Pakistan Journal of Life and Social Sciences
www.pjlss.edu.pk
https://doi.org/10.57239/PJLSS-2025-23.2.00157

RESEARCH ARTICLE

A Comprehensive Review of Prefabricated Low-Cost Houses

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ARTICLE INFO

Received: May 12, 2025

Accepted: July 22, 2025

Keywords

Low-Cost Housing
Prefabricated Construction
Sustainable Materials
Affordable Building Methods
Local Construction Techniques

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ABSTRACT

This study provides a detailed review of prefabricated low-cost housing solutions, emphasizing how construction expenses can be minimized through smart planning, modern techniques, and the efficient use of local and sustainable materials. The paper aims to correct the widespread misconception that low-cost housing means poor quality, showing instead that affordability can be achieved without sacrificing strength, durability, or functionality. Key strategies include optimizing design, choosing cost-efficient materials, and phasing non-essential finishes. The study also highlights the environmental benefits of using recyclable, energy-saving, and biodegradable materials. Through this review, the research outlines practical approaches that make decent housing more accessible to low-income communities.

INTRODUCTION

Efficient project management combined with low cost materials and economical construction technologies and alternate construction methods enables the achievement of low cost housing. The profits obtained from these methods reduce construction expenses which enables low-cost housing availability to everyone. The term affordable housing describes housing that works within the budget of lower and middle income families. The growing demand for low-cost housing projects stems primarily from urbanization. The selection of building materials needs to match local requirements to enhance life value through innovative structure development or existing structure refinement. The goal of sustainable urban housing development requires innovative approaches to build human settlements while integrating energy and environmental factors.

A sustainable housing project requires equal attention to environmental concerns and economic factors and social needs and technical aspects. The engineering project and construction materials account for 60% of the total expenses in low-income housing projects. The total cost of resources gets divided into two parts with walls representing 50% and construction time taking up 45%. The selection of wall building material depends heavily on material source as well as manufacturing techniques and labor requirements. This paper aims to deliver an extensive evaluation of low-cost building design alongside planning and appropriate material selection and construction methods.

2. Review on Low Cost Building

Rinku Taur et al (2009)

This paper investigates prefabricated construction methods for low-cost housing, analyzing key building components—foundations, walls, doors/windows, floors, and roofs—separately to optimize cost and speed.

• Main techniques studied include:

• Structural block walls

• Mortar-less block walls

• Prefabricated roofing systems: precast RCC planks, hollow concrete panels, ferro-cement panels

Key Benefits Identified

• Faster Construction: Prefabricated components eliminate the need for on-site shuttering and scaffolding, speeding up construction timelines .

• Cost Savings: Reusable molds for precast elements and reduced manual labor result in material and labor cost reductions .

• Improved Quality & Cleanliness: Standardized factory-made elements ensure higher quality, better site cleanliness, and lower defect rates .

CONCLUSION

The study concludes those prefabrication techniques—across walls, roofs, floors, and other structural elements—offer a cost-effective, time-efficient, and quality-improving approach to low-cost housing. By adopting modular, factory-made components, builders can deliver affordable homes more rapidly and sustainably.

Mohannad sharif zami et al (2010)

This review examines the use of stabilized earth a blend of compressed soil with additives like cement or lime—as a low-cost, sustainable alternative to traditional brick and concrete in urban housing across developing countries.

Key Conclusions:

• Substantial Cost Savings: Earth-based construction is significantly cheaper than conventional methods due to low material costs and reduced processing .

• Environmental Advantages: It lowers energy use, CO_2 emissions, and environmental pollution, while requiring minimal manufacturing and transport .

• Adequate Structural Performance: Stabilized earth delivers appropriate strength, durability, thermal comfort, and fire resistance.

• Self-Build Feasibility: Its simplicity supports self-construction, which is beneficial in low-income settings

• Adoption Challenges: Barriers include:

• Professional resistance and reluctance to prescribe earth in urban contexts

• Lack of standards and quality control systems

• Cultural and regulatory inertia

Final Takeaway:

Stabilized earth is a cost-effective, sustainable, and locally adaptable building material for low-cost urban housing in developing countries. While technically viable, its wider adoption requires addressing professional biases, setting standards, and offering policy incentives to support its implementation.

VivanW.Y.Tam (2011)

In her paper "Cost Effectiveness of Using Low Cost Housing Technologies in Construction" (Procedia Engineering 14:156–160), Tam compares traditional construction practices in India with low-cost, eco-friendly alternatives—covering foundations, walls, roofs, and lintels. Through real-world case studies, she evaluates structural strength, safety, durability, and user satisfaction alongside financial performance.

Key Results & Conclusions:

• Walling Technologies:

• Saved approximately 26.1% in construction costs compared to traditional methods

• Roofing Technologies:

• Achieved cost savings of around 22.7% .

• Overall Impact:

• Low-cost housing technologies proved to be effective, safe, and satisfying to users, without compromising structural integrity.

• Environmental & Social Benefits:

• These methods use locally available materials, reduce environmental impact, and provide affordable housing solutions for low- and middle-income families.

Bottom Line:

Tam's research shows that adopting low-cost, sustainable construction technologies can reduce overall building costs by over 20% while maintaining quality, safety, and user satisfaction making them a viable strategy for affordable housing in developing countries.

Kuo-Liang Lin (2011) This study addresses the challenges of human resource allocation in remote construction projects, where firms must decide between deploying regular staff or hiring local temporary employees. The paper introduces a decision-making model that estimates the total project cost, encompassing direct construction costs, expected project losses, and management expenses. A case study of three remote construction projects illustrates the model's application.

Key Conclusion:

The findings indicate that assigning regular project administrators—who can mitigate managerial flaws and reduce project losses—is more advantageous than hiring local staff. Conversely, for lower-level positions like site engineers, local employees are preferred due to their lower wages and minimal impact on overall project performance.

John M.Hutcheson (2011) conducted research about project management of low cost housing in developing countries which revealed that this paper examines designs together with cost control systems and communications and contract law and planning. The analysis of evidence from the paper's problems demonstrates the necessity for design simplification and local support challenges which require thorough advanced planning. The conclusions emphasize the requirement to gather self-supportive teams of multi-disciplined professionals and sub professionals with care.

Pachecotorgal et al (2012) This study explores the development of eco-efficient concrete by using industrial waste materials as partial replacements for traditional concrete ingredients. The aim is to create concrete that is both environmentally friendly and structurally reliable, helping to reduce the massive carbon footprint of the construction industry.

The researchers review the use of materials such as:

• Fly ash, slag, and silica fume as partial cement replacements

• Recycled aggregates like crushed concrete, ceramic waste, rubber, and glass

They analyze the effects on mechanical strength, durability, and overall sustainability of the resulting concrete mixtures.

Key Conclusions:

• Significant Environmental Impact:

Using industrial waste reduces CO_2 emissions and energy consumption in concrete production.

• Maintains Strength:

When replacing 20–30% of cement, concrete still maintains acceptable compressive strength and durability.

• Recycled Aggregates are Effective:

Materials like crushed ceramics and rubber can successfully replace natural aggregates in many construction applications.

• Supports Sustainable Construction:

These eco-friendly alternatives are not only technically feasible but also scalable, making them ideal for large-scale use in green building initiatives.

Final Conclusion:

REPHRASED: The study confirms that incorporating industrial waste and recycled materials into concrete production is a practical and sustainable solution. It helps reduce the environmental burden of construction without compromising on quality—making eco-efficient concrete a key component of future green building strategies.

Dhiraj B Tapkir et al (2012)

The study analyzes three different construction methods used for low-cost housing in Pune, India:

1. Conventional in-situ construction

2. Precast concrete components

3. Aluform (aluminum formwork) technique

These methods are compared in terms of cost, time, and quality based on field data and interviews.

Key Findings:

• Aluform technique delivered the best performance, cutting construction time by 58% and costs by approximately 32% compared to conventional methods .

• Precast construction also achieved significant improvements—reducing time by 33% and costs by 25% compared to traditional techniques.

• The primary drivers of savings were:

• Reduced on-site labor and time

• Controlled material usage

• Minimized quality defects and rework

Conclusion:

The researchers conclude that innovative construction techniques—especially aluminum formwork (aluform) and precast systems—offer substantial benefits for low-cost housing. These methods provide faster build times, lower costs, and improved quality, making them highly suitable for large-scale affordable housing developments.

Swatikchowdhury et al (2013)

The paper assesses a range of locally sourced, sustainable building materials—such as compressed earth blocks, straw, bamboo, fiber-cement composites, fly ash bricks, aerocon panels, and rice husk ash—as viable alternatives to expensive concrete and steel in India.

Key Takeaways:

• Significant cost reduction in construction by using materials native to India's rural and semi-urban areas.

• Eco-friendly solutions, decreasing environmental impact through reduced transport and utilization of agricultural/industrial by-products.

• Enhanced building performance, with improved thermal insulation, fire resistance, and quality from prefabricated panels (e.g. Aerocon).

• Local practicality, leveraging readily available materials and simple techniques, ideal for rapid, low-cost housing like India's "Valmiki" slum-upgrading projects.

• Challenges remain: Need for technical precision, training for local builders, standardization, and addressing potential toxicity in some industrial by-products.

Caponetto et al (2013)

This study evaluates the use of sustainable, low-cost building materials and eco-friendly construction techniques suitable for affordable housing projects. It reviews various ecological alternatives—such as bamboo, rammed earth, hempcrete, straw bales, recycled steel, and mycelium—that reduce environmental impact while maintaining structural integrity and cost-efficiency.

Key Conclusions:

• Eco-materials are viable: Many natural or recycled materials (e.g., bamboo, hempcrete, rammed earth, straw bales, recycled steel, and mycelium-based products) can effectively substitute traditional building materials in low-cost housing.

• Environmental benefits: These materials significantly reduce embodied energy, carbon emissions, and waste compared to conventional construction materials .

• Structural performance & durability: When selected and processed correctly, ecological materials can meet safety standards and offer adequate durability for residential use.

• Contextual adaptability: The effectiveness of eco-materials depends on local availability, cultural acceptance, and appropriate construction techniques.

• Implementation challenges: Adoption is hindered by limited technical knowledge, lack of regulatory frameworks, and market unfamiliarity with non-traditional materials.

Bottom Line:

Ecological building materials offer a realistic and sustainable approach to low-cost housing. Their reduced environmental impact, cost-effectiveness, and performance potential make them compelling alternatives. Increased research, standard-setting, policy backing, and capacity-building are essential to mainstream these solutions in affordable housing.

Sengupta Nilanjan et al (2013)

This study evaluates the suitability of cost-effective and environmentally appropriate construction technologies (CECT) for the Indian housing sector. The technologies were assessed based on:

• Community acceptance

• Climatic suitability

• Economic viability

• Environmental sustainability

• Ease of implementation and maintenance

Data was collected through field studies, literature reviews, and technical assessments to identify the most appropriate technologies.

Key Conclusions:

• Techniques like unburnt bricks, Rat-Trap Bond walls, and Filler Slab roofing demonstrate strong economic feasibility and environmental sustainability without compromising safety or aesthetics.

• There is high community acceptance, especially in rural areas, facilitating widespread adoption.

• The low cost of these technologies makes them suitable for low-income housing projects, including government initiatives like "Housing for All."

• Their climatic appropriateness improves thermal comfort inside buildings, reducing energy needs for cooling.

Final Conclusion:

The study concludes that environmentally appropriate, low-cost construction technologies are not only economically viable and sustainable but also socially acceptable and practical for the Indian housing context. It recommends promoting their use in government programs and community projects to effectively address housing needs.

The research conducted by **David William Dobson et al (2013)** investigates whether sustainable construction costs more at first or results in future financial advantages. The authors examine sustainable college building expenses through real-world data analysis and survey responses from industry experts to evaluate initial costs against operational advantages.

Key Conclusion:

Sustainable construction requires higher upfront expenses but delivers financial advantages through reduced energy costs and maintenance expenses and emission reductions during its operational period. The research demonstrates that improved policies together with increased awareness and better incentives should be implemented to boost adoption rates in public and private sectors..

Tomas.U.Ganiron et al (2014)

This study explores the use of prefabricated modular housing as an alternative to traditional concrete block construction. It found that prefab technology:

• Reduces construction costs

• Speeds up building time

• Improves quality and reduces waste

• Enhances user satisfaction

• Supports sustainable, eco-friendly practices

The authors conclude that modular prefabrication is a smart solution for affordable and fast housing, especially in regions with high demand and limited resources.

Iwuagwu ben ugochukwu et al (2015)

This study addresses the housing crisis facing Nigeria's growing urban poor population. With rapid urbanization and a lack of affordable housing, the authors examine how the use of local building materials can serve as a cost-effective and sustainable strategy to reduce construction costs and improve access to housing. The paper highlights the inefficiency of past government-led housing programs and proposes the adoption of indigenous materials and intermediate technologies as practical alternatives.

Key Conclusions:

• Local building materials such as laterite, bamboo, adobe, and stone are more affordable, readily available, and environmentally friendly than conventional imported materials.

• Adopting local materials can reduce construction costs by up to 60%, making housing more accessible to low-income urban dwellers.

• There are economic benefits to promoting local industries and environmental benefits by reducing the energy and emissions associated with importing materials.

• Despite the advantages, challenges remain, including:

• Lack of awareness and poor public perception of local materials

• Inconsistent quality standards and technical limitations

• Weak institutional support for policy implementation

• The success of local material strategies depends on:

• Government policies that support and promote local production

• Training and capacity building for local artisans and builders

• Public education to shift social attitudes and perceptions

Final Thought:

The authors conclude that local building materials offer a realistic and impactful solution to the housing crisis among the urban poor in Nigeria. However, achieving long-term results requires a combination of policy reform, technical support, and public engagement to shift mindsets and overcome systemic barriers.

Ali Haider Jasvi1 et al (2015)

This study explores how locally available, low-cost building materials—such as fly ash bricks, rice husk, banana fibers, bamboo, and lightweight concrete—can be used to construct affordable and sustainable housing in rural India.

REPHRASED: The main goal is to reduce construction costs while maintaining safety and structural quality, and at the same time protect the environment by using agricultural and industrial waste materials.

Key Points:

• These materials can reduce construction costs by 30–60%.

• They are eco-friendly, renewable, and easy to access in rural areas.

• Many of them have sufficient strength for rural housing needs.

• Challenges include low awareness, lack of technical training, and resistance to using unfamiliar materials.

Bredenoord J (2016)

On This study highlights that low-income housing is predominantly built incrementally and by the households themselves, driven by financial constraints and limited resources. Despite common assumptions, sustainable housing is achievable even at low costs, provided that the right physical, social, and technical conditions are met.

Key conclusions include:

• The integration of natural, renewable, and locally available materials significantly reduces both construction costs and environmental impact.

• Technical support and knowledge transfer to self-builders are essential for adopting sustainable building methods effectively.

• Improvements in urban planning such as enhancing urban density and connectivity, alongside strengthening community organization through cooperatives and local groups, play a critical role in the success of sustainable housing projects.

• The major challenges to implementing sustainable low-cost housing are lack of awareness, insufficient technical skills, and poor planning.

REPHRASED: Overall, the research demonstrates that affordable housing and sustainability can be successfully combined through incremental building processes, community involvement, and proper guidance. Achieving this balance requires coordinated efforts from governments, NGOs, and local communities to facilitate access to sustainable materials, technical training, and organized social frameworks.

Preetpal Singh et al (2016) conducted research about Low Cost Housing: Need For Today's World which showed that construction costs in India rise at twice the rate of national inflation. The construction industry experiences a 15 percent annual cost increase because of rising steel and cement and brick and timber and labor expenses. The conventional building materials and construction methods have become unaffordable for low-income groups and a significant portion of middle-income groups. The situation demands the adoption of cost-effective construction methods through traditional technology advancement with local resources or modern construction material implementation with structured inputs to achieve economic solutions. The implementation of Low Cost Housing Technologies enables us to decrease housing construction costs by about 25 percent.

Felix Raspall at al (2016) conducted research on Building from End-of-Life: An Alternative Approach for Low-Cost Urban Housing which shows that Our research examines the potential of using construction materials at the end of their life cycle to create new construction elements for low-cost housing. The informal city already operates a market system for salvaged materials. The urbanized world typically ignores construction reuse practices. The research provides methods to build affordable housing units using recycled construction materials while considering functional requirements and aesthetic appeal and economic feasibility.

2.2 Concluding Remarks

• Low-cost construction is crucial in architecture and civil engineering, especially in developing countries with high demand for affordable housing.

• The study reviews strategies, materials, and techniques that reduce construction costs without compromising quality, safety, or durability.

• Focus on alternative materials such as:

• Compressed earth blocks

• Recycled materials

• Prefabricated components

• Use of efficient construction methods that save labor and time.

• Emphasis on sustainability, energy efficiency, and use of locally available resources.

• Findings suggest that applying low-cost construction methods can:

• Significantly address housing shortages

• Improve living standards

• Promote environmentally friendly practices

3. CONCLUSIONS

Housing is a basic human need that fulfills:

• Safety and security

• Self-esteem and personal satisfaction

• Social status and cultural identity

• After analyzing various low-cost construction methods, the following are found to be most effective:

• Use of natural and renewable materials

• Use of eco-friendly building resources

• Dependence on locally available materials to reduce transportation and cost

• Minimizing resource allocation by optimizing material use

• Implementation of innovative construction techniques

• These practices lead to:

• Cost reduction in housing projects

• Sustainable development and green building outcomes

• Positive impact on the environment and community well-being

4. Future Recommendations:

• Encourage research and innovation in low-cost and sustainable construction technologies.

• Invest in training programs for local workers and engineers on alternative building techniques.

• Promote the use of local materials through policy support and incentives.

• Integrate green building standards in all affordable housing projects to ensure long-term sustainability.

• Establish partnerships between governments, NGOs, and private sectors to fund and support low-cost housing initiatives.

• Raise awareness in communities about the benefits of eco-friendly and cost-effective housing.

• Develop building codes and regulations that support and allow the use of non-conventional, low-cost materials.

• Use modular and prefabricated systems to speed up construction and reduce labor costs.

• Incorporate smart design principles that reduce energy consumption and maximize space efficiency.

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