A Feasibility Study of BIM Technology in the Renovation Process of Ageing Districts

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Abstract. At a time of rapid technological development, people's demand for quality of life is increasing. To ensure that the core location of the region is integrated with the surrounding locations, the government is working on the renovation and refurbishment of the old community. In the process of renovation, the establishment of a building information model and the realization of building Informa ionization can provide the whole process and multi-faceted data support for the renovation project. This effectively improves the quality of the project and provides assistance for operation and maintenance during the use of the building. Based on this, this paper takes BIM technology as the entry point, describes the application of BIM technology in the transformation of old areas, and conducts research on the technical transformation of old areas.

Keywords: BIM, old community renovation, residential building, BIM-parametric refurbishment.

1. Introduction

BIM, or Building Information Modeling, is officially explained as using Revit software, BIM models were created for typical existing and new homes. Based on the BIM models created, alternative renovation scenarios and different reconstruction scenarios were developed. The application of BIM technology is expected to assist city planners and urban development planners in making urban development decisions, especially in densely populated neighborhoods.

In recent years, under the support of advanced technology, advanced technology, all points of the new district have adopted a more perfect technical system, the whole district building structure, and building function optimization, to improve the actual application of the building quality. However, for some of the older neighborhoods, it is limited by the constraints of construction technology and building materials, etc., in the inherent life cycle, it is difficult to play out the corresponding architectural functions, which in turn creates a lagging problem with the new period of the construction market. Along with the continuous improvement of people's quality of life, the function and quality demand for the old community is also gradually improved. The realization of the old community renovation project is to analyze the existing district environment and building structure. The realization of the old neighborhood renovation project is to analyze the existing neighborhood environment and building structure, etc., and formulate the technical renovation process in line with the new technology, new materials, and new equipment to ensure that the realization of each type of function is based on people's demands and to improve the quality of the actual application. The paper discusses the application of BIM technology in the transformation of old neighborhoods.

2. Development of BIM Technology and Current Strategies for Renovation of Old Community

2.1. The Development of BIM Definitions

Prof. Charles Eastman of the School of Architecture at the Georgia Institute of Technology in the United States created the idea for BIM at the end of 1970 [1]. The viewpoints of BIM have expanded since its creation. Design, estimation, the building life cycle, performance, and technology are some of these viewpoints. Applying BIM has distinct objectives during the pre-construction, construction, and post-construction phases of a construction project [2]. The Architecture, Engineering, and

Construction (AEC) industry has been using BIM in construction projects since the middle of the 2000s [1,2]. The National Cancer Institute (NCI) in Putrajaya, Malaysia, the Crussel Bridge in Helsinki, Finland, the Sutter Medical Center in Castro Valley, California, and the One Island East office building are all examples of BIM projects. at the University Tun Hussein Ong in Johor, Malaysia, and the Sultan Ibrahim Hall (formerly the multi-Purpose Hall) [3]. Eastman asserted that the lack of updating and the difficulty in envisioning the building led to inefficient construction designs in the late 1970s [3]. To address these issues, several organizations in Finland and the United States created a computer program employing information and communication technology (ICT). The evolution of the definition of BIM based on the development of computer programs from 1975 to 2023 can be seen in Figure 1.

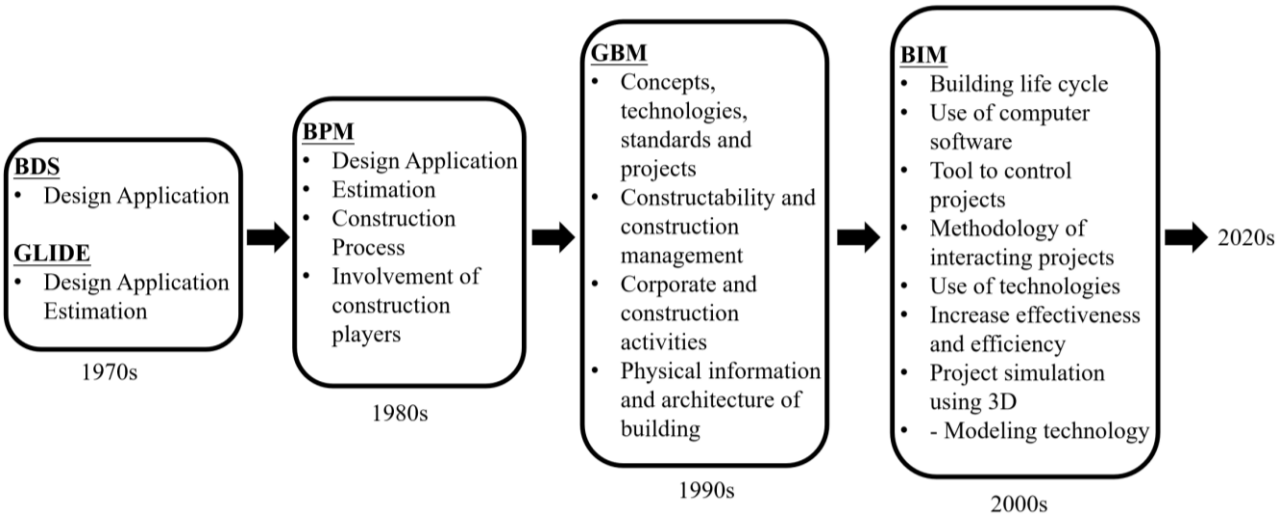

Figure 1. The development of BIM definitions (Picture credit: Original)

2.2. Literature Review on Renovation of Old Community

In 1961, Jacobs raised concerns about the demolition and reconstruction approach to renovating historic cities and proposed that the distinctive characteristics of each historic city and the diversity of residential communities should be protected [4]. Jacobs argued that renovations should be carried out gradually and on a small scale. Old residential neighborhoods can be renovated following resident requirements and capacities, according to Highfield and David [5]. This is a financially sound strategy to enhance inhabitants' quality of life. Botta proposed three residential retrofitting strategies, including sustainable retrofitting, environmentally friendly retrofitting, and prudent retrofitting [6]. He asserted that thoughtful examination of a wide range of issues, including technology, history, society, the environment, and people, is necessary for sustainable home remodeling. According to Weinsziehr et al., low household income, the presence of elderly family members, and the cost of retrofitting older structures are the main barriers to the energy-efficiency retrofitting of existing buildings in aging neighborhoods [7].

Zhang et al. conducted a case study of the Sanhejiayuan neighborhood retrofit project in the East District of Ningbo Airport and evaluated the relevance, important elements, and practice of "+sponge" retrofitting of historic communities [8]. Using collective action theory, Li and Wang investigated the value preference dilemma and the difficulties of negotiating scales when renovating elevators in an elderly residential neighborhood in Guangzhou City [9]. Wang and Li examined the problem of constructing elevators in an old residential construction project and investigated alternative solutions using deliberate policy analysis based on role-playing [10]. Liang et al. were able to examine and classify the need for property management by fusing the characteristics of traditional property management with the problems that occur after rehabilitating older communities [11]. They then proposed a management model appropriate for property enterprises and related suggestions for improving and transforming property management. Ni introduced the formulation and deviation

analysis of the progress management plan of the renovation project, among other methods for ensuring the management of the rehabilitation project's progress in historic residential areas [12].

3. Status of BIM Application for Renovation of Old Community

3.1. Advantages of BIM Technology Based on Emission Reduction Policies

Under the ongoing implementation of the strategy of energy conservation and emission reduction in buildings, the transformation of old buildings in China is also gradually accelerated. This primarily refers to the analysis of the substantial energy use and pollution problems existing in the old building system, and then combining with new technologies and techniques to achieve the optimization of the whole process to improve the quality of the entire building applications. The existing building energy consumption structure, In the implementation of new technologies, the traditional building system of high energy consumption has become the main benchmark for the optimization of the current structural system, such as HVAC engineering and heat ventilation structure, etc, and the new period of the building benchmarks there is a certain degree of variability, which requires the entire project construction, three-dimensional analysis of the original building structure, to provide data support for the subsequent renovation works and program determination. The determination of the data support [13].

The construction and application of the building information model is to carry out three-dimensional and visualization analysis for the whole old building structure, through the parameterized authentication of data information, to ensure that the building process presented by each data structure can accurately explain all kinds of influence mechanisms within the scope of the whole project. In addition, in terms of the design and functionality of the old building structure itself, there are certain differences between the technical process the structural framework, and the new building system, while the construction of BIM technology can be deeply rooted in the entire technical process, and through the corresponding instrumentation, the hidden defects within the building structure can be detected, for example, through the condition detection instrumentation to analyze the wear and tear within the building structure, and to combine with the existing construction benchmarks to construct the building structure. Combined with the existing construction benchmarks, construct a more complete construction and transformation system, in line with the needs of engineering construction [14].

3.2. Applicability of BIM Technology in Different Situations

Different cities and regions have different building forms and problems with older housing, and BIM can help people analyze the problems in a targeted way and provide more visual solutions. The normal service life of an apartment building in many Asian cities is 20 years due to the poor quality of the building materials and components. Reduced visual comfort for residents is caused by components of transparent and translucent materials that deteriorate quickly, require little care, and have limited daylight access in typical apartment designs. Utilizing BIM software, the current apartment was virtually rebuilt. The building model was converted to computer-aided design software before the parametric daylight analysis was conducted using environmental simulation software. Enhanced modular building envelopes and apartment designs that use less energy for artificial lighting, heating, and cooling have been developed for better visual and thermal comfort. The visual comfort analysis of the renovated flats revealed an average improvement in daylight autonomy and a factor of 15% [15].

BIM tools are frequently used to conduct in-depth evaluations of various construction programs, particularly in terms of embedded environmental implications. If data from BIM and LCA are merged, especially at the building level, the amount of effort required for life cycle impact assessment may be minimized. This is supported by a study conducted in collaboration with the City of Vancouver as part of the City's initiative to repair the City's historic heritage properties. By comparing the effects of production, construction, operation, and demolition, the study sought to analyze the life-cycle

greenhouse gas emissions of older (pre-1940) homes under various refurbishment or rebuilding scenarios [16]. The municipality identified several renovation or reconstruction scenarios using the data computed in BIM based on the findings of the pilot project study, which identified the actual retrofit possibilities for the aforementioned building complexes to be taken into account in the grant program as well as the most popular and affordable ways to improve the energy performance of the existing buildings. The most effective residential development scenarios for aged building complexes in North America can be identified using the analyzed data from BIM, whether it be to renovate current homes or build new homes by demolishing old ones.

4. Combination of BIM Technology and Renovation of Old Community

BIM technology has gradually matured and is being used in various building and infrastructure sectors. The application of BIM technology in the renovation of old districts has become an inevitable trend.

4.1. The Convenience of BIM Technology

BIM technology is frequently used to refer to computer-aided designs that are 3D graphic-based, object-oriented, and important to architecture as a new tool for architecture, engineering, and civil engineering. It may integrate a range of information in a three-dimensional model information database and be involved in a building's design, construction, and operation up until the end of the building's full life.

BIM models were made for typical new and existing residences using the Revit software. Alternative refurbishment scenarios and various rebuilding scenarios were generated based on the BIM models that were created. To get the best results, various options are contrasted and compared simultaneously. The BIM model can also assist the designer in figuring out the life cycle greenhouse gas emissions associated with each choice during the manufacture of materials, construction, operation, maintenance, and demolition phases of the life cycle.

A multi-category bill of materials that contains all the building supplies needed for both new and existing homes can be created using the built BIM model. The GHG emission values for each construction material were discovered using the TRACI 2.1 V1.04 methodology and the Ecoinvent 3.3 life cycle inventory database in SimaPro 8.3 [16]. Additionally, the BIM model was used to determine the amount of materials removed and the amount of new materials added as a result of the renovation of the existing house. The Ecoinvent 3.3 database was used to estimate emissions from the disposal of waste. To preserve regional applicability, data from each region was used in all of the aforementioned material and process analyses.

Building information modeling (BIM) in architectural practice aids in limiting the number of structures, improving the accuracy of designs, and facilitating the sharing of building data and component information between various file formats, experts, and analytic tools [17]. In-depth analyses of diverse construction initiatives are regularly carried out using BIM technologies, especially in terms of embedded environmental effects. If data from BIM and LCA are merged, especially at the building level, the amount of effort required for life cycle impact assessment may be minimized. This is supported by a study conducted in collaboration with the City of Vancouver as part of the City's initiative to repair the City's historic heritage properties. The study of various building design solutions to lower a facility's service energy consumption is also made possible by the use of BIM modeling [19].

4.2. The Visualization of the Renovation in Old Community through BIM Technology

Optimized design for the renovation of the old community using BIM technology with a user-friendly interface for 3D visualization. Through the application of BIM technology, it can use the visualization characteristics, take the data information model as the support system of engineering design and construction, analyze and determine the whole design scheme through the data can be

operated, and ensure that the building process mapped out in the model is in line with the current demand for transformation of old neighborhoods. At the same time, the unified construction of the data information model, the model information can be truly rooted in the entire design phase process, to ensure that the professional construction of the question of the fit, through the whole process, the whole life cycle of the coverage of the characteristics of the real realization of the data information as a benchmark for the virtualization of the reconstruction, and further through the simulation of certification of all types of design links exist in the hidden problems for the development of the subsequent engineering and construction projects. Provide data support to avoid unnecessary cost loss problems [20].

In the engineering construction process, BIM technology itself has the data model construction function, can be based on the data parameters, the loss of different projects in the data analysis such as mechanical and electrical engineering, plumbing and air conditioning engineering, etc., through the data listed each other, to ensure that each type of parameter information will not be in the intrinsic data model within the space of the collision and conflict phenomenon, and then ensure that the relevant lines in the use of the process of consistency. To ensure the consistency of the relevant lines in the use of the process. In addition, through the marking and listing of data parameters, the installation efficiency can be maximized to ensure the logic and professionalism of each type of construction process to meet the demand for refined construction.

4.3. BIM Technology Applied to the Renovation of Transportation Systems in Old Community

4.3.1. Pre-construction Applications

In the pre-construction application, based on the existing service life of the old neighborhoods, some of the old neighborhood buildings have been in use for about 30 years, and in terms of technology and materials, along with the internal and external wear and tear, the load of the building structure of the old neighborhoods has already reached a critical value. At the same time, from the design point of view, there are certain limitations in the design form of the sense of age and the overall structural performance, which makes the spatial environment and the internal structural characteristics of the actual application process cannot meet the requirements of the new era of the application of building structures. For this, in the actual construction process, the application and realization of BIM technology should be implemented in the whole building system.

Firstly, BIM technology is applied to construct and analyze the data model of the building structure, detect whether there is any parameter difference in the internal structure, and further determine whether the material performance and the use of the whole building can achieve consistency.

Secondly, considering the coordination between the whole building structure and the surrounding environment, BIM technology can be utilized to carry out the whole process of pre-construction analysis, such as the ecological environment, quality environment temperature, humidity environment, etc., to define the functional layout of the old building as well as a series of problems that existed during the design process, and then formulate a more comprehensive design and transformation plan by combining the data parameters.

Thirdly, the use of advanced measuring instruments can carry out three-dimensional data acquisition and analysis of the entire building structure. Relying on BIM technology, the diversified information of the building structure can be detected more intuitively and scientifically. For example, the laser scanning technology will present in the building structure with all kinds of parameters and structural defects for all-round mapping, to ensure that the structural performance and parameters of the docking between. Through these techniques, the later transformation process can be combined with the parameter changes in the abnormal situation and set out the corresponding plan to meet the project maintenance needs [21].

4.3.2. Applications in the Construction Process

The construction phase in the transformation of old district buildings has comprehensive and complex characteristics, which must ensure the relevance of different professional construction, and need to ensure that construction professionals do not collide with each other so that the source can solve the problem of excessive cost loss and improve the efficiency of engineering construction. In the application of BIM construction technology, through the visualization function provided by the data model, the data information generated during the construction process can be collected and analyzed in real time, and the logical relationship between the data can ensure that each type of information in the presentation process is based on the building construction process for real-time expression. At the same time, BIM can also provide a data integration platform for the construction side and the supervisory side, so that the coordination between them is more detailed, deepening the focus of engineering construction. The data communication function supported by the BIM platform can be used for quick communication between the project unit and the design unit, and then technical improvements can be made on the platform. Through the simulation function of the data model, each engineering construction point has a feasible communication mode between the two sides, truly realizing the controllable analysis based on technology, and improving the overall quality of engineering construction [22]. The floor plan of the old house was drawn based on the available data and the BIM model as shown in Fig. 2.

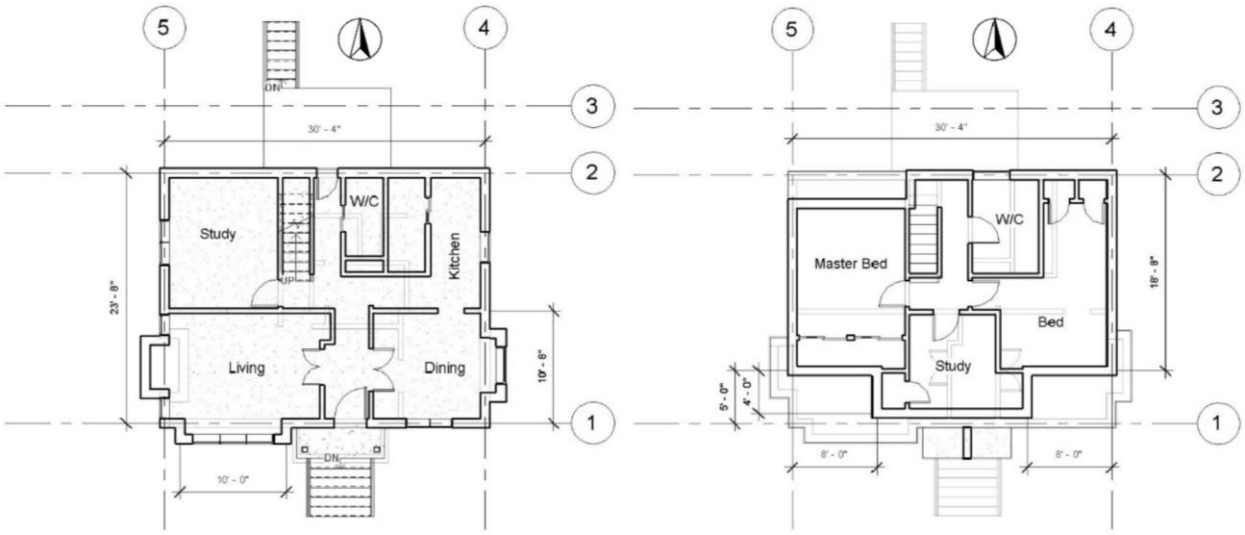

Figure 2. An example of an old house floor plan [16]

The data processing function carried out by BIM technology is built on the diversified and synergistic processing requirements of the whole system to realize the accurate listing of data. For the construction project, in the pre-design, medium-term construction, late operation, and maintenance process, the construction and application of the whole project system is the whole process in the construction process. The application of BIM technology can further deepen the project supervision utility, based on the construction of the data information and internal resource base, to realize the systematic and scientific data comparison and analysis. These applications for the entire engineering construction planning and engineering promotion effect, can be real-time data changes, through the data simulation visualization function, the entire engineering construction digital listing, and further promote the engineering project. Take the collaborative processing of cost budget and cost loss as an example, Through the chart and CAD automatic generation function of BIM software, the economic consumption generated by the whole material technology and labor is analyzed, and then the consumption points between different professions are statistically analyzed. In the process of the whole project, BIM technology is used to deeply analyze the loss rate generated by different price parameters, and then simulate and analyze the cost of the whole old district in real time. Finally, compared with the benchmark database, find out the proportion of loss in the construction of the building, which can more quickly account for the cost of the budget items and various types of

exceeding the standard data, etc., and further provide data support for the consumption of the total amount of the project and the construction[23].

5. Conclusion

The application and realization of BIM technology in the transformation of the old community can maximize the efficiency of the project. Through the globalization and visualization of data analysis, ensure that the implementation of technical processes can be correctly used in the transformation of the district project to improve the quality of engineering construction. Looking forward to the future development process, the state can increase resource investment, fully explore the new technology system, improve the efficiency of the transformation of old urban areas, and lay a solid foundation for urban construction.

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