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The Integration of BIM In the Application of Green Building Materials in Construction Projects

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ABSTRACT

In recent years, with the growing call for sustainable development, green building materials, which are of great meaning for reducing resource and environmental impacts, have attracted more and more attention. However, in China, a country with frequent construction activities and high resource consumption, the application of green building materials in construction projects still faces challenges. Building Information Modelling (BIM) as an emerging technology in the construction industry can increase the adoption rate of green building materials in construction projects. The aim of this study is to identify the barriers encountered in the application of green building materials in Chinese construction projects, and to propose corresponding improvement measures by integrating BIM in the decision making. This study adapted a qualitative research method, using semi-structured interviews as a research tool. A total of 6 respondents (including project managers, architects, engineers, and researchers) from Chinese construction companies and research institutions collected interview data and used Nvivo software to analyze and summarize. The results of this study show that although the application of green building materials in construction projects in China still faces challenges, including market acceptance and supply chain issues, cost and economic feasibility issues, and lack of relevant technology and knowledge. In addition, the study found that BIM technology made a great contribution in promoting the application of green building materials. Through BIM technology, the whole life cycle information management such as material selection, engineering simulation and performance evaluation of construction projects can be carried out, so as to improve the application of green building materials. By exploring the obstacles to the application of green building materials in China's construction projects and combining with the promotion of BIM technology, this study puts forward a series of specific suggestions and solutions to foster the application of green building materials. This research has made certain theoretical and practical contributions to foster the application of green building materials for the sustainable development of China's construction industry.

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1. Introduction

In today's society, sustainable development has become a global consensus, and people are increasingly aware of the limited resources and the urgency of environmental protection. In this context, green building materials, as a key factor in achieving sustainable building and environmental protection goals, are increasingly receiving widespread attention. Green building materials can not only effectively reduce resource consumption and environmental impact in construction activities [1], but also provide people with a more comfortable and healthy living environment. These advantages make the application of green building materials in construction projects an important research field.

At the same time, the rise and wide application of Building Information Modeling (BIM) technology has also triggered profound changes in the construction industry. BIM technology integrates and coordinates all aspects of construction projects through digital means, improves the efficiency of design, construction and operation, and effectively reduces waste of resources and costs [2]. It provides strong support for the sustainability and high efficiency of construction projects and has become an important tool in the field of modern architecture.

In this context, the combination of green building materials and BIM technology is gradually becoming the direction of exploration in the construction industry. The combination of green building materials and BIM technology can enable building projects to better consider sustainability, optimize resource utilization, and reduce environmental burdens in the design, construction, and operation stages [3]. This integration is of great and positive significance for realizing the goal of green buildings and promoting sustainable development. The objective of this paper is to find out the obstacles encountered in the application of green building materials in Chinese construction projects, and to put forward corresponding improvement measures by integrating BIM into decision-making.

2. Literature review

2.1 Concept and Application of Green Building Materials

This section will delve into the basic concepts of green building materials, and explore their application scope and practical effects in construction projects. By explaining the definition and characteristics of green building materials and their application cases in sustainable building practices, it will establish a comprehensive understanding of green building materials for readers and lay a solid foundation for in-depth research in subsequent chapters.

*2.1.1 Definition and characteristics of green building material*s

Green building materials refer to materials that are environmentally friendly, sustainable and energy efficient. They are designed to minimize environmental impact while providing long-term benefits to the building and its occupants. Green building materials are increasingly used in construction projects worldwide due to their environmental sustainability, energy efficiency, and economic benefits [4,5]. Its core features include energy efficiency, environmental protection and resource renewable. As one of the largest construction markets in the world, China is paying more and more attention to green building materials to reduce carbon footprint and promote sustainable development. As an important part of sustainable buildings, green building materials emphasize the minimization of resource consumption and environmental impact during their life cycle [6]. Green building materials not only have strict standards in the selection of materials, but also focus on reducing energy consumption and waste generation during use. This section will explain in detail the

definition, characteristics and standards of green building materials, paving the way for subsequent discussions on their application in construction projects. By reviewing the existing green building materials application cases at home and abroad, understanding the practical experience of different countries and regions in green building materials, and provide valuable reference for this study.

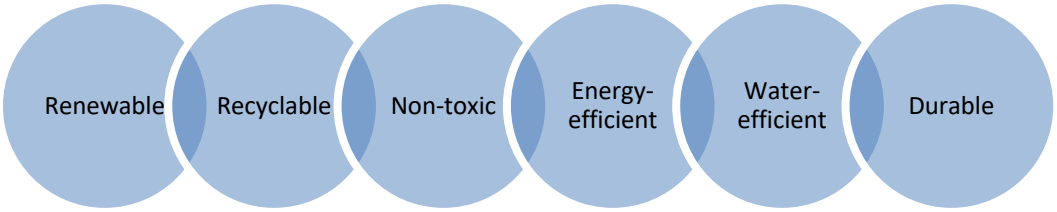

Fig. 1. Characteristics of Green Building Materials [5]

2.1.2 Application cases of green building materials in construction projects

Due to their sustainability and advantages for the environment, green building materials are becoming more and more common in the construction sector. Here are a few examples of green building practises used to building projects:

i. The Living skyscraper Challenge certification, one of the highest certifications for sustainable buildings, was earned by the six-story office skyscraper The Bullitt Centre in Seattle, Washington [24]. To save energy, the building's façade is constructed of FSC certified wood and has triple-paned windows. Rainwater is gathered and cleaned by the building's rainwater harvesting system, which is then used to supply the building with water. A composting toilet system that uses 90% less water is also present in the building.
ii. Another illustration of a green construction that incorporates sustainable materials is The Edge construction in Amsterdam, Netherlands [7,8]. The structure is intended to be energy-neutral and has earned the highest level of sustainability certification, BREEAM Outstanding. Photovoltaic panels on the building's façade provide more energy than the structure needs. Additionally, the structure incorporates a smart lighting system that minimises energy use by adjusting lighting based on occupancy and daylight levels.
iii. The Bank of America Tower in New York City is a sustainable building that has earned the LEED Platinum certification [25]. Low-iron glass covers the façade of the building, reducing solar heat gain and the demand for cooling. Additionally, a waterless urinal system that consumes 40% less water is used in the building. The structure also contains a cogeneration system that uses natural gas to generate power and heat, which lowers energy usage.

In conclusion, because of their strength and environmental advantages, green building materials are spreading throughout the construction sector. These case studies show how green building materials can be used in a variety of ways to improve buildings' environmental performance while using less energy and water. Green building materials are increasingly likely to be used as sustainability gains importance in the construction sector.

2.2 BIM Technology and Construction Industry

Building Information Modeling (Building Information Modeling, BIM) technology, as a brand-new digital building design and management method, has been widely concerned and applied in recent years. BIM technology originated in the 1980s. It was mainly used for three-dimensional model representation of buildings at first. With the advancement of computer technology, BIM has

gradually evolved into an integrated design and management tool [9]. Its core idea is to integrate building information into a digital model to realize the digital management of the whole process of construction projects, from design, construction to operation and maintenance, in order to improve efficiency, reduce costs and optimize decision-making [21].

BIM technology is widely used in the construction industry, covering all stages of construction projects [11]. First of all, BIM technology can realize highly detailed architectural models in the design stage, enabling designers to more intuitively display design intentions, and at the same time quickly compare and evaluate various design schemes. Secondly, BIM can realize the simulation and optimization of the construction process in the construction stage, reduce errors and conflicts, and improve construction efficiency. In addition, BIM technology can also support the management and operation and maintenance of construction equipment, and realize the information management of the whole life cycle of the building [12].

The advantages of BIM technology are mainly reflected in the following aspects. First of all, BIM technology can accurately express architectural design and construction information [11]., help all parties better understand the project, and reduce communication errors. Secondly, BIM technology supports multidisciplinary collaborative design, and different disciplines can work in the same model to improve the consistency and coordination of design. In addition, BIM also has simulation and simulation functions, which can predict the performance and response of buildings in different situations, and help optimize design and decision-making [10].

To sum up, the application of BIM technology in the construction industry not only improves the efficiency of design and management, but also provides new ideas and methods for the sustainable development of construction projects. In the application of green building materials, BIM technology is expected to play an important role in further promoting the realization and promotion of green buildings.

2.3 Integration of Green Building Materials and BIM

The integration of green building materials and BIM technology has a wide range of possibilities, providing a new way for the sustainable development and greening of construction projects [11].. This integration can be achieved in many ways, from material selection to building lifecycle management [23]., all of which can be supported and optimized with the help of BIM technology.

By integrating the characteristics of green building materials with BIM models, more accurate material selection, performance simulation and full life cycle management can be achieved at each stage of the construction project [22], thereby optimizing energy efficiency, reducing environmental impact, and contributing to the development of sustainable buildings. Provide strong support. This integration not only brings benefits to the design and construction process [20], but also continues to play a role in the operation and maintenance phase of the building, laying a solid foundation for more environmentally friendly and efficient construction projects. At the same time, the comprehensive sharing and integration of information can be realized [11], so as to achieve the sustainability and greening goals of each stage of the construction project. This integration provides new opportunities and challenges for the development of the construction industry, and also provides strong support for the promotion and realization of green buildings.

3. Research Methodology

3.1 Study Design

This section will introduce the research methodology adopted in this study, aiming to deeply explore the barriers to the application of green building materials in construction projects and the role of BIM technology in it. This research chose to use a qualitative research method because it can provide a deep and comprehensive understanding of the nature of the problem and the factors behind it [13]. Qualitative research methods can capture the real perspectives and experiences of participants in real-world scenarios, thereby providing diverse perspectives on research questions [14].

The core data collection method of this study is semi-structured interview. The reason for choosing a semi-structured interview is its flexibility and openness [15], which allows the interviewees to express their opinions freely and also allows the researcher to inquire in depth according to the purpose of the research [16]. In terms of interview design, the complexity of green building materials and BIM technology has been fully considered and developed interview guidelines for multiple roles such as project managers, architects, engineers and researchers.

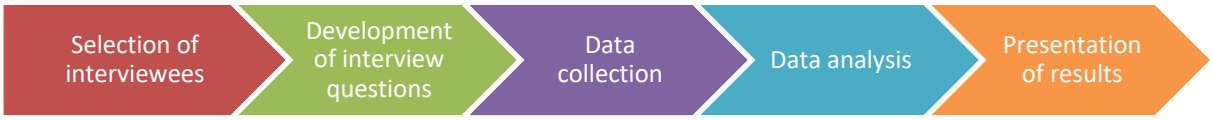

Fig. 2. Research Design [15]

Through the above research design [17], this study will fully understand the barriers to the application of green building materials in construction in the future, as well as feasible improvement constructions. Qualitative research method selection, providing insights and understanding, helps to demonstrate the reversibility and flexibility of the research topic.

3.2 Criteria of Respondents

The interviewees are all construction industry practitioners who are actively involved in the application of green building materials, and the interviewees who have participated in green building materials construction projects have all participated in at least one green building materials-related construction project. Of course, the requirement to participate in such projects is at least some understanding of green building materials and BIM technology, including relevant regulations. All interviewees have more than three years of experience in construction engineering, enough to be interviewed, and all have professional titles in related fields, mainly in three categories: project managers, engineers, and architects. Both project managers and engineers have practical application experience and can raise more practical questions and opinions. Architects have a deeper understanding of the definitions, advantages and disadvantages of green building materials and BIM technology.

3.3 Data Collection and Analysis

This section describes the selection process of the interviewees in detail, and selected relevant personnel with rich practical experience in Chinese construction enterprises and research institutions

as research samples. During the interview process, the privacy and informed consent of the interviewees were fully respected and ensure a comfortable and open interview environment [18]. Through in-depth exchanges with the interviewees, a wealth of data was obtained on the obstacles in the application of green building materials, the role of BIM technology, and improvement suggestions.

In order to effectively manage and analyze the large amount of interview data, this study adopted Nvivo software. The software provided powerful text analysis capabilities that allowed this research to categorize, label, compare and organize interview content to uncover patterns and associations [19]. Through this software, this study can dig deep into the meaning behind the data and provide strong support for subsequent research findings.

Through the introduction of research methods in this section, readers will understand the method selection and operation process in this research. This paper will make full use of the advantages of qualitative research and semi-structured interviews, deeply explore the status quo and problems of green building materials application and reveal the role of BIM technology in it. At the same time, the application of Nvivo software will provide reliable tools and support for data analysis.

4. Results and discussion

4.1 Barriers to the Application of Green Building Materials in Construction Projects

By collating and summarizing the opinions of participants in different roles, the obstacles encountered in the application of green building materials in construction projects were identified, including market acceptance, supply chain issues, cost and economic feasibility, technology and knowledge lack of many other obstacles.

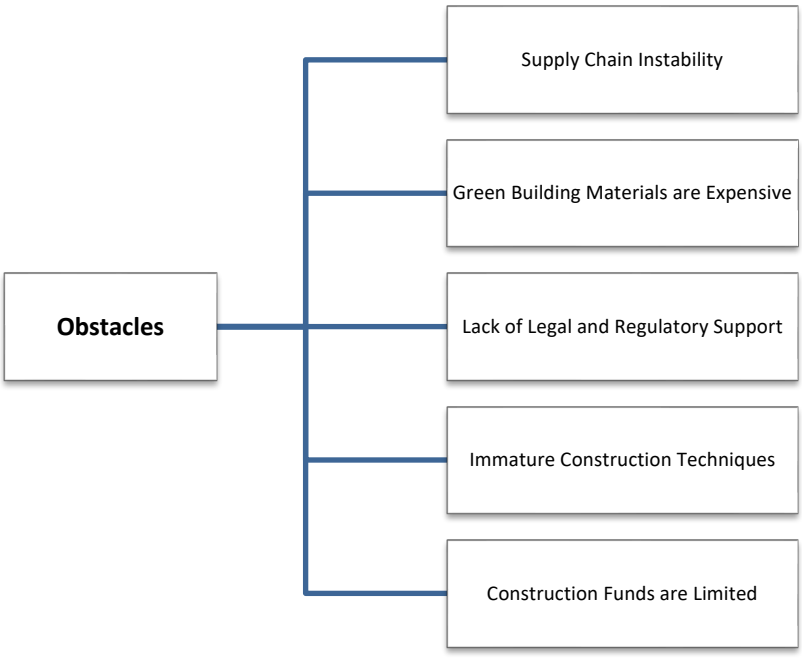

Fig. 3. Specified Summary of respondents' perceptions of obstacles to application of green building materials in construction projects

4.2 Improvement Measures for the Application Integration of BIM in Green Building Materials in Construction Projects the Role of BIM Technology in the Application of Green Building Materials

Through the analysis of the collected data, the improvement measures for the integration of BIM application of green building materials in construction projects can be mainly through the government's introduction of relevant support policies, the establishment of green building material databases, the establishment of collaborative platforms, training, and education, etc., so that BIM technology can be more effectively integrated. Integrate with the application of green building materials in construction projects, promote the application of green building materials in construction projects, and achieve more efficient and sustainable architectural design and construction processes. These measures will help to improve the application efficiency and sustainability of green building materials and promote the development of the construction industry in a more environmentally friendly and sustainable direction.

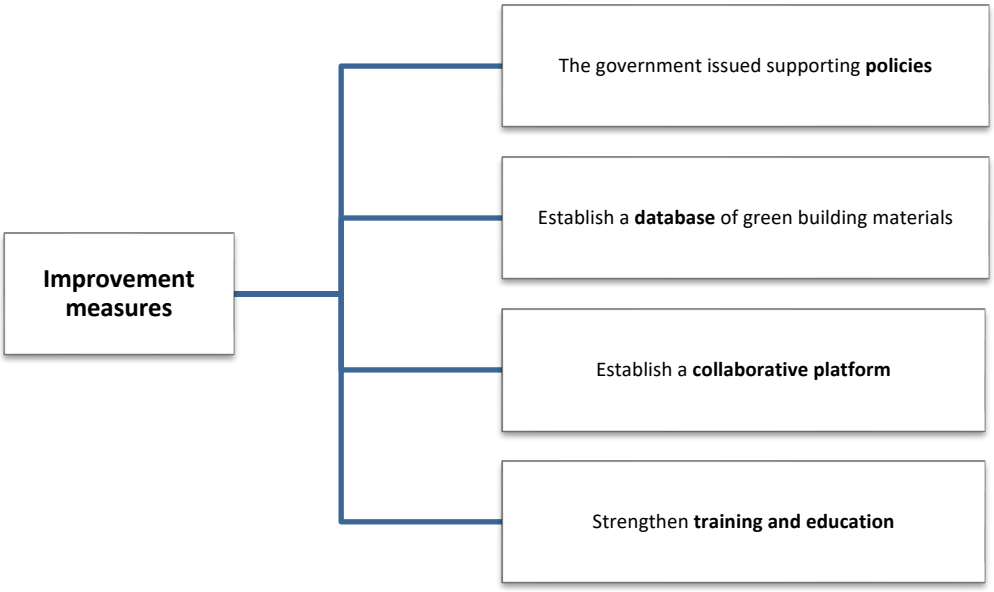

Fig. 4. Specific summary of respondents' perceptions of Improvement measures for the application integration of BIM in green building materials in construction projects

5. Conclusions

This study identified the obstacles encountered in the application of green building materials in China's construction projects and put forward corresponding improvement suggestions and solutions by combining BIM technology. Although there are still some challenges, with the deepening of further research and cooperation, it is believed that through BIM technology, the application of green building materials in Chinese construction projects will usher in a broader development prospect. It is hoped that this study can provide useful reference and inspiration for academics and practitioners in related fields and make certain theoretical and practical contributions to promote the application of green building materials and the sustainable development of Chinese construction industry.

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