



Research on the Design of Green Buildings Based on Building Information Modelling (BIM) Technology

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Abstract: This study explores the integration of Building Information Modelling (BIM) technology in the design of green buildings. By leveraging BIM technology effectively, the design quality of green buildings can be enhanced, ensuring alignment with relevant green building standards and fostering a harmonious relationship between green buildings and the environment.

Keywords: building information modelling; BIM technology; green building; design

1. Introduction

Green building engineering represents a crucial direction in contemporary construction projects. Many current projects strive to meet established green building standards. Designing green buildings in compliance with these standards ensures environmental harmony and enhances the quality of life for residents. This paper investigates the application of BIM technology in green building design, aiming to ensure its effective use and to enhance the living standards of building occupants.

2. Analysis of Building Information Modelling (BIM) Technology and Green Building Design

By integrating BIM technology with green building design principles, this analysis explores how buildings can meet stringent standards and enhance the quality of life for their occupants.

2.1 Analysis of BIM technology

Building Information Modelling (BIM) technology is a sophisticated digital tool that significantly enhances building design and construction processes. It allows for detailed 3D visualization of building projects, enabling construction personnel to observe and interact with comprehensive models. For example, architects and engineers can use BIM to create detailed floor plans, structural models, and MEP (mechanical, electrical, and plumbing) systems layouts. This visualization capability facilitates better planning and decision-making throughout the project lifecycle, from initial design to final construction and beyond.

BIM technology promotes effective coordination and communication among project stakeholders, ensuring that design, construction, and operational phases align with building standards. For instance, BIM can be used to identify and resolve potential clashes between different building systems, such as electrical conduits and plumbing pipes, before construction begins. This preemptive coordination reduces errors and rework, saving time and costs.

Additionally, BIM offers advanced simulation and optimization features. Architectural designers can perform energy analysis to optimize building performance, simulate different lighting scenarios to enhance indoor environments, and assess structural integrity under various conditions. These simulations help designers make informed decisions that improve efficiency and performance, such as choosing materials with better thermal properties or designing more effective ventilation systems.

BIM also supports precise control over architectural design and construction processes. Construction managers can use BIM to schedule tasks, allocate resources, and monitor progress in real-time, ensuring that projects stay on track and within budget. For example, by linking the BIM model to project management software, teams can visualize the construction sequence and identify any potential delays or bottlenecks.

Furthermore, BIM's mapping features provide valuable services for the operation and maintenance of buildings. Facilities managers can use BIM to track the location and condition of assets, plan maintenance activities, and ensure compliance with safety regulations. For instance, a facility manager can quickly locate a faulty HVAC unit within a building using the BIM model and access detailed maintenance records to expedite repairs.

Overall, BIM technology enhances the quality, efficiency, and sustainability of building projects, ensuring they meet

user needs and industry standards effectively.[1]

2.2 Green Building Design

Green building design integrates environmental considerations throughout a building's life cycle to enhance sustainability and performance. This approach ensures that buildings meet environmental standards, maintain functionality, and extend their service life. Key aspects include energy efficiency, resource conservation, and pollution reduction. For instance, energy-saving measures involve high-efficiency HVAC systems, solar panels, and advanced insulation to minimize energy consumption. Land and water conservation strategies can include green roofs, rainwater harvesting, and xeriscaping, reducing water usage and promoting biodiversity. Material conservation is achieved through recycled and sustainable materials, enhancing durability and reducing environmental impact.

Furthermore, green building design aims to minimize pollution by using low-VOC paints and finishes, efficient waste management systems, and air purification technologies, ensuring healthy indoor environments. These sustainable practices not only provide high-quality, eco-friendly living spaces but also promote a harmonious relationship between buildings and their natural surroundings. This holistic approach enhances residents' well-being while supporting broader environmental goals, such as reducing carbon emissions and conserving natural resources.

In green building design, it is essential to prioritize the health and well-being of occupants by focusing on indoor air quality, heat radiation, and environmental pollution. Addressing these factors during the design phase ensures that the building provides a healthy and sustainable environment for its residents. Additionally, incorporating intelligent design features, such as advanced network communication systems, video surveillance, and integrated control systems, enhances both security and operational efficiency.

Energy management is another critical aspect, requiring the integration of energy recycling and reuse systems to meet the building's energy demands sustainably. Optimizing spatial design is also crucial; by reducing the number of non-load-bearing walls, the building's practicality and flexibility can be significantly improved. Overall, these strategies collectively contribute to creating efficient, healthy, and adaptable green buildings.-load-bearing walls can be reduced, so as to promote the enhancement of the practicality of the building.

3. Impact of BIM Technology on Green Building Design

Analyzing the integration of BIM technology within the context of green building design is essential to ensure the successful completion of these projects and to enhance overall building performance. The following analysis examines how BIM technology impacts various aspects of green building design, highlighting its contributions to improving service levels and sustainability.

3.1 Achieve Digital Management

The application of BIM technology to building design can make the building design meet the needs of digital management. During the period of green building design, high standard management mode is chosen to save energy and protect the environment. During the green building design, it is necessary to develop a low-cost building that meets the requirements of digital management.[2]

The application of BIM technology in building design facilitates effective digital management. By adopting high-standard management practices during the green building design phase, it is possible to save energy and protect the environment. For example, BIM can be used to perform energy simulations, helping designers optimize the building's energy performance by selecting appropriate materials and systems. This ensures that the building meets stringent sustainability criteria, such as those set by LEED or BREEAM certifications.

Additionally, BIM technology supports the integration of IoT (Internet of Things) devices and smart building systems. These integrations enable real-time monitoring and control of building operations, such as HVAC systems, lighting, and security. For example, sensors embedded in the building can collect data on energy usage and indoor air quality, which can then be analyzed to make informed decisions about maintenance and operation, thereby enhancing efficiency and occupant comfort.

In summary, BIM technology not only facilitates the creation of low-cost, energy-efficient buildings but also supports the comprehensive digital management of the entire building lifecycle, from design and construction to operation and maintenance. This holistic approach ensures that buildings are sustainable, efficient, and responsive to the needs of occupants and the environment.[2]

3.2 Data support

The design phase of green buildings is influenced by numerous systematic, complex, and professional factors. It is essential to address critical elements such as water supply and drainage, ventilation, and heating to ensure that the building meets relevant green building standards. The implementation of BIM technology significantly enhances this process by providing robust data support.

One of the key advantages of BIM is its ability to perform simulations and analyses that support sustainable design. For instance, BIM can simulate water flow and drainage patterns to optimize the design of water supply and drainage systems. This ensures efficient water usage and minimizes waste, which is critical for green building certification.

Additionally, BIM technology can be used to model and analyze ventilation and heating systems. By simulating airflow and thermal performance, designers can optimize these systems to enhance energy efficiency and indoor air quality. For example, BIM can help identify the best locations for windows and vents to maximize natural ventilation and reduce reliance on mechanical systems.

That is said, BIM enhances the ability to track and manage materials used in the construction process. By providing detailed information about the quantity and type of materials required, BIM helps in selecting sustainable materials and reducing waste. This aligns with the goals of green building design, which emphasize resource conservation and environmental protection.

In summary, the integration of BIM technology in green building design provides substantial data support that enhances the planning, execution, and sustainability of the project. It allows for real-time information access, detailed simulations, and improved collaboration, ensuring that the building meets high environmental and efficiency standards.

3.3 Improved Design Reliability

During the green building design process, BIM technology significantly enhances the reliability and compliance of the design with relevant standards. By employing BIM, green building designs can achieve higher levels of energy efficiency and environmental protection, thereby improving the living standards of building residents.

BIM technology facilitates clash detection, which is crucial for identifying and resolving conflicts between different building systems before construction begins. For example, it can detect potential issues where ductwork intersects with structural beams or columns, preventing costly rework and delays. This proactive approach ensures that the construction process proceeds smoothly and that the final building operates efficiently and safely.

Moreover, BIM enhances the precision of cost estimation and scheduling. By providing accurate quantities and specifications of materials, BIM helps in creating more reliable budgets and timelines. This transparency ensures that projects stay within budget and on schedule, which is essential for maintaining the financial viability of green building projects.

BIM's ability to produce detailed, accurate design drawings is another critical aspect. These drawings are essential for obtaining building permits and meeting regulatory requirements. By ensuring that all design elements comply with green building standards, BIM helps in securing necessary approvals more efficiently. For instance, BIM can generate comprehensive documentation for LEED certification, streamlining the certification process and ensuring that the building meets all required sustainability criteria.

The integration of BIM technology in green building design provides substantial improvements in reliability and compliance. By enabling detailed visualization, advanced simulations, sustainable material selection, and enhanced collaboration, BIM ensures that green building designs meet high standards of energy efficiency, environmental protection, and occupant comfort. [3]

4. Analysis of Green Building Design Based on BIM technology

Using BIM technology as the foundation for analysis, this examination of green building design aims to understand how BIM applications enhance the service quality and performance of green buildings.

4.1 Simulation Analysis of Wind Environment

The application of BIM technology in green building design necessitates a comprehensive simulation analysis of the wind environment. This involves utilizing Computational Fluid Dynamics (CFD) technology through tools such as Autodesk Simulation CFD, PHOENICS, and ANSYS Fluent to conduct detailed analyses.[4]

For the outdoor wind environment, BIM technology facilitates performance analysis using airflow vector maps, trace maps, and pressure maps. This data is critical for the overall planning of the green building design, including the relationships between building groups and construction details, ensuring that the wind environment does not adversely impact the building.

In terms of the indoor wind environment, BIM technology enables precise analysis of air outlet arrangements, air formation, and air volume. This information is essential for designing an efficient and effective air conditioning system for the green building, ensuring optimal indoor air quality and thermal comfort.

4.2 Performance Analysis of Thermal Environment

In green building design, the thermal environment plays a crucial role in shaping the building's performance. It is essential to meticulously control this environment, employing BIM technology for detailed simulation of indoor temperature fields, vector fields, and other parameters. This allows for strategic design considerations such as sunshade placement and insulation material selection to ensure optimal thermal conditions and energy efficiency in the green building.[5]

Moreover, BIM facilitates strategic decisions regarding sunshade placement, glazing options, and insulation materials. These decisions are crucial for mitigating solar heat gain, reducing cooling loads, and ensuring year-round thermal comfort without excessive reliance on mechanical systems. BIM's ability to integrate environmental data enables designers to simulate different scenarios and optimize building envelope designs for maximum energy efficiency.

In addition to indoor considerations, BIM technology supports the analysis of outdoor thermal conditions across the building site. By analyzing solar exposure and wind patterns using geographic information systems (GIS) data integrated into BIM models, designers can minimize heat island effects and optimize site planning for natural ventilation and passive heating and cooling strategies.

Furthermore, BIM facilitates holistic performance evaluations by integrating acoustic, energy, and lighting simulations. Acoustic simulations ensure effective sound insulation, creating quieter and more comfortable indoor environments. Energy simulations assess the building's overall energy performance, helping to achieve sustainability goals by minimizing operational energy use. Optical simulations optimize daylight penetration and artificial lighting strategies, enhancing visual comfort and reducing reliance on artificial lighting.

5. Conclusion

This study centers on analyzing Building Information Modeling (BIM) technology as applied to green building design. It comprehensively examines the core aspects of BIM technology relevant to green building design, explores its implications, and delves into its impact on various facets such as wind environment simulation, thermal performance analysis, and other critical parameters. By focusing on these areas, the study aims to enhance the effectiveness of green building design, fostering harmonious integration with the environment and better meeting the needs of building residents.

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