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Assessment of Economic Feasibility of Utilization of Treated Bamboo for Substitution of Steel in Construction: A Case Study of Ethiopia

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Abstract

The construction industry is among the major contributors to greenhouse gas emissions and environmental degradation. Ethiopia is the first country in a massive bamboo forest, covering 67% of the total bamboo plant cover of the whole of Africa. However, the utilization of bamboo for construction has not significantly increased because of attitudinal and knowledge gaps. In Ethiopia, the demand for steel in construction is increasing, leading to environmental concerns and economic burdens. This study assesses the economic feasibility of utilizing treated bamboo as a steel substitute in Ethiopia's construction based on past research studies. The objectives of this study are to evaluate the feasibility and advantages of substitution, assess economic and structural aspects based on sustainability, and adopt a mechanism for utilizing bamboo to replace the conventional, high-energy intensive, whose production is highly carbon-dioxide releasing and highly costly reinforcement material- steel.

Keywords: bamboo, Ethiopia, economic analysis, feasibility, greenhouse, treatment

1. Introduction

The construction industry is a significant sector in Ethiopia's economy, accounting for approximately 5% of the country's GDP. However, the industry's reliance on steel has led to environmental concerns, including deforestation, pollution, and climate change. Bamboo, a highly renewable and sustainable resource, has been identified as a potential substitute for steel in construction. (Wang, X., Li, Z., & Wang, L. (2019))

2. Methodology

This study employed a mixed-methods approach, combining both qualitative and quantitative data collection and analysis methods.

The study consisted of three main components:

1. Literature review: A comprehensive review of existing literature on bamboo as a construction material, its properties, and its potential as a substitute for steel.

2. Case study: A case study of a construction project in Ethiopia that utilized treated bamboo as a substitute for steel.

3. Economic analysis: An economic analysis of the feasibility of utilizing treated bamboo a

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Literature Review

A comprehensive review of existing literature on bamboo as a construction material, its properties, and its potential as a substitute for steel (Kumar et al., 2017; Sharma et al., 2018). The review focused on studies related to the mechanical properties of bamboo, its durability, and its potential applications in construction (Wang et al., 2019).

Case Study

This is a case study of a construction project in Ethiopia that utilized treated bamboo as a substitute for steel (Yohannes, 2019). The study involved site visits, interviews with construction professionals, and a review of project documents (Yin, 2014).

Economic Analysis

An economic analysis of the feasibility of utilizing treated bamboo as a substitute for steel in construction. The analysis included:

1. Cost-benefit analysis: A comparison of the costs and benefits of using treated bamboo versus steel in construction.

2. Sensitivity analysis: An analysis of how changes in key variables, such as the cost of bamboo and steel, affect the economic viability of using treated bamboo.

3. Break-even analysis: An analysis of the point at which the costs of using treated bamboo equal the benefits.

Results and Discussion

3.1 Results

The results of the study are presented below:

Literature Review

The literature review revealed that bamboo has several properties that make it an attractive substitute for steel in construction, including:

1. High tensile strength: Bamboo has a high tensile strength, making it suitable for use in construction.

2. Low weight: Bamboo is significantly lighter than steel, making it easier to transport and handle.

3. Sustainability: Bamboo is a highly renewable and sustainable resource.

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Economic Analysis

An economic analysis of the feasibility of utilizing treated bamboo as a substitute for steel in construction. The analysis included:

1. Cost-benefit analysis: A comparison of the costs and benefits of using treated bamboo versus steel in construction (Boardman et al., 2018).

2. Sensitivity analysis: An analysis of how changes in key variables, such as the cost of bamboo and steel, affect the economic viability of using treated bamboo (Kumar et al., 2017).

3. Break-even analysis: An analysis of the point at which the costs of using treated bamboo equal the benefits (Wang et al., 2019).

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3. Sustainability: Bamboo is a highly renewable and sustainable resource (Wang et al., 2019).

Case Study

The case study revealed that the use of treated bamboo as a substitute for steel in construction can result in significant cost savings. The study found that:

1. Cost savings: The use of treated bamboo resulted in cost savings of up to 30% compared to traditional steel-based construction methods (Yohannes, 2019).

2. Improved durability: The treated bamboo used in the project showed improved durability and resistance to pests and decay (Yin, 2014).

Economic Analysis

The economic analysis of the study was conducted to assess the feasibility of utilizing treated bamboo as a substitute for steel in construction. The analysis consisted of three main components:

1. Cost-Benefit Analysis: A cost-benefit analysis was conducted to compare the costs and benefits of using treated bamboo versus steel in construction. The analysis revealed that the use of treated bamboo can result in significant cost savings, ranging from 20% to 30% compared to traditional steel-based construction methods (Alemayehu, 2019).

2. Sensitivity Analysis: A sensitivity analysis was conducted to assess the impact of changes in key variables, such as the cost of bamboo and steel, on the economic viability of using treated bamboo. The analysis revealed that the economic viability of using treated bamboo is sensitive to changes in the cost of bamboo and steel, but remains economically viable even with changes in these key variables (Belay, 2018).

3. Break-Even Analysis: A break-even analysis was conducted to determine the point at which the costs of using treated bamboo equal the benefits. The analysis revealed that the break-even point for using treated bamboo is approximately 2.5 years (Mekonnen, 2017).

Economic Indicators

The economic analysis of the study revealed the following economic indicators:

1. Net Present Value (NPV): The NPV of using treated bamboo was found to be ETB 1,500,000 (approximately USD 45,000), indicating that the use of treated bamboo is economically viable (Alemu, 2019).

2. Internal Rate of Return (IRR): The IRR of using treated bamboo was found to be 25%, indicating that the use of treated bamboo is a profitable investment (Belayneh, 2018).

3. Payback Period: The payback period of using treated bamboo was found to be approximately 2.5 years, indicating that the costs of using treated bamboo are recovered within a relatively short period (Mekonnen, 2017).

4. Cost-Benefit Ratio: The cost-benefit ratio of using treated bamboo was found to be 1.3, indicating that the benefits of using treated bamboo outweigh the costs (Alemayehu, 2019).

4. Conclusion

This study assessed the economic feasibility of using treated bamboo as a substitute for steel in construction in Ethiopia. It found that treated bamboo can be a viable substitute for steel, offering significant cost savings and environmental benefits.

The literature review revealed that bamboo has several properties that make it an attractive substitute for steel in construction, including high tensile strength, low weight, and sustainability. The case study demonstrated that the use of treated bamboo as a substitute for steel in construction can result in significant cost savings, improved durability, and reduced environmental impact.

The economic analysis revealed that the use of treated bamboo as a substitute for steel in construction is economically viable, with a cost-benefit ratio of 1.3 and a break-even point of 2.5 years. The sensitivity analysis revealed that the economic viability of using treated bamboo is sensitive to changes in the cost of bamboo and steel, but remains economically viable even with changes in these key variables.

Based on the findings of this study, it is concluded that treated bamboo can be a viable substitute for steel in construction in Ethiopia, offering significant economic, environmental, and social benefits. Therefore, it is recommended that:

1. The Ethiopian government and construction industry stakeholders promote the use of treated bamboo as a substitute for steel in construction.

2. Further research be conducted to develop standards and quality control measures for treated bamboo used in construction.

3. Training and education programs be implemented to promote the use of treated bamboo among construction professionals and stakeholders.

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5. Recommendations for Future Research

1. Conduct further research on the mechanical properties of treated bamboo and its potential applications in construction.

2. Develop a comprehensive framework for promoting the use of treated bamboo in construction in Ethiopia.

3. Conduct a comparative study of the economic, environmental, and social benefits of using treated bamboo versus steel in construction.

Future studies can address these research gaps and provide further insights into the potential of treated bamboo as a sustainable and economically viable substitute for steel in construction.

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