

Environmental Impact of Green Building Design Based on BIM Technology

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ABSTRACT

To alleviate the environmental damage caused by traditional buildings, green buildings came into being. However, the current green buildings are not comprehensive enough, with limitations such as limited green concept, difficult design, uneven quality, the lack of technical talents and high cost. This paper summarizes the characteristics of BIM Technology, which is combined with the application of BIM Technology in green buildings. It found that the application of BIM Technology improves the green building design, reduces the waste of resources, shortens the construction time of green buildings, and reduces the environmental pollution and carbon emission caused by the construction.

Keywords: *green building, BIM technology, environmental protection, building performance analysis*

1. INTRODUCTION

With the continuous development of science and technology, people's quality of life is constantly improving and their demand for housing is also increasing. In this case, people's pursuit of quality of life is in contradiction with environmental protection, and the high energy consumption caused by buildings has caused serious damage to the environment. According to Lan Hamilton [1], in 2019, the total carbon dioxide emissions of the global construction sector reached the highest value so far. Nearly 1 billion tons of carbon dioxide emissions accounted for 28% of the total global energy related carbon emissions, and the decarbonization momentum of the construction sector was slowing down. From 2016 to 2019, the global decarbonization process was almost halved. In this case, the goal of achieving a net zero carbon stock by 2050 is far from being achieved. According to He [2], the original buildings are facing severe challenges. Most buildings have huge building energy consumption, the proportion of building water in urban water resources consumption is too heavy, and it is easy to cause serious environmental pollution in the production process. With the influence of COVID-19, the healthy and stable building environment will be further destroyed. Therefore, the development and use of green buildings is imperative. This paper summarizes the characteristics of BIM Technology and its application in green buildings and summarizes the positive impact of

green buildings based on BIM Technology on the environment.

2. GREEN BUILDING

2.1 Definition

The Green Building is a high-quality building to save resources, protect the environment, reduce pollution, provide people with healthy, applicable, and efficient use space, and maximize the harmonious coexistence between man and nature in the whole life cycle.

2.2 Design Concept

Green design refers to giving priority to the environmental attributes in the whole life cycle of the product while ensuring the basic performance, service life and quality of the product [3], which means that the design of green building should not only meet the requirements of energy conservation and emission reduction, but also meet the due performance of the building, and this requirement should run through the whole life cycle of the building. According to Su [4], Green Building should include: first, energy conservation; Second, combining with climate; Third, material and energy recycling; Fourth, respecting users; Fifth, respecting the base environment; Sixth, excellent overall design concept. According to Tang [5],

combined with the characteristics of modern architecture, four principles of green design can be summarized:

First, the principle of reasonable economic expenditure: all excellent green building designs should be implemented under the condition of reasonable expenditure. Excellent economic evaluation is the basic condition for decision-makers to make decisions

Second, the 4R principle of resource utilization: 4R including Reducing Reusing Recycling and Renewable, which need be paid attention to the use of resources

Third, Environmental affinity principle: green buildings should not only meet the comfort of the internal environment of the building, but also maintain the ecological environment outside the building

Fourth, high social recognition: an excellent green building design should respect the local cultural tradition, try to integrate with the local style and obtain the acknowledgement.

2.3 Significance in environmental protection

With the proposal of green building and the positive response from all over the world, the traditional development mode of construction industry began to change. The traditional construction industry is one of the three major energy consuming industries. Its energy consumption accounts for 30% in the society and 16% of building materials resources. In the whole life cycle of design, construction, use and demolition, a large amount of energy and resources will be consumed and cause serious pollution to the environment [6]. The emergence of green buildings has greatly alleviated this situation. In the process of construction, green buildings focus on natural environmental factors such as air circulation and the use of sunlight and use advanced ideas and technologies to solve the problem of environmental pollution. The design strives to be harmonious and integrated with the surrounding environment, ensure the comfortable experience of residents, promote the harmony between man and nature, and effectively protect the natural environment [7].

3. BIM TECHNOLOGY

3.1 Definition

BIM refers to Building information modeling. This concept was first proposed by Chuck Eastman of the United States in the 1980s. BIM technology includes all model information, functional requirements and

component characteristics required by architecture, and integrates all information of the whole life cycle of a building project from design, construction, maintenance and demolition. This concept was perfected and summarized by NBIMS national building information model standard in 2007: BIM technology digitally expresses the physical and functional characteristics of construction projects. It is a reliable knowledge sharing and decision-making basis for the whole life cycle of construction projects. It is the behavior of building virtual building models. The goal of BIM Technology is to visually analyze the project and conflict, check the standards and specifications, carry out the project cost, etc.

3.2 Main Features and Advantages

Comprehensive model information: BIM Technology not only provides basic information such as geometric information and physical information, but also includes design information such as structure type and building materials, as well as construction information such as construction cost, progress and quality [9].

Mutual correlation of model information: for the model established by BIM Technology, mutual identification and correlation of information can be achieved in different stages and different construction types, and the data is time effective. The modification of a certain content will automatically link with other relevant contents for change. The accuracy and efficiency of the design are improved [10].

Parameterization of model information: BIM Technology defines the geometric parameters of building objects, and digital parameters make energy consumption analysis and cost analysis convenient and intuitive.

3D model: the 3D model of BIM is different from the previous plane model. It better shows the overall structure of the building model, intuitively and clearly reflects the complex modeling of the building, which is convenient for all departments to have a better understanding and understanding of the building and is conducive to subsequent communication and exchange.

Diversification of export results: BIM model can export various forms of information results, such as plan, elevation, section drawing, bill of materials and equipment, bill of quantities, comprehensive pipeline layout; collision detection report and other data output results in the form of documents or tables, which is conducive to the comparative analysis and modification of schemes [11].

BIM technology has powerful building performance analysis function, which can provide real and reliable data for buildings through analysis, including energy use

and carbon emission, evaluate the performance, and optimize the buildings based on evaluation.

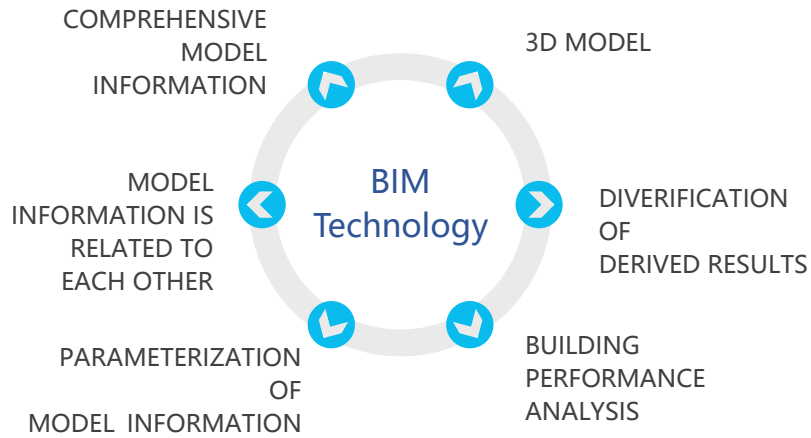


Figure 1. Main Features and Advantages

4.STATUS

4.1 Limitations of Green Building

In recent years, the green building industry is growing vigorously, but the rapid development is growing with pain.

First, the green building industry lacks professionals and designers who lack complete and clear ideas for green building design. In addition, there are few existing cases of green building which lack of practical reference, resulting in unclear design details. Secondly, the technical level is limited, and there are many Utopian green ideas. Even though many construction projects have adopted green building technology, the technology still has not been fully promoted. Many construction sites do not use the most advanced technology, resulting in good and bad green building quality. In the actual construction process, limited by the technical level, many green ideas are difficult to put into practice and cannot meet the initial expectations. Finally, the construction cost of green building is high, and there is often a waste of resources exceeding the expectation in the design and construction stage. In addition, to pursue interests, developers use the government's policy subsidies for the green building industry to blindly apply for projects for construction, which leads to the increase of various benefits of green building [12]. The long-term development of green building still needs more standardized design system and more advanced design technology.

4.2 Application of BIM Technology in Green Building

BIM Technology has a relatively perfect development in the construction field and can play an important role in all links of the whole life cycle of construction projects. It also plays an important role in the development of green buildings. The specific applications are as follows [13, 14]:

First, project feasibility judgment stage: the BIM Technology can provide the basic building model for the project for simulation, discussion, analysis, and judgment of relevant personnel. Unlike the previous analysis only through conceptual drawings, BIM model makes the project more intuitive and clearer, saves human and material resources, and avoids the waste of resources. BIM Technology can combine local geographic information, simulate local environmental climate, conduct suitability analysis, highlight design points, and integrate with the local environment.

Second is the design stage: the traditional 2D drawing design has high error rate, and heavy workload and is difficult to communicate. When a certain link is changed, most designs need to be changed one by one, which is time-consuming and labor force consuming. When BIM technology is put into use, all links are designed and changed according to the unified model. When one link needs to be changed, the parameters of other related links will be adjusted in time to make all links work together. The use of 3D model in BIM technology provides more

intuitive cognition for green building design, and can simulate daylighting, sunshine, ventilation, sound, and vision from multiple angles for the design team to discuss and analyze.

Third is the construction stage: before construction, the design plan can be checked for errors through collision inspection. The 3D model built by BIM technology can intuitively observe the irrationality of the design. Compared with the complexity of traditional drawings, BIM technology reduces the mistakes that may occur during construction and saves resources. BIM technology can be used for simulating the construction progress. Through the combination of space and time, a visual 4D (3D + time) model can be established to more intuitively and accurately reflect the whole construction process, make reasonable planning and construction planning, carry out scientific construction, effectively manage and control construction resources, reduce resource waste, shorten construction time and reduce environmental pollution caused by construction.

5. POSITIVE IMPACT ON THE ENVIRONMENT

Traditional software cannot accurately simulate the terrain, landform, vegetation and other objective natural factors, the lack of environmental analysis, resulting in the completion of the building cannot effectively protect the environment or even damage the environment. The application of BIM technology improves this situation to a large extent and has a positive impact on environmental protection:

First, BIM Technology has a powerful simulation function, which can establish a reliable natural environment model, understand the characteristics of the natural environment of the building to be completed in advance, rely on scientific analysis and improvement, adjust measures to local conditions, avoid possible damage to the local environment, and make an ideal environmental protection scheme. The green building based on BIM Technology can protect the environment more accurately and effectively.

Second, BIM Technology can provide technical support for the calculation of green building in building physics, thermal engineering, optics, acoustics, and other aspects, make the calculation and analysis more convenient and accurate, make the design planning of green building more scientific and reasonable, remove redundant design steps, save resources, make it better

distribution and application, and greatly reduce the cost consumption [15].

Third, the construction stage is the stage that causes the greatest damage to the environment in each stage of building completion. The excellent simulation ability of BIM technology can rationally arrange the construction site intelligently and avoid land waste. Management can achieve accurate control of resources, resource consumption statistics, water and electricity saving. Moreover, with the support of BIM technology, the cooperation between various departments of construction projects is more coordinated and efficient, which greatly reduces the working hours. It not only saves costs, but also reduces the environmental pollution caused by long-term construction.

Fourth, BIM's excellent evaluation system can analyze and provide a variety of information about green buildings, such as resource utilization and carbon emissions, which is conducive to designers to make more specific and reliable schemes for the optimization of green buildings. It makes every effort to rationalize resource utilization and minimize carbon emissions. It can also reduce the noise impact of the building itself on the surrounding environment by simulating the sound environment inside the building [16]. Complete information storage will also play a positive role in the future development of green buildings and improve the protection of the environment.

6. CONCLUSION AND PROPOSAL

At present, the destruction and consumption of the environment by buildings in the world are increasing day by day. The emergence of green buildings alleviates this situation and plays a positive role in the environmental protection. However, the current green buildings still have certain deficiencies. BIM technology is a modeling technology with comprehensive modeling information and interrelated characteristics, which can be applied in the early, middle, and late stages of green buildings. It makes up for the shortcomings of current green buildings, saves costs, shortens construction time, reduces environmental pollution caused by construction, reduces carbon emissions, and is conducive to environmental protection. This paper only had a discussion based on the combination of existing BIM technology and green building, it lacked a specific data comparison and simulation. In the future, it will start to compare the green buildings designed by BIM technology in the world with ordinary green buildings, to better highlight the importance of BIM technology. With the continuous

development of science and technology and the gradual improvement of BIM technology, BIM technology can be put into more fields in the process of green building design and make contributions to environmental protection.

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