Chapter

A Study on Contractors' Perception of Using Wood for Construction

Hüseyin Emre Ilgın, Markku Karjalainen, Olli-Paavo Koponen and Anu Soikkeli

Abstract

Construction work is very resource-intensive, and construction projects contain many parameters, in which the choice of building material is one of the critical decisions with numerous criteria, e.g., cost, durability, and environmental impact. Moreover, this complex process includes different parties such as contractors, architects, engineers, where contractors are the most influential decision-makers in material selection. Increasing the use of renewable materials such as wood, which is a technically, economically, and environmentally viable alternative in buildings, can make construction more sustainable. The perceptions of the contractors influence what they propose and therefore the increase in wood construction. With the increasing resource efficiency and the need to adapt to climate change in the construction industry, there is need for contractors to implement sustainable practices. In this chapter, contractors' perceptions of the use of wood in buildings were examined. The results are expected to contribute to environmental remediation by developing strategies to counter perceived barriers and providing insight into new solutions to a conservative space and expanding the use of wood to achieve a more sustainable construction industry. In addition, recommendations for future research, e.g., adhesive- and metal-fastener-free dovetail wood board elements as sustainable material alternatives were presented.

Keywords: engineered wood products, construction, contractors, perception, carbon footprint

1. Introduction

The last two decades have witnessed a dramatic increase in environmental awareness and concern about the impacts of business activities on climate and natural resources on a global scale, and environmental degradation is often addressed as a worldwide problem [1–6]. In this sense, the building construction industry can contribute significantly to the reduction of CO_2 emissions, high energy consumption, excessive waste, and the development of a more resource-efficient and sustainable building environment [7–10]. More specifically, construction activities involve the use of a wide variety of materials, such as concrete, steel, timber where the choice of these materials has significant impacts on the environment [11, 12] as in the cases of tall timber buildings such as the 25-story and 87 m high Ascent

(Milwaukee, structurally topped out) (**Figure 1**), the 22-story and 73 m high HAUT (Amsterdam, under construction) (**Figure 2**), and the 18-story and 58 m high Brock Commons Tallwood House (Vancouver, 2017) (**Figure 3**) [13].

There are several criteria to consider in the selection of building materials, including stability, durability, environmental impact, speed of assembly, cost, and availability [14, 15]. Although design professionals are often involved in this process [16], contractors have the most influence in material selection decisions and therefore play an important role in supporting sustainable development in the context of the construction industry [8, 17, 18].

With the increasing resource efficiency and the need to adapt to climate change in the construction industry, contractors need to execute sustainable practices. However, contractors' decision-making and perceptions of structural frameworks remain largely unexplored, and there are few studies on the selection of structural frameworks involving contractors' perspectives (e.g., [7, 8, 19]).

Wood is the primary building material used by mankind throughout history, a sustainable and renewable building material [20, 21]. The use of wood in construction can affect carbon balance by reducing fossil fuel consumption in manufacturing compared with alternative materials, preventing emissions from cement processing, and storing carbon in wood products and forests. Thus, increasing the use of wood in construction and other long-lasting uses will help achieve sustainable development goals, where timber is recognized as a sustainable material in all major green building rating tools, e.g., Leadership in Energy and Environmental Design (USA) and the BRE Environmental Assessment Method (UK).

Wooden buildings are characterized by a lower carbon construction concept than non-wood buildings [22–26], and timber construction represents a lower embodied energy consumption compared with steel and concrete production [7]. Wooden structures provide significant advantages in combating climate change, because wood can be used as an alternative to other materials to reduce greenhouse gas emissions, but also has unique features such as storing large amounts of carbon in the structure [27, 28]. For example, estimated environmental impact of wood use in Brock Commons Tallwood House (**Figure 3**) was calculated as 1753 metric tons of CO_2 in terms of carbon stored in the wood [29]. Besides being used as a building material during the construction, wood can be reused as a raw material for other structures after the building's service life or, as a last resort, burned

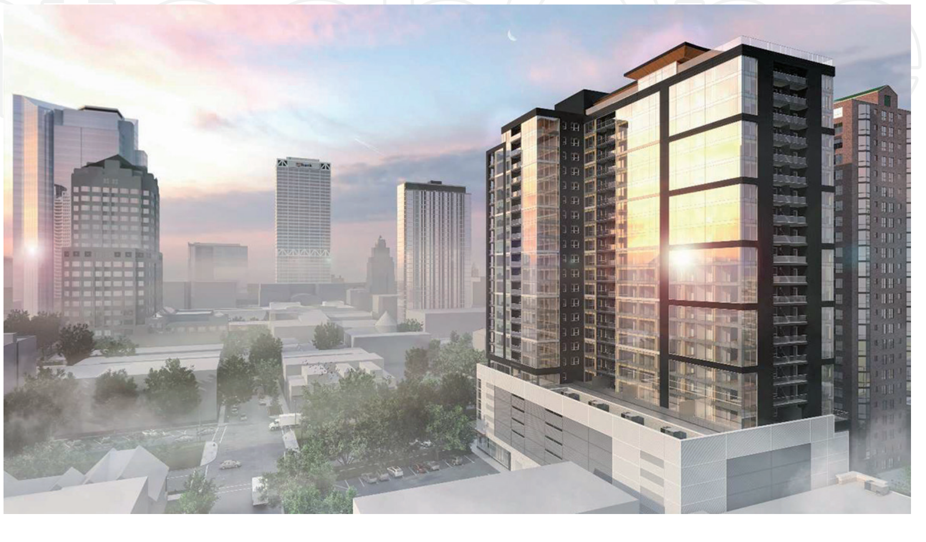

Figure 1.
Ascent (Image courtsey of Jason Korb/Korb + Associates Architects).

Figure 2.
HAUT (Photo courtsey of Jannes Linders).

Figure 3.
Brock Commons Tallwood House (Photo by Michael Elkan and courtsey of Acton Ostry Architects).

instead of fossil fuels [30–32]. The use of wood has many other advantages such as esthetic value, better design adaptability, ease of construction, living comfort, and indoor quality [15, 33, 34].

A better understanding of the perspectives of key actors, such as contractors, in the selection of structural frameworks, can improve insights into concrete path dependency. Because of the CO_2 effects of structural frameworks, such knowledge contributes to understanding the key factors for the development of a more sustainable built environment.

Overall, this chapter examines the perceptions of the contractors regarding the use of wood in buildings. It is believed that the results will contribute to environmental remediation by developing strategies against perceived barriers and providing insight into new solutions to a conservative space and expanding the use of wood to achieve a more sustainable construction industry.

In this chapter, wood or timber refers to engineered wood products (EWPs) [35, 36] such as CLT (a prefabricated multilayer EWP, manufactured from at least three layers of boards by gluing their surfaces together with an adhesive under pressure), laminated veneer lumber (LVL; made by bonding together thin vertical softwood veneers with their grains parallel to the longitudinal axis of the section, under heat and pressure), and glue-laminated timber (glulam) (abbreviated as GL; made by gluing together several graded timber laminations with their grains parallel to the longitudinal axis of the section).

2. Studies on contractors' perceptions of the use of wood for construction

In the literature, many studies focus on the technological aspects of EWPs, their use in construction, and different building solutions [37–50]. Several studies address wood as a structural material in buildings from the perspectives of key professionals (e.g., [8, 17, 51–58]) and consumers or residents (e.g., [59–64]); while there is a very limited number of works focusing on EWPs from the contractors' perspective in the literature. They are from different countries such as Sweden, Finland, Australia focusing on the use of wood as a structural material through surveys and/or interviews.

Among the studies, Hemström et al. [8] conducted interview-based research among contract managers working in contracting companies about their role in the sociotechnical regime, the choice of structural framework, and their perceptions of different alternatives. The results showed that because of their critical position in the firm, managers greatly influence the choice of the structural framework for multifamily buildings managed by the established concrete-based sociotechnical regime. The results also indicated that, due to cognitive rule-based decision-making processes, when assessing the cost of different structural frameworks, they applied their previous experience with concrete solutions as a structural material rather than making deep cost assessments. This approach has prevented timber-framed multifamily buildings from entering common use. While strong incentives for the use of concrete have made it difficult for timber frames to become more common, initiatives promoting wood could contribute to increased awareness and perceptions of wood construction and expectations for future developments in Sweden.

Riala and lola [19] conducted a study through 18 interviews with representatives from the entire value chain to identify the barriers to the adoption of multistory timber construction in Finland, the ways that wood competes with established solutions, and the possibilities for partially integrating construction into the bioeconomy. The results showed that although barriers to its adoption still exist, multistory timber construction can offer competitive solutions for more sustainable construction. A noteworthy finding of concern for the wood products industry was that interviewees with the most experience in multistory timber construction were more critical than those with less experience. This showed that building more wood and gaining more experience is not enough to increase the popularity of wood construction. Additionally, limited possibilities were found to relate the construction industry to bioeconomy. The best way to ensure greater use of renewable materials in multistory construction would be to focus on increasing the competitiveness of multistory timber construction. For this, it was necessary to take advantage of the strengths of the wooden structure such as lightness and prefabrication possibilities and focus on improvement.

Through the qualitative analysis of the data from 36 interviews, Wang et al. [7] examined the perceptions and insights of British construction experts (e.g., industry interest group, timber manufacturer, construction material merchant) to increase understanding of Green Building and the potential of using wood for the UK construction industry. The results confirmed the important role played by the British government in the creation, promotion, and development of Green Building and showed a positive increase in the use of wood in the UK construction industry, supporting the idea that the environmental performance of wood was the main factor in wood adoption. Experts with sound knowledge of wood as a building material were also shown to agree on wood's superior environmental properties; however, end-users who do not know about wood products often have a strong prejudice against their use. Finally, it was shown that legislation, environmental awareness, attitudes and traditions, market and competition, publicity and communication, and technology and know-how are among the main drivers promoting wood as a sustainable solution for Green Building in the UK construction industry. Additionally, most respondents rated the lack of education as one of the most prominent challenges in the current construction industry, hindering the expansion of potential applications of wood products. Following the discussion on wood providing the optimal solution for Green Building (e.g., [21, 65]), the study found a generally positive attitude toward the use of wood in the UK construction industry and found support for the idea that environmental performance is the main driver for wood adoption in the Green Building concept.

Through a survey of 74 experienced construction industry participants (e.g., architects, contractors, developers, and government officials), Xia et al. [11] explored the main barriers to the use of timber framing in multistory construction in Australia. According to the results, the barriers identified can be broadly divided into five groups: lack of legal support, lack of industry interest, lack of experienced professionals, perception of wood framing disadvantages, and limited awareness of wood framing advantages. The survey confirmed the limited awareness of the new wood technologies available, as well as the biggest barriers to the perceived increase in maintenance costs and fire risk. The results are expected to benefit the government and the timber industry by contributing to environmental remediation by developing strategies to increase the use of multistory timber technologies by countering perceived barriers in the Australian context. One approach to overcoming these barriers might be the collaboration of various stakeholders such as governments, customers, designers, and contractors. It was suggested that the government may introduce more supportive legislation and regulations to encourage the use of wood for structural purposes. Industry training (e.g., workshops and seminars) and education in timber structures might have contributed to increasing awareness and knowledge of technological innovations in wood products in the construction industry.

Tan et al. [66] extensively reviewed studies on the relationship between sustainability performance and contractors' competitiveness. The results indicated that there was no unique relationship between the two variables. Therefore, a framework for the implementation of sustainable construction practices was developed to increase competitiveness to help contractors develop their sustainability policies, strategies, and practices to meet the growing need for sustainable development in the construction industry.

Qi et al. [4] aimed to identify the factors affecting contractors' adoption of green construction practices through a survey. The results showed that managerial concern is the most important driver in the adoption of green practices. Significant relationships were also found between government regulation and enterprise size, along with the adoption of green construction practices, while there was no substantial evidence of the relationship between the adoption of green construction practices and perceived stakeholder pressures. This study aimed to contribute to better decision-making regarding the implementation of green construction practices.

3. Conclusions and recommendations

This study aimed to understand the contractors' perceptions of the use of wood for construction. In doing so, this chapter attempted to identify perceived major barriers to timber utilization. However, as the focus of conducted research among contractors differed as noted above, it was not possible to compare these studies with each other, but still, some conclusions were reached as follows: (a) their previous experience with concrete solutions, especially as a structural material, could have prevented them from conducting in-depth analysis for new materials; (b) building more wood and gaining more experience may not be enough to increase the popularity of wood construction; (c) lack of legal support, lack of industry interest, lack of experienced professionals, lack of education, perception of wood framing disadvantages, and limited awareness of wood framing advantages as well as the perceived

Figure 4.
Adhesive- and metal fastener-free dovetail wood board element.

increase in maintenance costs and fire risk were cited as barriers to wood use; (d) managerial concern was among the most important drivers for the adoption of green practices related to wood use.

In this context, the following recommendations can help address identified issues among contractors by improving general attitudes toward the use of wood: (1) providing initiatives that promote wood for increasing awareness and perception of wood construction and prospects for future developments; (2) increasing competitiveness by highlighting the strengths of wooden structure such as lightness and prefabrication possibilities; (3) establishing collaboration of critical stakeholders such as governments, customers, designers, and contractors;

(4) introducing more supportive legislation and regulations at the government level to encourage the use of wood for structural purposes; (5) organizing industry training (e.g., workshops and seminars) and education in wooden structures to increase awareness and knowledge of technological innovations in wood products in the construction industry; (6) conducting more research projects (e.g., the DoMWoB project/Dovetailed Massive Wood Board Elements for Multi-Story Buildings – *see Acknowledgments and Funding*) [67] and developing more innovative and environmentalist EWPs (e.g. adhesive- and metal-fastener-free dovetail wood board elements) (**Figure 4**) [68] to demonstrate the potential of wood for use in construction.

It is believed that this chapter will help deepen the understanding of the various aspects that shape the decision-making process particularly among contractors in the use of EWPs for construction.

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