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A Comprehensive Statistical Analysis of Multi-Story Timber Residential Buildings in Finland (1995-2025)

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Abstract
By the end of 2024, Finland had approximately 1.55 million buildings, excluding holiday residences and agricultural structures, with residential buildings accounting for nearly 65% of the total gross floor area. Among European countries, Finland ranks second after Spain in terms of the proportion of multi-story residential buildings, with nearly 47% of Finnish housing units located in such structures. Despite an annual construction rate of 35,000–45,000 new housing units, timber multi-story apartments represent only 1% of total new housing construction. However, when two-story buildings are included, the market share of wooden residential buildings increases to approximately 6%. By March 2025, Finland had constructed around 200 timber residential buildings exceeding two stories, comprising 6,000 apartments. In recent years, the use of cross-laminated timber (CLT) and laminated veneer lumber (LVL) in frame-based volumetric modular element construction has gained significant traction within Finland's timber residential sector, reflecting a growing shift toward industrialized wood-based building solutions.
Keywords: Timber construction; Multi-story residential building; Volumetric modular element; CLT; LVL.

1. Introduction

The forest industry is one of the key sectors of the Finnish economy. In 2022, the total value of forest industry production was approximately EUR 20 billion. The sector contributes around 18 percent of Finland's export revenue (Forests and the Economy, 2025). In Finland, a total of 20.3 million hectares of land is available for wood production, with forest cover representing a significant percentage of the country's land area. The annual increment of growing stock is approximately 103 million cubic meters. In 2023, the total roundwood harvest amounted to around 73 million cubic meters (Luke, 2025). This growing resource base supports various applications, including bioenergy production, construction, the wood product industry, and the development of diverse processed bioproducts.

The history of construction in Finland is deeply rooted in wood construction, which has long been the dominant building material, particularly for small-scale structures (Ilgın and Karjalainen, 2022). Nearly all recreational buildings in Finland are made of wood, and at present, approximately 90 percent of detached houses are constructed using timber (Savolainen et al., 2022). Approximately one-third of detached house builders in Finland currently opt for log homes (Lakkala et al., 2020). Timber construction is also becoming increasingly prevalent in public buildings, particularly schools and kindergartens, where ensuring a healthy and comfortable indoor climate is a priority (Ilgın et al., 2023). According to Puuinfo statistics (2025), since the 2010s, Finland has constructed approximately 500 timber kindergartens and 300 timber schools (Figure 1), reflecting a growing commitment to sustainable and health-conscious building solutions.

Figure 1. 3-story high log-framed school in Tuusula.

Finland is one of the most forested countries in the world. Although its land area constitutes only 0.07 percent of the Earth's surface, Finland's share of the global forest area is nearly ten times greater, at approximately 0.6 percent (Ji et al., 2024). Approximately four-fifths of Finland's sawn timber is utilized in construction, with residential building projects playing a particularly significant role (Karjalainen, 2017a). As of the end of 2024, Finland had approximately 1.55 million buildings, excluding holiday residences and agricultural structures (ROTI, 2025). Residential buildings account for two-thirds of the total building stock, encompassing nearly 3.2 million registered dwellings. Over the past two decades, Finland has maintained an annual construction rate of 35,000–45,000 new dwellings, leading to an annual renewal rate of just over one percent for residential buildings (Karjalainen and Ilgın, 2024). Finland ranks as Europe's second most apartment-oriented country after Spain, with 47% of all dwellings located in apartment buildings. Approximately three-quarters of newly constructed dwellings each year are in apartment buildings, where the typical structure contains 28–32 units. For the past sixty years, concrete has remained the dominant material in Finland's apartment building market (Karjalainen et al., 2021a).

Climate change is a scientifically established reality (Levy et al., 2025). Wood is an ecological and environmentally friendly renewable material (Ilgın and Karjalainen, 2021; Ilgın et al., 2021; Karjalainen et al., 2021b; Tulonen et al., 2021) (Figure 2). During its growth, one cubic meter of wood can absorb approximately one ton of CO_2 from the atmosphere. Given that the mass of wood is around 500 kg/m³, with roughly half of this mass consisting of carbon (250 kg/m³), forests serve as significant carbon sinks while timber and wood products act as long-term carbon storage solutions (Aaltonen, 2019). Due to these attributes, wood plays a crucial role in mitigating global warming and should be increasingly promoted as a sustainable construction material worldwide (Laitinen et al., 2024). Furthermore, the forest sector remains a key pillar of Finland's bioeconomy, contributing over half of its total value (Nifatova et al., 2024).

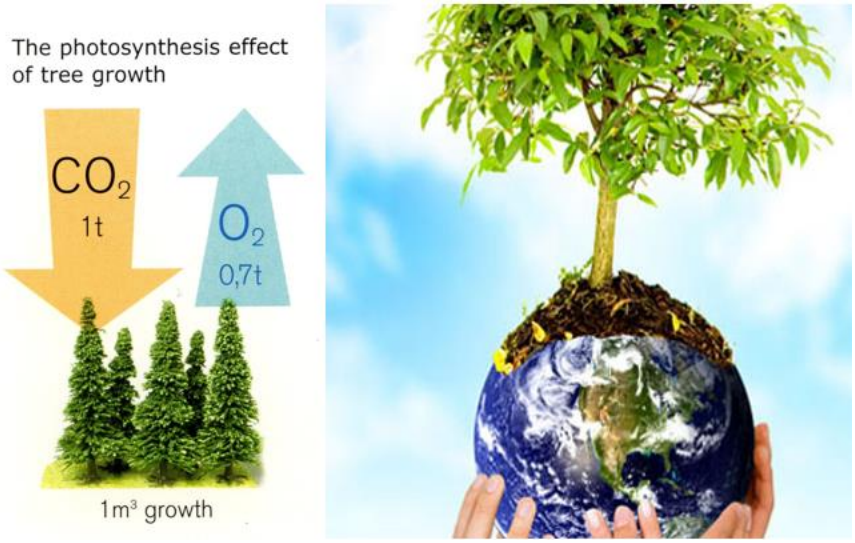

Figure 2. Wood is an ecological and environmentally friendly renewable material.

As a domestic, local, renewable, and environmentally friendly energy source and building material, wood is expected to gain increasing prominence in sustainable construction. This aligns with Finland's national bioeconomy strategy, which emphasizes the promotion of timber construction across the country. Additionally, this approach is in line with European climate policies and serves as a response to the growing demand for sustainable building practices in Finland (Bosman and Rotmans, 2016). Finland's Building Act has recently been reformed and came into effect on January 1, 2025. Starting in early 2026, the assessment of buildings' environmental impacts will become mandatory. The government has emphasized that, for environmental reasons, wood should be used as a substitute for emission- and energy-intensive building materials whenever feasible. In alignment with climate change mitigation efforts, more than 60% of Finland's municipalities have already established goals and regulations for promoting wood construction and have designated multiple areas for wooden buildings in their zoning plans. Residential buildings, energy-efficient renovations of suburban residential façades, the addition of extra floors, and infill construction represent the greatest areas of growth potential for timber construction in Finland.

Empirically, Finland presents an interesting case, as multi-story timber construction has been a key focus of national policy since the 1990s, with strong expectations for future market growth (Vihermäki et al., 2020). Following the construction of three pilot timber residential buildings, Finland's fire code was revised to permit residential and office buildings with timber structures and façades up to four stories in 1997 and up to eight stories in 2011. A further

revision in 2018 expanded this allowance to include residential, office, lodging, and institutional buildings with timber structures and façades up to eight stories (The National Building Code of Finland – Structural Fire Safety, 2017). Additionally, timber residential and office buildings exceeding eight stories can be constructed based on a functional fire design analysis, as in the case of the 16-story high Joensuu Lighthouse (Figure 3).

Figure 3. Joensuu Lighthouse.

Since 1995, Finland has allowed the construction of wooden apartment buildings taller than two stories, representing a significant advancement in building regulations and construction practices. As of March 2025, Finland has completed 200 wooden apartment buildings exceeding two stories, encompassing approximately 6,000 apartments. This upward trend is further supported by a wooden apartment project survey conducted in June 2022, which anticipates the construction of approximately 14,000 additional wooden apartments in the coming years. When including two-story small apartment buildings, the current market share of wooden apartment buildings in Finland is estimated at around 6%. While these buildings have generally received positive feedback, they have yet to achieve a competitive advantage sufficient for widespread market adoption.

As an engineered wood product, CLT—a prefabricated multi-layered EWP manufactured from at least three layers of boards bonded together with adhesive under pressure—has been available in Europe since its invention in the early 1990s, primarily in Germany and Austria, where it was initially used for small-scale projects (Espinoza et al., 2015). However, in recent years, CLT, along with LVL—which is produced by bonding together thin vertical softwood veneers with their grain oriented parallel to the longitudinal axis under heat and pressure—has gained increasing popularity as a structural material for tall timber buildings. This growing preference is due to its high strength, rigidity, and versatile applicability in modern construction (Schickhofer, et al., 2016).

2. Frame systems for timber apartment buildings in Finland

Various load-bearing frameworks are employed in the assembly of wooden housing structures (Breyer et al., 2019). Finnish manufacturing facilities possess the capability to produce timber-based structural components that align with the requirements of the residential sector. In Finland's earliest wooden dwellings, the predominant construction approach was the American platform-framing technique, which relies on a sequential floor-by-floor arrangement of vertical members (Figure 4.) This method typically involves the use of preprocessed wooden components, either assembled incrementally at the construction site or integrated as prefabricated modules of varying sizes and degrees of completion.

Figure 4. Typical platform-frame construction in Oulu in 1996.

In contemporary timber residential construction, the preference leans toward larger structural components, with laminated timber increasingly incorporated into stud-frame assemblies. Additionally, various hybrid framing techniques can be applied. Generally, the structural frameworks in timber housing feature relatively modest span lengths, typically ranging between 4.5 and 8 meters. Furthermore, Finnish timber-framed residential buildings predominantly exhibit wooden façades, though alternative façade materials are also viable for design variations.

In recent years, CLT has emerged as a widely adopted construction method in Finnish residential building projects (Vatanen et al., 2017). The primary load-bearing components, both vertical and lateral, are composed of large-scale timber panels. These CLT panels consist of multiple layers of wooden boards arranged perpendicularly and bonded together with adhesives. Additionally, construction techniques integrating CLT and LVL in volumetric modular systems have gained rapid prominence in Finland's timber housing sector. The use of dry, lightweight, and highly prefabricated structural components enables fast assembly, significantly shortening on-site construction time and, consequently, reducing overall costs (Figures 5 a, b).

(a)

(b)

Figure 5a-b. Modular volumetric elements.

However, due to transportation constraints, the standard modular element dimensions are typically 4.5 meters in width, 3.0 meters in height, and 13.5 meters in length. Moreover, some Finnish residential buildings have been constructed using a pillar-beam-ribbed slab system based on LVL technology. This structural approach is relatively advanced and is particularly competitive in the construction of 3- to 4-story timber residential and office buildings. Additionally, Glulam (glued laminated timber) is a suitable material for beam-column structural systems.

The advancement of the CLT system in Finland was initially driven by Stora Enso, which, in 2016, also commenced the production of Laminated Veneer Lumber (LVL) panels—constructed from glued veneer layers—at its Varkaus facility. Another key Finnish manufacturer of LVL products is Metsä Wood. Domestic production of CLT began earlier, in December 2014, with the establishment of the CrossLam factory in Kuhmo (Figure 6). Since then, CLT panel manufacturing has expanded to include factory production in Alajärvi, notably at Hoisko CLT.

Figure 6. CLT factory, Crosslam, Kuhmo, Finland, 2014.

3. Resident survey of timber apartment buildings in Finland

In the late 1990s, Karjalainen (2002) conducted an extensive resident survey on Finland's first multi-story timber apartment buildings. The study included seven timber apartment complexes, comprising a total of 20 buildings and 242 residential units. Responses were collected from 197 apartments, yielding a notably high response rate of 81.4%. The survey findings indicated that residents held favorable opinions toward timber apartment buildings and expressed a strong preference for expanding the use of wood in Finnish construction.

In 2017, the Ministry of the Environment commissioned a comprehensive survey on timber apartment buildings, conducted by the Department of Architecture at Tampere University (TAU). This study examined nine of the most recent timber apartment projects across Finland, encompassing a total of 17 buildings and 585 residential units. The resident survey received 308 responses, yielding a response rate of 52.6% (Karjalainen and Ilgın, 2021).

Savolainen et al. (2022) explored Tampere residents' views on multi-story timber-framed apartments through a questionnaire with 151 responses. Findings indicate high user satisfaction, with most residents appreciating fresh air, suitable indoor temperature in winter, safety, and functional features like storage, location, facade, and wood visibility, though some reported noise issues from upper floors and stairwells. Additionally, there is market demand, particularly among environmentally conscious consumers who value eco-friendly, low-carbon materials and cozy wooden interiors, with wood most desired on facades, floors, and ceilings. The study serves as a guide for architects and developers to better meet residents' expectations.

Across all three resident surveys, timber apartment buildings were widely regarded as inviting, comfortable, and providing a high-quality indoor environment. They were also evaluated as functional, architecturally well-designed, fire-resistant, and acoustically insulated. However, the findings highlighted the need for enhanced impact sound insulation in lightweight intermediate floors (Figure 7). Additionally, residents expressed a strong preference for increased wood usage, particularly in the interior cladding of stairwells, balconies, and apartments.

Figure 7. Concrete topping for improving impact sound insulation in intermediate floor.

The developers of all the projects considered them highly successful, with positive feedback received during their operational use. As a result, they expressed a strong interest in continuing the construction of new wooden apartment buildings. In the residential construction sector, competition is anticipated among various building materials, construction techniques, and stakeholders within the timber industry. Continuous innovation is expected to drive the sector forward, offering diverse solutions for both developers and residents while strengthening timber construction as a viable and competitive building method.

4. National wood construction programs

Finland’s Ministry of Employment and the Economy implemented the National Timber Construction Program in parallel with the Forestry Strategic Program (MSO) from January 1, 2012, to September 30, 2015. The primary goal of this initiative was to mitigate the carbon footprint of the construction sector by significantly promoting the use of domestically sourced timber. Subsequently, the Ministry of the Environment introduced a new timber construction program, running from August 1, 2016, to December 31, 2018. This program has since been extended and is currently set to continue until the end of 2024.

Within the framework of these programs, new wooden construction sites are systematically identified in cooperation with the country's leading developers, construction firms, municipal decision-makers, and urban development organizations in growth centers. The focus has been on large-scale developments rather than individual buildings, ensuring that wood is integrated both naturally and competitively in these projects.

The Finnish government also aims to advance timber construction as a means to support regional economic growth and employment. Expanding the use of wood in construction is expected to boost demand for domestic wood products, enhance export opportunities, and simultaneously generate new job opportunities across the country.

5. Timber construction training and collaboration

Over the past three decades, wood construction education at all levels in Finland has been consistently updated to align with the increasing demand for large-scale industrial timber construction. Architects have demonstrated a growing interest in wood as a building material, reflected in the rise of wooden apartment complexes, residential districts, schools, daycare centers, music halls, churches, chapels, bridges, and sports facilities. For structural engineers, the transition to Eurocodes, CE markings, and continuously evolving energy and environmental regulations has necessitated ongoing professional development. To assist designers, intuitive and practical design guides, digital

tools, and specialized software have been developed, streamlining the planning and implementation of timber structures.

Across the country, efforts have been directed toward refining, standardizing, and enhancing the efficiency of timber construction initiatives, as well as research and innovation, by fostering stronger collaboration and communication among industry stakeholders. Intense competition remains essential for the expansion and global reach of the timber products sector. Additionally, advancements have been made in the production capabilities, product innovation, industry networking, and market proficiency of timber manufacturing companies.

6. Wood Construction Research and Education at Tampere University (TAU)

Tampere University (TAU) has designated timber construction research and education as a strategic priority. Since 2021, Professors Sami Pajunen and Markku Karjalainen have co-led the Doctoral School for Industrial Timber Construction within the Faculty of Built Environment. The doctoral school primarily focuses on PhD research projects, complemented by other academic work, including bachelor's and master's theses. The outputs generated—such as dissertations, publications, and reports—are openly accessible to professionals in the timber construction industry.
Beyond producing high-quality and multidisciplinary research, the Doctoral School for Industrial Timber Construction at TAU seeks to strengthen the connection between academic institutions and the construction industry through education, public engagement, and knowledge dissemination. Advancing industrial timber construction requires both research-driven innovation and highly skilled professionals to enhance technical solutions and industry competitiveness. Graduates from the doctoral school have successfully integrated into the workforce during their studies and continue to contribute to innovation in their fields. The expertise cultivated within the program is recognized as vital for the development of both domestic and international timber construction.

TAU School of Architecture conducted a study titled “Competitiveness of Timber Apartment Buildings,” which analyzed key characteristics of timber apartment buildings constructed in Finland between 1995 and 2025. The study examined factors such as the number of floors, apartment sizes, structural systems, and ownership types. The findings have been systematically compiled in statistical summaries and comparative figures (Figures 8–10). The results indicate that the structural systems used in Finnish multi-story timber apartment buildings were predominantly platform-frame structures (44%) and volumetric modular systems based on CLT technology (46%). Other solutions included veneer pillar-beam-ribbed slab frames (5%), CLT or LVL slab elements (5%), and a single log-frame structure (1%). The data suggest that CLT and LVL-based modular elements are emerging as the dominant technologies for new multi-story timber residential buildings in Finland. A significant regulatory shift occurred in 2018, when the Finnish fire code was revised to permit greater use of exposed timber surfaces in building interiors. This regulatory change has favored CLT construction, allowing massive wood surfaces to remain visible in interior spaces (Figure 11). Additionally, timber-concrete composite slab systems were the most widely used solution for intermediate floors primarily due to their superior sound insulation properties.Regarding apartment ownership structures, the study found that Finnish timber residential buildings consist of rental apartments (58%), privately owned units (33%), right-of-residence housing (8%), and semi-privately owned apartments (1%).

The timber apartment buildings constructed in Finland to date contain an average of 30 residential units (calculated as 6,000 apartments across 200 buildings). The most prevalent building height is 3 to 4 stories, accounting for 62% of all timber apartment buildings (with 22% being three-story structures and 40% being four-story buildings).

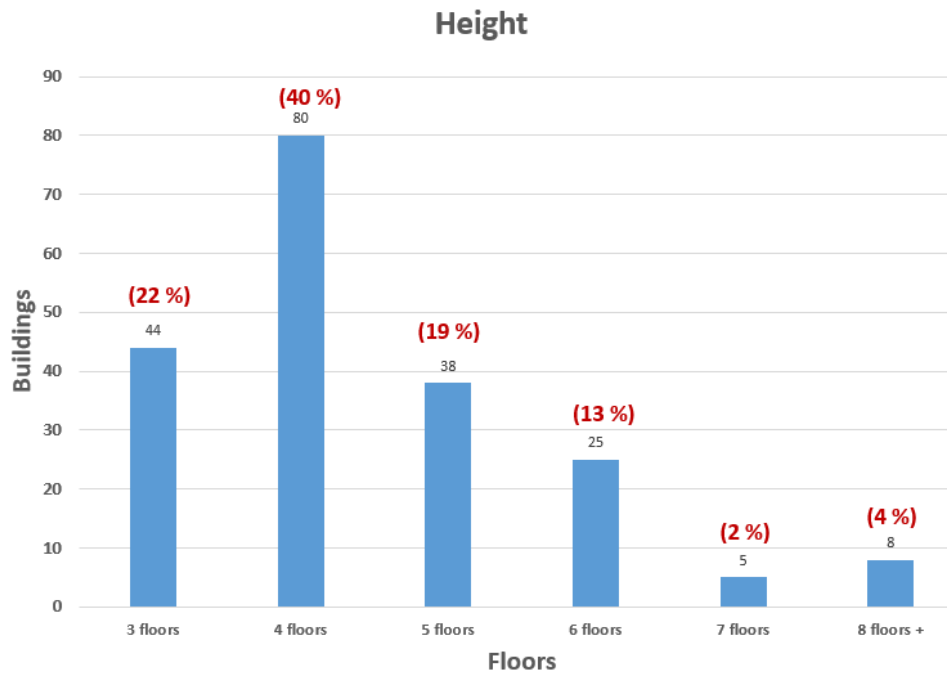

Figure 8. Height of Finnish multi-story timber apartment buildings.

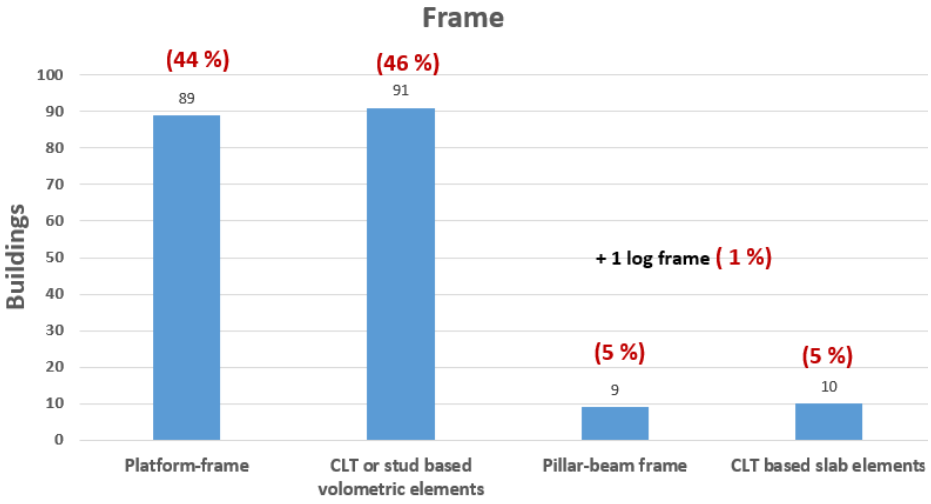

Figure 9. Frame of Finnish multi-story timber apartment buldings.

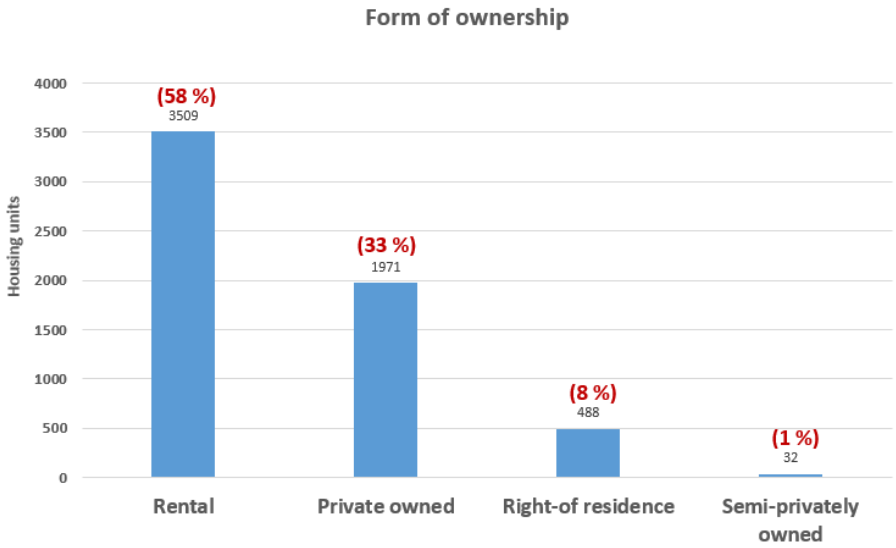

Figure 10. Form of ownership of Finnish multi-story timber apartment buildings.

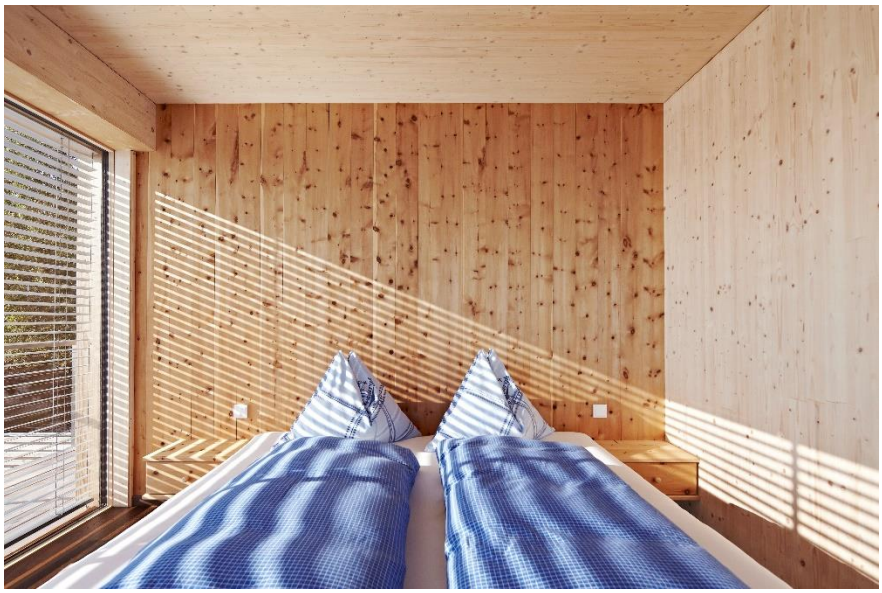

Figure 11. Inhabitants desire visible wooden surfaces in interior spaces.

Finally, the advancement of productivity in industrial wooden apartment building construction necessitates a comprehensive enhancement of the entire construction process rather than isolated optimizations. Key to improving the competitiveness of wooden apartment buildings is the standardization of design solutions and the optimization of both industrial modular manufacturing and on-site operations. Furthermore, productivity gains can be realized through effective design management, project implementation models, contract models, and streamlined site logistics. Achieving a significant leap in productivity requires collaborative efforts from all stakeholders involved, including developers, designers, industrial prefabricators, on-site operators, and crucially, the end-users of the apartments. It is incumbent upon designers and industry leaders to implement and operationalize the changes and standardized developmental areas identified through the research project. Additionally, there is a need for continued efforts to gather and refine cost data specific to wooden apartment building construction. In conclusion, the path towards enhancing productivity in industrial wooden apartment building construction requires ongoing collaboration, innovation, and systematic improvements across all facets of the construction process.

7. Conclusions

Timber construction is a key contributor to the bioeconomy, as promoting the use of wood supports the sustainable and responsible management of forests. Expanding the use of timber in building projects also serves as an effective strategy for achieving the energy and climate objectives outlined in Finland's National Energy and Climate Strategy, helping to reduce the country's carbon footprint by 2030.

This study examined the structural frame design, building height, and ownership structure of multi-story timber residential buildings constructed in Finland between 1995 and 2025. The findings indicate that the most common height for these buildings is 3 to 4 stories. In terms of structural systems, platform-frame construction and volumetric modular element designs based on CLT were the most frequently employed solutions. For intermediate floors, timber-concrete composite slab systems were predominantly used due to their superior sound insulation properties. Regarding ownership distribution, timber apartment buildings in Finland primarily consist of rental and privately owned units.

The study concluded that competitiveness of wooden apartment buildings can be significantly improved by standardizing design solutions and optimizing both industrial modular manufacturing and on-site operations. Furthermore, productivity gains can be realized through enhanced design management, the implementation of effective project and contract models, and improved site logistics.

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Conflict of Interests

The Authors declare that there is no conflict of interest.

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