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Obstacles to green building accreditation during operating phases: identifying Challenges and solutions for sustainable development

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ABSTRACT

Due to environmental benefits, green architecture has become increasingly popular, but many green building assessment systems predominantly evaluate design and construction rather than operational stage. This study seeks to identify the impediments to green building accreditation during the operational phases and investigate potential solutions to these issues. To reach this objective, the study compared international green building standards such as LEED, BREEAM, and Green Star with Chinese green building evaluation guidelines. The study also included functional case studies of certified buildings in order to investigate the obstacles encountered by green building initiatives in greater depth. According to the study, the greatest obstacles to green building accreditation during operating phases are inconsistencies in government regulations, market constraints that impede the developers' interests, and difficulties in meeting technological criteria. These findings emphasize the imperative need for policymakers, market participants, and technology developers to collaborate and resolve the identified challenges in order to ensure the longevity of green buildings. Overall, this study contributes to the expanding corpus of knowledge on green building practices and offers stakeholders insights to facilitate the development of sustainable structures. By addressing the identified obstacles, the study can maximize the benefits of green buildings and promote eco-friendly building practices.

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Green architecture; green building rating systems; operational phases; sustainability; environmental benefits

1. History and introduction

Accreditation for green buildings is a strategy for attaining sustainable growth in the building sector via the promotion of environmentally responsible practices in building design, construction, and operation. Concerns over pollution, natural resource depletion, and population increase gave rise to the environmental movement in the 1960s and 1970s, whence the notion of green construction emerged (Sinha, Gupta, and Kutnar 2013).

BREEAM, created in the early 1990s in the UK, is one of the first green building assessment systems. There have been many more grading systems developed since then to compare and contrast different green construction strategies. Several sustainability factors, such as energy efficiency, water conservation, indoor air quality, and material selection, are used in these grading systems (Olubunmi, Xia, and Skitmore 2016).

Sustainable building practices, including design, construction, and operation, have gained more and more attention in recent years. Occupants and building operators have considerable control over energy use, water consumption, and waste production throughout the operational phase of a building's lifetime, and this has a direct bearing on the structure's total environmental performance (Yudelson 2010).

However, there may be several barriers to attaining green building certification throughout the operational part of a facility's lifetime, and achieving sustainable development during this time might be difficult. The first step towards promoting sustainable construction practices and attaining sustainable growth in the building sector is identifying these issues and developing ways to solve them (Olubunmi, Xia, and Skitmore 2016).

As urbanization continues to accelerate, the community and society are becoming increasingly concerned with environmental and energy issues (Cajot and Schüler 2019; Keirstead, Jennings, and Sivakumar 2012). Green buildings are believed to promote health, safety, comfort, and environmental consciousness; consequently, the concept of green design has become a fundamental topic in contemporary construction (Cole 2019; Zuo and Zhao 2014). Nonetheless, the literature (Zuo and Zhao 2014) lacks a consistent system for green architecture due to varying degrees of economic development, regional environment, resource requirements, and other factors.

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The United States Environmental Protection Agency (EPA) provides a definition of green building that includes terms such as eco-friendly architecture and sustainable building. Green building refers to a structure constructed in a manner that minimizes its impact on the natural environment and uses renewable resources to the greatest extent possible throughout its lifetime, including design, construction, operation, maintenance, repair, renovation, and demolition (Kibert 2016). In contrast, sustainable construction in China, based on the fundamental elements of the nation's sustained growth, conserves resources such as power, land, water, and material, preserves the natural environment, and conserves natural resources throughout the entire lifecycle of the construction in order to provide individuals with a healthy, suitable, and effective use space that is also in harmony with the environment (Zhang et al. 2017). This strategy emphasizes the significance of incorporating green building considerations throughout the entire construction lifecycle, necessitating additional green building implementation criteria.

After developing the concept of green architecture, a system for evaluating the installation and execution of green construction was required. As a result, the Building Research Enhancement Environmental Assessment Method (BREEAM) was created in 1990 to provide a more thorough and comprehensive assessment of buildings (Doan et al. 2017). Other green building rating systems, such as Green Star and Leadership in Environmental and Energy Design (LEED), were subsequently developed. BREEAM is presently regarded as the most prestigious rating system (Reed et al. 2009), In addition, these evaluation systems assess green construction based on a variety of factors, including interior environmental conditions, energy consumption, and materials (Nguyen and Altan 2011; Reed et al. 2009). However, the majority of these evaluation algorithms analyze structures during both the design and performance phases.

It is crucial to comprehend that green building grading systems have varying certification procedures for environmentally favorable structures. In BREEAM, pre-assessment estimators are utilized to provide an early indication of how a project will perform, which is neither a recognized rating nor a final result, but helps to comprehend what is possible (Doan et al. 2017). The assessor is then required to document the undertaking as quickly as possible. While the majority of green building certification procedures consider both the design and post-construction phases, grading programs classify their scores according to the building's lifecycle periods.

In China and other nations, the majority of green-certified buildings only satisfy the criteria for the design phase of the green designation, not the operational phase (Geng et al. 2012). Similarly, the construction area of LEED O&M (operation and maintenance) projects in the United States represents only 4.52 percent of all structures that have received LEED certification. 6.35 percent of China's structures have been certified as operationally sustainable. In addition, only 6.79% of all green building initiatives are currently operational, and 4.08% of all new construction space in the United States is occupied by green structures (Yudelson 2010; Zhang et al. 2019). As a result, there are still relatively few legitimate green buildings that can provide people with healthy, pleasurable, and environmentally favorable environments. It is the source of numerous criticisms of ecological construction.

Therefore, more industry practitioners and academics are advocating for the construction of genuinely green buildings, arguing that green building assessment should be limited to the operation phase. Now that there is a greater focus on the aftereffects of green construction, there is a significant lapse in certifying green buildings during their operation phases. Consequently, the purpose of this study is to identify the obstacles to green construction certification throughout all phases of operation and to propose solutions.

This study found major gaps in green architecture knowledge and execution. To begin, the certification of green buildings during their operational period has been neglected, resulting in a substantial lapse in ensuring long-term sustainability and environmentally favorable outcomes. Secondly, the lack of a consistent system for green design due to variable economic growth, regional settings, and resource requirements emphasizes the need for a comprehensive and standardized framework that accommodates diverse contexts while promoting sustainable practices. The study intends to promote sustainable and environmentally friendly construction by filling these gaps. This research and solutions aim to improve green building certification and design.

2. Evaluation of existing rating systems for green buildings

Challenges and solutions related to green building accreditation during the operating periods of a building's tenure are the subject of prospective research inquiries. For instance, one of the possible research queries was, "How effective are current rating systems in promoting sustainable building practices throughout the entire building lifecycle, from design to post-construction operation?" This query could be applied specifically to the operating phase of a building in order to determine the obstacles and potential solutions to attaining sustainable development during this phase.

2.1. Challenges to green construction implementation

Despite increased interest in green building, there are considerable obstacles to its implementation. Samari et al. (2013) conducted a study that illustrates some of these problems, notably during the development phase of green buildings in Malaysia. One of the major challenges highlighted was a lack of awareness and understanding of green building practices and technologies among project stakeholders. As a result, people are resistant to change and reluctant to try new and inventive approaches. Furthermore, Guribie et al. (2022) claim that financial incentives are critical in the early stages of green building implementation for both manufacturers and users. Without such incentives, people may find it difficult to take the necessary measures to transition to sustainable building practices. Incentive programs can assist in overcoming the early costs of investing in green technologies and encouraging greater adoption of environmentally friendly practices. Another issue is the lack of adequate legislation and policies to support sustainable building. Government assistance is critical in pushing the shift to green building practices, and it can be difficult for builders and developers to implement sustainable practices without the necessary legislation and regulations in place.

Furthermore, most research on green building certification focuses solely on the design phase of construction, with little emphasis placed on the operating elements of green buildings. To maintain the sustainability of green buildings, long-term maintenance and operation must be considered.

Overall, while the benefits of green construction are obvious, overcoming the obstacles to its adoption remains a key task for governments, developers, and other players in the construction sector.

Findings from research conducted to determine what is standing in the way of the development of green buildings in Vietnam found that legislative and institutional hurdles were largely seen as the most difficult ones (Nguyen et al. 2017). This study surveyed 215 construction industry experts and government officials to verify the findings of the literature, which identified 41 obstacles to green architecture in Vietnam. However, these hurdles only took into account the design phase of green building construction, and certification during the use phase was again left out. A similar study looked at the importance of several factors inhibiting the deployment of green construction technologies on a large scale (Shen et al. 2018) and found that a knowledge gap, expenses, motives, interest or demand, and green construction rules and restrictions were the challenges that were cited most often. However, this study, like many others, fails to adequately address the obstacles that hinder green-certified buildings from being constructed at any point during the operative construction phases. In a similar vein, there have been numerous research studies conducted that have focused on the obstacles that prevent the adoption of green building practices at the first phases of decision-making; nevertheless, there is a clear dearth of research that identifies the obstacles that prevent a lack of certification during the project implementation (Ebert, Essig, and Hauser 2012; Vierra 2016). The cost savings and other advantages of green buildings continue to accrue even after the building has been put into use. Therefore, obtaining the green certification throughout operating phases is crucial for achieving the anticipated beneficial results of green buildings. The goal of establishing sustainable buildings will not be met if they do not function as planned and provide the anticipated savings. As a result, this study presents a fresh method for determining what prevents green buildings from being put into operation.

2.2. Green building grading systems from across the world

Several countries have devised green building grading schemes to promote ecologically sustainable buildings. Each system takes a unique method to evaluating environmental structures. The following are some of the most widely used green building assessment methods around the world, which are briefly presented below and will be further investigated in this section:

BREEAM (Building Research Establishment Environmental Assessment Method): Developed in the United Kingdom, this rating system assesses buildings based on their sustainability and environmental performance. BREEAM evaluates a variety of factors of building design, construction, and operation, including energy efficiency, water usage, waste management, and indoor environmental quality.

LEED (Leadership in Energy and Environmental Design): established by the US Green Building Council, this globally known certification program focuses on sustainable design and construction techniques. LEED provides a framework for evaluating building environmental performance and supports the development of innovative solutions to reduce negative environmental consequences.

Green Star: This Australian rating system assesses building environmental performance and promotes sustainable design and construction practices. Green Star has its own set of evaluation techniques for evaluating the effectiveness of green building operations such as energy and water usage, waste management, and interior environmental quality (Gandhi and Jupp 2014).

Three-Star Certification: This Chinese green building grading system assigns stars to structures on a scale of one to three, with three being the highest degree of success. A building must meet certain requirements for certification, including energy performance, water efficiency, material selection, indoor environment quality, and site selection and planning.

Other major green building assessment methods are as follows:

The WELL Building Standard: is a rating system that promotes health and wellness in buildings. It assesses the impact of buildings on human health by examining aspects such as air and water quality, lighting, diet, fitness, and comfort.

The Living Building Challenge: is a certification scheme that encourages regenerative design and construction approaches. It encourages building designers and operators to construct places that generate more energy than they consume, collect and treat all water on-site, and use only non-toxic, locally sourced materials.

EDGE (Excellence in Design for Greater Efficiencies): created by the International Finance Corporation, this rating system evaluates buildings based on their resource efficiency. EDGE evaluates building designs based on energy and water consumption, building materials, and operating methods.

These grading systems have been implemented by governments all over the world, and they have aided in the promotion of sustainable building practices. For example, when the One Angel Square skyscraper in Manchester, UK, was erected in 2013, it received the highest ever BREEAM score due to features such as rainwater harvesting and renewable energy sources. Because of features like as energy-efficient lighting, a green roof, and advanced water-conservation systems, the Bank of America Tower in New York City received Platinum LEED certification. Due to features such as solar panels, natural ventilation, and efficient lighting systems, the Pixel Building in Melbourne in Australia achieved a 6-star Green Star certification, the highest possible rating.

The 3-Star Certification system in China has aided in sustainable urbanization and lowered greenhouse gas emissions. Over 20,000 projects, including residential, commercial, and institutional structures, had been recognized under the method as of 2021 (Three-Star Certification, n.d.). Overall, these grading systems are assisting in reducing the negative environmental impact of buildings and promoting more ecologically friendly building practices around the world (Zuo and Zhao 2014).

In the following, this study examines the global adoption of green building rating systems, including BREEAM, LEED, and Green Star. They all use unique methods and criteria. Table 1 provides examples of them and shows that the two most popular green building rating systems, LEED and Green Star, are for either new designs and construction or as-built buildings, respectively. It also shows that users are not fond of tools that concentrate on the operational phase of construction.

2.2.1. Breeam

Since its establishment in 1990, BREEAM (Building Research Establishment Environmental Assessment Method) has been widely utilized as a building evaluation technique (Doan et al. 2017; Sánchez Cordero, Gómez Melgar, and Andújar Márquez 2019), It is regarded as one of the most comprehensive and widely accepted analyses of a structure's sustainability performance, offering significant insights into best practices for green building, implementation, and operation.

BREEAM is widely utilized throughout Europe and beyond, according to Schweber and Haroglu (Schweber and Haroglu 2014) with over 426,000 construction projects licensed and 1.95 million buildings registered in over 60 countries and territories as of September 2015. As the first of its kind, it had a considerable impact on subsequent attempts to assess green buildings, paving the way for the growth of green structures.

It is worth mentioning that most structures are evaluated during the design phase rather than the operational period, as the BREEAM methodology defines this more explicitly. BREEAM, on the other hand, continues to deliver significant insights throughout a building's life cycle, from design to operations and maintenance.

Finally, with its comprehensive approach and global reputation, BREEAM is a valuable tool for promoting sustainable building practices. Its pioneering position in the sector, as well as its widespread adoption, have contributed to it becoming one of the most extensively utilized building evaluation systems in the world.

2.2.2. Leed

The United States Green Building Council created LEED as a comprehensive grading system for sustainable buildings in 1994 (Suzer 2015). One of the primary aspects that has led to LEED's popularity is its ability to give credible validation of the green attributes of a building or area. LEED accreditation assures that structures are environmentally friendly in their design,

Table 1. Specifics on worldwide grading methods for environmentally friendly buildings.

Class	BREEAM	LEED 4.1	Green Star v1.3
Organizational Forerunner	Construction Research Establishment	U.S. Green Building Council (USGBC)	Australian Green Building Council
Category of Evaluations	• Not classified • Passed • Good • Very good • Excellent • Outstanding	• Certified • Silver • Gold • Platinum	• 1 star - Certification ineligible • 2 star - Certification ineligible • 3 star - Certification ineligible • 4 star - Certification confirmed "Best practice" • 5 star - Certification confirmed "Australian Excellence" • 6 star - Certification confirmed "World Leader"
Available Scheme Types (latest in use)	• The Global BREEAM • Global BREEAM Rating System for New Constructions (NC) • BREEAM Global Refurbishments and Conform • BREEAM global In-Use • BREEAM Global Community Bespoken	LEED 4.1 • Building Design & Constructions (BD + C) • Interior Designs & Constructions (ID + C) • Buildings Operation & Maintenance (O + M) • Neighborhood Developments (ND)	• Design & as built • Interior • Community • Performance
Scheme that has widespread application	BREEAM New Constructions (NC) international	Building Design & Constructions (BD + C)	Design & as built
Suitable method for analyzing performance			
Operating schemes for primary credit categories	• Management • Safety and health • Energy • Transportation • Water • Components • Waste • Ecology and land usage • Contamination • Creativity	• Locale and transportation • Sustainable sites • Water conservation • Vitality and ambiance • Materials and assets • Quality of Indoor Environment • Regional precedence • Innovation	• Administration • The state of the indoor environment • Energy • Transportation • Water • Components • Biodiversity and land use • Emission • Innovation

construction, operation, and maintenance. This benefits not only the environment but also the health and well-being of the people who live and work in these buildings. However, while LEED provides a great framework for sustainable design, the evaluation step is not defined, therefore most structures focus on their design phases rather than their operational phases. In 2018, for example, 358 new structures had design phase registrations for the LEED v4 grading system. Unfortunately, only 122 of these structures received accreditation for operation and maintenance (Ferreira et al. 2023; Suzer 2015). Reliable validation of a building's or neighborhood's green qualities is made possible by LEED certification, which in turn paves the way for the creation of structures that are both healthy and economical to run and operate. The evaluation step is not defined by LEED. Therefore, most structures put more effort into their design phases than their operating phases. Among the 358 new buildings with design phase registrations for the LEED v4 grading system in 2018, only 122 were certified for operation & maintenance certifications (ElSorady and Rizk 2020). This pattern implies that many builders emphasize LEED certification during the design phase but do not employ green techniques throughout the operational phases.

Despite this constraint, LEED continues to be the most commonly utilized green building certification scheme in the world, with hundreds of projects seeking certification each year. LEED has accelerated the development of a greener construction sector, assisting in the creation of more efficient and healthier buildings while decreasing environmental impacts.

2.2.3. Australian – Green Star

The GBCA was founded in response to increased concern about the environmental impact of the built environment by industry leaders, government officials, and environmental organizations (Gandhi and Jupp 2014). Its purpose was to lead the transition to more sustainable building techniques and to educate stakeholders on the necessity of decreasing greenhouse gas emissions, water usage, and waste creation.

The invention and implementation of the Green Star system, which has become a widely known and acknowledged benchmark for measuring the sustainability of buildings in Australia, was one of the GBCA's most notable successes. The approach assesses buildings using nine criteria, including energy efficiency, water conservation, indoor environmental quality, materials, and innovation. Projects that meet specified requirements are given a rating of one to six stars, with six being the highest possible.

Since its inception in 2003, the Green Star system has aided in the advancement of innovation and best practices in the construction industry (Morris et al. 2018; Xia et al. 2013). It has encouraged the use of environmentally friendly design ideas and technology such as passive solar design, photovoltaic systems, rainwater collection,

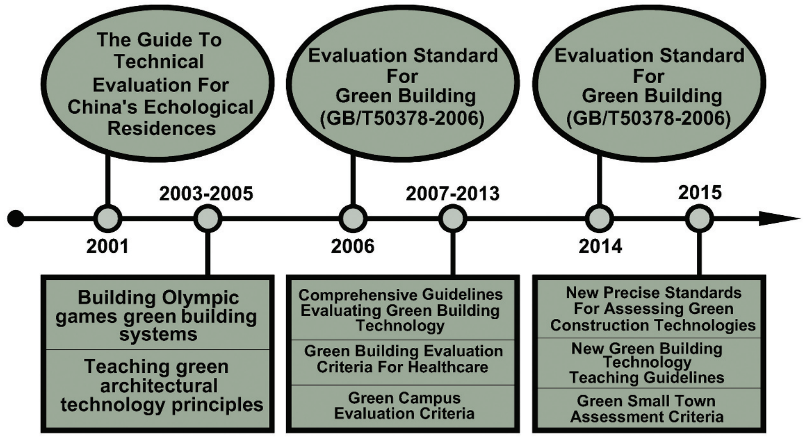

Figure 1. China's ESGB's progress process.

and green roofs. By establishing a consistent language and set of norms, the system has also encouraged collaboration among various stakeholders, ranging from architects and engineers to contractors and building owners.

To supplement the existing Green Star system, the GBCA launched a new suite of assessment elements in 2015. These features were created to enable increased adaptability and flexibility in response to changing conditions and requirements. The following are the four approaches featured in the new suite:

Design & As Built: This approach evaluates building environmental performance during the design and construction phases.

Interior: This method assesses the long-term viability of fit-out projects that occupy existing structures, such as offices or retail spaces.

Communities: This method assesses the long-term viability of large-scale development initiatives that have a substantial impact on the local community.

Performance: This method assesses buildings' ongoing environmental performance and supports continual improvement throughout time (Sartori et al. 2021; Zuo et al. 2017).

While the Green Star system has received widespread appreciation for its role in promoting sustainable building techniques, it does have limitations and critiques. Some stakeholders have complained that the approach prioritizes technical performance requirements over social or cultural factors. Others have questioned the ranking method for emphasizing design and construction above operating performance. Furthermore, some have complained that the approach is extremely restrictive and does not allow project teams the flexibility to investigate novel alternatives that may not fit within the present framework.

Despite these concerns, the GBCA and the Green Star system continue to be prominent players in the Australian construction industry. The system has aided in the transformation of the sector by establishing high sustainability standards and providing a path for other countries and areas aiming to lessen their environmental impact. As the importance of tackling climate change grows, the GBCA's activities will almost certainly continue to play an important part in determining the future of the built environment in Australia and beyond.

2.3. *Progression of green building assessment criteria in China*

The development of environmentally friendly construction in China is still in its early phases (Cao et al. 2015). However, various programs have recently been undertaken by the Chinese government and other governmental bodies to promote the construction of ecologically friendly buildings (Karamoozian and Hong 2022). The Green Building Action Plan was released on 1 January 2013 by the State Council's Central Office, the Ministry of Construction and Urban-Rural Development, and the National Development and Reform Commission, with the stated goal of having 20% of all newly constructed buildings comply with green building guidelines by December 2015 (Brown 2015). In March 2014, the CPC Central Committee issued the New Urban Growth Plan (2014–2020), which clarified the medium-term goal of the green building initiative. Sustainable buildings are expected to account for at least 50% of new construction by the end of December 2020 (Taylor 2015). As illustrated in Figure 1, China has been enacting and enforcing green building regulations and policies since at least 2001. Between 2008 and 2015, China implemented a system for reviewing green building accreditation applications. There were 4071 certified green building efforts, covering an area of 472,000,000 square meters (Cao et al. 2022; Lo 2014). There are 3890 green design initiatives and 212 green operating projects totaling 446 million square meters.

China's dedication to environmentally friendly building practices goes beyond these first attempts. In 2016, the Ministry of Housing and Urban-Rural

Development issued the "Technical Guidelines for Green Building Evaluation," which detailed China's green building requirements and certification methods. Furthermore, the Chinese government fosters innovation in this sector by providing financial incentives such as tax exemptions and subsidies to enterprises that develop new technology or ways for more sustainable building. They have also launched programs to educate the public about green building principles and certification, as well as attempts to encourage greater local participation in sustainable development projects. Finally, China has collaborated with international organizations and governments to develop its green building projects, such as by establishing a cooperation agreement with the US in 2016 to promote sustainable construction techniques and exchange knowledge and expertise in this field.

Overall, China's efforts to promote green building projects show a dedication to lowering the environmental impact of construction methods and developing a more sustainable future for everybody.

2.3.1. Green building evaluation standards in China

As stated in the introduction, the assessment of the operation phase of construction is, at a minimum, comparable to other nations and methods. However, China has its own green building grading mechanism known as the green building assessment standards in China. In 1990s, China was exposed to the notion of green construction, and since then, the country has created its own assessment criteria. The first national standard for assessing green buildings in China was drafted by the Ministry of Construction in June 2006 under the title "green building evaluation criteria" (the ESGB, or Evaluation Standard for Green Building) (GB/T50378-2006), and its 2014 edition, "green building evaluation criteria," had also the identical title when it came out in the first month of 2015 (GB/T50378-2014). Table 2 lays out the discrepancies between the various norms.

Evaluation element, as shown in Table 2, relates the kind of building. Moreover, the assessment step takes into account the design and construction evaluations. The assessment of the design takes into account the following factors: (1) the preservation of land and the quality of the outdoor area; (2) the conservation and use of energy; (3) the conservation and utilization of water; (4) the usage of material resources; and (5) the quality of the indoor environment. Both the sixth chapter, which covers construction management, and the seventh chapter, which covers operation management, have sections on operational assessment. Together, these chapters cover the whole lifecycle of building structures.

The Chinese green building grading tool's assessment method is broken down into two parts: first-level indications and secondary indications. The latter must contain control condition and score items. In addition to that, the two of them jointly founded innovation plus. The earliest "green building evaluation criteria," GB/T 50378-2006, included six key elements: (1) lands utilization and outside surroundings; (2) conservation and use of energy; (3) conservation and efficient use of water; (4) materials conservation and usage; (5) the interior environment; and (6) operating procedures handling. The already updated GB/T50378-2014 also included "construction management" for efficiently exploring entire life-cycle of the building. The criteria for assessment are scored using weights. Due to the worldwide energy crisis, all countries have prioritized energy efficiency and emission reductions, making energy savings the top priority. The second benefit is land preservation and the natural area. Apart from the energy problem, the destruction of the global ecology is also a major concern. China has become more aware of the need to protect the environment as its living standards have risen. This criterion for assessment is thus appropriate to the national context.

Various types of assessment include quantitative assessment and controlled rating. The assessment outcome will be labeled "fulfilled" if the predetermined criteria have been met or "unfulfilled" otherwise. This statement has the benefit of being straightforward and easy to understand. Country green building standards are rated in accordance with LEED by incorporating lessons from international green building codes and knowledge. (EBGS 2006 replaced "the preferences" with "the rating item" and "the general item" from the previous standard.) The total value of the points

Table 2. A comparative analysis between the EBGS 2006 and 2014.

	EBGS2006	EBGS2014
Criteria for evaluation	Construction of a Private Dwelling or a Public Structure (workplace, retail center, lodging, hotel)	Both residential and public buildings (unlimited)
The stage of evaluation	Evaluation of both the Design and the operation of the Work (after 2008)	Evaluation of the design as well as assessment of the operation
Assessment Scheme	Land and outdoors environment conservation, material and energy conservation, water conservation, interior environmental quality management, and outdoor environment conservation	Energy efficiency, waste reduction, material reuse, water conservation, indoor environment, project management, and build management
The Technique of Evaluation	Keeping track of the quantity of provisions	★ $50 \leq \Sigma Q < 60$\s★★ $60 \leq \Sigma Q < 80$\s★★★ $80 \leq \Sigma Q$
extra component	Null	novation (below 10)

in each category adds up to 100, the overall score in the assessment system. A green building must get at least 40 out of 100 points on each of the criteria.

As an assessment process, green building certifications are grounded in the ESGB Green Building Evaluation Standards and any applicable national requirements. Specialists assembled by the Chinese Housing Ministry assess household and public buildings in seven categories: (1) lands utilization and outside surroundings; (2) conservation and use of energy; (3) conservation and efficient use of water; (4) materials conservation and usage; (5) the interior environment; (6) operating procedures handling; and (7) supervision of the building process. In order to ensure conformity with green construction standards, specialists assess each of the seven criteria and compile a final report.

The process of identifying a green building can be broken down into two distinct phases: the Design Assessment of Green Buildings phase, which takes place following a thorough review of the building's blueprints, and the Operation Assessment of Green Buildings phase, which takes place within one year of continuous occupation. A green building's success in protecting the environment should be measured across all indicators. The design assessment identification phase, in contrast to the building and operation phases, focuses on the designing and planning phases.

3. Methodologies used in research

The purpose of this research is to look at the green qualities of buildings in various cases around China. The study objective is, "How do these buildings acquire their green characteristics during operation?" To answer this question, a multiple case study methodology with qualitative research methods will be used (Thomas 2021). The study's goals are to investigate the aspects that lead to green building characteristics, identify best practices for sustainable building operations, and make recommendations for future projects.

The selection of case studies is a critical aspect of this research. The following case studies have been chosen based on their diverse characteristics and relevance to the research objectives:

(1) Nanjing Vanke Jiuduhui Project: A large-scale residential construction in Jiangsu province's Nanjing city, recognized for its energy-saving initiatives and sustainability-oriented programs (Chinese National Development and Reform Commission, April 2017).
(2) Shanghai Tower: A LEED Platinum-certified skyscraper in Shanghai, known for its innovative energy-saving features such as a double-skin curtain wall and renewable energy generation technologies.
(3) Shougang Park: A transformed eco-park in Beijing, built on a former steel factory site, featuring green infrastructure, passive solar architecture, and LEED Platinum-certified structures.

These case studies represent different approaches to attaining sustainability in building and community development in China. The purpose of including these case studies is to provide insight into best practices for sustainable building operations and to investigate the aspects that lead to green building characteristics during the operational phase.

Methods of data collection will include interviews, observations, and document analysis. Researchers will employ multiple data sources to check their conclusions to ensure the triangulation of data sources. More than 50 participants were chosen based on their first-hand knowledge of the project and their ability to contribute complementary but distinct viewpoints. The researchers intend to include a varied spectrum of volunteers of various ages, genders, and origins. These participants were selected as experts based on their extensive experience and active participation in the under study green building and sustainable development initiatives. This number was chosen to ensure that sufficient breadth and depth of insights were gathered, allowing for a comprehensive understanding of the research objectives. This sample size was deemed sufficiently representative to include a variety of perspectives and roles within the discipline, making it a balanced and efficient selection.

Thematic analysis, a qualitative method for discovering patterns and themes in data (Feagin, Orum, and Sjoberg 2016; Yazan 2015), will be used to analyze the data. Two separate researches will undertake the analysis to confirm the findings' validity and reliability. The findings will then be presented in narrative form.

The research will seek written consent from all participants and secure their identities to ensure confidentiality and informed consent. Personal information about participants will be kept safe in compliance with ethical standards (Tellis 1997). To get a feel for the project, it's important to conduct interviews with key actors, achieving a balance with those that can give complementary but distinct perspectives. Table 3. shows demographic information of 5 interviewees in one of the cases.

3.1. Overview of the study cases

The research will look into several instances of green building and sustainable community development in China. One example is the Nanjing Vanke Jiuduhui project, a large-scale residential construction in Jiangsu province's Nanjing city. Nanjing Vanke Real Estate Co., Ltd. purchased the project in 2009, and it proceeded through four stages of development,

Table 3. Interviewers' information.

Expert	Age	Gender	Position	Professional Background	Affiliation	Years of Expertise
Expert 1	46	Male	Engineer	Civil engineering	The Housing and Building Administration	4
Expert 2	37	Female	Director	Architecture	Construction and Real Estate Corporation	11
Expert 3	51	Male	Managerial Assistant	Energy management	Housing and Building Administration	5
Expert 4	28	Female	Engineer	Mechanical Engineering	Contractor	7
Expert 5	36	Male	Researchist	Sustainability	University	5

beginning with conceptualization in June 2013 and ending in January 2022. There is a total buildable area of 125,986.51 square meters, which includes high- and low-rise dwellings, an elementary school, and commercial space. High-rise homes account for 82.2% of all dwellings, green site rates account for 38.5% of all dwellings, and shear wall construction for high-rise structures and frame construction for low-rise buildings are notable elements of this development. The Chinese National Development and Reform Commission recognized the Nanjing Vanke Jiuduhui project as one of the country's significant energy-saving projects in April 2017, and it became the first group of sustainability-oriented programs and the first group of green construction demonstrative projects in the area in June 2017. In addition, the project obtained three stars for planning in March 2020, as well as building and operation in February 2022.

Another case study is the Shanghai Tower, a skyscraper in Shanghai that has gained LEED Platinum certification and was named the Council on Tall Buildings and Urban Habitat's "Best Tall Building Worldwide" in 2016. A double-skin curtain wall, an innovative air filtration system, rainwater harvesting, and onsite renewable energy generation technologies are among the sustainable design characteristics of the building.

The Shougang Park, a former steel factory site in Beijing that has been turned into an eco-park with green infrastructure including as wetlands, gardens, and stormwater management systems, is a third case study. Several LEED Platinum-certified structures in the park also incorporate passive solar architecture, natural ventilation, and other sustainable features to cut energy usage and carbon emissions.

These case studies show different approaches to attaining sustainability in building and community development in China, and they can provide significant insight into best practices for sustainable building operations.

4. Principal findings from the operational assessment

For its operational phase, the Nanjing Vanke Jiuduhui project received three stars. While it has remarkable characteristics such as high green site rates and effective use of shear wall construction, there is space for growth in areas such as team communication and collaboration, as well as more efficient resource utilization.

The Shanghai Tower was not graded in the given context for its operational phase, but it could benefit from continued review to ensure that its sustainable design attributes are efficiently exploited and maintained throughout time.

In addition, the Shougang Park was not graded for its operating phase in the present environment, but it might benefit from ongoing evaluation of the efficiency of its sustainable features in lowering energy usage and carbon emissions.

Overall, these case studies show many approaches to attaining sustainability in building and community development in China, as well as useful insights into best practices for sustainable building operations. Future projects can build on these successes and strive for even higher levels of sustainability by reviewing the operational efficiency of current projects and identifying areas for improvement.

4.1. Land preservation and productive use

4.1.1. Nanjing Vanke Jiuduhui project

The Nanjing Vanke Jiuduhui project prioritizes land preservation and productive usage through sustainable development approaches. To minimize environmental damage and optimize land use efficiency, the project's design takes into account the original terrain, southern climate, ecological planning, and technological constraints. For example, the project makes use of subterranean space and efficient high- and low-rise residential designs to maximize storage and equipment space while lowering the project's total footprint.

4.1.2. Shanghai Tower

The Shanghai Tower was developed with a focus on environmentally friendly land use methods. The building's design was meticulously planned to conserve as much green space as possible while adding new sustainability features. Furthermore, the building's double-skin curtain wall and on-site renewable energy generation technologies allow it to obtain LEED Platinum certification while reducing its carbon footprint.

4.1.3. Shanghai Tower

Shougang Park: Shougang Park was created to encourage productive use while protecting the land and ecology. The project demonstrates how previously contaminated land may be converted into a lively natural environment that supports biodiversity and sustainable living by repurposing a former steel mill site into a green eco-park. The Park includes substantial green infrastructure such as wetlands, gardens, and stormwater management systems that not only reclaim the land but also provide visitors with a unique and immersive natural experience in the center of Beijing.

4.2. Usage and conservation of energy

In today's environment, it is critical to apply sustainable energy practices, and three important case studies demonstrate new ways to improve energy efficiency and conservation. In an area with both hot summers and cold winters, Nanjing Vanke's proposal focuses on natural ventilation to improve community design and apartment architecture. By increasing window openings to well over 10% of total floor space, the project exceeded code standards, resulting in better natural ventilation inside buildings. Solar-powered hot water equipment was also built to heat water in high-rise structures. Residents rely on a solar-vacuum tube system that is directly connected to the water supply, while solar panels heat water in the basement. On the higher and lower levels, approximately 27% of households (227 out of a total of 836) employ solar thermal systems.

Shougang Park, a former steel factory that has been transformed into a new urban development project, offers a wide range of cultural and leisure activities, including museums, art galleries, and sports facilities. To lessen its environmental impact, the park features sustainable technologies such as solar panels, wind turbines, and a rainwater collection system.

Similarly, to reduce overall energy consumption, the Shanghai Tower incorporates sophisticated building features such as a double-skinned façade, intelligent air-conditioning, and regenerative elevators.

These three case studies demonstrate how innovative solutions and a commitment to decreasing carbon emissions may lead to sustainability. These initiatives serve as models for future development that prioritize the health of both people and the world by applying modern technologies and supporting renewable energy sources (Wang et al. 2021).

4.3. Usage and conservation of water

Water conservation and recycling measures have been successfully implemented in three urban development case studies. Recycled water was extensively employed in the Nanjing Vanke Jiuduhui Project for purposes such as agricultural, road spraying, and landscape irrigation, making it the first project of its sort in southeast China to adopt such a large-scale system (Prakash and Kumar 2013) (Prakash and Kumar 2013). The Shanghai Tower, one of the world's tallest buildings, implemented a comprehensive water management plan that included features like rainwater harvesting, greywater recycling, and low-flow fixtures, resulting in a 21% reduction in water consumption when compared to comparable buildings. To manage stormwater runoff at Shougang Park in Beijing, an innovative "sponge city" approach was used, which involved using permeable surfaces, green roofs, and other ways to absorb and filter water before releasing it back into the environment. These projects necessitated the use of cutting-edge technology, community approval, and efficient maintenance, but the end result was a more sustainable and cost-effective water infrastructure. If additional communities took comparable initiatives toward water conservation and recycling, tremendous progress could be made toward fostering a more sustainable future.

5. Reducing waste and maximizing material use

The four-stage Nanjing Vanke Jiuduhui Project was founded on residential architecture fundamentals. Decorative architectural expenditures accounted for only 0.28% of overall costs, far less than the allowed 2%, and the structures were constructed entirely of prepared concrete. Solid waste materials generated throughout the project included cardboard, metal, cement blocks, asphalt, tin cans, plastics, glass, plasterboard, and wood. According to Table 4, 41.42 percent of total garbage was recycled. Using recycled materials reduces waste, raw material consumption, and the environmental impact of material manufacturing and distribution. The eco-friendly and cost-effective approach of reusing materials, which also reduces carbon emissions, completely reflects the

Table 4. Utilization ratio of waste materials for Nanjing Vanke Jiuduhui project.

Material	Material use (kg)	The volume of waste (kg)	Quantity of waste materials recycled (kg)
Mortars	44154898.00	4415486	1324753
Building Components	14277297.22	2141590	1070899
Alloy steel	11687603.75	584381	584494
Stone	2620441.26	131020	65640
Aluminium	576251.11	28820	28820
Glass doors and windows	2433849.38	121696	-
Total amount of waste		7422993	
Utilized waste volume			3074606
Ratio			41.42%

importance of material conservation for green buildings (Chandhran and Elavenil 2022; Larsson et al. 2006).

Another example of sustainable architecture in China is the Shanghai Tower. The tower was developed with an emphasis on environmental sustainability and energy efficiency in mind. It has an innovative double-skin facade that reduces solar gain and heat loss, reducing the need for heating and cooling. A rainwater harvesting system captures and reuses rainwater for landscaping and other non-potable applications. Furthermore, the building has energy-efficient lighting fixtures, water-saving fixtures, and HVAC systems. These characteristics aided the Shanghai Tower in achieving LEED Platinum certification, the highest possible grade under the LEED system.

Shougang Park is yet another example of Chinese sustainable building. The Park, which was originally home to a steel factory, has been turned into a modern industrial park focused on sustainable development. The Park has undertaken a variety of environmentally friendly initiatives, including the utilization of renewable energy sources such as solar and wind power, the promotion of electric vehicles, and the implementation of a complete waste management system that includes recycling. The Park also has green roofs and walls, which provide insulation and aid in temperature regulation. These activities aided Shougang Park in attaining LEED Gold certification.

When civil engineering and interior design are combined, homeowners benefit from a turnkey solution that requires no significant pipeline adjustments after registration. This allows for immediate building and decorating while conserving materials throughout the construction process. It also avoids difficulties in late decorating and takes into account the true wants of homeowners while adhering to green building operations guidelines.

To meet ESGB 2014 standards, it's important to consider several aspects, including whether projects will support new green building rating tools during their lifespan. Researchers have uncovered credit concerns that can be solved by global rating methods. International green building rating systems, such as LEED, BREEAM, and Green Star, consider criteria such as water, energy, material components, and land consumption. The study cases performed well on these criteria, using only water-saving equipment for significant savings. They also managed Green Star emissions and BREEAM waste components.

The Nanjing Vanke Jiuduhui Project, Shanghai Tower, and Shougang Park are examples of Chinese sustainable architecture that incorporate sustainable materials, energy-efficient systems, and sophisticated technologies to reduce waste and maximize material utilization. These projects received high ratings under worldwide green building assessment systems, serving as models for future sustainable development in the country (see Table 5).

Despite the success of these projects, few receive certification during the actual implementation phase. Researchers conducted interviews with key project roles to learn about the difficulties encountered in obtaining this certification. By considering these factors, it is possible to achieve greater sustainability in building design and construction while reducing environmental impact.

6. Interview and findings discussion

Interviews revealed a variety of operational issues in green construction projects, including uneven government regulations, insufficient marketplace support for builders' profitability, compliance hurdles, inadequate inter-ministry collaboration, and more. Respondents discussed the effects of centralized macro-control and localized customized implementations on the success of green building programs. In response to these concerns, solutions and best practices were proposed. Respondents recommended for the use of energy-efficient materials, the incorporation of renewable energy sources into construction, and the use of energy monitoring technologies. They also supported green building incentives and laws requiring sustainability criteria for new development projects. The emphasis was on improving inter-departmental communication and coordination, developing future green construction experts, finding alternative finance routes, and dispelling stakeholders' misunderstandings. The interview findings provide light on the obstacles and best practices in green building projects. Addressing these difficulties and implementing best practices can enable policymakers, developers, and stakeholders to build a more environmentally sound and sustainable future.

6.1. Thematic analysis findings

This section expands on the findings of the thematic analysis of the interview data, revealing crucial aspects that illuminate both obstacles and opportunities in Chinese green construction efforts:

6.1.1. Inconsistent Government Regulations

Regional variations and conflicting government legislation hamper uniform green construction practice adoption.

6.1.2. Market Acceptance and Profitability

Due to the limited demand for sustainable construction, striking a balance between profitability and green practices is difficult.

Table 5. Criteria for evaluating green buildings that are taken into account by international assessment tools.

Tools for evaluating green buildings	Operations and maintenance for LEED v4.1 certified buildings								Performance Rating of Green Star, Version 1.3
	International tool assessment criteria								
Chinese tool assessment criterion	Transportation and locality	Sustainable sites	Water conservation	Energy and the environment	Resources and materials	The State of the Indoor Environment	Innovation	Priority in the region	Management
Utilization and land preservation	✓★	■✓	✓★	■✓	-	-	-	-	-
energy usage and conservation	-	-	-	■★	-	■✓	✓★	-	-
Using and conserving water	-	-	■✓★	-	-	■✓	-	✓★	✓★
Using and conserving materials	-	-	-	-	■✓★	-	-	-	-
Tools for evaluating green buildings	Performance Rating of Green Star, Version 1.3								International BREEAM New construction
	International tool assessment criteria								
Chinese tool assessment criterion	The State of the Indoor Environment	Energy	Transportation	Water	Materials and components	Ecosystems and land usage	Emission levels	Innovation	Management
Utilization and land preservation	-	-	✓★	✓★	-	■	-	-	-
energy usage and conservation	■✓	■★	-	-	-	■✓	-	✓★	-
Using and conserving water	■✓	-	-	■✓★	-	■✓	-	-	✓★
Using and conserving materials	-	-	-	-	■✓★	-	■✓★	-	-
Tools for evaluating green buildings	International BREEAM New construction								
	International tool assessment criteria								
Chinese tool assessment criterion	Wellness and health	Energy	Transportation	Water	Materials and components	Waste	Ecosystems and land usage	pollution	Innovation
Utilization and land preservation	-	-	■✓★	✓★	-	■✓★	■✓★	-	-
energy usage and conservation	-	■	-	-	-	-	-	-	-
Using and conserving water	-	-	-	■✓★	-	-	-	-	-
Using and conserving materials	-	-	■✓★	-	■	■✓★	-	-	■✓★

■ Nanjing Vanke Jiuduhui Project
✓ Shanghai Tower
★ Shougang Park

6.1.3. Challenges in Green Building Standards Certification

Technical restrictions and a lack of knowledge with cutting-edge technology impede achievement of certification standards.

6.1.4. Balancing Developer Interests and Environmental Goals

The difficulty of balancing current developer interests with long-term environmental goals throughout operational periods.

6.1.5. Localization and Centralized Control

Effective green construction policies require a balance of localized adaptations and centralized oversight.

6.1.6. Collaboration Across Departments

Deficiency Government agency engagement is a roadblock in the advancement of green building initiatives.

6.1.7. Legal Framework and Enforcement

Analyzing the benefits and downsides of mandated green building initiatives.

These thematic domains shed light on the complex terrain of green building initiatives, giving a nuanced foundation for a thorough assessment of their interconnection with current literature and possible impact on the trajectory of sustainable construction.

7. Sustainable projects accredit in operational phase: obstacles and suggestions

The interviews with participants who have firsthand knowledge of green building projects revealed a variety of roadblocks that can obstruct the process of acquiring a green building license throughout the operational phase. Among these difficulties are:

(1) Inconsistent government rules
(2) Lack of support from the marketplace to help support builders' profits
(3) Difficulty in meeting requirements
(4) Responding to the interests of developers
(5) Localized special implementations and centralized macro-control
(6) Inadequate collaboration between diverse departments
(7) The implementation of mandatory measures

Recommendations for future green construction initiatives were offered to solve these challenges. Among these suggestions are:

(1) Education for future green building experts
(2) Planning for practical architecture
(3) Enhancement of mechanisms available in the market for green buildings
(4) Effective promotion measures and recommendations for green buildings

These included creating incentives for developers to incorporate green building practices, raising public awareness of the benefits of green buildings, enacting regulations requiring all new construction projects to meet certain sustainability standards, improving communication and collaboration among diverse departments, developing programs to educate future green building experts, and exploring alternative financing options such as green bonds or subsidies for green buildings.

Thematic analysis was used to evaluate the data gathered from the interviews, which allowed for the discovery of patterns and themes present in the responses. The study discovered that certain factors, such as the use of energy-efficient materials, the implementation of renewable energy systems, and the incorporation of systems that monitor and manage energy use, contribute to green building characteristics.

Multiple data sources were employed to confirm the validity and reliability of the findings, including interviews, observations, and document analysis, with the goal of triangulating the data sources. To confirm the authenticity and reliability of the results, two distinct researchers analyzed the data gathered from the interviews.

To guarantee that ethical considerations were taken into account, all participants provided written consent, and their identities were secured. In accordance with ethical guidelines, personal information was kept confidential.

7.1. Obstacles

7.1.1. Government rules that are inconsistent

Since 2008, green building assessment labels have been utilized in China. Local governments are employing coercive methods to promote green buildings, such as requiring a green building design assessment label prior to issuing building permits or granting acceptance. However, the government's rules contain inconsistencies that must be addressed. In particular, the assessment of the operating phase is not performed until one year later, posing difficulties for authorities endeavoring to monitor compliance with green building standards.

Various measures could be implemented to resolve this issue. First, a national governing body could be established to establish and enforce uniform rules for green construction assessments. This would guarantee that all local administrations adhere to the same criteria.

Secondly, assessment procedures ought to be revised to coincide with the conclusion of construction. This would make it simpler for officials to monitor compliance with green building standards and ensure that buildings satisfy the required specifications.

Thirdly, governments should provide tax breaks or subsidies to builders who construct green structures to encourage conformance with green building standards. This would increase the prevalence of green building practices and provide a financial incentive for compliance.

Lastly, public awareness campaigns and educational initiatives should be implemented to increase public comprehension of the significance of green building practices. Greater public demand for green buildings will put pressure on governments to implement consistent rules and promote sustainable development.

7.1.2. The incompetence of the marketplace to help support builders' profits

Building sustainable water systems presents a number of difficulties for contractors. Profitability can be impacted by market-related issues in addition to weighing the costs of implementation and maintenance versus potential savings. For instance, demand for sustainable practices may be restricted if the market does not fully support or recognize them, which would reduce the financial incentives for builders. Furthermore, it might be challenging to precisely estimate the long-term advantages and disadvantages of sustainable water systems, particularly if the builders lack expertise or knowledge in this field. This may make profitability criteria more ambiguous and make it more difficult for builders to make wise selections. The building sector must prioritize and reward sustainability while supplying contractors with the tools and information they need to meet these challenges. By doing this, we can construct a more prosperous and long-lasting future for builders and the larger sector of the industry.

7.1.3. Difficulties in meeting green building standards

There are several green building technologies that can be used throughout the design phase to acquire green building certification. Many of these technologies, however, are not commonly used, and some may not operate optimum in terms of technical efficiency. Architects and planners may also be unfamiliar with the various technology approaches available for designing green buildings.

Green building construction frequently necessitates the usage of new materials, as the qualities of domestic materials may not fulfill the essential criteria. This involves the importation of new materials, which raises material and shipping expenses. Furthermore, the usage of novel materials can have an impact on the building's architectural plan. The addition of a soundproof floor, for example, may impact the overall height of the building.

7.1.4. Responding to the interests of the developers

The lack of enthusiasm among developers is one of the primary obstacles to establishing operational certification for green buildings. If the project obtains a green design accreditation, the developer will benefit from increased demand for the building. Throughout the building's operating period, however, only the residents will reap the benefits. As a result, developers are unmotivated to pursue green building operating stage certification.

7.1.5. Localized special implementations and centralized macro-control

Policies are decided upon by the governments, which create the foundation for green buildings via legislation, rules, and incentives. The government is, in theory, also a backer of scientific inquiry and technological advancement. Green buildings are inextricably linked to the use of new technologies. That's why it's up to the government to foster innovation in technology. Because of variations in weather across China, there is a lack of national guidelines that apply everywhere. Research and utilization of quantitative, qualitative indexes should be strengthened, and evaluation methods should include quantitative criteria of high quality. The Chinese government should provide a framework for the introduction of green building rating systems based on the country's fundamental requirements. In the meanwhile, province and municipal governments should both craft green construction laws tailored to their own regions, as seen in Nanjing and Dalian, for example, as well as in other cities around China.

7.1.6. Inadequate collaboration between diverse departments

It is not the duty of an organization or department to create and assess green buildings. It must include energy, water supplies, land, materials, and the interior environment, as well as other issues that necessitate collaboration among the Improvement and Reform Committee, the Planning Department, the Finance Department, the Construction and Engineering Department, the Department of Transport, or any relevant agencies, together with improved green building management and implementations. The impact of green building investments on regional economies should be analyzed across all departments. It is important that they spread the word to builders that going green will increase their return on investment.

7.1.7. The implementation of mandatory measures

The vast majority of green building assessment systems all over the world rely on volunteers for their implementation, which necessitates a high level of knowledge on the part of the business. Certain huge building projects, however, need mandatory steps to be taken for their long-term advantages. A significant part of the responsibility for promoting the use of green construction practices should fall on the government. Reports from interviewees suggest that in China, a green building assessment label is needed before a building permit can be issued. Green building design is greatly aided by using this approach. Nevertheless, the scope of this method can be expanded to include operational implementation.

7.2. Suggestions

7.2.1. Education for future green building experts

As a result, a lack of technological literacy has become a barrier to the advancement of green architecture. From a personal standpoint, the current rating method does not meet all requirements for green buildings. Therefore, it's important to provide appropriate training and test for qualifications for the appropriate staff. The government should maintain its funding for R&D on energy-efficient technology to advance the field of technological communication. In addition to this, elevating the quality of the property management is of equal significance. Nowadays, property management staff do not fully grasp the concept of green architecture, which has a significant impact on the operating phase of green structures. As a result, it's crucial to invest more time and effort into raising the property management team's competence and cultural sensitivity to the topic of green construction.

7.2.2. Planning practical architecture

Not only should design plans focus on getting green building assessment labels for the design phase, but also on quality, budget, cost, time, and other variables. When the design stage is complete, the architects should collaborate with the building's owners and the real – estate sector on the procedure for obtaining a green building assessment label for the operational phase. Also, the designers should relay any and all information about green building materials and technology to the appropriate department. This will ensure that green buildings are able to function as they should right from the start of the design process.

7.2.3. Enhancement of the mechanisms available in the market for green buildings

Market demand is a restriction on the current trend of sustainable construction. Yet, environmental regulation would point environmentally friendly construction in a more productive direction. One of the most crucial guarantees for advancing green building operational assessment is the availability of accurate market data. Information that is both open and accurate can assist stakeholders in better understanding both risks and advantages, in addition to providing a key guide to green building financing. Simultaneously, by instituting a market-competitive system and setting up expert green building advisory companies, it will ensure the construction of "green" structures (Anthony Jnr 2020). When it comes to new agencies, new materials, and emerging technologies, it's important to promote and support innovation and bring in qualified investors.

7.2.4. Effective promotion measures and recommendations for green buildings

As a result of globalization, green building assessment systems from other countries are being used to evaluate architecture in China. Among the systems for assessing the performance of green buildings, BREEAM and LEED are the ones that are most often employed. More research needs to be done to see if different assessment models work with China's current situation and goals for the future. On the other hand, the majority of those interviewed advised the same sort of steps to encourage efficient and sustainable green building structures throughout the operating phases. In addition, these methods can also be utilized to address challenges.

8. Overview and conclusion

Significant impediments to achieving green building accreditation throughout the operational phase were found to exist throughout the study. These barriers included a variety of government rules, a lack of market support for builder profitability, trouble meeting requirements, and difficulties promoting cross-departmental cooperation. Concrete and doable recommendations were made to address these problems, including encouraging future green building professionals to pursue education, incorporating practical architecture design, enhancing market mechanisms for green buildings, and implementing effective advertising strategies for eco-friendly buildings. In conclusion, sustainable growth can be attained through green building. Green building practices must be promoted and adopted by the public at all stages of development, but especially during the operational stage, with the help of industry players, policymakers, and the general public. We can construct a greener, more resilient future for our communities and the globe by adopting green building practices.

It's important to be aware of the study's implications: The findings' application to other regions with different socio-economic and regulatory conditions may be limited by the study's exclusive focus on green construction projects in China. Furthermore, relying heavily on case studies and interviews runs the risk of introducing subjective biases and limitations in data collection and interpretation. To acquire a thorough understanding, future studies should take into account difficulties experienced across the whole life cycle of green buildings, including the construction and design phases. The potential for green buildings to reduce carbon emissions and resource consumption over time might be examined in future research directions, which might also examine the long-term performance and environmental implications of green buildings. Comparative studies of the various green building rating systems in use throughout the world may point out best practices and potential areas for improvement. Looking into cutting-edge methods and supplies for green building could lead to more practical and affordable solutions. Additionally, researching the financial effects of green building projects, such as their return on investment (ROI) and cost-benefit ratios, might influence investors and developers to embrace them more widely. The social and psychological factors that influence occupant behavior and happiness in green buildings can also be understood, and this knowledge can be used to advance sustainable practices and improve user experiences.

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