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BIM application in Quantitative Assessment of High-Speed Information and Communication Criteria for Building Certification

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Abstract: As buildings become increasingly diverse in size and type, a continuous process of generating and processing various information within these structures occurs. This process is being addressed with the advancement of high-speed information and communication technology, which is being extensively applied in buildings. Such changes are institutionalized through the certification of high-speed information and communication buildings. This certification is crucial for ensuring the quality and connectivity of the essential communication infrastructure in modern buildings. Building Information Modeling (BIM) has established itself as an effective tool for the integrated management of design, construction, and operation in architectural projects. This research aims to refine and categorize the evaluation criteria suitable for the building certification based on high-speed information and communication criteria and to explore the applicability of BIM tools based on these criteria. By enhancing the substitution and connection of each library, the functionalities of BIM programs for a comprehensive review of information and communication facilities are expected to be applied in a more utilitarian direction.

Key words: Ultra-high-speed information and communication technology, Building certificate regulation, Building Information Modeling (BIM), BIM Libraries

1. INTRODUCTION

As the forms and functions of buildings become more diverse, information and communication technology (ICT) is increasingly utilized within these structures. Buildings that integrally use ICT services in areas such as structure, facilities, electrical systems, and fire safety are defined as high-speed information and communication buildings. The architectural field has shown interest in high-speed ICT buildings, leading to the establishment of a certification system in April 1999, with the certification process commencing in May 1999[1]. Since August 2009, certification review tasks have been ongoing. This certification of high-speed information and communication buildings contributes to the advancement of internal communication networks and the widespread distribution of high-speed internet, alleviating bottlenecks in high-speed communication networks[1]. It is expected to play a leading role in laying the foundation capable of fully accommodating future advanced ICT services. High-speed ICT buildings are characterized by the need to process and recover large amounts of information quickly and efficiently, especially in disaster or emergency situations[2]. The unique technology of compiling and processing massive amounts of information is also present in Building Information Modeling (BIM), which combines information from various facilities such as fire safety, facilities, electrical systems, and structure into a unified 3D model. This study aims to integrate high-speed information and communication building certification with BIM tools. BIM plays a crucial role in supporting decision-making during the design, construction, and operation phases by digitally representing the physical and functional characteristics of buildings. As the importance of ICT and BIM in the architectural field increases, their efficient integration holds the potential to innovate the design, construction, and operation of buildings. However, the current high-speed information and communication certification standards do not adequately consider integration with BIM, limiting the optimization of ICT functionalities in building management through BIM. This research analyzes the possibilities of integrating high-speed information and communication certification with BIM programs to explore ways to improve the information management and communication functions of buildings from design to maintenance. It focuses on evaluating the integration possibilities between two domains: the analysis of high-speed information and communication certification standards and the use case studies of BIM programs. The proposed integration approach aims to enhance the information and communication functionalities and management efficiency of buildings while promoting the digital transformation of the architectural field and contributing to the development of future-oriented building management and operation strategies.

2. Literature review

S. Jaeyoung, L. Jinkook, 2016 [3] suggest utilizing BIM for automated code compliance checks by detailing the objects and attributes presented in the Korean Building Code. P. Jungwook et al., 2009 [4] analyze the meaning and functionalities of BIM, reviewing domestic and international examples to discuss the proper implementation methods of BIM. They suggest that while BIM may not solve all issues in the architectural field, such as increasing production efficiency and reducing errors, it can be successful when actively adopted for complex, large-scale projects. S. Jongkwan et al., 2013 [5] analyze rules for performing automatic reviews based on BIM models of ductwork facilities. This analysis involves three main steps: first, analyzing the design and construction standards of ductwork to identify review items; second, deriving rules for the review items; and third, applying these rules to BIM models for review. The review items are broadly categorized into shape, placement, connection, insulation, finishing, and others. Through literature review, this study presents a strategic analysis of the evaluation criteria for the certification of high-speed information and communication buildings by analyzing standards and deriving rules for automatic review in ICT facilities, applying them to relevant aspects of BIM information.

3. Research process

The certification system for high-speed information and communication buildings is divided into two categories: the certification for high-speed information and communication buildings and the certification for home networks. As shown in Table 1, there are facilities classified into three categories for high-speed information and communication building certification, and there is home network certification. The high-speed information and communication building certification is divided into three levels: premium grade, first grade, and second grade, while the home network certification is divided into three levels: AAA grade, AA grade, and A grade.[2]

Table 1. Types and Classes of High-Speed Information and Communication Building Certification Facilities[7]

facility	facility	rating
High-Speed Information Communication Building Certification	Apartment house, semi-housing officetel	Special grade, grade 1 and 2
	Business facilities	
	Rowing House, Multi-family House, Dormitory, Urban Living House	
Home Network Authentication	Home network	AAA grade (home loT), AA grade, and A grade

For each type of facility certification, there are multiple items that are inspected. As seen in Table 2, there is the certification for high-speed information and communication buildings, which includes six review items, and the certification for home networks, which comprises two review items.

Table 2. Types and Classes of High-Speed Information and Communication Building Certification Facilities[8]

type	category
High-Speed Information Communication Building Certification	Wiring facilities
	Central District Communications Office
	Plumbing facilities
	In-house wiring performance
	Drawing Management
	Digital broadcasting
Home Network Authentication	Wiring facilities
	Examination items (1), (2), (3)

The diagram presented in Fig 1 visually represents the methodology for integrating these certifications with BIM programs. The first part begins with the characteristics of high-speed information and communication buildings, focusing on the unique aspects of these buildings and leading to the convergence of high-speed information and communication building certification with BIM tools. Here, the application of BIM tools is tailored to the certification process, utilizing the specificity of BIM. The middle part starts with the analysis of certification review criteria, breaking down the criteria into property classifications such as purpose and precautions. It then moves to the stage of changing the order, reorganizing the information into a more systematic structure, considering purpose, space plus size, and rating. The quantitative analysis simplifies the process by formulating the data, adding symbols, and removing unnecessary elements. The final part illustrates research on the application of BIM programs, translating refined certification criteria into applicable BIM property information, which includes items such as purpose, area, depth, length, number, and space. This information will guide the creation and organization of a comprehensive BIM library, including Component, Room, and Area Families, as well as Project Information. Overall, the methodology diagram depicts a gradual integration of BIM tools starting from the unique characteristics of high-speed information and communication buildings, enhancing the review process and creating an organized BIM library to support all phases of building design, construction, and maintenance.

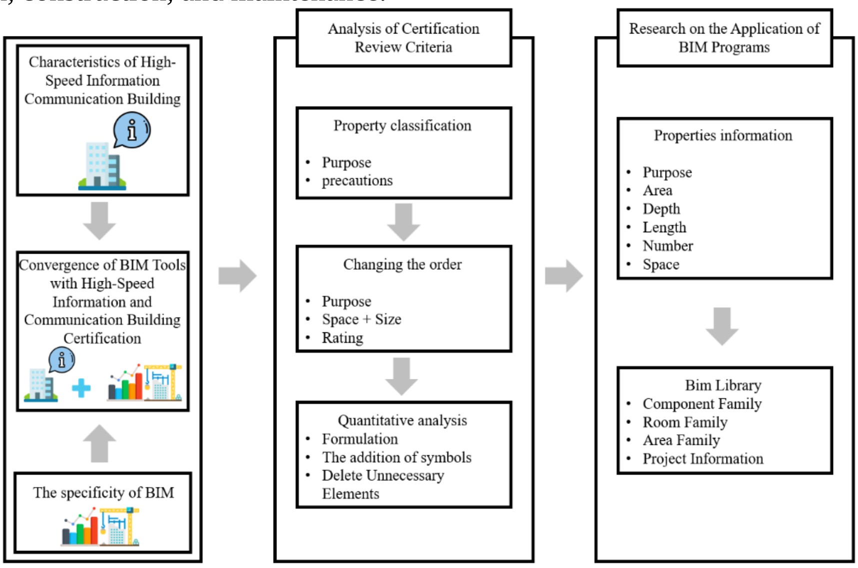

Fig 1. Methodology diagram

3.1. Analysis of Certification System Evaluation Criteria

Among the various review items, the review item for the household terminal box, which pertains to wiring facilities, was analyzed. The terminal box (distribution box) serves as a housing that accommodates terminals for connecting wiring cables to subscriber lead-in wires and is typically installed on utility poles and used as a branching point. The specifications for the types of facilities are restricted. The review items for the household terminal box are indicated in Table 3.

Table 3. Specification requirements for household terminal boxes[9]

facility	rating	criterion

Apartment, semi-housing officetel	a special grade	mandatory area of 0.2 m^2 or more (depth 8 cm or more)
	the first grade	recommended area of 0.2 m^2 or more (depth 8 cm or more)
	2nd grade	300 mm × 300 mm × 80 mm or more size is recommended
Rowing House, Multi-family House, Dormitory, Urban Living	a special grade	300 mm × 300 mm × 80 mm or more recommended installation
	the first grade	
	2nd grade	

Note 1) Apartments and quasi-housing studio apartments with a special grade and a total floor area of less than 60㎡ must have a mandatory installation of at least 300㎜ x 300㎜ x 80㎜.

Note 2) At least one separate power outlet must be secured for the equipment of high-speed internet service providers.

Note 3) The household terminal box should be installed in an exposed location that does not hinder operation and management due to surrounding structures or facilities and is free from the risk of flooding and condensation (excluding shoe cabinets, laundry rooms, verandas, and balconies). However, shoe cabinets are an exception for households with a total floor area of less than 60㎡.

The specification standards for household terminal boxes can be broadly divided into three categories: first, for apartments and residential-type officetels; second, for row houses, multi-family houses, dormitories, and urban-type living houses; and third, for exceptions, which are outlined in the cautionary notes. To analyze these standards by attribute, they are classified according to use, area, depth, symbols and signs, length and number, conditional statements, space, and grade in Fig 2. The use is marked in red, grade in gray, area in orange, symbols and signs in light green, depth in yellow, conditional statements in sky blue, and space classification in purple, with each attribute assigned a corresponding color.

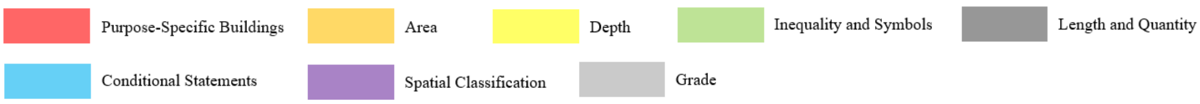

Fig 2. Attribute Classification

Through the use of color-coding for attributes, the sections pertaining to the use of facilities and cautionary notes are differentiated by colors as shown in Fig 3. In the sentences, the word "or more," which is frequently used, corresponds to symbols and signs, and thus is depicted in light green, while 0.2m², being an area, is represented in orange. In the cautionary notes, additional information regarding the space attribute, which was not previously mentioned, is provided, indicating that a purple classification for space attributes has been applied.

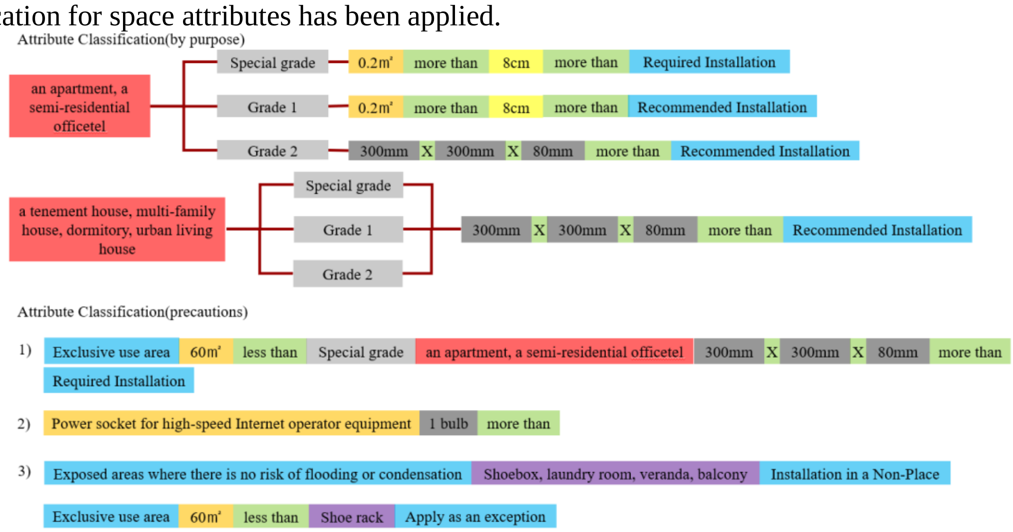

Fig 3. Attribute Classification [facility(fuction), Precautions]

Through the distinction of color attributes, it is possible to identify that sentences in the certification system contain various attribute information. After completing the attribute distinction process, as shown in Fig 4, the order is changed to first position the use and space lines, followed by scale and grade. Before positioning the information on grades, additional symbols such as equal signs are placed, and unnecessary parts are removed in the order modification process.

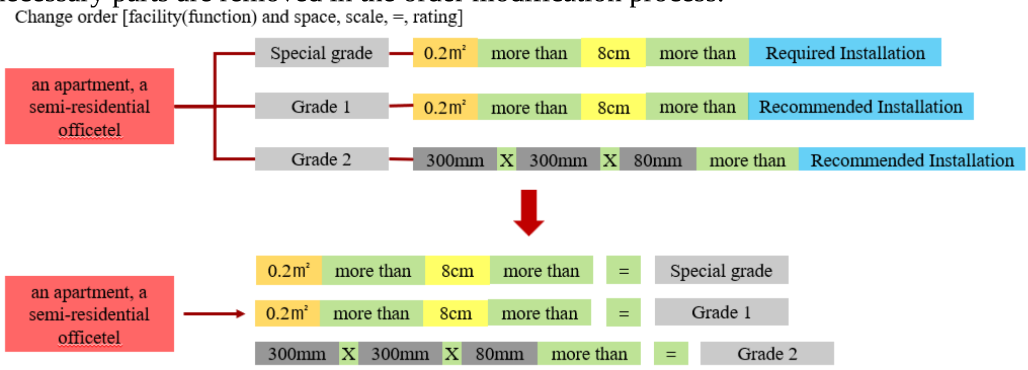

Fig 4. Change order [facility(function) and space, scale, =, rating]

Once the classification of attributes and the change of order are completed, the process proceeds to convert everything into equations except for the characters corresponding to the attributes, as shown in Fig 5. This simplification is achieved through quantification[6], a process of converting into formulas for quantitative analysis. This same process is repeated for other sentences as well, proceeding to quantification[6] as shown in Fig 6. This process is essential as it creates a structure that allows for the quick and efficient verification of items necessary for BIM.

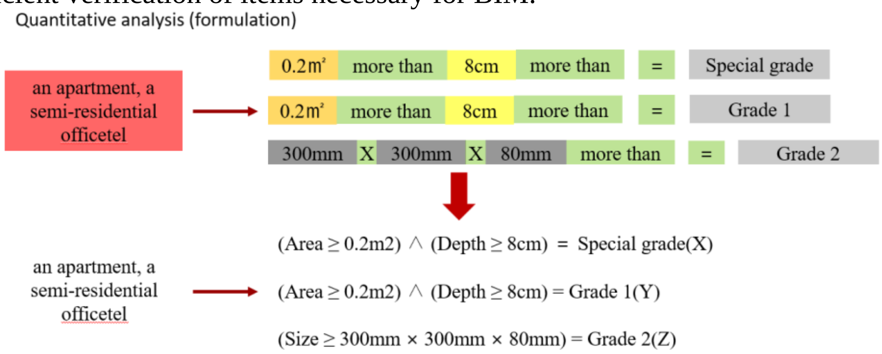

Fig 5. Quantitative analysis (formulation)

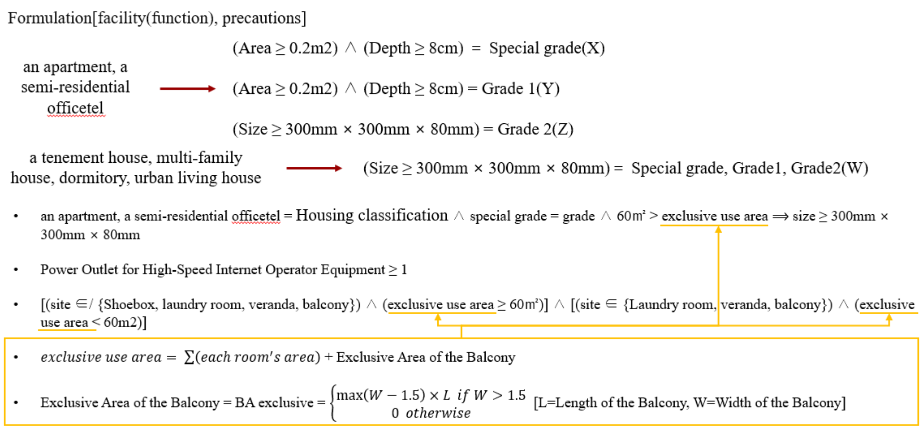

Fig 6. Formulation[facility(function), precautions]

3.2. Research on the Application of BIM Programs

The strategic analysis of the certification review criteria is utilized in the second stage of the study, which involves the application of BIM programs. One such BIM program, REVIT, is used for this purpose. The drawing presented in Fig 7 is a model of a residential space comprising an apartment with five rooms, two bathrooms, one kitchen and dining area, one living room, one entrance hall, and two balconies. To apply the household terminal box in this drawing, the LAN facility_hub_WALL FDF family is utilized. This family is placed in the hallway space near the entrance.

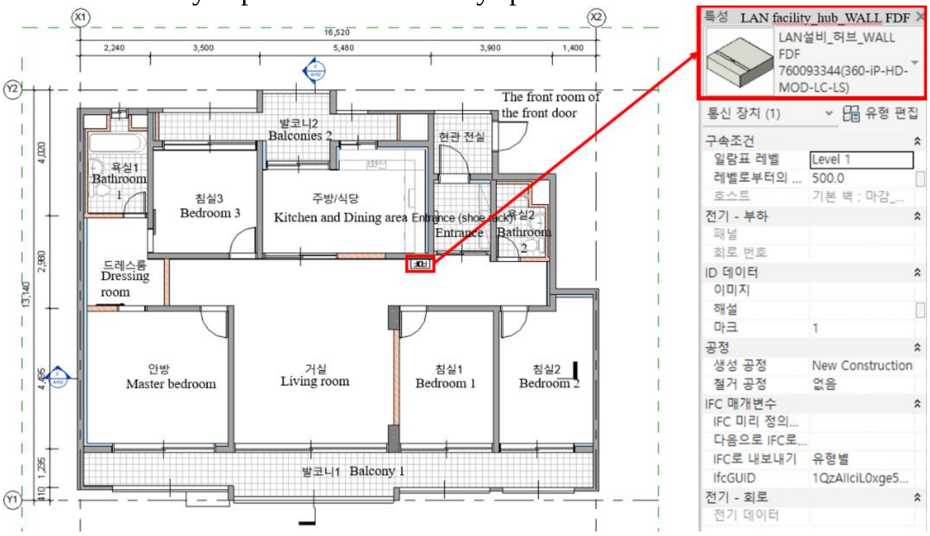

Fig 7. Floor plan and generation junction box library

Using this family, the review process considers only the attributes of use, area, depth, length and number, and space as necessary elements for BIM. Firstly, the BIM information pertaining to use is entered through the project parameters section as shown in Fig 8, and information about the use can be verified through the representative use item in the project information section. Since the current space is an apartment, it can be confirmed that the representative use is also an apartment.

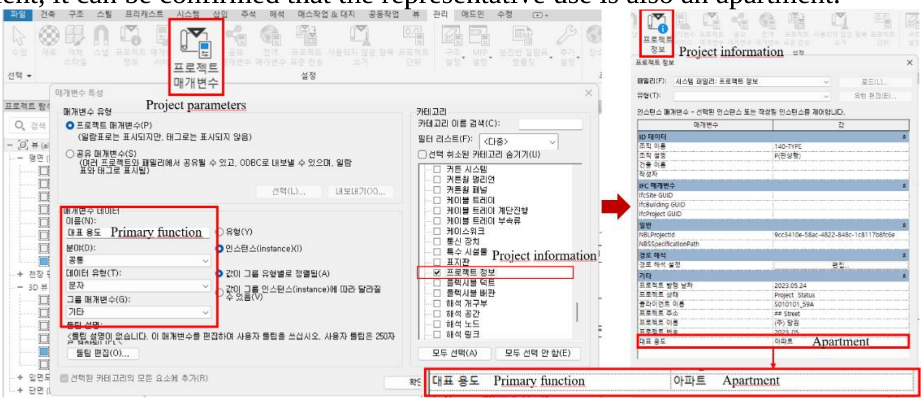

Fig 8. BIM information requirements for building usage details

Secondly, the BIM information pertaining to area, depth, and length can be verified within the household terminal box family as shown in Fig 9 (red). Length requirements can be met through the dimensions of width, depth, and height, and the area requirement can be indirectly met through the multiplication of width and height. The depth requirement can be met through the depth dimension. The area is calculated as width x height = 300mm x 1000mm = $0.3m^2$, satisfying the requirement of $\geqq 0.2m^2$, and the depth of 30cm satisfies the requirement of $\geqq$ 8cm, indicating that it meets the standards for premium grade (X) and first grade (Y). Thirdly, in terms of the requirement for at least one power outlet for high-speed internet service provider equipment, Fig 9 (yellow) can include information on the rated capacity, voltage, and frequency pertaining to power, but it is observed that there is a lack of information regarding the number of such outlets in the family, indicating a data shortfall in the specific equipment section.

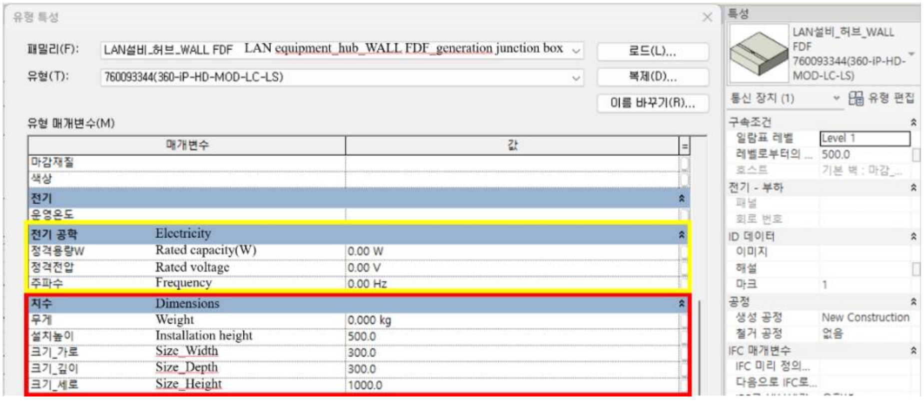

Fig 9. Length, area, depth, quantity, voltage, and frequency

Fourthly, the BIM information regarding the space and the area of that space is indicated in Fig 10. For the space naming, the LAN facility_hub_WALL FDF family, which is the household terminal box family, allows for the connection of space information in the installation location item within the family property information. Space information can also be linked from the room family in the name item located in the ID data section and the space classification item in the miscellaneous section. For the area of the space, information about the area can be linked from the area item within the area family property information. When attempting to calculate the exclusive area of the apartment drawing through Fig 10, the results are as follows. The sum of all spaces, excluding balconies A and B, is 156.8m². In balcony A, an additional area is calculated because the middle part exceeds the minimum width (1.5m), resulting in (2.3m - 1.5m) X 2.3m = 1.84m². Similarly, in balcony B, an additional area is calculated because the middle part also exceeds the minimum width (1.5m), resulting in (1.6m - 1.5m) X 5.3m = 0.53m². Therefore, the exclusive area of this apartment drawing is calculated as 156.8m² + 1.84m² + 0.53m² = 159.17m². Since this is larger than the specified exclusive area of 60m² mentioned in the cautionary notes for the household terminal box, it confirms that installation can be made in places other than the shoe rack, laundry room, veranda, and balconies, such as in the living room area.

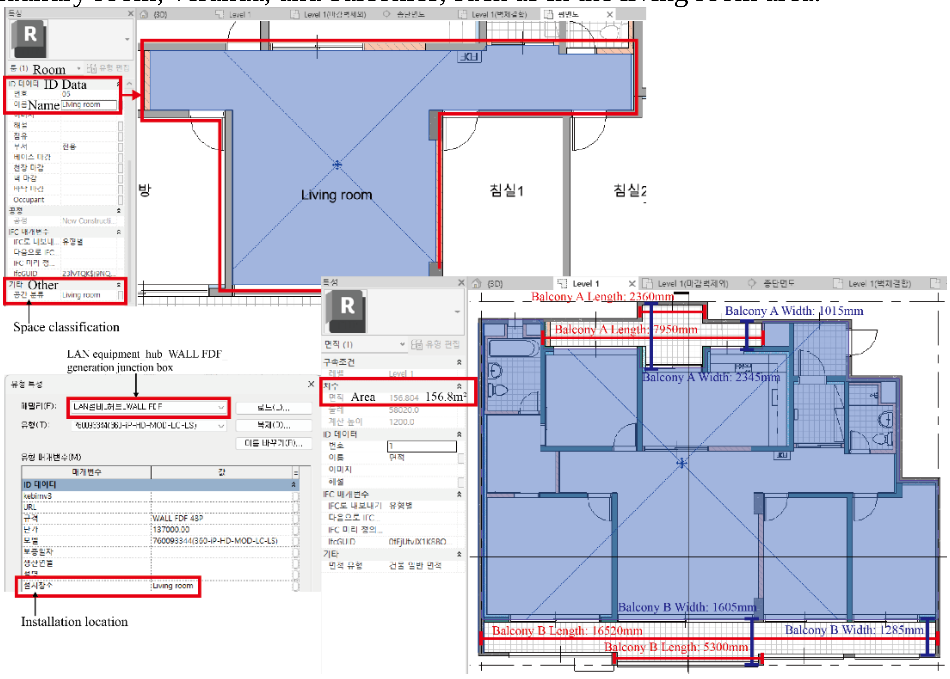

Fig 10. Space and area for each space

4. Conclusion

This research is grounded in the shared characteristics of high-speed information and communication buildings and BIM. It starts with an analysis of the certification review criteria for high-speed information and communication buildings and progresses through several stages to a strategic analysis that collects the necessary conditions for libraries suitable for each piece of information in BIM programs and compiles numerical data. This allows for an understanding of the review criteria and compatibility with BIM. The study has identified a significant lack of library information related to ICT facilities in BIM and points out the need for improvement of existing libraries(families) and development of missing libraries(families), considering the recent advancements in libraries and ICT-related BIM. Such improvements would strengthen the interconnections and interactions between libraries and enhance the role of BIM in comprehensive ICT facility management. The research has identified gaps in library information to strengthen the interaction between high-speed information and communication buildings and BIM, providing important insights for efficient management of ICT facilities using BIM. It also deepens the understanding of how the development and improvement of BIM libraries can enhance the efficiency and effectiveness of ICT facility management. However, the study has limitations. It focuses on high-speed information and communication buildings in a specific region, requiring caution in generalizing to other regions or building types. The data and analysis used are primarily based on existing literature and technical specifications, and there may be a lack of in-depth analysis of actual application cases in the field. Moreover, the development and integration of BIM libraries is a complex process that requires the participation and collaboration of various stakeholders, yet the study does not address specific strategies for these aspects. Future research could overcome these limitations by exploring the applicability of BIM libraries in various building types and regions, further advancing the integration of BIM and ICT to enhance the efficiency and effectiveness of ICT facility management. Additionally, with new technological advancements and policy changes, there is a need for standardized BIM models and evaluation models that can flexibly respond to these changes, suggesting a system that can review comprehensive information through BIM auxiliary programs is necessary.

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