Research on the Optimization of Green Building Performance Based on BIM Technology

Le Lv*

Architectural Design Institute, Chinese Academy of Engineering Physics, Mianyang 621000, Sichuan Province, China

Corresponding author: Le Lv, lvle3333@qq.com

Abstract: With the acceleration of urbanization, the construction industry has developed rapidly worldwide but has also brought serious environmental problems. Traditional architectural design methods often only focus on the function and beauty of the building while ignoring its impact on the environment. In addition, the lack of effective design and construction management methods also led to high resource and energy consumption. To overcome this challenge, the concept of green building came into being. Green buildings emphasize reducing the negative impact of buildings on the environment and improving resource utilization efficiency throughout the entire life cycle. BIM technology provides strong support for achieving this goal. Based on this, starting from the role of BIM technology in green building performance optimization, this article analyzes the optimization of green building performance solutions based on BIM technology in detail to promote the sustainable development of buildings.

Keywords: BIM technology; Green building; Performance solution optimization

1. Introduction

As the concept of sustainable development continues to spread and environmental problems become increasingly severe, green buildings, as an important practice to achieve energy conservation and emission reduction in buildings and promote ecological balance, have become an inevitable trend in the development of contemporary architecture. Green buildings focus on the efficient use of resources and minimization of environmental impact in all aspects of design, construction, operation, and maintenance, aiming to provide a healthy and comfortable living and working environment while achieving economic benefits during the life cycle. Among them, optimizing the performance of green buildings through scientific and technological means is the core of green building research. BIM technology is widely used in the construction industry. Its efficient and accurate data processing and visual display capabilities have significantly improved the design, construction, and management levels of buildings. Integrating BIM technology into the field of green buildings can achieve refined management and dynamic analysis of the overall performance of the building, thereby providing strong technical support for the optimization of green building performance solutions.

2. BIM technology and green building

BIM technology is a digital tool representing the physical and functional characteristics of buildings, infrastructure, and equipment. It provides a collaborative platform for all project participants by creating a shared information model, improving work efficiency and information consistency. BIM technology can be used throughout the entire life cycle of a building, from design and construction to operations management. Green buildings fully consider energy conservation, environmental protection, economy, adaptability, and other aspects in building design, construction, and operation, aiming to reduce the negative impact on the environment and provide users with healthy, efficient, and suitable buildings. Its characteristics include energy saving and efficient use of resources, reducing environmental load, improving indoor environmental quality, and considering the impact of the entire life cycle.

3. Role of BIM technology in green building performance optimization

3.1. Realizing full-professional collaborative design and improving design efficiency and quality

In green building design, collaboration among various disciplines is crucial. BIM technology provides a unified platform for architecture, structure, electromechanical engineering, and other majors, allowing each major to be designed using the same model. This can effectively avoid the loss and misunderstanding of information transmission and ensure the coordination and accuracy of the design. In addition, BIM technology provides efficient and accurate design tools for green building design. Through BIM software, designers can quickly create three-dimensional models for performance analysis and optimization, improving design efficiency and reducing error rates, thus improving design quality [1,2].

3.2. Optimizing the selection of building materials and resources and promoting the integration of renewable energy and energy-saving technologies

BIM technology can help designers choose more environmentally friendly and sustainable building materials and resources. Through information like the source, production process, and transportation of the materials in the BIM model, materials with less impact on the environment can be selected. In addition, using BIM technology, renewable energy systems and energy-saving technologies such as solar and wind energy can be easily integrated into building design. The optimal energy system layout and configuration can be found through simulation and analysis, thereby improving energy efficiency and building sustainability [3].

3.3. Improving building performance prediction and evaluation capabilities and promoting sustainable development of the construction industry

Through the simulation and analysis functions of BIM technology, the performance of the building in terms of energy consumption, environmental comfort, natural lighting, etc., can be predicted during the design stage. This allows designers to promptly identify and address potential performance issues, improving the building's sustainability and adaptability. At the same time, applying BIM technology in green building performance optimization also promotes the sustainable development of the construction industry. It enhances environmental awareness and technical levels of architectural design and drives the development of related industrial chains. This helps to build a more sustainable and environmentally friendly construction industry ecosystem [4].

4. Green building performance solution optimization based on BIM technology

4.1. Energy-saving design

In terms of energy-saving design, BIM technology can optimize design plans and improve the energy efficiency of buildings through its characteristics of parameterization, visualization, and information sharing. First, using the 3D modeling function of BIM, designers can visualize the design of the building at an early stage and intuitively observe and optimize the layout and shape of the building to make full use of renewable energy sources such as natural light and wind energy. Secondly, through BIM's energy consumption analysis tools, designers can accurately calculate the energy consumption of the building and optimize it accordingly. For example, energy-saving effects can be achieved by adjusting the design of the insulation layer of the building wall and selecting window types. Besides, by simulating the light environment of the building through BIM, designers can reasonably design the windows and external shading facilities of the building to make full use of natural light and reduce artificial lighting [5]. In addition, by using BIM to simulate the wind environment around the building, designers can rationally design the building layout, improve the ventilation efficiency of the building, reduce the use of air conditioners, and reduce energy consumption [6].

4.2. Green building material selection

Green building materials, also known as ecological building materials, refer to building materials that can reduce the negative impact on the environment during production, use, and reuse while performing excellently. With the continuous improvement of environmental awareness, more and more construction projects are choosing to use green building materials.

With the help of BIM technology, efficient selection of green building materials can be achieved. This mainly lies in BIM technology's information integration and sharing, simulation, and optimization functions. First, BIM models can integrate all information about the building, including the performance, specifications, costs, etc., of building materials, allowing designers, architects, and engineers to quickly compare and choose suitable green building materials. Secondly, BIM software can simulate the building environment, such as heat conduction, lighting, wind direction, etc. Through simulation, the environmental impact of different building materials can be predicted to optimize material selection. Furthermore, BIM technology can accurately calculate the quantity and specifications of building materials, thereby accurately controlling costs. Simulation can also predict material requirements during construction to avoid waste. BIM technology can also accurately schedule and prefabricate materials, reduce on-site construction errors, and improve construction efficiency [7].

When selecting green building materials with the help of BIM technology, the following steps should be followed: (1) Before selecting green building materials, it is necessary to clarify the evaluation standards of green buildings and the specific needs of the project; (2) BIM software is used to establish a detailed model of the building, including structure, equipment, and various professional contents; (3) Information on various green building materials, including performance parameters, environmental protection standards, costs, etc., are obtained and a green building materials library is established; (4) the information are input into the BIM model according to construction needs and standards, and the building materials are adjusted to simulate the impact of different materials on building performance, such as heat insulation, thermal insulation, and lighting; (5) using BIM models, the quantity and construction time of required building materials can be accurately calculated, and cost and time planning can be carried out; (6) an environmental impact assessment of the selected green building materials is conducted, such as carbon emissions and resource consumption, and their results are compared with traditional building materials to make optimal decisions; (7) in the BIM model, the building materials' source, performance parameters, and maintenance requirements can be recorded in detail to facilitate later maintenance and management.

4.3. Climate adaptability design

Adapting to climate change and improving buildings' climate adaptability are core components of green building design. BIM technology provides a powerful tool for climate adaptability design, helping to optimize the performance of green buildings [8].

BIM models can simulate the performance of buildings under different climate conditions, such as temperature, humidity, wind pressure, etc., and then analyze their impact on building performance. Through simulation, designers can predict and solve possible problems in advance and optimize design plans. Secondly, BIM software supports parametric design. This means that designers can adjust architectural design parameters according to climate conditions, such as the building's orientation, window-to-wall ratio, shading facilities, etc., to better adapt to climate change [9].

At the same time, combined with the energy consumption simulation function of BIM, the energy consumption of buildings under different climate conditions can be analyzed, the energy system design of the building can be optimized, and the energy utilization efficiency can be improved. In addition, BIM technology can facilitate collaborative work among various disciplines, including structure, electromechanical, landscape, and other disciplines. Various factors can be comprehensively considered through multi-disciplinary collaborative design to achieve better climate adaptability design [10].

4.4. Smart device integration

With the advancement of science and technology, smart devices such as smart lighting, smart security, smart HVAC, etc., are increasingly used in buildings. The integration of these devices can not only improve energy efficiency and reduce energy consumption [11] but also improve the comfort and safety of the building. BIM technology also offers many advantages in terms of intelligent equipment integration. The BIM model contains all information about the building, including the equipment's location, specifications, performance, etc., which provides a unified information platform for integrating smart equipment. Secondly, BIM technology can realize collaborative design between various disciplines so that the intelligent equipment can be seamlessly integrated into the main building. Furthermore, through the simulation function of BIM, the impact of smart equipment on building performance can be predicted, thereby optimizing the layout of the equipment. In addition, through BIM models, intelligent equipment can be easily managed and maintained, improving operation and maintenance efficiency.

When integrating smart devices based on BIM technology, the types, and functions of smart devices that need to be integrated must first be clearly defined based on the functional requirements of the building. Then, BIM software will be used to build a detailed model of the building. The model needs to include the structure, the equipment used, and other professional contents. After the model is established, the intelligent equipment should be selected and arranged in the BIM model according to requirements. This step requires consideration of the equipment's performance parameters, space requirements, and impact on building performance. In this process, it is necessary to ensure that the design of intelligent equipment is coordinated with the main design of the building to avoid conflicts. At the same time, the convenience of installation, commissioning, operation, and maintenance of the equipment needs to be considered. After the settings are completed, you can use the BIM software's simulation function to simulate the smart equipment's operating effects. For example, simulate the lighting effects of intelligent lighting systems in different scenarios and the impact of intelligent HVAC systems on the indoor environment. The equipment layout and system configuration are optimized and adjusted based on the simulation results. After completing equipment installation and system integration, comprehensive testing must be carried out to ensure that all smart devices are operating normally and that the overall system

performance meets expected goals. Finally, all information related to smart device integration must be compiled into complete documentation and delivered to the owner or operator along with the BIM model. The documentation should include an equipment list, layout diagram, system configuration diagram, operation manual, etc.

4.5. Long-term performance monitoring and optimization

A property management system based on BIM technology can achieve refined management of building facilities. By combining with the Internet of Things technology, real-time monitoring and early warning of building facilities can be achieved, improving facilities' operating efficiency and extending the facilities' service life. BIM technology and the Internet of Things can be used to build a long-term performance monitoring system for the building. The system can conduct real-time monitoring and data collection of building energy consumption, environmental parameters, equipment operating status, etc. Then, the collected data is processed and analyzed through data analysis software, and key indicators reflecting the building's performance are extracted. Using these indicators, the operating status of the building can be evaluated, and existing problems and room for optimization can be discovered. Finally, based on the results of data analysis, corresponding performance optimization measures are formulated. For example, adjusting the building energy system's working parameters, improving the building's environmental comfort, etc. Through continuous performance monitoring and optimization, the energy efficiency and environmental quality of buildings can be continuously improved [12].

5. Conclusion

BIM technology can effectively integrate and manage relevant data on green buildings. Dynamic simulation and analysis can assist designers in making more accurate and efficient design decisions, optimizing building performance, and achieving energy-saving goals. In the future, with the integration and application of BIM technology and other high-tech technologies such as big data, artificial intelligence, and the Internet of Things, it is expected that the performance of green buildings will continue to improve and the construction industry will develop towards a more intelligent and green direction. In addition, the continuous exploration and optimization of the integration and application of BIM and green buildings will also lead to new discoveries and progress in the research of this field. Green buildings will become smarter and more efficient in the future, further contributing to the sustainable development of society.

Disclosure statement

The author declares no conflict of interest.

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