



Research Trends in Affordable Modular Housing

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ABSTRACT

This study explores the intersection of modular construction and affordable housing, emphasizing the gap between academic research and industry practice. Using a mixed-method approach that combines descriptive analysis, topic modeling, and thematic synthesis of 43 peer-reviewed studies and influential industry reports, the paper identifies key themes: cost efficiency, sustainability, rapid construction, and customizability. While academia largely focuses on technological innovation and environmental benefits, industry sources highlight persistent barriers—namely, financial constraints, fragmented building codes, labor shortages, and public skepticism. The findings reveal a misalignment between theoretical advantages and real-world feasibility, particularly regarding large-scale adoption. By critically comparing scholarly output with industry realities, the paper underscores the urgent need for integrated policy reform, standardized regulatory frameworks, workforce development, and financing models tailored to modular construction. Practical recommendations are offered to help policymakers and stakeholders bridge the research–practice divide and unlock the full potential of modular building as a scalable solution to the affordable housing crisis.

KEYWORDS

Affordable housing; Modular and offsite construction; Topic modeling; Descriptive analysis; Literature review

INTRODUCTION

High construction material costs, inadequate human resources, and rising urban population density exacerbate the housing deficit, primarily due to the scarcity of affordable housing. The U.S. Department of Housing and Urban Development (HUD) defines housing as affordable when a household spends no more than 30% of its income on housing costs, including utilities. According to the World Bank (2022), affordable housing must be adequate in both quality and location, while ensuring that costs do not prevent occupants from meeting other essential living expenses. Modular construction—the practice of relocating certain site-based work to off-site facilities such as fabrication or modular assembly factories—is gaining attention for its potential benefits, including reduced material waste, improved efficiency, enhanced quality, and overall cost savings (Choi et al., 2019). Affordable modular housing exists at the intersection of modular construction and affordable housing policy. It combines the cost-efficiency and speed of off-site

modular construction with the goal of providing housing that low- and moderate-income households can afford. This approach seeks to reduce production costs and timelines while maintaining standards of quality, location, and livability. As such, it offers a scalable solution to address the growing affordable housing deficit. Despite many advantages, the approach continues to face substantial challenges, including regulatory barriers, supply chain disruptions (Choi et al., 2019; Paliwal et al., 2021), and a persistent gap between research and practice (Choi et al., 2019).

This paper critically examines the existing body of research on affordable modular housing alongside empirical insights from industry reports, with the aim of exposing the disconnect between academic theory and industry implementation. The analysis focuses on key obstacles such as policy constraints, financial limitations, and scalability challenges. Drawing from current literature and reports, the study offers practical recommendations for policymakers, housing authorities, and construction stakeholders to help bridge these divides and support the broader adoption of modular construction as a viable solution to the affordable housing crisis.

METHODOLOGY

Quantitative and qualitative analysis techniques are utilized to conduct a comprehensive literature review on affordable modular housing. The analytical approach is therefore divided into three complementary approaches: topic modeling, descriptive analysis, and thematic analysis.

Data Collection

The literature review employed a broad and systematic approach, drawing from diverse sources to ensure comprehensive coverage. Major academic databases, including Web of Science, American Society of Civil Engineers (ASCE) journals, Emerald Insight, and Scopus—were utilized to gather relevant research articles. Only peer-reviewed publications containing the precise keywords of interest were included. The search strategy focused on the intersection of “modular construction” and “affordable housing,” using targeted combinations of these terms to guide the selection process.

Descriptive Analysis

A quantitative analysis was carried out to examine the temporal evolution and distribution of research on affordable modular housing. Publication trends were evaluated by year to identify patterns in research interest and scholarly activity. Additionally, a source analysis was conducted to highlight the primary publication venues and assess their influence. The study captured annual publication counts, growth trends, and the distribution of publications across different source types. This descriptive analysis sheds light on the maturity of the research domain and uncovers shifts in scholarly focus over time. It provides critical context for thematic findings by illustrating how research interest aligns with market developments, policy shifts, and technological advancements within the modular construction industry.

Topic Modeling & Analysis

Latent Dirichlet Allocation (LDA), an unsupervised machine learning technique, was employed to uncover the underlying thematic structure within the literature corpus. The process began with standard text preprocessing, including cleaning, tokenization, and vectorization using TF-IDF,

while removing stop words to convert the text into a machine-readable format. LDA was then applied to generate latent topics. To determine the optimal number of topics, models ranging from two to ten topics were tested and evaluated based on their semantic coherence and thematic distinctiveness. The four-topic model was identified as offering the most meaningful representation of the literature. To ensure the validity and interpretability of the extracted topics, expert reviews were conducted, assessing the relevance and clarity of each theme. In parallel, a targeted selection of recent (2019–2024), policy-relevant industry reports from reputable institutions was curated based on their explicit focus on modular construction’s role in addressing affordable housing at both local and national scales. The results from the LDA topic modeling were later compared with insights from these industry reports to illuminate the disconnects between academic research and real-world practice in affordable modular housing.

RESULTS AND DISCUSSION

Descriptive Analysis

The resulting corpus included 168 documents returned by the initial search, applied relevance criteria based on title, abstract, and keywords, and produced 43 papers. The literature spans the period from 2006 to 2025 for historical and current trends. The criteria selection was based on peer-reviewed research and included influential industry reports and policy documents to identify practical implementation views outside academic discourse.

Publication Trends by Year

Figure 1 shows the academic publication trend for affordable modular housing. From 2005 to 2020, publication rates averaged just 1.40 papers per year, rising sharply to 4.60 between 2020 and 2025. This growth reflects rising concerns over affordability, urbanization, and sustainability (Said et al., 2014; Generalova et al., 2016). Early studies (2005–2015) focused on feasibility and cost analyses, while later work (2016–2019) shifted toward sustainability and automation. Since 2020, research has increasingly addressed policy reforms and urban housing crises (Mackenstadt & Dang, 2022). Yet despite the academic surge, modular construction still comprises only 6.7% of the U.S. housing market (Modular Building Institute, 2024). A gap remains: academic optimism continues to outpace industry reality, where financing, regulatory hurdles, and labor shortages dominate. Future research must move beyond theoretical benefits toward actionable solutions for policy, finance, and workforce development.

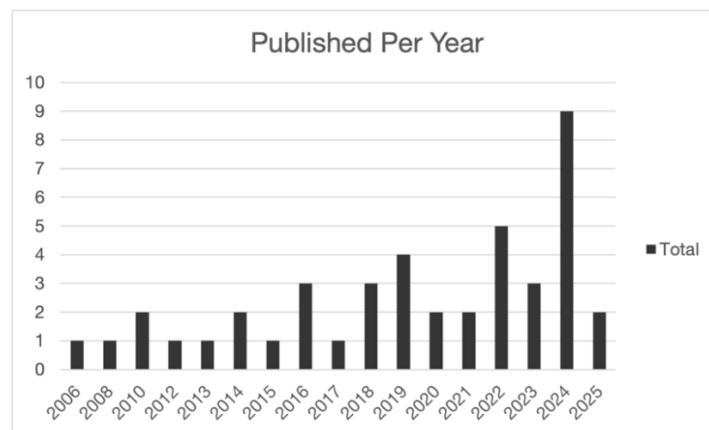


Figure 1. Publication trend of academic research on affordable modular housing by year published.

Publication Sources

An analysis of research focus areas reveals that 56.8% of the publications fall within engineering and construction journals, while 11.4% are categorized under sustainability, and only 6.8% address housing policy and urban planning. This distribution underscores the dominance of technical and engineering discourse in current research on affordable modular housing, accompanied by a notable scarcity of critical discussions on financial, regulatory, and policy dimensions (Zonta, 2024). Engineering and construction publications primarily engage with technological innovations, modular systems, and automation, emphasizing optimization, materials, and prefabrication techniques. Sustainability journals, in turn, focus on energy efficiency, life-cycle assessment, and carbon footprint reduction. However, the limited representation of housing policy and urban planning with just 6.8% of the total, represents a significant shortcoming, particularly in addressing real-world constraints such as zoning regulations, financing mechanisms, and scalable implementation strategies (Julien & Stewart, 2025). This imbalance between academic research and industry priorities is echoed in industry reports, which consistently cite financing challenges, inconsistent building codes, and labor shortages as the primary barriers to modular construction adoption (San Mateo County, 2024). Despite their practical significance, these issues remain markedly under-researched relative to technological advancements, highlighting a critical gap in the literature that must be addressed for meaningful progress in the field.

Topic Modeling Analysis

The literature on affordable modular housing, characterized by the LDA topic modeling text, identified four separate topic clusters. These topics, which have defining keywords and descriptions, are presented in Table 1.

Table 1. Main topics identified through LDA analysis.

Topic	Key Terms	Description	Number of articles
Benefits and Barriers for Affordable Modular Housing	Construction, housing, modular, building, deterrents	Modular construction design techniques used for affordable housing	9
Sustainable & Efficient Modular Designs	Construction, housing, design, energy, building	Cheap materials and innovative methods for affordable modular housing	19
Rapid Modular Construction	Construction, modular, assembly, time, min	Methods promoting faster modular construction for affordable housing	5
Customizability and Comfort	Construction, housing, modular, design, building	Maximizing the comfort and options for affordability of modular housing	10

Academic research on affordable modular housing heavily favors sustainability and energy efficiency (32.1%), often at the expense of addressing financial barriers and policy fragmentation. Despite claims of cost-effectiveness, industry reports emphasize financing

hurdles, zoning inconsistencies, and labor resistance as key obstacles (Zonta, 2024). Only 20% of studies directly tackle affordability, mostly focusing on theoretical cost savings rather than real-world challenges. Customizability appears in 19.6% of the literature but rarely connects to affordability impacts, while rapid construction research remains limited at 8.9% despite promising timeline reductions (San Mateo County, 2024). In Figure 2, the contrast between industry needs and academic topics is visualized. Without a stronger shift toward policy, finance, and labor force solutions, modular housing risks remaining a celebrated idea rather than a realized transformation.

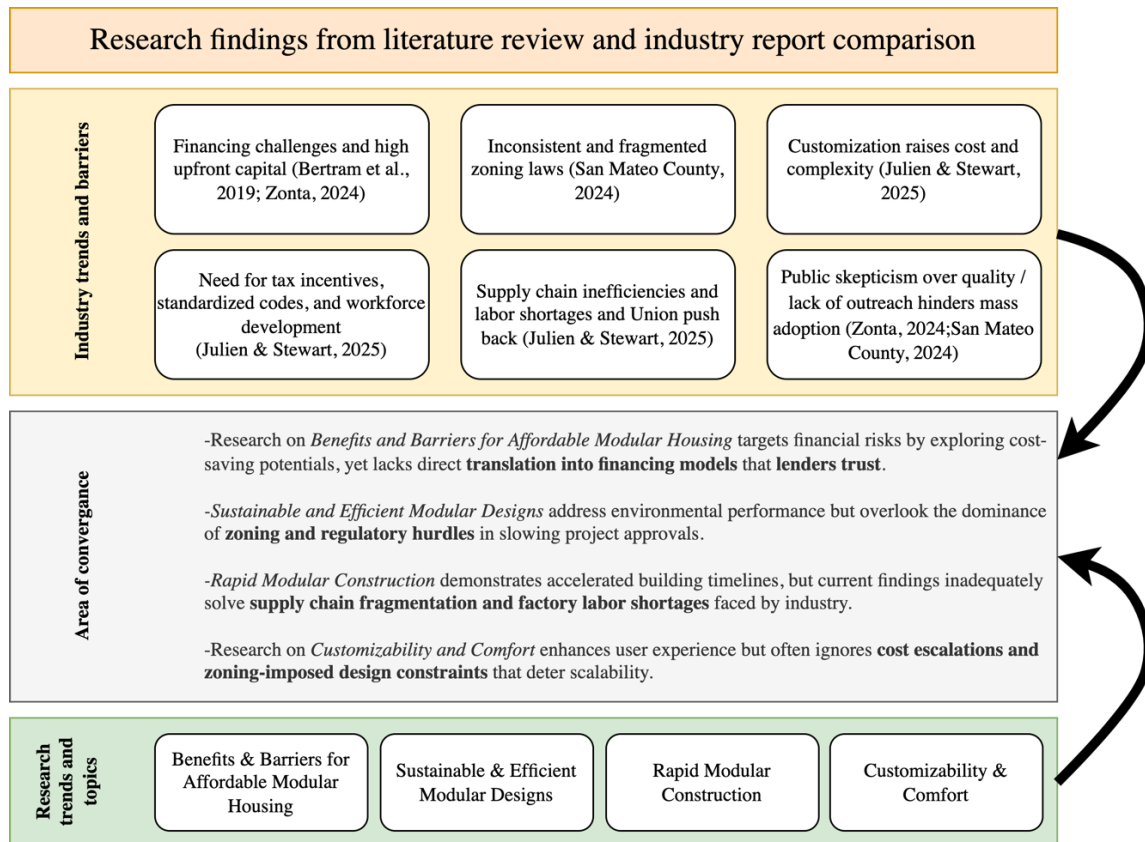


Figure 2. Research findings from literature review and industry report comparison.

Benefits and Barriers for Affordable Modular Housing

Academic studies highlight cost savings, waste reduction, and faster timelines as key benefits of modular housing (Said et al., 2014). However, industry reports point to financing challenges, inconsistent regulations, and supply chain inefficiencies (Bertram et al., 2019). Khorshid et al. (2024) confirm cost and time efficiency, but Zonta (2024) notes that high upfront capital requirements deter developers. Fragmented zoning laws increase compliance costs and create uncertainty (San Mateo County, 2024). Labor shortages further restrict factory output (Julien & Stewart, 2025). While academic work advocates policy reform, industry demands tax incentives, standardized codes, and workforce development (Julien & Stewart, 2025).

Sustainable & Efficient Modular Designs

Modular innovation focuses on energy efficiency and resilience. Satola et al. (2020) showed net-zero container homes cut emissions but increase lifecycle impacts. Bras et al. (2020)

demonstrated bio-concrete's carbon benefits, though design code inefficiencies remain. However, industry reports argue that carbon innovations don't offset greater barriers: financing risks, zoning fragmentation, and labor shortages (Julien & Stewart, 2025; San Mateo County, 2024). Lenders see modular projects as risky, and variable local codes inhibit scaling.

Rapid Modular Construction

Studies commend modular construction for its speed and cost-efficiency. Mackenstadt and Dang (2022) emphasize affordable Accessory Dwelling Units (ADU), while Riggs et al. (2023) advocate for urban micro-units. Ouda and Haggag (2024) and Parisi and Donyavi (2024) credit automation for accelerating delivery and reducing costs. However, financing hurdles, zoning restrictions, and public skepticism continue to stall adoption. Labor unions push back against modularization, and without targeted incentives, automation alone cannot meet housing demand (San Mateo County, 2024; Zonta, 2024).

Customizability and Comfort

Academic research supports modular customization for urban flexibility and occupant well-being (Generalova et al., 2016; Kim & Kim, 2016). New techniques cut costs and time (Kumar Mandala & Nayaka, 2025), but adoption faces policy and supply chain limits. Industry reports warn that customization increases cost and complexity (Julien & Stewart, 2025), while zoning limits design freedom (Zonta, 2024). Public skepticism, rooted in quality concerns, remains high. Without standard codes and public outreach, mass adoption is unlikely (San Mateo County, 2024).

CONCLUSION AND FUTURE DIRECTIONS

Scholarship on affordable modular construction supports cost-effectiveness, efficiency, and speed of construction but does not address financial, regulatory, and labor-related barriers to mass adoption. While studies find technology innovations, customization, and green advantages, industry studies note that funding issues, fragmented zoning codes, and labor availability are far more significant barriers to uptake (Julien & Stewart, 2025). To scale effectively and achieve the productivity potential promised by modular construction, manufacturers must evolve their business models and production strategies. This includes building large-capacity factories that support economies of scale, often requiring output levels of 1,000 to 5,000 units annually to maximize cost efficiency (Bertram et al., 2019). Recommendation for researchers is to further investigate the already implemented modular frameworks to further facilitate the standardization of modular construction, to speed up standardization of building codes and consequently facilitating project approvals (Bertram et al., 2019). Moreover, modular firms must integrate vertically across the value chain—partnering with developers and suppliers, standardizing design processes for manufacturing, and digitizing operations to enable just-in-time logistics (Bertram et al., 2019). Such integration can help mitigate supply chain disruptions and improve cost predictability, making modular construction more attractive to developers and investors. Skilled labor shortages remain a major barrier to modular adoption, driving up wages and construction costs. Offsite manufacturing offers relief by centralizing production and attracting non-mobile labor. In high-demand regions like California—which needs 3.5 million new units by 2025—this model has clear potential (Bertram et al., 2019). Yet many modular facilities already face capacity limits and backlogs, exposing the need for systemic investment (Bertram et al., 2019). Labor constraints slow production and undermine cost efficiencies. Despite its promise,

modular's limited uptake shows that financial incentives, regulatory reform, and workforce development are still essential. Without addressing these systemic barriers, modular housing will remain an underutilized resource rather than a transformative solution to the affordable housing crisis. Future research must move beyond theoretical advantages and focus on aligning policy frameworks, financing mechanisms, and labor market solutions to bridge the gap between academic findings and industry implementation (San Mateo County, 2024).

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