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Strategic Framework for Lifecycle Cost Management in Green Building Projects: Managerial Economics Analysis in The Indonesian Context

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ABSTRACT

Green building projects in developing countries often face implementation challenges due to the emphasis on initial costs and limited consideration of long-term economic benefits. Conventional cost management approaches are therefore insufficient to support sustainable investment decisions. This study proposes a strategic framework for lifecycle cost management (LCCM) in green building projects based on managerial economics principles, with a focus on the Indonesian context. Using a conceptual research approach, the framework integrates lifecycle costing with key managerial economics tools, including discounting, cost–benefit analysis, sensitivity analysis, and risk assessment, to support decision-making across the building lifecycle. The results indicate that lifecycle-oriented economic evaluation provides a more rational basis for assessing the financial performance of green buildings, demonstrating that higher upfront investments can be economically justified through long-term operational savings and reduced risk. The framework also supports the alignment of green building regulations with economically sound project management practices. This study contributes by positioning LCCM as a strategic managerial instrument and offers practical insights for improving the financial viability of green building investments in developing economies.

KEYWORDS: Lifecycle Cost Management; Green Building; Managerial Economics; Sustainable Construction; Developing Countries

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INTRODUCTION

The building sector is widely recognized as a major contributor to global energy consumption, carbon emissions, and material resource depletion. Empirical evidence indicates that buildings account for a substantial share of final energy use and greenhouse gas emissions across their lifecycle, particularly during the operational phase [1]. In developing countries, such as Indonesia, rapid urbanization, population growth, and large-scale infrastructure development further amplify these environmental and economic pressures, making sustainable construction practices increasingly imperative.

Green building has emerged as a strategic response to these challenges by promoting energy efficiency, resource conservation, and environmental performance throughout the building lifecycle. Numerous studies have demonstrated that green buildings are capable of delivering significant long-term economic benefits, including reduced operational costs, lower energy consumption, and enhanced asset value [2]. Nevertheless, in many developing economies, the adoption of green building remains constrained by the perception of higher initial investment costs and uncertainty regarding long-term financial returns.

In Indonesia, this challenge is particularly pronounced. Project decision-making practices in the construction sector are predominantly driven by short-term capital expenditure considerations, while long-term operational, maintenance, and end-of-life costs are frequently underestimated or overlooked. Although regulatory frameworks have begun to encourage sustainable construction—such as the issuance of green building regulations at the municipal level (e.g., Jakarta Governor Regulation No. 38/2012 on Green Buildings) and the national regulation on green building implementation (Minister of Public Works and Housing Regulation No. 21/PRT/M/2021)—economic evaluation practices have not fully evolved to support lifecycle-oriented decision-making. As a result, green building initiatives often struggle to gain broader acceptance among project owners and investors.

Lifecycle Cost Management (LCCM) offers a comprehensive approach for evaluating the economic performance of buildings by accounting for costs incurred throughout the entire lifecycle, including planning, construction, operation, maintenance, replacement, and disposal phases. Previous studies in Building and Environment and Energy and Buildings emphasize that lifecycle-based cost analysis provides a more realistic representation of building economics compared to traditional cost estimation methods focused solely on initial investment [3]. From a managerial economics perspective, LCCM supports rational resource allocation, intertemporal cost optimization, and strategic decision-making under uncertainty—capabilities that are particularly critical in capital-constrained developing economies.

Despite the growing body of literature on green buildings and lifecycle costing, the integration of managerial economics principles into lifecycle cost management remains fragmented, especially in the context of developing countries. Existing studies tend to examine lifecycle costing, energy efficiency, or sustainability assessment as isolated components, with limited emphasis on strategic economic decision-making frameworks [4]. In Indonesia, the application of lifecycle cost analysis is still limited in practice, and its alignment with national green building policies and market conditions has not been sufficiently explored in academic research.

Moreover, green building projects in Indonesia face additional economic complexities, including volatile energy prices, evolving regulatory requirements, limited availability of certified green materials, and disparities in stakeholder knowledge and technical capacity. These conditions increase investment risk and reinforce the need for a strategic framework that integrates lifecycle cost considerations with managerial economics tools such as discount rate selection, cost–benefit analysis, sensitivity analysis, and risk evaluation. Such an approach is essential to enhance confidence among decision-makers and to demonstrate that green building investments can be economically viable over the long term.

Accordingly, this study aims to develop a strategic framework for lifecycle cost management in green building projects based on managerial economics principles, with a specific focus on the Indonesian context as a representative developing economy. By aligning lifecycle cost analysis with national green building policies and institutional conditions, this research seeks to bridge the gap between sustainability-driven construction practices and economically rational project management. The proposed framework contributes to the literature by offering an integrated perspective that supports strategic decision-making across the building lifecycle, while also providing practical guidance for policymakers, project owners, and construction managers in advancing financially sustainable green building implementation in emerging economies.

DISCUSSION

1.Interpretation of the Strategic Lifecycle Cost Management Framework

This study proposes a strategic framework for lifecycle cost management (LCCM) in green building projects grounded in managerial economics principles. The framework emphasizes the integration of cost planning across all lifecycle phases—design, construction, operation, maintenance, and end-of-life—rather than focusing solely on initial capital expenditure. The findings reinforce recent studies suggesting that lifecycle-based economic evaluation provides a more accurate representation of the financial performance of green buildings compared to traditional cost estimation approaches [5][3].

From a managerial economics perspective, the framework highlights intertemporal decision-making as a critical factor in sustainable construction. The application of discounting, cost–benefit analysis, and sensitivity analysis enables decision-makers to compare short-term investments with long-term economic returns, particularly energy savings and reduced maintenance costs. This supports the argument that higher upfront costs associated with green building technologies can be economically justified when evaluated over the full building lifecycle, a finding consistent with previous Q1 journal studies [6][7].

2. Lifecycle Cost Distribution and Economic Rationality

The discussion of lifecycle cost distribution reveals that operational and maintenance costs represent the dominant portion of total lifecycle costs in green buildings, especially in tropical climates such as Indonesia. Energy consumption, building services maintenance, and replacement of mechanical and electrical systems significantly influence long-term expenditure. This aligns with findings from Energy and Buildings and Journal of Cleaner Production, which emphasize that lifecycle economic benefits are primarily realized during the operational phase rather than at the construction stage [5][3].

The proposed framework addresses this issue by encouraging early-stage design decisions that prioritize energy efficiency, material durability, and maintainability. From a managerial economics standpoint, such decisions represent rational cost optimization strategies, as they reduce future operational risks and uncertainty. This approach is particularly relevant for developing countries, where energy price volatility and limited access to capital increase the importance of long-term cost predictability.

3. Relevance to the Indonesian Green Building Context

In the Indonesian context, the findings indicate a persistent gap between green building regulations and economic decision-making practices. Although national and local regulations—such as the Ministry of Public Works and Housing Regulation No. 21/PRT/M/2021 and municipal green building mandates—have established sustainability requirements, their implementation is often compliance-driven rather than value-driven. Cost evaluations remain largely focused on initial investment, limiting the effectiveness of green building policies.

The proposed LCCM framework offers a mechanism to operationalize these regulations by translating sustainability requirements into measurable economic outcomes. By aligning lifecycle cost indicators with regulatory criteria (e.g., energy efficiency, water conservation, and material performance), the framework supports more transparent and economically rational decision-making. This finding is consistent with studies in developing economies that highlight the need for stronger economic justification to enhance stakeholder acceptance of green building practices [2][4].

4. Managerial Economics Implications for Decision-Makers

The integration of managerial economics tools within the LCCM framework has significant implications for project owners, developers, and construction managers. First, the use of sensitivity analysis and scenario planning allows stakeholders to assess the impact of uncertainties such as energy price fluctuations, technological changes, and policy shifts. This enhances risk awareness and supports strategic investment decisions under uncertainty.

Second, the framework promotes value-based decision-making rather than cost-minimization strategies. By considering lifecycle value instead of upfront cost alone, decision-makers can prioritize investments that maximize long-term economic and environmental benefits. This aligns with contemporary managerial economics literature emphasizing value optimization and strategic resource allocation in complex project environments.

Third, the framework facilitates better communication among stakeholders by providing a common economic language for sustainability. Lifecycle cost indicators can serve as a bridge between technical sustainability metrics and financial performance, improving collaboration between designers, engineers, and financial decision-makers.

5. Contribution to Theory and Practice

From a theoretical perspective, this study contributes to the green building and construction management literature by integrating lifecycle cost management with managerial economics into a unified strategic framework. Unlike prior studies that treat lifecycle costing as a technical assessment tool, this research positions LCCM as a strategic economic instrument supporting long-term decision-making in sustainable construction.

From a practical standpoint, the framework provides actionable guidance for implementing lifecycle-based economic evaluation in developing countries. For Indonesia, it offers a pathway to strengthen the economic rationale of green building policies and to increase market acceptance among private developers and investors. Policymakers may also leverage the framework to design incentive mechanisms—such as tax benefits or financing schemes—based on verified lifecycle cost performance rather than initial construction cost alone.

6. Limitations and Future Research Directions

Despite its contributions, this study has several limitations. The proposed framework is primarily conceptual and requires empirical validation through real-world case studies or quantitative lifecycle cost analysis of green building projects in Indonesia. Future research should focus on applying the framework to different building types and regional contexts to assess its robustness and adaptability.

Additionally, future studies could integrate lifecycle cost management with lifecycle environmental assessment to develop a holistic life cycle sustainability assessment (LCSA) framework. The inclusion of digital tools such as Building Information Modeling (BIM) and energy simulation could further enhance the accuracy and practicality of lifecycle economic analysis in green building projects.

CONCLUSION

This study has developed a strategic framework for lifecycle cost management (LCCM) in green building projects grounded in managerial economics principles, with particular relevance to developing-country contexts such as Indonesia. The findings confirm that conventional cost management practices, which prioritize initial capital expenditure, are insufficient for capturing the true economic performance of green buildings. Instead, lifecycle-oriented economic evaluation provides a more rational and comprehensive basis for decision-making by accounting for costs and benefits incurred throughout the entire building lifecycle.

The proposed framework demonstrates that integrating managerial economics tools—such as intertemporal cost analysis, discounting techniques, cost–benefit evaluation, sensitivity analysis, and risk assessment—enables stakeholders to reconcile sustainability objectives with long-term financial efficiency. By emphasizing value optimization rather than short-term cost minimization, the framework supports economically justified investments in energy-efficient systems, durable materials, and sustainable design strategies. This reinforces the central conclusion that green building projects can achieve both environmental and economic sustainability when evaluated using a lifecycle perspective.

In the context of Indonesia, this study highlights a critical gap between green building policies and practical economic decision-making. Although regulatory instruments have increasingly mandated sustainable construction practices, their effectiveness remains constrained by the absence of structured lifecycle-based cost evaluation mechanisms. The strategic LCCM framework proposed in this research provides a practical means to operationalize green building regulations by translating sustainability requirements into measurable and economically meaningful indicators. As such, it strengthens stakeholder confidence and enhances the feasibility of green building implementation in emerging economies.

From a theoretical standpoint, this research contributes to the sustainable construction and construction management literature by repositioning lifecycle cost management as a strategic managerial function rather than a purely technical assessment tool. The integration of managerial economics into LCCM advances existing knowledge by offering a unified framework that supports long-term strategic decision-making under uncertainty. Practically, the framework provides actionable guidance for project owners, developers, construction managers, and policymakers seeking to improve the financial viability and long-term value of green building investments.

Despite its contributions, this study is limited by its conceptual nature and the absence of empirical validation through real-world project data. Future research should focus on applying the proposed framework to case studies of green building projects in Indonesia and other developing countries, as well as integrating lifecycle cost analysis with environmental and social impact assessments to achieve a holistic life cycle sustainability evaluation. The adoption of digital tools such as Building Information Modeling (BIM) and energy simulation is also recommended to enhance the accuracy and applicability of lifecycle economic analysis.
Overall, this study concludes that a strategic, lifecycle-based approach to cost management, informed by managerial economics, is essential for advancing economically viable green building practices. By aligning sustainability goals with rational economic decision-making, the proposed framework offers a robust foundation for supporting the long-term transition toward sustainable and resilient construction in developing economies.

Practical Implications

The findings of this study provide several practical implications for key stakeholders involved in green building projects, particularly in developing-country contexts such as Indonesia.
First, project owners and developers should adopt lifecycle cost management (LCCM) as a core decision-making tool rather than relying solely on initial cost estimates. By evaluating costs and benefits across the entire building lifecycle, owners can make more informed investment decisions that balance upfront expenditure with long-term operational savings. This approach supports value-based investment strategies and enhances the financial attractiveness of green building projects.

Second, designers and consultants are encouraged to integrate lifecycle cost considerations at the early design stage. Design decisions related to building envelope performance, energy systems, material durability, and maintainability have a significant impact on long-term costs. The strategic LCCM framework enables design teams to assess alternative design options based on their lifecycle economic performance, facilitating more transparent and economically rational design choices.

Third, construction managers can utilize the framework to improve cost planning and risk management throughout the project lifecycle. The incorporation of managerial economics tools—such as sensitivity analysis and scenario evaluation—allows managers to anticipate potential cost variations arising from energy price volatility, maintenance uncertainties, or technological changes. This strengthens project control and supports proactive decision-making during construction and operation phases.

Finally, financial institutions and investors may use lifecycle cost indicators as part of their project appraisal processes. By recognizing long-term cost efficiency and reduced operational risks, financiers can better assess the economic viability of green building projects and develop financing schemes that support sustainable construction practices.

Policy Implications

The results of this study also yield important policy implications for governments and regulatory bodies aiming to promote green building adoption in developing economies.
First, green building regulations should be complemented by mandatory or recommended lifecycle cost assessment guidelines. In Indonesia, existing policies focus primarily on technical performance criteria, while economic evaluation remains underemphasized.

Integrating lifecycle cost requirements into regulatory frameworks would improve policy effectiveness by demonstrating the long-term economic benefits of compliance.

Second, policymakers are encouraged to align incentive mechanisms with lifecycle economic performance rather than initial construction costs. Incentives such as tax reductions, development bonuses, or preferential financing could be linked to verified lifecycle cost savings, energy efficiency levels, or operational performance. This approach would encourage developers to prioritize long-term value creation and sustainability outcomes.

Third, capacity-building initiatives are essential to support the effective implementation of lifecycle cost management. Government agencies and professional institutions should promote training programs and technical guidelines that enhance stakeholder understanding of lifecycle costing, managerial economics, and sustainability assessment. Strengthening institutional capacity will reduce resistance to green building adoption and improve implementation consistency.

Finally, the strategic LCCM framework can inform national sustainable construction strategies by providing an economic rationale for green building investment. By embedding lifecycle-based economic evaluation into policy design and project approval processes, governments can foster a more resilient and economically sustainable built environment. This policy direction is particularly relevant for emerging economies seeking to balance rapid development with long-term sustainability objectives.

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