (%) |
|-----------------------------------------------------------|---------|-------|
| Unit energy savings                                       | Not considered at all | 10 (6.3) |
|                                                          | Not considered most of the time | 42 (26.3) |
| N = 160                                                   | Normal | 22 (13.8) |
|                                                          | Considered somewhat | 73 (45.6) |
|                                                          | Considered frequently | 13 (8.1) |
| Residents’ senses of energy saving                        | Undesirable consciousness | 7 (4.4) |
|                                                          | The energy use in common spaces does not matter to me | 22 (13.8) |
|                                                          | The heating of common spaces should be turned on at the highest temperature all the time, especially in cold weather | 29 (18.2) |
|                                                          | Total | 95 (59.4) |
|                                                          | I can turn on the air conditioner at a moderate temperature even in cold weather | 36 (22.5) |
| Desirable consciousness                                   | Total | 131 (81.8) |

4.4. Smart service demand

The survey to understand management related to smart technology was classified into safety support services, convenience support services, and comfort support services, and the results are shown in Table 11.

The highest score in the category of the safety support service was “the service of the automatic report and the identification of situation in real time in case of an elevator accident” (4.01). In addition, among the service items that support safety were parcel storage (3.66); health index information, telemedicine consultation, and emergency services (3.51); voice calls for older adults and children (3.43); a safe entrance to the front door (3.34); the shortest elevator operation route (3.46); and the automated reporting service in defective common spaces (3.53). All items in this category received a score higher than three (normal).

The items on services that support convenience and comfort – sharing eco-information within the complex (2.63), providing telework (2.90), digital stairs (2.73), 3D image screens and performances with virtual reality experience (2.84) – showed a score lower than three (normal). The need for safety support services is stronger than those for convenience and comfort. In addition, the online community, real-time common space utilization information, and comfort services also demonstrate the need for smart displays and LED lighting in the plaza. According to Comprehensive Measures for Improving the Quality of Life Based on Technology (2007), safety is regarded as an important factor that supports the basic needs of residents (K2Base 2007). In other words, the residents of the apartment complex require safety more than
the convenience and comfort afforded by the common space of the complex. In addition, among the safety features, it was found that the service to prevent an elevator accident was most strongly required. Since elevators are common spaces with the highest occupancy rates, safety concerns are significant.

5. Discussion
The apartment management model in China started late; thus, insufficient attention has been given to management services, causing disputes and distrust between managers and residents. The direction of management services applicable to China needs to be developed by considering China’s national conditions, culture, and present management status.

5.1. Residents’ awareness and adoption of smart management
Residents’ uncertainty about how to use common spaces and facilities, and the importance of environmental maintenance led to poor utilization of common spaces and facilities in the apartments, and to dissatisfaction. In other words, the residents did not have enough awareness of and attachment to common spaces and facilities, so they did not care about the maintenance of these spaces and facilities. To increase residents’ satisfaction, the convenience and comfort of the occupant should be emphasized in these spaces with a focus on residents’ feelings and experiences in such spaces and facilities. It is essential to be aware that people become more concerned about privacy issues, thus smart management services should be provided with residents’ privacy protection.

5.2. The role of the management department as a mediator with residents
People generally pay more attention to unit space when looking for a home, and less attention to common spaces and facilities. Common spaces and facilities in apartments are compulsorily provided based on building construction law. To maintain common spaces and facilities and increase residents’ satisfaction with them, active communication between managers and residents is necessary. The current management model is not occupant-centric, focusing on effective management, but it should play a mediating role in providing convenient and comfortable services to residents.

5.3. The Provision of Systematic Smart Services
The smart management of apartments is an important factor in the residents’ quality of life. Thus, it is desirable for residents to participate in the development of management services. This enables the residents to have trust in the services with an awareness of their common value for the apartment complex. For management services to be desirable from the residents’ perspective, it is necessary to establish a multi-channel intelligent information communication platform, whereby residents can communicate with the management department, strengthening the supervision of the services. In particular, with the use of smartphones, residents are not resistant to virtual communication for management services; thus, they could obtain such services easily, at any time, and anywhere. Systematic smart services could be provided through information communication platforms and virtual exchanges. The most critical aspect for the adoption of smart management services is the residents’ awareness of smart services and improved experience.

6. Conclusion
This study aims to investigate the consciousness and needs of residents in high-rise apartment complexes, by identifying the status of the management services in two complexes in China. Based on the results of the study, one direction for the smart management service model would be as follows:

First, the physical environment for common spaces should be developed to support interaction among residents at the block and the complex levels. There is a need for a space plan in which the block level can be equally adapted to all residents and a space plan to determine a common space function that is suitable to various residents at the complex level.

Second, a virtual community space could be a desirable way to promote community and eco-consciousness. The act of garbage separation is also a means of saving energy and protecting the environment. There is a need to conduct ideological education to raise awareness about the importance of garbage classification, such that the separation of garbage can be sustained in effective and active manner.

Third, it is necessary to prioritize based on human needs, such as psychological and physical health and the safety of residents. After the basic needs are met, these services can be further diversified as residents’ awareness of additional services is improved. That is, a more systematic approach to the development of smart management services should be developed in terms of the adoption of smart technologies.

Fourth, an appropriate channel for the exchange of opinions between residents and managers should be provided. Virtual communication applications for interactive communication or a management service can effectively deliver relevant information and collect opinions by residents actively utilizing common spaces. The interaction with such applications should be more intuitive and the real needs of residents should be analyzed for better management services.
Since residents of high-rise apartments in Beijing, China, do not have experience of management services via smart technology, they are unaware of the impact of these services on their lives. The result of this study has a limitation for generalizing due to a conduction of survey with two complexes. However, this study has identified the actual users’ demands which need to be reflected in the development of smart management services. The proposed virtual platforms would be more than a simple query system, which will enable managers to grasp residents’ problems promptly and to provide corresponding services. The high-rise apartment building of the future should satisfy the psychological and safety requirements of residents with an occupant-centric approach and promote deeper links between the complex and local communities for their convenience and comfort, with a strategically envisaged direction for the development of smart management services. This study would be a basis for raising residents’ awareness of smart management with a focus on user experiences for the development of a smart community.

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