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# Review and Prospects of China's Building Sustainability Assessment

**Shizhen Fan* and Jiaqing Sun**

*School of Architecture and Urban Planning, Chongqing Jiaotong University, Chongqing, China*

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***Corresponding author:** Shizhen Fan, School of Architecture and Urban Planning, Chongqing Jiaotong University, Chongqing, China. Email id: 694935829@qq.com

**Abstract**

In recent years, the rapid growth of China's construction industry has brought into sharp focus the paradox between energy shortages and the surging market demand. The increasingly dire ecological conditions underscore the imperative for a sustainable transformation within China's construction sector. The exploration of sustainable assessment for building projects in China dates back to the 1970s. This paper comprehensively examines the developmental trajectory of China's official standards for building sustainability assessment. Employing bibliometrics, we conduct an in-depth analysis of pertinent research literature in China, distilling the key focal points and research trends in building sustainability assessment. The article offers a synthesized overview of China's building sustainability assessment through a thorough literature review. Additionally, it presents a forward-looking perspective on the research in this domain, with the overarching goal of propelling the Chinese construction industry toward a more sustainable trajectory.

**Keywords:** Building Sustainability Assessment; China; Citespace; Review; Prospect

## Introduction

Since the Industrial Revolution, human technological and production capabilities have rapidly advanced, profoundly impacting the natural environment and societal structures. The industrialization process has given rise to waves of urbanization, driving urban construction and infrastructure development. However, it has also been accompanied by extensive land development, deforestation, and pollutant emissions, causing severe impacts on natural ecosystems. Global population growth has led to increased production and consumption demands, resulting in overexploitation and waste of natural resources [1]. This not only leads to the growing scarcity of natural resources but also triggers serious environmental issues such as climate change, rising sea levels, and loss of biodiversity. This series of problems underscores the immense damage to the environment caused by unsustainable production methods. Against the backdrop of recognizing these changes and their severe impacts, the concept of sustainability began to emerge in the 1960s and gradually gained global recognition. In the late 20$^{th}$ century and the early 21$^{st}$ century, various international building sustainability assessment standards and certification systems emerged, including the United States' LEED, the United Kingdom's BREEAM, France's HQE, Japan's CASBEE, among others.

These tools provide clear guiding principles for the construction industry, including standards for resource efficiency, energy performance, indoor environmental quality, and social responsibility. The advent of these tools has promoted the dissemination and popularization of building sustainability concepts, driving the construction industry towards a more sustainable direction to meet the growing environmental and social demands. The robust demand in the Chinese construction market, coupled with the significant consumption of resources and negative environmental impacts, places a crucial responsibility on the Chinese construction industry in advancing sustainable development [2]. In pursuit of sustainability and the implementation of green building concepts, China has successively promulgated a series of regulatory documents, including the "Green Performance Calculation Standard for Civil Buildings," the "Technical Assessment Manual for Chinese Eco-Housing," and the "Green Building Evaluation Standard." The formulation of these regulatory documents further propels the sustainable development of the construction industry. This paper begins by analyzing the development of China's building sustainability assessment tool. Subsequently, utilizing bibliometrics and focusing on 664 literature entries recorded in the CNKI database, the paper employs Cite space visualization software for visual analysis. This approach aims to uncover the research progress of Chinese scholars regarding building sustainability assessment providing a brief analysis and serving as a reference for future research in the field of sustainable construction.

## Concept of Building Sustainability

Building sustainability is a comprehensive concept that requires thorough consideration of the economic, social, and environmental aspects in both building and urban planning. Economic sustainability emphasizes the need for economically rational construction projects that create long-term economic value through the reduction of resource management and operational costs. Social sustainability focuses on the impact of buildings on society, demanding the provision of a safe and comfortable living environment, promoting community participation and development, and addressing social factors such as occupational health and human rights. Most importantly, environmental sustainability emphasizes the reduction of resource consumption, pollution, and waste generation [3], aiming to protect ecosystems through the use of renewable energy, reduced energy consumption, environmentally friendly materials, and rational water resource management. In addition, the concept of building sustainability includes a long-term perspective, ensuring not only the satisfaction of current needs but also the protection of the rights and living environment of future generations. Building sustainability requires a balance of economic, social, and environmental considerations throughout the design, construction, and operation processes to meet modern needs while safeguarding the rights and living environment of future generations.

## Development of China's Building Sustainability Assessment Tool

In the 1970s, China began to embrace the concept of sustainability for building projects, gradually increasing attention to the ecological environment. Over time, research on the sustainability assessment of building projects became more widespread, transitioning from predominantly qualitative assessments to more quantitative methods, resulting in the emergence of numerous assessment standards. In 1996, the Hong Kong Polytechnic University introduced the "Hong Kong Building Environmental Assessment Standard," designed to assess the quality of both new and existing residences. This standard's assessment focuses on various aspects, including the impact of the project's construction site on the regional environment, materials used in the project, quality control, technological applications, energy consumption, and project management. From the perspective of sustainable development, this standard emphasizes considerations of resources and the environment, incorporating technological and management concepts into the considerations of resources and the environment. The "Technical Assessment Manual for Chinese Eco-Housing" was jointly developed by the Ministry of Construction's Technology Development Promotion Center, the China Academy of Building Research, and Tsinghua University. It aims to promote the sustainability of China's residential industry, emphasizing the protection of natural resources, the creation of a healthy environment, and the coordination of ecological aspects with the surrounding environment. This assessment standard primarily focuses on the sustainability of residential areas and communities, covering five main areas: residential area environmental planning and design, energy and the environment, indoor environmental quality, residential water environment, and materials and resources. This standard emphasizes sustainability at the community level, including the planning of residential communities, energy efficiency, water resource management, and indoor environmental quality.

In 2001, the Ministry of Construction's Residential Industrialization Promotion Center issued the "Key Points and Technical Guidelines for the Construction of Green Ecological Residential Communities," emphasizing the crucial role of technology in promoting the construction of residential ecological environments. This guideline underscores the importance of technology, focusing mainly on the sustainability of residential communities and neighborhoods. Evaluation factors include the effective use of resources, environmental protection, social considerations, and the unified economic benefits, promoting the construction of residential ecological environments. Additionally, the "Green Building Evaluation Standard," jointly issued by the Ministry of Construction and the General Administration of Quality Supervision, Inspection, and Quarantine, is used to assess residential and public buildings. This assessment standard includes three levels of green building certification – one star, two stars, and three stars – depending on the building's performance in various aspects. Evaluation factors encompass energy conservation, water resource management, land use, material and resource utilization, indoor environmental quality, outdoor environment, as well as management and innovation. These factors comprehensively consider the sustainability of buildings, including resource utilization efficiency, environmental friendliness, and residential comfort, thereby promoting the development and practice of green building. These standards and guidelines collectively provide crucial guidance and support for the sustainable development of the construction industry.

Currently, China has made considerable progress in the research field of green building assessment. However, it is important to note that green buildings represent only one aspect of sustainable development. When considering the resource and environmental effects of green buildings as static products, we often overlook the economic benefits of the buildings themselves and the social benefits they bring. Internationally, building assessment standards focus more on areas such as resources, environment, technology, and management, emphasizing the importance of technology and management in achieving resource efficiency and environmental protection. From the perspective of evaluation indicators, China's current building sustainability assessment primarily focuses on energy conservation, water conservation, land use, environmental protection, lighting, ventilation, safety, technological advancement, and advanced management concepts. However, this kind of assessment tool


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largely neglects the basic needs of the building's surrounding area, such as education, employment, and living facilities. At the same time, it almost does not consider the economic benefits of the building itself and the external impact on the surrounding social and economic environment. According to the principles of sustainable development, the current assessment standards are evidently not comprehensive enough. Therefore, it is necessary to broaden our thinking on building sustainability, including social and economic dimensions, as well as the external impact on the regional society and economy. This will contribute to achieving a more comprehensive and effective assessment of building sustainability, better meeting people's living needs, and promoting sustainable development in society and the economy.

## Current Academic Research Status in China

### Overall Analysis

Figure 1 Using the topic "建筑可持续评价" (Building Sustainability Assessment) as a search term on the China National Knowledge Infrastructure (CNKI), a total of 664 relevant documents were retrieved. Visualizing the analysis of these documents reveals that research on building sustainability assessment in China began to emerge around 1997 and has been steadily increasing year by year. The peak of research activity was reached in 2020, followed by a gradual decline. However, it still remains a relatively popular and active research direction. Through the distribution chart based on institutions, it is evident that in the research on building sustainability assessment, Xi'an University of Architecture and Technology takes the lead with the highest number of publications, contributing a total of 28 relevant documents. Following closely are Tianjin University, Tsinghua University, Beijing Jiaotong University, Chongqing University, Huazhong University of Science and Technology, Southeast University, and others. This trend indicates that Xi'an University of Architecture and Technology has extensive experience and output in the field of building sustainability assessment research (Figure 2-4).

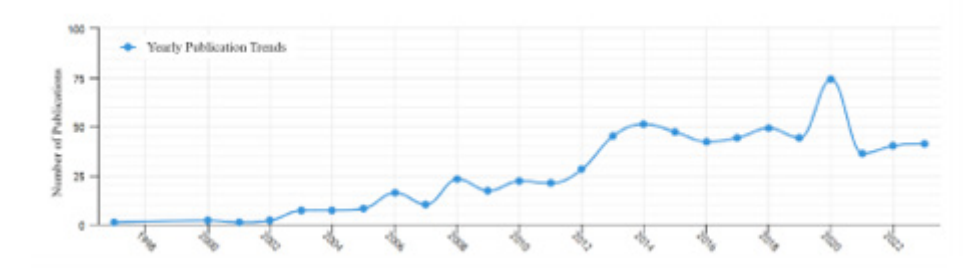


**Figure 1:** Trends in the Number of Publications on Sustainable Assessment of Chinese Construction in the CNKI Database.

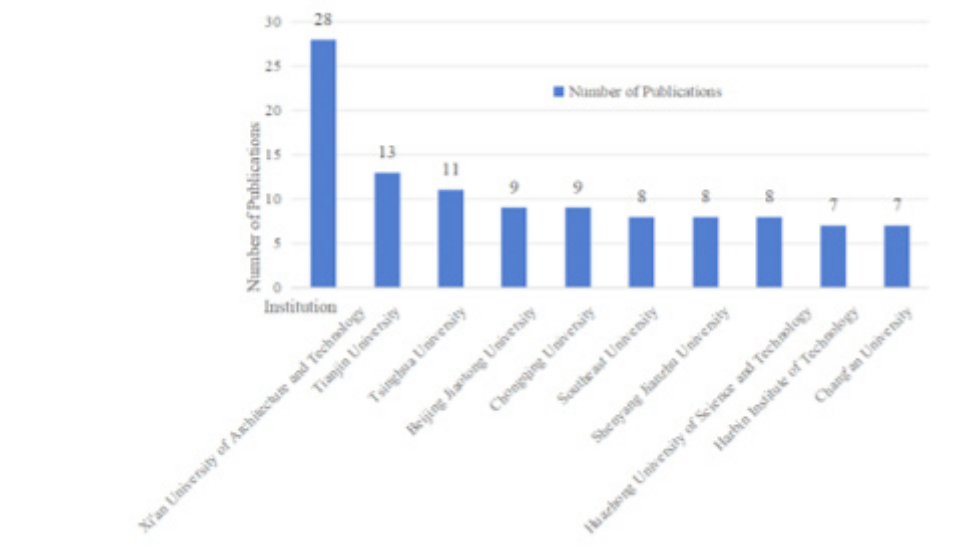


**Figure 2:** Distribution of Institutions in Research Publications on Sustainable Assessment of Chinese Construction Recorded in the CNKI Database.


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**Figure 3:** Cluster Map of Key Research Keywords in the Field of Sustainable Assessment Systems for Buildings.

**Top 8 Keywords with the Strongest Citation Bursts**

| Keywords | Year | Strength | Begin | End | 2013 - 2023 |
|---|---|---|---|---|---|
| 建筑业 | 2013 | 2.82 | 2013 | 2015 | |
| 绿色建筑 | 2013 | 8.56 | 2014 | 2019 | |
| 评价 | 2014 | 2.59 | 2014 | 2015 | |
| 可持续性 | 2013 | 1.73 | 2015 | 2016 | |
| 评价标准 | 2013 | 2.99 | 2016 | 2018 | |
| 评价体系 | 2013 | 2.31 | 2016 | 2017 | |
| 绿色施工 | 2018 | 1.51 | 2018 | 2020 | |
| 可持续 | 2021 | 1.45 | 2021 | 2023 | |

**Figure 4:** The Keywords with the Strongest Citation Bursts of Building Sustainability Assessment Research.

## Keyword Analysis

Utilizing Cite Space software for keyword cluster analysis and generating a time-varying keyword cluster map provides insights into several hot topics in the research field of building sustainability assessment in China. Clusters such as "评价体系" (Evaluation System), "绿色建筑" (Green Building), and "建筑业" (Construction Industry) emerge as key focal points over time. Furthermore, employing Cite Space software for burst detection reveals prominent keywords, including "建筑业" (Construction Industry), "绿色建筑" (Green Building), "可持续性" (Sustainability), and "评价标准" (Evaluation Standards). These keywords signify critical aspects that have experienced notable bursts of attention and activity within the research community, highlighting the evolving dynamics and emphases in the field of building sustainability assessment in China.

## Relevant Studies

In the context of sustainable development in the field of construction projects, various scholars contributed to the establishment and application of evaluation models. This review provides an overview of several key studies in this area. Zheng Longhai [4], based on green building theory and guided by the principles of sustainable development, comprehensively considered ecological technology, economy, social aspects, and operational management as the four key factors for sustainable construction. Applying the Analytic Hierarchy Process for indicator classification and utilizing the Grey Whitening Weight Function, Zheng constructed a sustainability assessment model for large public buildings. Yi Honglei [5] divided the entire lifecycle of construction projects into five stages: decision-making, design, construction, operation, and decommissioning. Examining


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sustainability characteristics from six dimensions—economic, environmental, social, resource utilization, health and safety, and project governance—Yi quantified the sustainability features of construction projects and discussed potential improvements.

Huang Mengying [6] conducted a comprehensive study and summary of the sustainable development evaluation of residential construction projects. Integrating existing evaluation systems and delving into sustainable development theories, Huang constructed a sustainability evaluation framework for residential construction projects based on economic, population, environmental, and resource subsystems. Zheng Yuting [7], using Hengsheng Tower as a case study, evaluated the sustainability of prefabricated buildings. She established sustainability evaluation indicators covering building performance, operation and maintenance, material costs, environmental quality, and energy consumption. Subsequently, she formulated an evaluation index system and constructed a model using the Grey Hierarchy Method. Shi Yuxin [8] employed Cite space tool for literature analysis, identifying sustainability influencing factors in the construction phase of public projects. These factors were categorized into four main dimensions: ecological, social, economic, and technical. Through system dynamics and questionnaire surveys, Shi optimized and screened evaluation indicators, determining weights using Analytic Hierarchy Process and modifying them with entropy method for scientific and rational weight allocation. Ultimately, a comprehensive evaluation model was constructed using the matter-element extension evaluation method.

Zhen Peng [9], based on China Statistical Yearbook, devised an evaluation method to assess the sustainability of urban construction environments in China over the past decade. The evaluation covered eight dimensions: Energy, Water, Social Aspects, Waste, Land Use, Economy, Air Quality, and Transport, and employed quantification to establish a holistic assessment framework. Han Ying [10] established an evaluation indicator system encompassing environmental, socio-cultural, economic, and technical aspects. Using Analytic Hierarchy Process and Delphi method, they determined weights to reflect community-wide sustainability, providing a model applicable to evaluating the sustainability of similar communities. Wu Deng [11], focusing on building and facilities, natural environment, people's satisfaction, and the transportation system, proposed a rapid assessment method for a preliminary understanding and in-depth impressions of the sustainability of urban construction environments. These scholars have conducted systematic research and improvements on building sustainability assessment methods, mainly based on the Analytic Hierarchy Process (AHP). By combining methods such as fuzzy evaluation, composite index method, entropy method, they aimed to enhance the objectivity and comprehensiveness of the assessment model. Additionally, some scholars further subdivided and expanded building sustainability assessment indicators, introducing new dimensions such as operation and technology on the basis of the three sustainability dimensions: economic, social, and ecological. Some researchers also classified sustainability assessment based on different building lifecycle stages, such as decision-making, design, construction, operation, and disposal stages, contributing to a more comprehensive and systematic evaluation of building sustainability performance.

## Conclusion

The research on building sustainability assessment in China has made significant progress, comprehensively covering environmental, economic, and social dimensions. This comprehensive evaluation provides more comprehensive guidance and standards for the Chinese construction industry. Environmental considerations play a crucial role in sustainability assessments, and the introduction and adaptation of green building certification systems such as LEED and BREEAM have propelled the sustainable development of the Chinese construction industry. Simultaneously, domestic green building standards in China continue to evolve to meet national conditions and market demands. In the realm of building sustainability assessment, stakeholders' social responsibility awareness is on the rise, encompassing considerations for the social impact of construction projects, community engagement, and employee well-being. This reflects the heightened expectations of Chinese society regarding the sustainability of the construction industry.

Despite the remarkable progress in the research of China's building sustainability assessment systems, challenges persist, including the diversity of standard systems, issues related to data collection and verification, and the need to enhance market awareness and acceptance. In conclusion, research on building sustainability assessment in China is an evolving and refining field. Looking ahead, we can anticipate more interdisciplinary studies to address the complex issues associated with sustainability assessments, driving the Chinese construction industry towards a more sustainable direction. This will contribute to alleviating environmental pressures, enhancing quality of life, and creating a more sustainable built environment for future generations.

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