

Article

Main Design Considerations and Prospects of Contemporary Tall Timber Apartment Buildings: Views of Key Professionals from Finland

Markku Karjalainen, Hüseyin Emre Ilgın * and Lassi Tulonen

School of Architecture, Faculty of Built Environment, Tampere University, P.O. Box 600, FI-33014 Tampere, Finland; markku.karjalainen@tuni.fi (M.K.); lassi.tulonen@tuni.fi (L.T.)

* Correspondence: emre.ilgin@tuni.fi

Abstract: As a result of increasing urbanization, the need for sustainable housing, e.g., tall (over eight-story) timber apartments, is increasing in Finland. Leveraging the experience of key Finnish professionals plays a significant role in the transition and expansion of sustainable timber housing as an essential part of the forest-based bioeconomy. This interview-based study will serve to fill a gap by examining the views of key professionals with experience in tall timber residential construction, using Finland as a case study. The 21 interviews primarily highlighted that: (1) the construction cost was the most important parameter affecting the architectural and structural design; (2) the most critical consideration influencing the overall design was reported to be the structural system selection and structural design, followed by city planning and client control; (3) key professionals assessed the building's form and the main dimensions of the building's mass as the most significant parameters affected by timber construction; (4) the main structural considerations that needed to be developed for tall timber housing were the bracing solutions and fittings, the structures of the intermediate floors, and load-bearing vertical/partition structures; (5) construction preconceptions, the lack of cost-competitiveness, and the lack of construction expertise/actors were considered to be major obstacles; (6) the most important parameters for the future of tall timber apartment buildings were reported to be education, timber construction marketing and public awareness, land delivery conditions, the unification of public administration, and financial support; (7) tall timber building design was reported to be a complex subject that requires close collaboration, especially between the architect, the structural designer and the wood supplier. This paper will help us to understand the boundary conditions affecting the design, the development needs in solutions, the importance of design parameters, the design parameters affected by timber construction, and the prospects, measures and obstacles to tall timber apartments from the perspectives of key Finnish professionals, thereby aiding the sound planning and development of tall timber housing projects.



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Keywords: tall timber apartment buildings; design considerations; prospects; key professionals' views; Finland

1. Introduction

Finland has been affected by increased urbanization [1] and, as a result, the demand for sustainable housing is increasing [2]. In this regard, multi-story and tall timber buildings can offer important business opportunities for a sustainable bioeconomic transition in Finland and other countries [3,4], with considerable environmental and economic life cycle benefits [5–7].

Multi-story timber construction has been promoted in Finland since the 1990s [8,9], and multi-story buildings can be the biggest opportunity for growth in timber construction in Finland [10]. Furthermore, today, multi-story timber building has had an opportunity to expand in Finland with policy support [11], as in the cases of the 14-story high Light-

house Joensuu [12], the 13-story high HOAS Tuuliniitty [13], and the eight-story high Puukuokka 1 [14].

Numerous pieces of research have been carried out on the technical, environmental, social and economic dimensions of the use of timber in buildings through different construction solutions [15]. Compared to these studies, there are relatively few studies in the literature from the perspective of construction professionals in the context of timber multi-story and tall construction, e.g., [16–20].

Even though some studies have found that construction key actors prefer traditional frame materials such as concrete over timber e.g., [21–23], it was observed that the attitudes of those who have experience working with timber frames greatly affect the results, e.g., [8,24,25].

There is a gap in the literature for research into the views of key professionals working with timber structures, particularly tall residential buildings. Moreover, no studies have been conducted to assess the use of timber in tall apartments on a multidimensional basis from the perspective of Finnish construction professionals, e.g., architects, structural designers and wood suppliers.

Even though wood has been a traditional building material utilized in housing for centuries, and has been used for other important purposes in homes, wood in the form of an ‘engineered timber product’ is a new material for city dwellers within the context of apartment buildings [26,27]. Furthermore, the trajectory of this new and emerging architectural typology has not been studied extensively, as mass timber construction techniques (particularly in the construction of tall buildings) are in their relatively early stages [28]. This research is therefore important for the greater adoption and use of this new material in Finland, especially in tall residential developments.

Overall, the objective of this research was to gain an overview of key Finnish professionals’ views regarding the use of timber in tall residential construction through an interview study. In order to understand the drivers and barriers to the design, implementation and prospects of tall timber residential projects in Finland, the following main research questions were identified:

- What are key Finnish professionals’ views of the boundary conditions affecting architecture and other design solutions in a tall timber apartment building?
- What are the design parameters affected by timber construction for architects, and what is the importance of the design parameters for non-architects in timber construction?
- What are the issues that need to be developed in the solutions used for tall timber apartment buildings?
- What are the views of key professionals on the barriers and measures associated with the implementation and prospects of tall timber apartment construction in the Finnish context?

This paper will help to identify the motivations and challenges of construction professionals with experience in tall timber housing, and will contribute to increasing the acceptability and attractiveness of tall timber apartment buildings in Finland.

For the purposes of this study, timber or wood refers to engineered wood products, such as cross-laminated timber (CLT) and glulam (GL). Moreover, in this research, ‘multi-story building’ and ‘tall building’ are defined buildings with over two stories and eight stories, respectively, and ‘apartment’ is defined as a multi-story residential building.

Additionally, it is worth mentioning that Finnish building regulations have permitted the erection of tall timber buildings since 2011. Timber buildings up to eight stories high can be constructed according to standard Finnish fire regulations, and buildings taller than that require a functional fire design analysis [29].

2. Research Method

The study was conducted through a literature survey mainly including international peer-reviewed journals and research projects. The literature review provided information for the creation of the interview-based survey design, which was intended to gather

information on the opinions of construction stakeholders in six contemporary tall timber apartments with a height of 7 to 14 stories built between 2015 and 2021 in Finland.

In this research, semi-structured interviews were applied as the best method for collecting data because the process allows interviewer and participant interactions and different perspectives to encourage the creation of new themes beyond what was initially discovered [30]. Between 11 March and 8 June 2020, 21 interviews (see Appendix A) were conducted on a five-point Likert scale among Finnish construction professionals (Table 1) who were actively involved in these six remarkable projects as key actors. The interviews were conducted by phone or using virtual meetings, and lasted approximately 1.5 h.

Table 1. Interviewees by their professional role.

Position	# of Interviews
Builder	5
Principal designer (architect)	5
Structural designer	3
Construction supervisor	2
Contractor	2
Wood supplier	2
City planner	2
Total	21

The interviews were divided into three parts. The first two parts addressed issues specifically through the case study itself. The third part was more generally concerned with the construction of tall timber apartments in Finland. In the first part, the views and the roles of different parties on and in the success of the overall process in the projects were evaluated. In the second part, the boundary conditions affecting architecture and other design solutions, the design parameters affected by timber construction, the importance of design considerations were scrutinized at a more general level. In the third part, the development needs in the solutions used, the obstacles, and the measures for the prospects in tall timber apartment building construction were assessed. In addition, open questions about re-engagement in a tall wooden apartment project and the future of these projects were used as additional sources of information. However, this study focused on the second (Part A/Sections 3.1–3.3) and third (Part B/Sections 3.4–3.6) parts in order to attempt to generalize the findings, as the first part included project-specific issues such as the project cost, project schedule and project management.

In Part A, the participants were asked how significantly the following boundary conditions affect the outcome and architecture of the projects. Additionally, the architects were asked how importantly timber construction affects design aspects such as space planning, façade openings and data modeling. The non-architect respondents were asked how important the same design aspects are to them. A Likert-type scale was used (from 1 (very low) to 5 (very significant)). A free comment box was provided for the respondents to justify their answer or make suggestions for improvement.

In Part B, the key professionals were asked how important they think it is to further develop the solutions, such as upper floor structures and balcony constructions for tall timber apartment construction. Moreover, the participants were asked what are the main obstacles—e.g., a lack of design skills, or city planning—to the implementation of tall timber apartments. The respondents were asked how functional and justified the measures such as increasing education and the unification of public administration are for prospects in the construction of tall timber apartments. A Likert-type scale was also used (from 1 (very low) to 5 (very significant)). Additionally, a free comment box was provided for the respondents to justify their answer or make suggestions for improvement.

3. Findings

3.1. Key Professionals' Survey: The Boundary Conditions Affecting Architecture and Other Design Solutions

In terms of the boundary conditions affecting architecture and other design solutions, among surveyed professionals, it was emphasized that the cost of timber construction was the most important factor influencing the architectural and structural outcome of the project, as shown in Figure 1. Several participants even stated that the continuous monitoring of costs is one of the essential factors driving the project. Additionally, the simplification of the floor plan and building form were evaluated as cost-cutting strategies.

The structural system and structural design were considered to be important parameters affecting the project. Moreover, it was stated that especially in volumetric modular systems, costs are mostly determined by the reproducibility of the total number of elements, such the cost savings have a significant impact on the building's overall architecture. Furthermore, it was reported that there was no major difference in the structural system responses between volumetric modular and large element systems, but volumetric modular systems created more boundary conditions than large element construction, especially for floor plans. Other critical factors were assessed, such as city planning and client control, which are not directly related to timber construction but are typically essential in all construction.

The importance of other factors, e.g., building regulations, government guidance and ARA (the Housing Finance and Development Centre of Finland) design guidance, varied according to the project, as seen in Figure 1. Additionally, the role of HVAC design for architecture and the overall building project was considered minor.

3.2. Key Professionals' Survey: The Design Parameters Affected by Timber Construction (for Architects)

As seen in Figure 2, regarding the design parameters affected by timber construction, the participant architects pointed out that timber construction has the most significant impact on the building's form, the main dimensions of the building mass, the architectural design schedule and the amount of design work. In the open answers, the design accuracy of timber construction was especially emphasized. The surveyed architects also highlighted the importance of the structural systems used and the boundary conditions set at the beginning of the design.

The impact of timber construction on the façade and surface material was seen by the architects as being both very minor and very important, and as being more broadly concerned with what type of building is considered to be a timber apartment. Additionally, the architects had similar attitudes towards façade openings.

The location of the stairwell, the size and distribution of residential units, the coordination of the plans, and data modeling were among the considerations in which the effect of timber construction on the design might be assessed as being important for architects in general, as shown in Figure 2.



Figure 1. Boundary conditions affecting architecture and other design solutions.

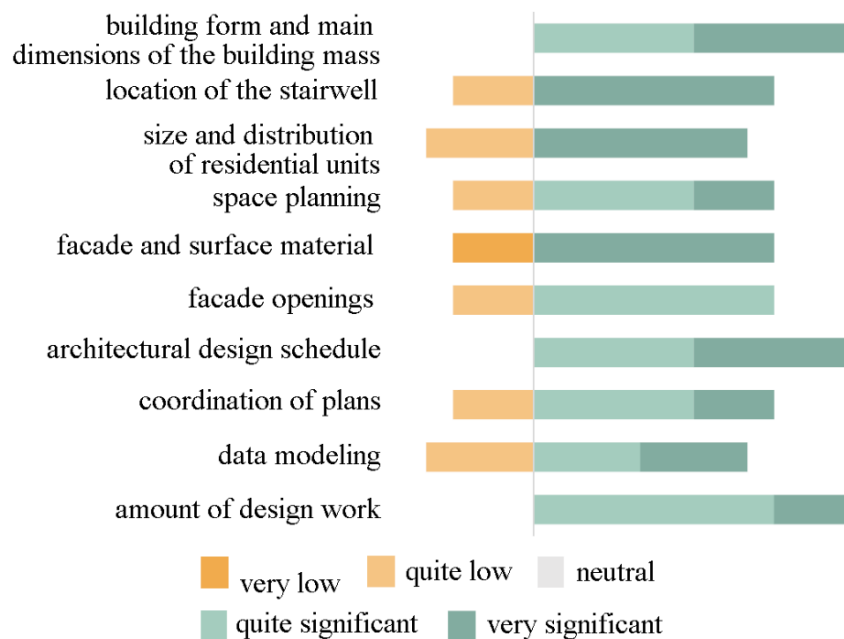


Figure 2. Design parameters affected by timber construction (responses from architects).

3.3. Key Professionals' Survey: The Importance of Design Parameters (for Non-Architects)

In terms of the importance of the design parameters given in timber construction, structural designers and wood suppliers reported the building's form, the main dimensions of the building's mass and the location of the stairwell as being the most significant solutions to be made in the architectural design of tall timber apartments (Figure 3). These parameters were followed by façade openings, space planning, the coordination of plans, and the size and distribution of residential units in order of importance.

Similarly, in the case of builders, the size and distribution of the residential units were particularly important after the space planning; this is not directly related to timber construction, but is equally important in all residential construction. The coordination of plans and the location of the stairwell were assessed as significant parameters, while the façade openings were mostly considered to be a minor consideration.

As seen in Figure 3, based on the responses from non-architect participants (except for structural designers, wood suppliers and builders), the parameters addressing the façade and surface material, space planning and coordination of plans were mostly rated as significant considerations affecting the design in terms of timber construction, whereas the façade openings were seen as a small issue for some non-architect respondents and a big issue for others. In addition to this, comments from these participants also often expressed the view that a timber façade is not automatically associated with timber construction, but that wood is primarily seen as a frame material. Moreover, the use of wood as a visible surface material was generally considered more necessary for interiors than for exteriors. On the other hand, data modeling and plan coordination were frequently highlighted in interviews as critical factors influencing the design among the key professionals surveyed.

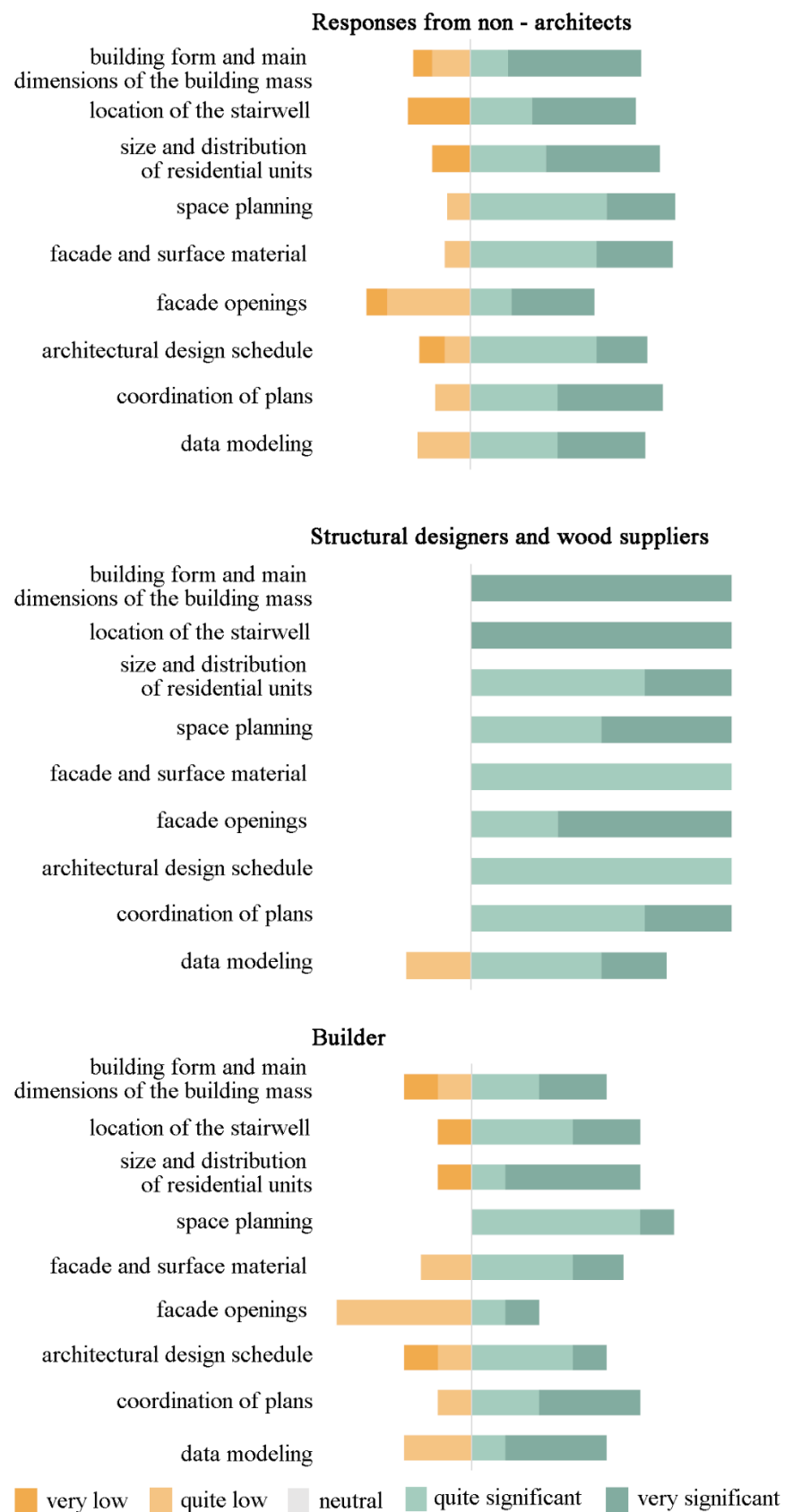


Figure 3. Importance of the design parameters in timber construction (responses from non-architects).

3.4. Key Professionals' Survey: The Development Needs in Solutions

In terms of the development needs in the solutions used for tall timber apartment buildings, according to the respondents, structural solutions such as bracing solutions and fittings, the structures of intermediate floors, and load-bearing vertical/partition structures were assessed as the most important considerations to be developed, as shown in Figure 4. Additionally, it was stated that bracing solutions and fittings were the most critical structural design difference between high- and low-rise timber buildings. Moreover, the surveyed participants reported that the bracing of tall buildings requires special solutions for connections that are different from the basic parts of the low-rise building.

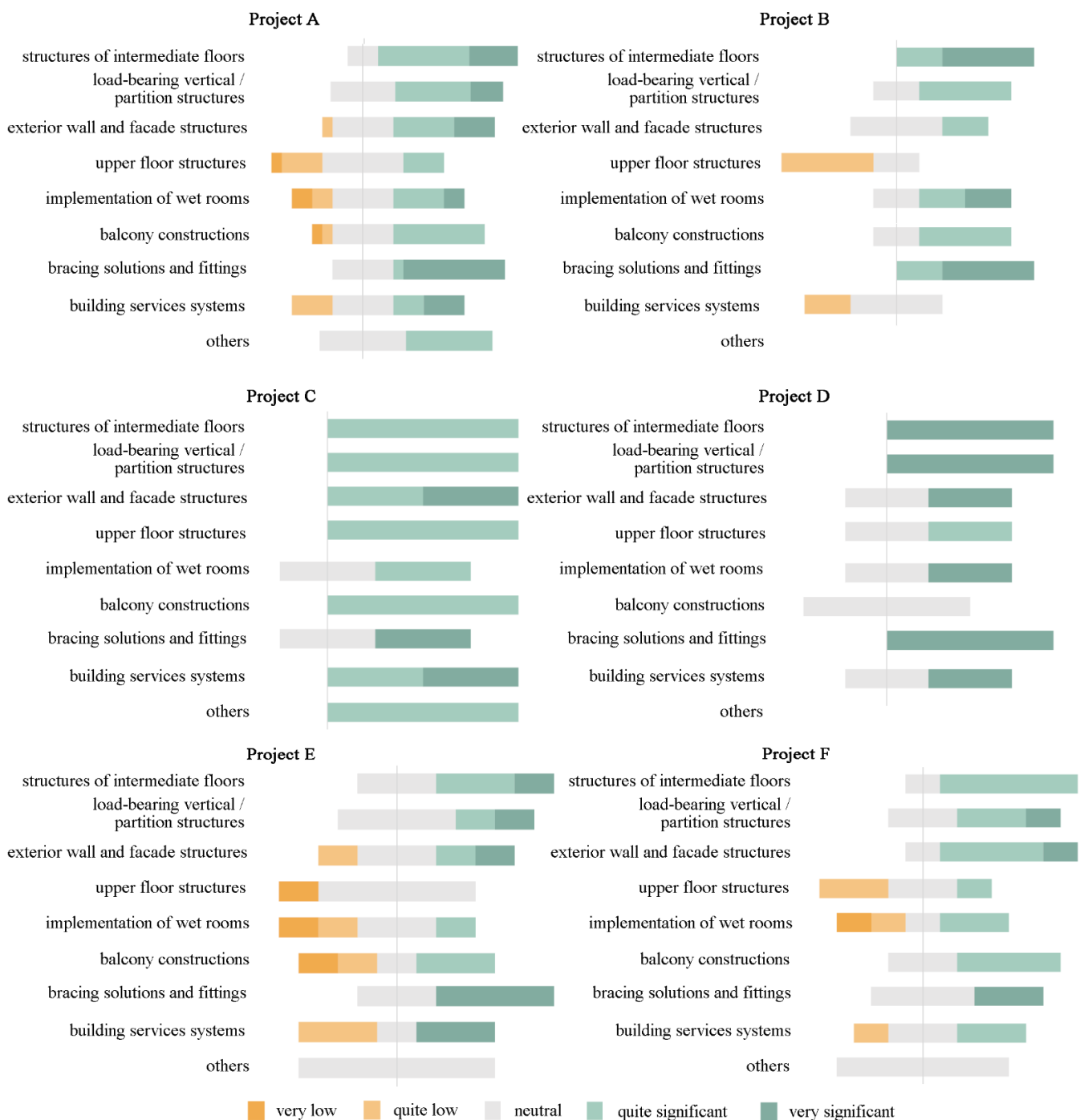


Figure 4. Development needs in the solutions used for tall timber apartment buildings.

The functionality of the intermediate floors was often regarded as one of the biggest challenges in the construction of timber apartment buildings. These floors were considered to be structurally functional in themselves, but the problems were related to their cost competitiveness and the laborious application of multi-layer structures.

Concerning the exterior wall and façade structures, the development of more pre-fabricated façade elements and the improvement of the quality of the façade details in architectural solutions were underlined. A wooden façade was considered an efficient solution, but it was hoped that more versatile architectural options would be developed in addition to traditional wood paneling. It was pointed out that façade element suppliers should be included in the façade design at every stage, in order to provide more complete solutions.

Other parameters regarding upper floor structures, the implementations of wet rooms, and balcony constructions varied according to the project. Furthermore, in terms of their development needs, different views were expressed among different disciplines in some projects, as seen in Figure 4.

The impact of building service systems—e.g., HVAC solutions—was almost negligible, but the design process, which is different from that of concrete structures, came to the fore, especially in structures with large element systems.

3.5. Key Professionals' Survey: The Obstacles

In terms of the obstacles to the implementation of tall timber apartment buildings, the respondents assessed construction preconceptions as being the most significant barrier to tall timber residential construction (Figure 5). The lack of cost-competitiveness and the lack of construction expertise/actors were also identified as other major obstacles to tall timber housing.

While the level of expertise in architectural and structural design was evaluated as being satisfactory during the interviews, it was also stated that there are very few dominant players, especially in the structural design of timber apartment buildings in Finland. Regarding structural design, the need to develop standard solutions and transfer information to new actors was also emphasized.

According to interviews, it was considered that tall timber apartment buildings will become more common with experience and improved cost competitiveness; however, unless tall timber structures are strongly supported by the public authorities, it is unlikely that timber apartment buildings will proliferate any further than this.

One of the main obstacles in the development of tall timber structures was reported to be one-off projects, meaning that the refinement of training and building concepts did not materialize. On the other hand, many interviewees considered that the demand for tall timber apartment buildings in Finland was generally low. However, the construction of the first tall apartment building in Finland was considered to be a significant factor in the credibility of timber construction.

In terms of cost competitiveness, according to wood suppliers, building components were often competitively priced compared to a precast concrete house of similar size, but still, the cost of the finished house was not competitive enough even if the timber frame was in itself. The difference in material consumption between solid wood and heavy construction was also highlighted.

3.6. Key Professionals' Survey: The Measures for the Prospects in Tall Timber Apartment Building Construction

As seen in Figure 6, the interviews on the measures to be taken for the prospects in the construction of tall timber apartments focused on education, timber construction marketing, public awareness, land delivery conditions, the unification of public administration, and financial support as the most effective ways to improve this sustainable construction.

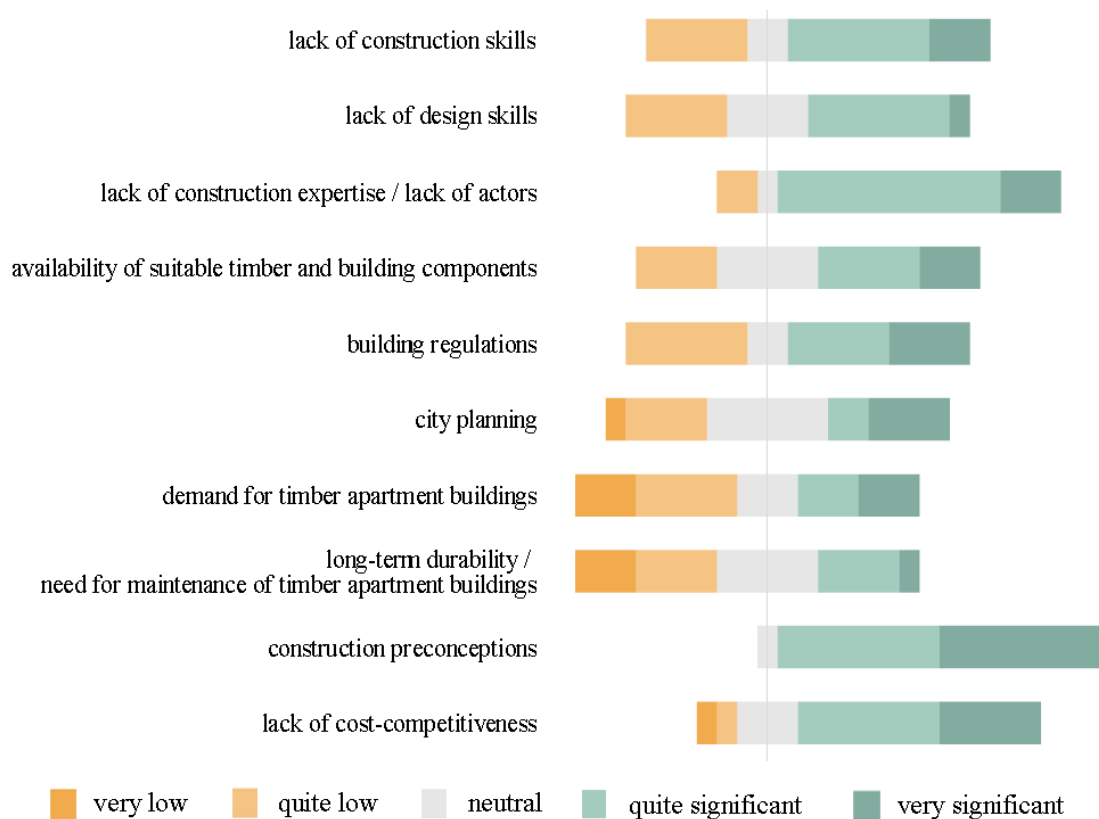


Figure 5. The main obstacles to the implementation of tall timber apartment buildings.

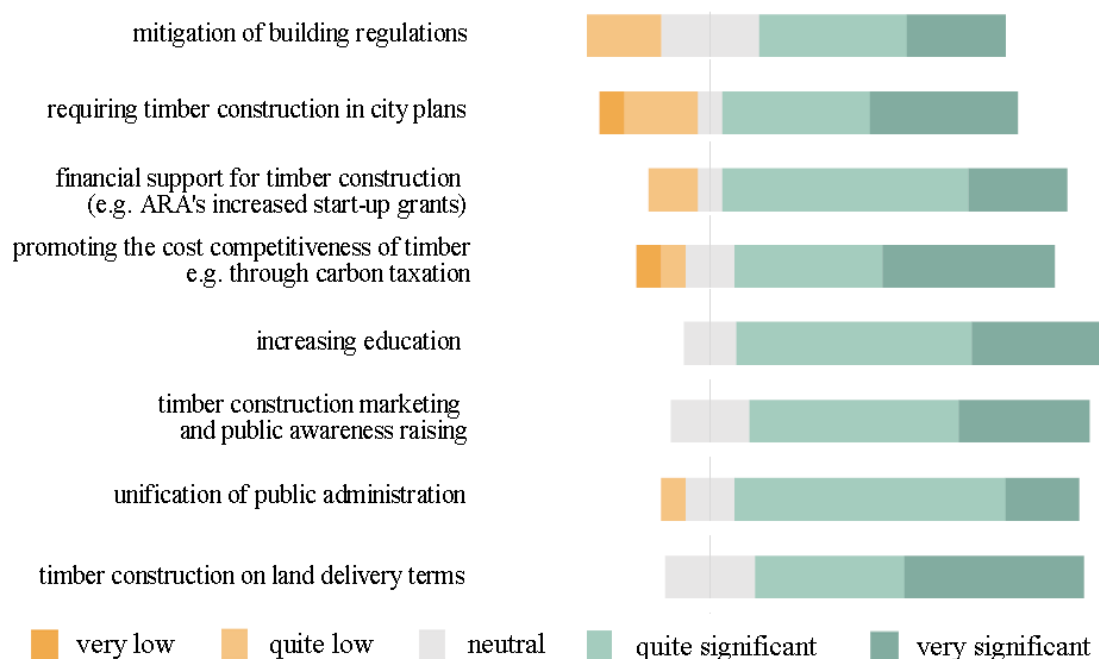


Figure 6. Measures for the prospects of tall timber apartment building construction.

4. Discussion

The findings of this paper, for example regarding the identified main barriers to the use of timber in tall apartment construction, confirmed some of the results (e.g., the lack of cost-competitiveness and support from the public authorities) reported in other studies, such as [18,31,32].

Our findings about the use of simple architectural plans and forms, which were considered to be utilized as a cost-reduction strategy, resembled the finding in the study of [28]. Kuzmanovska's comparative study [28] examining 46 multi-story timber buildings showed that linear plans and regular extrusions predominated, contrary to current trends in composite or reinforced concrete high-rise building typologies [33–35].

Based on the views of the Finnish construction professionals, the structural system and structural design have a substantial impact on tall timber apartment projects. Similarly, architectural and structural design should be considered together in the planning of high-rise buildings with steel, reinforced concrete, or composite structural systems [36–38]. Furthermore, the structural system, especially in supertall buildings (higher than 300 m or 75 stories), is closely connected to the form and function of the building, and therefore to the architectural design [39].

The surveyed key professionals, including architects, also emphasized the importance of the structural system used in tall timber apartment buildings. This finding is supported by the fact that, especially in tall buildings, architectural and structural design should be considered together, as the alternatives in the choice of a structural system become restricted by the limitations imposed by the height of buildings [34,39].

City planning also came to the fore as one of the important considerations affecting tall timber residential projects. This finding was supported by many studies, e.g., [33,40–42], highlighting similar topics such as the integration of the city and high-rise buildings, the harmony of tall buildings with the urban fabric, and the creation of spaces with high-rise buildings through urban design analysis.

The interviews emphasized that the use of wood as a visible surface material is generally seen as being necessary for interior spaces rather than for the building exterior. This finding can be attributed to the studies by [43–45] focusing on the use of wood as a residential material in interiors and furniture. On the other hand, regarding exterior building façades, it was emphasized that prefabricated façade elements and quality of the façade details in architectural solutions should be improved. This can be attributed to the advantages of prefabricated façade solutions, such as shortening the construction time and eliminating the need for scaffolding [28].

The importance of data modeling was emphasized by the participant professionals as a critical parameter affecting the planning process of tall timber apartment projects, as it is in many other projects such as mass house building projects [46], large scale complex building projects [47] and off-site construction [48].

According to the participants, structural solutions such as bracing solutions and fittings, the structures of intermediate floors, and load-bearing vertical/partition structures were assessed as the most critical parameters that needed improvement. This resembled the findings in the studies by [49–51] that structural strength in tall timber buildings was still not fully understood due to the complex nature of timber.

The survey respondents considered construction preconceptions to be one of the major obstacles to tall apartment building construction. This can be associated with the findings by [52] that stereotypes (associated with widely known public beliefs, such as its combustive characteristics) were described as barriers to the use of timber in residential construction.

According to the interviews, it was believed that tall timber apartment buildings will become more common with experience and increasing cost competition, and therefore the lack of cost-competitiveness was identified as one of the most important obstacles to the use of timber, which was supported by the findings in the studies of [18,53]. Additionally, [25] underlined the maintenance costs of timber construction as a perceived barrier. However, the earlier findings by [54] indicated some different views on this subject. Roos' study [54] highlighted that some responding architects claimed that timber could be cost-effective when applied correctly.

Our findings of a lack of construction expertise/actors were assessed as a major barrier to the use of timber in tall residential construction; this was also reported in several

studies, e.g., [52]. This finding can be attributed to the findings by [25,52,54] regarding the knowledge gaps or lack of expertise and limited awareness of emerging technologies in timber construction.

Based on the views of the key Finnish professionals regarding structural design, the need to develop standard solutions was considered to be one of the most important obstacles preventing the common use of tall timber structures. Similarly, [55] reported that standards consisting of the product, testing and design are among the prerequisites for the establishment of a solid timber construction using CLT, and therefore it was recommended to create a globally harmonized standards package to expand the application areas of timber engineering and increase the competitiveness of CLT.

In the view of the participants, it was unlikely at this time that timber apartment buildings would proliferate any further than this unless tall timber structures are strongly supported by public authorities. This may be one of the reasons for public policies promoting the use of wood in construction in Finland [56], as in other countries such as Australia, Canada and Japan [32].

The surveyed professionals often noted that the demand for tall timber apartment buildings in Finland was generally low. This finding can be attributed to [57], which highlighted that large-scale timber construction—e.g., tall timber buildings in Finland—is stuck in a vicious circle. Additionally, [57] reported that demand should pick up before reducing the costs of building taller timber structures, improving construction processes and filling the skills gap, considering concrete's 40-year advantage over wood in Finland.

The importance of increasing education was emphasized in terms of measures for the development of tall timber apartment constructions. Similarly, many studies related to the use of timber in building construction, e.g., [17,20,58,59], pointed out the significance of this issue. In addition, some recent studies, e.g., [60–62], highlighted the critical parameters contributing to the diffusion of tall timber housing, timber construction marketing and public awareness, as identified in our study. Moreover, the land delivery conditions and the unification of public administration were important considerations, but no comparison could be made with other studies on these topics, as no similar studies were found on the measures for the development of tall timber residential construction at the time of writing.

Financial support was assessed as another significant factor for the diffusion of high-rise timber construction in Finland. This resembled the findings in the recent study of Finnish municipal civil servants by [63], which reported criticism of the Finnish government for not having sufficient financial policy to support the actors involved in multi-story timber construction to take the risk of financial uncertainty.

5. Conclusions

This interview study aimed to examine Finnish construction professionals' views of contemporary tall timber apartment buildings. In doing so, this paper attempted to identify the boundary conditions affecting the design, the development needs in the solutions used, the importance of the design parameters, the design parameters affected by timber construction, and the prospects, measures and obstacles to tall timber apartments in Finland.

As for the profile of the key Finnish professionals surveyed in the residential construction industry, these included a total of 21 builders, principal designers (architects), structural designers, construction supervisors, contractors, wood suppliers and city planners involved in six contemporary tall timber apartment projects.

The most critical parameter influencing architectural and other design solutions was the cost of timber construction. Besides this, the most important factor affecting the design of tall timber apartment buildings was considered to be the choices of the structural system and the structural design, highlighting the maximum dimensions limited by the structural system and the reproducibility required for industrial manufacture, followed by city planning and client control.

Among architects, timber construction was assessed to have the most significant influence on the building's form and the main dimensions of the building's mass, the architectural design schedule, and the amount of design work. Moreover, the importance of the structural system used was also highlighted. Similarly, the non-architect participants' focus was on the building's form and the main dimensions of the building's mass, as well as the location of the stairwell. They also underlined the need to develop prefabricated façade elements and improve the quality of façade details in architectural solutions by including façade element suppliers at every stage. While data modeling and plan coordination were pointed out in the interviews as a significant factors affecting planning, it was stated that the impact of building services systems, e.g., HVAC solutions, on the project was very small.

On the other hand, the main considerations that needed development for tall timber apartment buildings were bracing solutions and fittings, the structures of the intermediate floors, and the load-bearing vertical/partition structures. In addition to construction pre-conceptions, the lack of cost-competitiveness and the lack of construction expertise/actors were reported as major obstacles to tall timber apartment development in Finland. Education, timber construction marketing and public awareness, land delivery conditions, the unification of public administration, and financial support were reported as the most important parameters for the future of tall timber apartment buildings. According to the results, tall timber apartment buildings in Finland were publicly supported and experimental construction was actively encouraged. This was a critical issue for the widespread use of this building typology.

Tall timber building design is a complex issue that requires advanced interdisciplinary collaboration and teamwork, especially close interaction between the architect and the structural designer, which is a fact that architects should know. Furthermore, it was important that the wood supplier and the structural designer be involved in the design at the earliest possible stage, as special expertise in wood construction is needed from them together.

Future studies could focus on other opportunities for Finnish timber apartment buildings, related know-how in foreign markets, and the examination of export perspectives. Future works on the potential diffusion of tall (over eight stories high) residential buildings could also scrutinize the attitudes of consumers and residents towards using more timber, as their perceptions have a major influence on the anticipated transition towards a forest-based bioeconomy in Finland.

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Appendix A Interview Questions

1. What would you give to the completed project and the implementation process?
Finished building (1–5)
construction/project management (1–5)

- construction (1–5)
architectural/main design (1–5)
permitting process and official activities (1–5)
building components manufacturing process (1–5)
Do you want to justify your answer or make suggestions for improvement?
2. How much influence do you think the following parties had on the outcome of the project?
builder (1–5)
principal designer/architect (1–5)
structural designer (1–5)
contractor (1–5)
wood supplier (1–5)
city planner (1–5)
construction supervisor (1–5)
Do you want to justify your answer or make suggestions for improvement?
3. How much impact do you think the following parties had on the cost of the project?
builder (1–5)
principal designer/architect (1–5)
structural designer (1–5)
contractor (1–5)
wood supplier (1–5)
city planner (1–5)
construction supervisor (1–5)
Do you want to justify your answer or make suggestions for improvement?
4. How much influence do you think the following parties had on the project schedule?
builder (1–5)
principal designer/architect (1–5)
structural designer (1–5)
contractor (1–5)
wood supplier (1–5)
city planner (1–5)
construction supervisor (1–5)
Do you want to justify your answer or make suggestions for improvement?
5. How much influence do you think the following parties had on the project schedule?
project planning (1–5)
competition (1–5)
general design control (1–5)
implementation planning control (1–5)
construction control (1–5)
commissioning (1–5)
schedule management (1–5)
information management (1–5)
cost management (1–5)
quality management (1–5)
Do you want to justify your answer or make suggestions for improvement?
6. How significantly did the following boundary conditions affect the outcome and architecture of the project?
structural design (1–5)
structural system (1–5)
HVAC design (1–5)
city planning (1–5)

- building regulations (1–5)
 government guidance (1–5)
 ARA design guidelines (1–5)
 client control (1–5)
 cost of timber construction (1–5)
 Do you want to justify your answer or make suggestions for improvement?
7. How significantly did timber construction affect the following aspects of design? (question for architects only)
- building's form and main dimensions of the building's mass (1–5)
 location of the stairwell (1–5)
 size and distribution of residential units (1–5)
 space planning (1–5)
 façade and surface material (1–5)
 façade openings (1–5)
 architectural design schedule (1–5)
 coordination of plans (1–5)
 data modeling (1–5)
 amount of design work (1–5)
 Do you want to justify your answer or make suggestions for improvement?
8. How important are the following areas of design from your perspective? (question for non-architects)
- building's form and main dimensions of the building's mass (1–5)
 location of the stairwell (1–5)
 size and distribution of residential units (1–5)
 space planning (1–5)
 façade and surface material (1–5)
 façade openings (1–5)
 architectural design schedule (1–5)
 coordination of plans (1–5)
 data modeling (1–5)
 Do you want to justify your answer or make suggestions for improvement?
9. How important do you think it is to further develop the following solutions in terms of tall timber apartment building construction?
- structures of intermediate floors (1–5)
 load-bearing vertical/partition structures (1–5)
 exterior wall and façade structures (1–5)
 upper floor structures (1–5)
 implementation of wet rooms (1–5)
 balcony constructions (1–5)
 bracing solutions and fittings (1–5)
 building services systems (1–5)
 others (1–5)
 Do you want to justify your answer or make suggestions for improvement?
10. What are the main obstacles to the implementation of tall timber apartment buildings?
- lack of construction skills (1–5)
 lack of design skills (1–5)
 lack of construction expertise/lack of actors (1–5)
 availability of suitable timber and building components (1–5)
 building regulations (1–5)
 city planning (1–5)
 demand for timber apartment buildings (1–5)

- long-term durability/need for maintenance of timber apartment buildings (1–5)
 construction preconceptions (1–5)
 cost of timber construction (1–5)
 Do you want to justify your answer or make suggestions for improvement?
11. How functional and justified do you consider the following measures for the prospects in tall timber apartment building construction?
 mitigation of building regulations (1–5)
 requiring timber construction in city plans (1–5)
 financial support for timber construction (e.g., ARA's increased start-up grants) (1–5)
 promoting the cost competitiveness of timber, e.g., through carbon taxation (1–5)
 increasing education (1–5)
 timber construction marketing and public awareness-raising (1–5)
 unification of public administration (1–5)
 timber construction on land delivery terms (1–5)
 Do you want to justify your answer or make suggestions for improvement?
12. Open question.
 Would you join a tall timber apartment building project again?
13. Open question.
 How do you think about the future of tall timber apartment building construction in Finland?
 (1) very low (2) quite low (3) neutral (4) quite significant (5) very significant

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