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Study on the Path of Green Construction and Intelligent Buildings in Promoting the Sustainable Development of the Construction Industry

Yue Liu*

Hainan Vocational University of Science and Technology, Haikou 571126, Hainan, China

**Author to whom correspondence should be addressed.*

Abstract: Against the background of energy conservation and emission reduction, green construction and intelligent buildings have become an inevitable trend in the transformation of the construction industry. They effectively reduce environmental damage and pollution caused by construction projects during the construction process, improve the comfort and health of buildings, and are conducive to promoting the sustainable development of China's construction industry. This paper analyzes the relationship between green construction and intelligent buildings, examines the dilemmas faced by the integrated development of green construction and intelligent buildings, and proposes measures such as optimizing architectural design schemes, advancing technological innovation, improving energy utilization efficiency, actively applying BIM technology, and strengthening building lifecycle management, so as to promote the sustainable development of China's construction industry.

Keywords: Green buildings; Intelligent buildings; Construction industry; Development dilemmas; Sustainable development

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1. Introduction

With the acceleration of urbanization, environmental pollution and energy shortage have become increasingly prominent, and the construction industry has become one of the main sources of environmental pollution and carbon emissions. Faced with this severe challenge, the construction industry, with sustainable development as its goal, is accelerating technological innovation in green buildings and intelligent buildings, promoting green and environmentally friendly building materials, and reducing building energy consumption and carbon emissions. It also uses new technologies such as BIM and the Internet of Things to strengthen construction management, realize

intelligent management of building materials, construction processes, and quality management, improve energy utilization efficiency, and thereby enhance the construction quality and comfort of construction projects. This paper clarifies the relationship between green construction and intelligent buildings, strives to balance environmental protection, resource utilization, and ecological conservation, strengthens the full-cycle management of construction projects, promotes the sustainable development of the construction industry, and provides references for urban construction.

2. The correlation between green construction and intelligent buildings

Green construction and intelligent buildings are research hotspots in the modern construction field, and also important foundations for the sustainable development of the construction industry. Their correlation lies in jointly promoting the sustainable development of the construction industry and implementing energy conservation and emission reduction goals. Green construction focuses more on handling the relationships between environmental protection, resource conservation, and ecological balance during the construction process of building projects, while intelligent buildings emphasize the use of new technologies such as artificial intelligence and mechanical automation to achieve full-cycle management of building projects. The two have a mutually promoting and complementary relationship, jointly driving the sustainable and high-quality development of the construction industry [1].

Firstly, different from traditional architectural design and construction models, green construction focuses more on the selection of environmentally friendly materials to reduce environmental damage and construction waste. Intelligent buildings, on the other hand, use BIM technology, big data, etc., to manage the ventilation, lighting, power, and air conditioning systems in buildings. They automatically adjust indoor lighting and air conditioning systems based on indoor and outdoor temperature, light, and other factors to optimize resource allocation [2]. For example, in intelligent buildings, sensors are used to automatically adjust indoor lighting brightness and air conditioning temperature, and environmentally friendly external wall insulation materials are selected, thereby reducing energy consumption. It can be seen that intelligent buildings and green construction are highly consistent in terms of energy conservation and emission reduction goals.

Secondly, the sustainable design concept in green construction can only be realized with the support of intelligent building technologies. Intelligent buildings use artificial intelligence, big data, and other technologies to monitor and manage the entire process of building projects, realizing the rational use of electrical and water resources, reducing waste of electricity and water, and lowering the overall energy consumption of buildings. This thus implements the concept of green construction and achieves the goal of sustainable development in the construction industry, reflecting the complementary relationship between the two. For example, a certain intelligent building adjusts the air conditioning temperature in summer and winter through a central control system and adjusts the brightness of lighting according to light conditions, avoiding resource waste and effectively reducing various costs [3].

Thirdly, intelligent buildings can collect energy consumption data such as electricity, water resources, and gas, and analyze the data to provide accurate data references for green construction and promote the improvement of green construction technologies [4]. For example, intelligent buildings can collect energy consumption data of ventilation, power, and air conditioning systems, conduct quantitative analysis on the green energy-saving effect of buildings, and provide guidance for the innovation and improvement of subsequent green construction

technologies.

3. Difficulties faced in the development of green construction and intelligent buildings

3.1. Challenges in technology integration and implementation

Green construction and intelligent buildings still face numerous challenges in the process of technology integration and implementation, which are mainly reflected in the integration and coordination between different technologies and systems, placing higher demands on practitioners in the construction industry. In green construction, it is necessary to integrate different types of energy-saving and environmentally friendly materials. Construction workers are required to select materials such as external wall insulation materials and solar panels based on local environmental characteristics and project requirements. For intelligent buildings, however, technologies like automatic control, artificial intelligence, and big data need to be integrated into architectural design and operation and maintenance management [5]. These technologies span multiple fields and not only require technical adaptability—such as the compatibility and adaptability between BIM technology and automatic control systems, and between insulation materials and building appearance design—but also increase the difficulty of developing green construction and intelligent buildings invisibly.

3.2. Challenges in cost and economic benefits

Green construction and intelligent buildings require relatively high initial investment and have a long payback period. Energy-saving effects are difficult to yield returns in the short term, which imposes a considerable economic burden on investors. For example, green construction uses environmentally friendly and energy-saving materials, whose cost is much higher than that of traditional building materials, increasing the project cost invisibly and deterring many investors. The central control systems installed in intelligent buildings are also expensive; they require regular replacement and debugging of intelligent equipment, and the subsequent maintenance costs are relatively high, posing a severe challenge to investors [6]. In summary, the investment returns of green construction and intelligent buildings are full of uncertainties, which have become an important factor restricting their integrated development and also affect the sustainable development of the construction industry.

3.3. Difficulties in building lifecycle management

In the development of green construction and intelligent buildings, building lifecycle management is an important and complex challenge. It is reflected in the overall management from the design, construction, to operation and maintenance stages, which needs to be carried out based on the environment, project budget, etc. For example, in the design stage, it is necessary to select environmentally friendly materials according to the project budget and environmental characteristics to ensure high resource utilization, low carbon emissions, and low energy consumption throughout the building's lifecycle. Materials with durability, low maintenance costs, and recyclability should be prioritized. In the construction stage, investors and constructors must adhere to the concept of energy conservation and emission reduction, use BIM software to accurately calculate material consumption, reduce material waste, and promptly identify problems in the construction process to avoid rework—thereby controlling project costs and laying a good foundation for subsequent operation and maintenance [7].

4. Paths for green construction and intelligent buildings to facilitate the sustainable development of the construction industry

4.1. Promoting technological innovation and integration, and practicing the concept of green construction

Universities, research institutes, and enterprises should strengthen cooperation, jointly develop energy-saving and environmental protection materials as well as intelligent management technologies, promote technological innovation and integration, and accelerate the integration of green construction and intelligent buildings, thereby advancing the sustainable development of the construction industry. Firstly, universities, research institutes, and enterprises should actively develop new-type environmentally friendly building materials, energy-saving technologies, and intelligent systems to reduce the cost of environmentally friendly building materials, enabling more construction enterprises to adopt such materials, thus reducing construction waste and energy consumption. For instance, multiple parties can jointly develop high-efficiency, environmentally friendly, and thermal insulation materials, reducing the thermal conductivity of building materials to 0.02 W/(m·K) to minimize heat loss of buildings, thereby accelerating the innovation of building exterior wall insulation materials [8]. Secondly, universities and enterprises can jointly develop intelligent building management systems, improving the compatibility and user-friendliness of these systems to meet the intelligent building management needs of residential buildings, public buildings, and enterprises, thus reducing the energy consumption of electricity, gas, and water resources. For example, the two parties can develop intelligent control systems that collect data such as outdoor illumination, temperature, and humidity through sensors, and intelligently adjust indoor air conditioning and lighting systems to achieve the management goals of intelligent management and reduced energy consumption. Finally, all parties should actively integrate different technologies to promote the integration of green construction and intelligent construction technologies, and perfectly integrate solar panels and wind power generation equipment with building structures and architectural design, so as to enhance user experience and artistic design effects. For example, combining wind power generation, solar panels with traditional architectural design to achieve "self-sufficiency" can truly reduce the electrical energy consumption of buildings, improve the aesthetics and practicality of buildings, and realize the goal of sustainable development of the construction industry [9].

4.2. Optimizing architectural design schemes and implementing the concept of energy conservation and emission reduction

Architectural design is the prerequisite for realizing green construction and intelligent buildings, laying a solid foundation for intelligent construction, full-cycle management, and the transformation of the construction industry towards energy conservation and emission reduction. Firstly, architects should uphold the concepts of green construction, energy conservation, and emission reduction, carry out design based on the ecological environment of the construction project site and project budget, minimize damage to the natural environment, adopt ecological architectural design principles such as rational energy utilization, environmentally friendly materials, and efficient water resource utilization, and select environmentally friendly materials and intelligent equipment to reduce the emission of greenhouse gases such as carbon dioxide [10]. In addition, designers should also reasonably plan building space, optimize spatial layout, and make full use of inherent conditions such as natural lighting and ventilation to ensure indoor ventilation and natural lighting of buildings, thereby reducing the waste of water and lighting resources. Secondly, designers should comprehensively consider the orientation, ventilation, and lighting of buildings and building materials, reasonably plan indoor layout and building orientation, and make

full use of natural light and ventilation to meet the residents' needs for natural ventilation and lighting, reducing residents' use of air conditioners and lighting fixtures, thus achieving the goal of energy conservation and emission reduction. At the same time, designers should also try to select recyclable building materials, such as clay bricks, ecological bricks, plant-based polyurethane foam boards, and polycarbonate boards. These materials can not only reduce the generation of construction waste but also realize the recycling of building materials, reducing resource consumption, thereby promoting the sustainable development of the construction industry [11].

4.3. Improving energy utilization efficiency and reducing environmental pollution

Construction enterprises should establish the concept of sustainable development, improve energy utilization efficiency, vigorously promote and apply solar energy, energy-saving lighting equipment, and intelligent control systems, reduce energy consumption and carbon emissions during the construction and operation and maintenance phases of buildings, minimize environmental damage and pollution, and achieve sustainable development goals. During the construction phase, construction personnel can choose recyclable or renewable building materials to reduce resource exploitation and consumption. For example, selecting high-efficiency thermal insulation materials, energy-saving glass curtain walls, and high-performance doors and windows can improve construction quality while reducing construction waste and carbon emissions [12]. In intelligent buildings, construction enterprises can install solar photovoltaic panels on the roofs and walls of buildings, ensure the stability and safety of the panels, convert solar energy into electricity, and use clean energy to power the buildings, thereby reducing the consumption of electrical resources. In addition, construction units can install light sensors, temperature sensors, and video monitoring equipment indoors, set indoor temperature and brightness according to the season, and automatically adjust the brightness of indoor lighting fixtures and air conditioning temperature through intelligent building control systems. This not only reduces management workload but also enables intelligent regulation, thereby lowering energy consumption and accelerating the transformation of the construction industry towards sustainable development.

4.4. Scientific application of BIM technology to achieve intelligent management

BIM technology can help construction enterprises understand the requirements of various links, such as project design, budget management, material management, and operation and maintenance management, realize data sharing and real-time update of construction information, thereby improving the efficiency and quality of project construction. First, construction enterprises can build a BIM technology management platform, present the effect of design drawings through a 3D visualization model, analyze the indoor and outdoor environment of buildings, the utilization of building materials, and the planning of indoor space layout, flexibly adjust construction plans to ensure the construction progress, and thus reduce energy consumption during the construction process. For example, construction personnel can use BIM software to conduct virtual simulation tests on indoor natural lighting, sunlight, seismic coefficient, etc. of buildings, automatically generate civil engineering, mechanical and electrical equipment, and engineering organization construction plans, timely adjust existing problems, and obtain optimal green construction plans and intelligent building design drawings, thereby reducing energy consumption during construction and operation [13]. Second, investors can use BIM software for building operation and maintenance management, connect the Internet of Things, big data, and BIM software to realize real-time supervision of the building's internal ventilation ducts, gas, fire protection, electricity, lighting, and air conditioning systems. They can also install solar panels on the roof to use clean energy for power supply, and intelligently

adjust lighting, ventilation, and air conditioning systems according to seasons, weather, etc., so as to improve the living and office experience of owners, reduce the cost of building operation and maintenance management, lay a good foundation for the development of green construction and intelligent buildings, and promote the sustainable development of the construction industry [14].

4.5. Strengthening the management of building lifecycles and promoting the sustainable development of the construction industry

Construction enterprises should integrate green construction and intelligent buildings throughout the stages of design, construction, demolition, and material recycling, promptly address problems in each link, and reduce energy consumption to achieve sustainable development goals. Firstly, at the design stage, architectural designers should adopt the Life Cycle Cost Analysis (LCCA) method to scientifically evaluate the costs of project design, construction, operation, demolition, and material recycling, optimize project cost management, and select environmentally friendly materials and energy-efficient equipment with low operating costs and high initial investment returns. Secondly, during the construction phase, contractors should make good use of artificial intelligence and BIM technology, adopt modular management, actively promote the concept of prefabricated buildings, accurately control the usage of construction materials, improve construction efficiency, and shorten the construction period on the basis of ensuring project quality, thereby reducing project energy consumption [15]. In addition, enterprises should strengthen the management of the building operation and maintenance phase, and use intelligent building management systems to adjust ventilation, power, air conditioning, and lighting systems to ensure the stable operation of each system. Finally, enterprises should do a good job in building demolition and material recycling management, make plans before building demolition, identify recyclable and reusable construction materials, and target recycling these materials to provide recyclable materials for new buildings, thus realizing the sustainable development of the construction industry.

5. Conclusion

In summary, green construction and intelligent buildings are important measures for the sustainable development and transformation of the construction industry, as well as important channels for implementing the concept of energy conservation and emission reduction, and their importance is self-evident. Construction enterprises should deepen cooperation with universities and research institutes, actively develop new environmentally friendly, efficient, and high-performance construction materials, promote technological innovation and integration, cultivate compound construction talents, and drive the construction industry towards a more environmentally friendly, energy-saving, intelligent, and sustainable direction. Furthermore, construction enterprises should implement the concepts of green, energy-saving, environmental protection, and intelligent development in links such as design, construction, operation and maintenance management, and construction material recycling, strengthen full-cycle management, and achieve sustainable development goals.

Disclosure statement

The author declares no conflict of interest.

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