

Life-Cycle Cost Management of Construction Projects under the Green Concept

Jiale Shen *

College of Civil Engineering, Nanjing Tech University, 211816 Nanjing, China

* Corresponding Author Email: 202321059033@njtech.edu.cn

Abstract. To promote the sustainable development of the green building industry, this paper conducts research on the full life cycle cost management of construction projects under the green concept. Firstly, it reviews the relevant theoretical connotations, this is the foundation, analyzes the problems such as narrow management perspective and incomplete accounting system, and constructs a four-dimensional integrated management system consisting of the target layer, accounting layer, control layer, and technology layer. It also proposed differentiated control strategies for the four stages: planning and design, construction, operation and maintenance, and demolition and recycling. The full life-cycle cost management of green buildings cannot merely focus on economic costs. Instead, a three-dimensional accounting system integrating economy, environment and society should be established. By relying on collaborative control and digital technology, the balance between short-term green investments and long-term comprehensive benefits can be achieved, providing a theoretical reference for the implementation of green building cost management.

Keywords: Green building; full life cycle; cost management; construction project; integrated management system.

1. Introduction

In the context of the continuous advancement of the "carbon neutrality" goal and the green development strategy, green buildings have become the core direction for the transformation and sustainable development of China's construction industry. Traditional cost management in construction projects mainly focuses on the one-time investment during the construction phase, while neglecting the resource consumption, environmental costs and long-term benefits throughout the entire life cycle of the project, from planning, design, construction, operation to dismantling and recycling [1]. With the wide application of green building materials, green construction methods, and energy-saving technologies, scholars worldwide have conducted research on aspects such as the evaluation system for green buildings, the theory of the entire life cycle, and cost-benefit analysis, laying a theoretical foundation for the integration of the green concept and engineering cost management.

There are many scholars worldwide who have conducted research on the cost analysis and management of the entire life cycle of green buildings and have achieved some results. However, there are still many areas that need to be improved. For instance, although some construction enterprises have adopted green building technologies, they often only consider short-term economic benefits and losses, without paying attention to the long-term benefits throughout the entire life cycle. This situation not only dampens the enthusiasm of construction enterprises to participate in green building projects but also has a negative impact on the development of the green building industry [2]. European and American countries have well-established green building assessment systems such as Leadership in Energy and Environmental Design (LEED) and Building Research Establishment Environmental Assessment Method (BREEAM). These systems focus on the construction of quantitative models for the entire life cycle, and mainly explore the connections between green building materials, energy-saving technologies, and cost-effectiveness. The Japanese Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) system has developed a unique evaluation logic for the renovation of existing buildings, highlighting the green benefits

through comparisons before and after the renovation. This provides a new approach for green cost management from a perspective of the entire life cycle [3].

In the above context, this paper will systematically review the theories related to green buildings and life-cycle cost management, clarify the composition and management key points of the life-cycle cost of construction projects under the green concept; analyze the existing problems in the current life-cycle cost management of construction projects and the impact brought by green factors; construct a life-cycle cost management system applicable to green buildings, and propose phased cost control strategies; provide theoretical references for the cost control of green building projects.

2. The connotation definition of life-cycle cost management for green buildings

Figures Green buildings refer to buildings that, throughout their entire lifecycle from design to demolition and abandonment, can conserve resources, protect the surrounding environment, provide healthy, comfortable, convenient and efficient spaces for people, and strive to achieve a harmonious coexistence between humans and nature, with a high quality standard [4]. It implements the concept of sustainable development in every aspect of architectural design and daily operation, improving the efficiency of resource utilization, reducing the environmental impact, while also emphasizing the enhancement of living and usage quality, and integrating economic benefits with social value.

The life-cycle cost refers to the total sum of all expenses incurred throughout the entire process of a building, from its initial design and construction to its operation and maintenance after it is put into use, and finally to its dismantling and disposal [4]. This includes not only the upfront costs during the design and construction phases, but also the long-term expenditures such as maintenance, energy consumption, water resource usage, and waste disposal during the operation period. This calculation method breaks the previous limitation of only considering the costs of a single stage and can more accurately reflect the overall benefits brought by the construction project, providing a scientifically based reference for the construction project.

Integrating the concept of greenness into the cost management of the entire life cycle of construction projects is a management approach that combines the calculation of the entire life cycle cost with the development needs of green buildings. The most crucial aspect is to extend cost control to the entire lifecycle of green buildings, from planning and design, construction, operation and maintenance, to demolition and recycling. By conducting overall planning and coordinating optimization of costs at each stage, it is possible to balance the additional expenses incurred in the early stages of green buildings in terms of environmentally friendly materials and energy-saving technologies, and fully leverage the potential to reduce costs in the later stages of operation in areas such as energy conservation and water conservation[4], maximize the comprehensive benefits of green buildings in terms of economy, environment and society throughout their entire lifespan.

3. The dual influence of existing problems and green factors

3.1. The core problems existing in the management of the entire life cycle cost

At present, the full life-cycle cost management of construction projects in China has not yet broken free from the limitations of the traditional model. From the perspective of the development needs of green buildings, the problems that have emerged now include both the difficulties commonly found in traditional cost control and new issues that have arisen in the context of green development. These core issues can be classified into four aspects: management perspective, accounting system, technology application, and collaborative mechanism. Specific details can be found in Table 1 below.

Table 1. The core problems existing in cost management.

Problem Categories	Specific manifestations	The core issue
Management perspective	Focus on short-term cost control during the construction phase, while neglecting long-term costs during the operation and dismantling phases. No overall planning for the entire process of costs has been formed [5].	The short-term-oriented approach has led to a lack of awareness regarding the optimization of the entire life cycle cost.
Accounting system	Only the traditional economic costs are accounted for, without including carbon costs, environmental costs and other green dimensions. Moreover, there are no differentiated accounting standards, making it impossible to truly reflect the comprehensive cost-effectiveness [5,6].	The calculation dimensions are limited, and there is a lack of quantitative standards for green costs, making it difficult to reflect the comprehensive costs and benefits.
Technology application	There is a lack of dynamic cost models suitable for green buildings; the application of information technologies such as Building Information Modeling (BIM) and big data in the collection and dynamic analysis of green cost data is at an early stage, and the management efficiency is relatively low [5-7].	There is a mismatch between technological requirements and green cost control needs, and the quantification accuracy and efficiency are insufficient.
Collaborative mechanism	There are issues such as poor coordination among different stages and participants, inconsistent goals, cost shifting, and responsibility evasion, as well as conflicting objectives [5].	The management entities are scattered, the mechanism for collaborative and coordinated operation throughout the process is lacking, and the overall management efficiency is very low.

3.2. Analysis of the dual effects of green factors

Green-related factors such as green concepts, green technologies and green evaluation systems have not only promoted the cost management of construction projects but also brought about practical difficulties. The driving effect is mainly reflected in three aspects: First, it has brought about new changes to the cost management system. The original single management model in the industry has gradually shifted to a comprehensive management model that covers the entire life cycle and integrates multiple dimensions [1]; Secondly, it can reduce the expenses after the building is put into use. By using green building materials and energy-saving technologies, the building can consume less energy and water during its daily operation, thereby saving costs [8]; Thirdly, it can enhance the overall revenue of the project. Green buildings can generate additional income through obtaining certifications and reducing carbon emissions, providing more ways for cost recovery [8].

From the perspective of difficulties, there are two issues that stand out particularly. First, during the initial construction phase, more money is required. The prices of green building materials and energy-saving equipment are significantly higher than those of traditional materials and equipment. This results in higher costs for green buildings during the construction process. Some small-scale enterprises may not be able to afford it [8]; Secondly, the costs and benefits resulting from green investments are difficult to calculate using a uniform standard. Costs and benefits such as carbon costs and environmental benefits are invisible and cannot be precisely calculated. As a result, enterprises have difficulty knowing how long it will take to recover the costs after investing in green projects, and therefore their enthusiasm for participation is not high [2].

4. Construction of a life-cycle cost management system for green buildings and phased strategies

4.1. Construction of the full life cycle cost management system

Based on the development needs and practical problems of green buildings, a full life cycle cost management framework for green buildings that is suitable for the current situation of our industry

has been constructed. This framework adopts a four-dimensional structure of target layer, accounting layer, control layer and technology layer. All parts work together and form a closed-loop management system, achieving precise control of green costs and overall planning of the entire process.

Firstly, the target layer focuses on maximizing the comprehensive economic, environmental and social benefits throughout the entire life cycle of the construction project. At the same time, it takes into account the implementation of the dual-carbon goal and the improvement of the enterprise's economic benefits. For instance, during the planning and design stage, the focus is on controlling the incremental green costs at the source [1]; During the construction phase, efforts were focused on implementing lean construction and reducing resource waste [1]; During the operation and maintenance phase, the focus is on energy conservation and cost reduction, as well as improving the efficiency of operation and maintenance [6]; The dismantling and recycling stage focuses on resource recycling and cost reduction in disposal, ensuring that each specific direction is consistent with the overall direction [9].

The next is the accounting layer, which breaks the traditional limitation of cost accounting that only focuses on a single dimension, and clarifies the accounting indicators, quantification methods and standards under different dimensions. The economic costs include direct expenditures at each stage as well as additional costs related to green building materials and intelligent technologies [9]; environmental costs cover costs in areas such as carbon emissions and resource consumption; social costs are included in the cost compensation part of implicit benefits such as improvement in living environment quality. These are calculated using the income restoration method to provide precise data support for subsequent cost control.

Next is the management layer, which has established a multi-party collaborative control mechanism led by the government and dominated by enterprises, with participation from design, construction and operation units. The government has introduced incentive policies and industry standards, offering tax benefits, subsidies, and improving regulatory measures [4]; enterprises, as the main body of the control system, have formulated cost control plans throughout the entire life cycle, strengthened communication and coordination among different stages, and achieved collaborative management throughout the entire process.

Finally, there is the technical layer, which is centered around digital technology as its core support. The platform needs to integrate technologies such as BIM, Internet of Things (IoT) and artificial intelligence. During the design phase, the cost-effectiveness of the green scheme is simulated; during the construction phase, the cost and resource consumption can be monitored; during the operation phase, energy consumption costs can be optimized through intelligent analysis; and during the demolition phase, a resource recycling plan is planned [2]. At the same time, the platform is equipped with a risk warning section. When there is an overspending of costs, an early warning signal will be sent out promptly to achieve early risk prevention.

4.2. Stage-based green cost control strategy

Based on the above-mentioned four-dimensional integrated cost management system, targeted and implementable phased control strategies are proposed to achieve precise control of costs at each stage and collaborative optimization of the entire process costs. At the same time, the relationship between green investment and benefit output at each stage is balanced.

The core concept during the planning and design stage is to deeply integrate value engineering analysis with the comparison of localized green solutions [9]. From the very beginning of the project, the incremental green costs are locked in to prevent design changes and unnecessary cost losses in the later stage. At the same time, a balance must be struck between the green performance of the building and its cost-effectiveness, and measures should be taken at the source to control the total life-cycle costs of green building projects [2]. Based on the climate and resource conditions of the project area, as well as the usage functions of the building, a differentiated green technology combination plan can be designed to reduce cost waste. The value engineering method is used to

optimize the design scheme [9], and the value coefficients of each functional module of the building are analyzed. Design contents with high costs but low values are adjusted accordingly.

The construction phase is a crucial step in implementing cost control for green construction projects [10]. Through meticulous overall process management [9], technological innovation, as well as green building material control and the application of information technology, waste and additional expenses can be reduced. During this stage, it is necessary to optimize the procurement and management processes of green building materials, establish a database of green building material suppliers, and reduce procurement costs through centralized purchasing and long-term cooperation methods [10]. Implement lean construction management and formulate a special green construction plan [10], clearly defining the requirements for energy conservation, material saving and environmental protection at the construction site. Introduce information technologies such as BIM and IoT to achieve dynamic monitoring during the construction process [9]. Through the integration of BIM models with progress data, cost information and green indicators, real-time tracking of expenditure situations is conducted, promptly identifying overspending risks and taking adjustment measures. Utilize IoT devices to monitor water and electricity consumption, material usage, etc., to achieve refined management of resources [10]. Establishing an assessment mechanism involves breaking down the cost control indicators for green construction into each team and management personnel. Linking the reduction of costs, consumption, and performance assessment to these individuals can help minimize human waste [10].

The core of the operation and maintenance stage lies in intelligent energy-saving operation and maintenance [9]. By integrating dynamic cost monitoring and full-cycle data, we can review and continuously reduce energy and water consumption costs, improve operation efficiency, and fully leverage the cost advantages of green buildings in the operation stage [2]. At this stage, an intelligent operation and maintenance management platform integrating Internet of Things big data technology [9] needs to be established to conduct intelligent monitoring of equipment such as air conditioners, water supply and drainage systems, and elevators, and to automatically adjust parameters based on the situation to achieve energy conservation and consumption reduction. Establish a dynamic accounting analysis system [9], conduct periodic statistics on various costs such as energy consumption, water consumption, equipment maintenance, and facility operation, and analyze the deviation reasons of the predicted values during the planning stage [2], while also referring to data from similar buildings to optimize the control plan. Formulating standardized maintenance plans [2] is crucial for the regular inspection, preventive maintenance of energy-saving equipment, green building materials, and environmental protection facilities, which helps to extend their service life, reduce maintenance costs and production downtime, enhance personnel training to improve professional capabilities [9], and ensure the efficient operation of the facilities.

The core of the dismantling and recycling process lies in the recycling of resources. In the early stage, the requirement for disassembly is to achieve professional disposal through classified recycling for resource utilization, in order to balance the investment in dismantling and the income from recycling, and to achieve a win-win situation of both cost savings and environmental benefits [2]. Pre-plan specific schemes, conduct modular design and divide the demolition areas based on the component disassemblability. Clearly define the classification standards for materials such as steel, concrete, glass, and metal [2]. At the same time, control dust and noise to reduce the environmental governance costs. Introducing cooperation with specialized resource utilization enterprises for the classification processing of demolition materials enables the direct utilization of some parts for renovation and reuse. Construction waste can be processed into recycled building materials, achieving recycling and generating profits through sales [9]. Establishing a statistical system, calculating the demolition costs, recovering the profits, managing the expenses, and conducting comprehensive data analysis to evaluate the overall benefits and incorporating the information into the database can provide reference for subsequent projects [2, 9].

5. Conclusion

Based on the above research analysis, the following conclusions are drawn:

The full life-cycle cost management of green buildings is not a simple addition of traditional cost management. Instead, it is a comprehensive reconfiguration of the management logic, scope and objectives. At present, the all-process collaborative control model has greater promotional value than single-stage control. Its core is a three-dimensional integrated cost accounting system of economy, environment and society, taking into account both short-term investment and long-term benefits.

The cost control of green buildings should follow the logic of optimizing from the source, being lean in the process, and conducting long-term operation and maintenance. Optimization should be carried out for the planning and design stage, the construction stage, the management of green building materials, the operation stage, and the dismantling and recycling stage. Moreover, green buildings are more suitable to adopt recyclable building materials and modular components that can be disassembled.

Attention should be paid to the research and development of the cost intelligence control platform. By integrating cost and green performance data at all stages through technologies such as BIM and IoT, the accuracy of green cost accounting, dynamic monitoring, and risk warning capabilities can be enhanced.

There are still some deficiencies in the current research. In the field of full life cycle cost management of green buildings, the empirical cases and quantitative standards are still not perfect, and the feasibility and comparability of the strategies need to be improved. Regarding the future outlook, it is necessary to strengthen empirical research on typical cases, unify the green cost accounting standards, and promote the deep integration of digital technology and cost control.

References

- [1] B. T. Liu, "Research on the Whole Process Cost Management Strategy for Construction Projects [J]." Mar. Outlook. 04:163-165 (2026)
- [2] P. Miraj, M. A. Berawi, and S. R. Utami, "Economic feasibility of green office building: combining life cycle cost analysis and cost-benefit evaluation." Build. Res. Inf. 49(6): 624-638 (2021)
- [3] T. Sartori, R. Drogemuller, S. Omrani, F. Lamari, "A schematic framework for life cycle assessment (LCA) and green building rating system (GBRS)." J. Build. Eng. 38: 102180 (2021)
- [4] W. T. Franca, M. V. Barros, R. Salvador, A.C.de Francisco, M. T. Moreira, C. M. Piekarski, "Integrating life cycle assessment and life cycle cost: A review of environmental-economic studies." Int. J. Life Cycle Assess. 26(2): 244-274 (2021)
- [5] X. Qi, H. Bai, "Research on Influencing Factors and Control of Green Building Costs [J]." North. Archit. 10 (06):68-72 (2025)
- [6] F. Zhou, "Construction Project Life Cycle Cost Control System Construction [J]." Chin. Mark. 04:135-138. (2026). DOI:10.13939/ j. cnki. zgsc.
- [7] S. S. Ali, A. Abushaikh, "Comparative assessment of LEED, BREEAM, and GSAS in achieving environmental impact reduction: A performance-based analysis[J]." IOP Conf. Ser.: Earth Environ. Sci. 1587(1):012035 (2026). DOI:10.1088/1755-1315/1587/1/012035
- [8] Y. Liu, X. Guo, and F. Hu, "Cost-benefit analysis on green building energy efficiency technology application: A case in China." Energy Build. 82: 37-46 (2014)
- [9] W. J. Zhang, Research on Cost Control Strategies for the Entire Lifecycle of Green Buildings [J]. Inner Mong. Sci. Technol. Econ. 79-82 (2025)
- [10] L. Zhang, Analysis of Cost Control Strategies in Green Construction Project Management [J]. Archit. Budg.06:46-48 (2025).