Review Of Factors Influencing the Cost of Mass Timber Construction

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Abstract: This study identifies key factors affecting the construction costs of mass timber construction (MTC) compared to conventional materials. Through a systematic review of 68 peer-reviewed articles, the research categorizes cost drivers into seven major areas. It highlights general cost-saving strategies such as sustainable materials, BIM integration, and efficient management, as well as MTC-specific approaches like early design optimization, prefabrication, and local manufacturing. The findings aim to inform more cost-effective and efficient use of MTC in construction projects.

Key Words: Mass Timber Construction (MTC), Construction Costs, Environmental Benefits, Sustainable Materials, Prefabrication.

1. Introduction

Among increasing concerns about greenhouse gas emissions and climate change, industries are adopting sustainable strategies to reduce their environmental impact. The Architecture, Engineering, and Construction (AEC) industry is a significant contributor to CO2 emissions and solid waste production (Adams et al. 2019; NASA 2019). One of the emerging products in the AEC industry is mass timber, recognized for its lower carbon footprint and prefabricated construction process (Kesik & Rosemary, 2021). Mass timber refers to engineered wood products designed for large structural applications, made by bonding solid-sawn lumber or veneer into large panels, columns, or beams for load-bearing walls, floors, and roofs (Comnick et al. 2022).

Although MTC has gained significant attention in recent years, its higher cost compared to traditional steel and concrete remains a barrier to wider market adoption (Kremer & Symmons, 2015). This review study aims to examine the existing knowledge on construction costs, specifically focusing on MTC costs. Therefore, this systematic literature review investigates the factors that influence construction costs in general and examines how these factors specifically impact the cost of mass timber construction (MTC).

2. Method

A systematic review of publications from 2013 to 2024 was conducted using the Web of Science (WoS) database, initially retrieving 537 peer-reviewed articles. After eliminating duplicates and screening titles and abstracts, 58 articles were selected. Full-text screening and citation reviews further narrowed this to 45 articles, with additional studies from references bringing the total to 68.

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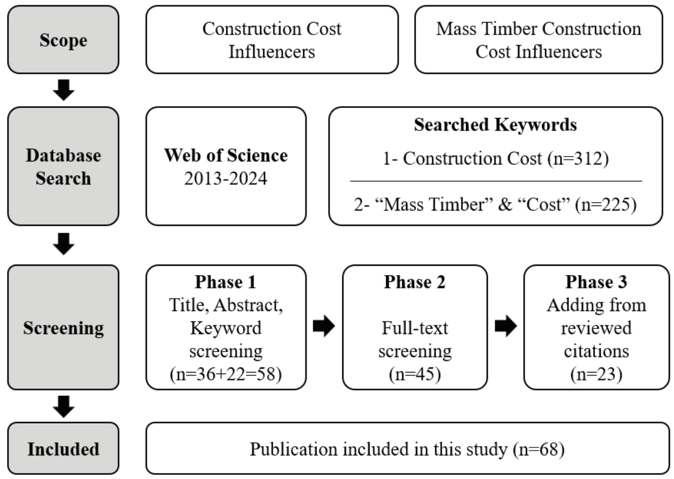

Figure 1. Systematic Literature Review Process on the Construction Cost

3. Literature Review

The reviewed literature is organized into seven key cost-related themes, spanning from broad industry factors to those specific to mass timber.

3.1. Market Conditions: Macroeconomic conditions and social perceptions are critical drivers in further adoption of mass timber construction (MTC). Economic conditions influence construction financing and cost forecasting. Public and private investments can lower green construction costs, while technological advancements support GDP growth and consumption (Alshboul et al., 2022).

Additionally, stakeholder perception is essential to project success (Kesik & Rosemary, 2021). Social media platforms like X enable public engagement with climate policy and sustainable construction. An analysis of 255,000 tweets (2009–2021) showed growing support for climate action and increasing interest in circular economy, net-zero goals, and mass timber (Debnath et al., 2022). Rising demand for mass timber, alongside tensions between conservation and sustainable management, influences construction costs (Comnick et al., 2022), but safety and durability concerns remain barriers, suggesting the need for better communication and education (Giorgio et al., 2022). Nepal et al. (2021) found that increased mass timber production could raise global prices up to 23%, challenging the assumption on cost savings.

3.2. Policies, Codes, and Regulations: Regulatory frameworks, safety regulations, and sustainability initiatives significantly impact MTC costs and adoption. Rising construction-related injuries highlight that contractors often view health and safety (H&S) compliance as costly and burdensome, creating a negative link between risk, compliance costs, and perceived savings (Windapo, 2013). This perception also affects mass timber adoption, where limited understanding of fire safety, regulatory requirements, and local manufacturing remains a barrier (Zaman et al., 2022). Public and private backing can significantly reduce sustainable construction costs, especially during deflationary periods (Alshboul et al., 2022).

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As sustainability gains momentum, circular economy practices, such as reuse, repair, and recycling, are becoming increasingly important (World Economic Forum, 2013). Efforts to support a low-carbon transition in MTC include circular strategies such as panel reuse, optimized design, and recycling CLT waste into products like mycelium insulation and solid fuel, despite technical challenges (Ahn et al., 2022).

3.3. Location and Site Conditions: Location significantly influences construction costs, with regional variations often benchmarked using construction cost indexes. For mass timber, regional factors like access to forestry and material supply also play a role; in the Western U.S., projected harvesting exceeding forest growth by 10% may drive up material costs (Comnick et al., 2022). Unexpected physical obstructions and changed site conditions are major risks in construction projects (Amarasekara et al., 2018). Location-based factors, such as seismic risk, also influence construction. However, while seismic acceleration increases notably across zones, the resulting rise in construction costs from additional material demand is relatively minor (Chrysanidis et al., 2022).

3.4. Building and Construction Type: Building classifications impact construction costs; one study using deep learning simulations showed that building attributes like occupancy and type improve early-stage cost prediction accuracy (J. Kim & Cha, 2022). Studies indicate design geometry—such as span length and height—can reduce both costs and emissions by up to 40% while Additional research confirms that gross floor area, number of stories, circulation space design, tendering methods, and scope changes are key drivers of cost overruns (Ahn et al., 2022; Kanyilmaz et al., 2023).

Based on the International Building Code (IBC), mass timber is typically classified as Type IV (Heavy Timber) but can also be used in Type III with proper fire-resistant design, allowing use across various occupancies if code-compliant (ICC, 2024). Studies show that low- to mid-rise buildings (five stories or fewer) are most suitable for MTC (Zaman et al., 2022). Economic viability varies by building type and height: Type III-B is cost-effective for shorter buildings, Type III-A and Type IV-HT are comparable for mid-rise, while Type IV-C and IV-B are preferable for taller structures, depending heavily on CLT costs (Chaggaris et al., 2021). Building components directly affect material, equipment, and labor costs, as well as constructability (K. H. Kim & Jeon, 2020). For instance, the cost-effectiveness of hybrid timber-concrete floors varies with timber-to-concrete ratios (Mirdad et al., 2021).

3.5. Materials: Material selection is one of the primary cost drivers in construction, impacting constructability and construction speed (Ramadhan et al., 2022). Structural materials, including mass timber, affect embodied carbon, energy use, and life cycle costs (Gauch et al., 2023). In MTC, increasing wood volume raises costs, with CLT flooring and fire protection materials such as gypsum board being major cost contributors (Chaggaris et al., 2021).

3.6. Technology: Technological advancements improve workflow efficiency, often reducing costs. Uncertainty in economic trends heightens the need for predictive tools and innovative construction methods to manage inflation and price volatility. Reliable construction cost index (CCI) predictions are crucial for managing risks and budgeting amid volatile economic conditions like inflation and price fluctuations (Aslam et al., 2023; Yu & Zuo, 2022). Recent research increasingly uses machine learning and artificial neural networks to improve cost estimation accuracy, employing methods such as VR integration (Zhou & Song, 2022), case-based reasoning with genetic algorithms (Jung et al., 2020), and neural network models (Lou & Guo, 2020; Sfichi et al., 2023).

Building Information Modeling (BIM) also enhances construction efficiency through quality control; for example, a BIM-based inspection system automates and streamlines tasks, reducing errors and speeding up temporary work inspections (Choi & Lee, 2022). Additionally, prefabrication speeds up MTC construction and enhances cost efficiency, influenced by design, production, transportation, and management (Lou & Guo, 2020).

3.7. Management Practices: Safety manpower, safety nets, temporary works, and construction difficulty can be improved through better management practices (Ahn et al., 2022). Constructability reviews (CR) involve expert review of construction documents before bidding to reduce defects, change orders, and cost overruns by identifying design errors, ambiguous specs, difficult features, industry limitations, and bidding challenges (Douglas & Gransberg, 2009). Additionally, promoting competition and reforming procurement practices can help lower costs and improve housing affordability (Guan & Cheung, 2023).

4. Results And Discussion

MTC offers several advantages over conventional structural materials. Environmentally, MTC has a comparatively low life-cycle impact, supporting sustainable building practices while promoting growth in the forestry sector (Gu et al., 2020). To leverage the environmental benefits of MTC, cost remains a significant barrier to broader market adoption. In general, it is essential to optimize material use, apply circular economy principles, and adopt efficient management and scheduling practices. Regional cost differences, site conditions, and supportive policies also play a key role. In MTC, cost reduction strategies include early design optimization, hybrid systems, prefabrication, and selecting suitable building types. Enhancing local manufacturing, managing supply-demand, and integrating BIM and FIM improve workflows and quality. Constructability reviews and stakeholder collaboration on fire safety, detailing, and sustainability further boost efficiency and reduce costs.

5. References

Adams, M., Burrows, V., & Richardson, S. (2019). *Bringing embodied carbon upfront*. www.worldgbc.org/embodied-carbon

Ahn, H., Son, S., Park, K., & Kim, S. (2022). Cost assessment model for sustainable health and safety management of high-rise residential buildings in Korea. *Journal of Asian Architecture and Building Engineering*, *21*(3), 689–700. https://doi.org/10.1080/13467581.2021.1902334

Alshboul, O., Shehadeh, A., Almasabha, G., Mamlook, R. E. Al, & Almuflih, A. S. (2022). Evaluating the Impact of External Support on Green Building Construction Cost: A Hybrid Mathematical and Machine Learning Prediction Approach. *Buildings*, *12*(8). https://doi.org/10.3390/buildings12081256

https://doi.org/10.52202/083252-0007

Amarasekara, W. D. L., Perera, B. A. K. S., & Rodrigo, M. N. N. (2018). Impact of Differing Site Conditions on Construction Projects. *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*, *10*(3). https://doi.org/10.1061/(ASCE)LA.1943-4170.0000257

Aslam, B., Maqsoom, A., Inam, H., Basharat, M. ul, & Ullah, F. (2023). Forecasting Construction Cost Index through Artificial Intelligence. *Societies*, *13*(10). https://doi.org/10.3390/soc13100219

Chaggaris, R., Pei, S., Kingsley, G., & Feitel, A. (2021). Carbon impact and cost of mass timber beam–column gravity systems. *Sustainability (Switzerland)*, *13*(23). https://doi.org/10.3390/su132312966

Choi, C. H., & Lee, J. (2022). A BIM-Based Quality Inspection System Prototype for Temporary Construction Works. *Buildings*, *12*(11). https://doi.org/10.3390/buildings12111931

Chrysanidis, T., Mousama, D., Tzatzo, E., Alamanis, N., & Zachos, D. (2022). Study of the Effect of a Seismic Zone to the Construction Cost of a Five-Story Reinforced Concrete Building. *Sustainability (Switzerland)*, *14*(16). https://doi.org/10.3390/su141610076

Comnick, J., Rogers, L., & Wheiler, K. (2022). Increasing mass timber consumption in the U.S. and sustainable timber supply. *Sustainability (Switzerland)*, *14*(1). https://doi.org/10.3390/su14010381

Debnath, R., Bardhan, R., Shah, D. U., Mohaddes, K., Ramage, M. H., Alvarez, R. M., & Sovacool, B. K. (2022). Social media enables people-centric climate action in the hard-to-decarbonise building sector. *Scientific Reports*, *12*(1). https://doi.org/10.1038/s41598-022-23624-9

Douglas, E. E., & Gransberg, D. D. (2009). *Implementing Project Constructability*.

Gauch, H. L., Dunant, C. F., Hawkins, W., & Cabrera Serrenho, A. (2023). What really matters in multi-storey building design? A simultaneous sensitivity study of embodied carbon, construction cost, and operational energy. *Applied Energy*, *333*. https://doi.org/10.1016/j.apenergy.2022.120585

Giorgio, B., Blanchet, P., & Barlet, A. (2022). Social Representations of Mass Timber and Prefabricated Light-Frame Wood Construction for Multi-Story Housing: The Vision of Users in Quebec. *Buildings*, *12*(12). https://doi.org/10.3390/buildings12122073

Gu, H., Liang, S., & Bergman, R. (2020). Comparison of building construction and life-cycle cost for a high-rise mass timber building with its concrete alternative. *Forest Products Journal*, *70*(4), 482–492. https://doi.org/10.13073/FPJ-D-20-00052

Guan, Y., & Cheung, K. S. (2023). The Costs of Construction and Housing Prices: A Full-Cost Pricing or Tendering Theory? *Buildings*, *13*(7). https://doi.org/10.3390/buildings13071877

International Code Council (ICC). (2024). *2024 International Building Code (IBC)*. ICC. https://codes.iccsafe.org/content/IBC2024P1

Jung, S., Pyeon, J. H., Lee, H. S., Park, M., Yoon, I., & Rho, J. (2020). Construction cost estimation using a case-based reasoning hybrid genetic algorithm based on local search method. *Sustainability (Switzerland)*, *12*(19). https://doi.org/10.3390/SU12197920

Kanyilmaz, A., Hoi Dang, V., & Kondratenko, A. (2023). How does conceptual design impact the cost and carbon footprint of structures? *Structures*, *58*. https://doi.org/10.1016/j.istruc.2023.105102

Kesik, T., & Rosemary, M. (2021). *Mass Timber Building Science Primer (MTBSP)*.

Kim, J., & Cha, H. S. (2022). Expediting the Cost Estimation Process for Aged-Housing Renovation Projects Using a Probabilistic Deep Learning Approach. *Sustainability (Switzerland)*, *14*(1). https://doi.org/10.3390/su14010564

Kim, K. H., & Jeon, J. Y. (2020). Evaluation of construction cost, time, and sustainable attributes of drywalls supported by resilient channels. *Sustainability (Switzerland)*, *12*(19). https://doi.org/10.3390/su12198102

Kremer, P. D., & Symmons, M. A. (2015). Mass timber construction as an alternative to concrete and steel in the Australia building industry: A PESTEL evaluation of the potential. *International Wood Products Journal*, *6*(3), 138–147. https://doi.org/10.1179/2042645315Y.0000000010

Lou, N., & Guo, J. (2020). Study on Key Cost Drivers of Prefabricated Buildings Based on System Dynamics. *Advances in Civil Engineering*, *2020*. https://doi.org/10.1155/2020/8896435

Mirdad, M. A. H., Daneshvar, H., Joyce, T., & Chui, Y. H. (2021). Sustainability Design Considerations for Timber-Concrete Composite Floor Systems. *Advances in Civil Engineering*, *2021*. https://doi.org/10.1155/2021/6688076

NASA. (2019). *Climate Change: Vital Signs of the Planet*. NASA. https://climate.nasa.gov/vital-signs/global-temperature

Nepal, P., Johnston, C. M. T., & Ganguly, I. (2021). Effects on global forests and wood product markets of increased demand for mass timber. *Sustainability (Switzerland)*, *13*(24). https://doi.org/10.3390/su132413943

Ramadhan, T., Paramita, B., & Srinivasan, R. S. (2022). Study of Cost and Construction Speed of Cladding Wall for Lightweight Steel Frame (LSF). *Buildings*, *12*(11). https://doi.org/10.3390/buildings12111958

Sfichi, A., Zadobrischi, E., Sfichi, N., Bădeliță, M., & Medrihan, M. (2023). Utility of Sharing Economy Principles in the Development of Applications Dedicated to Construction Cost Estimation. *Future Internet*, *15*(1). https://doi.org/10.3390/fi15010002

https://doi.org/10.52202/083252-0007

Windapo, A. (2013). Relationship between Degree of Risk, Cost and Level of Compliance to Occupational Health and Safety Regulations in Construction. *Australasian Journal of Construction Economics and Building*, *2*(13), 67–82. https://doi.org/10.3316/informit.399940651100881

World Economic Forum. (2013). *Towards the circular economy: Accelerating the scale-up across global supply chains*. https://www.weforum.org/publications/towards-circular-economy-accelerating-scale-across-global-supply-chains/

Yu, X., & Zuo, H. (2022). Research on Construction Cost Control Technology of Construction Project Based on Big Data Analysis Theory. *Mobile Information Systems*, *2022*. https://doi.org/10.1155/2022/8739097

Zaman, A., Chan, Y. Q., Jonescu, E., & Stewart, I. (2022). Critical Challenges and Potential for Widespread Adoption of Mass Timber Construction in Australia—An Analysis of Industry Perceptions. *Buildings*, *12*(9). https://doi.org/10.3390/buildings12091405

Zhou, L., & Song, S. (2022). Green Building Project Cost Budgeting and Cost Control Integrating Interactive VR Genetic Algorithm. *Mathematical Problems in Engineering*, *2022*. https://doi.org/10.1155/2022/3734946