What About Wood?—"Nonwood" Construction Experts' Perceptions of Environmental Regulation, Business Environment, and Future Trends in Residential Multistory Building in Finland

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Abstract

Despite the sustained interest in multistory wood-frame construction (WMC) along with an expanding bioeconomy, the rate of market uptake has been modest outside North America. Changing environmental values and regulation are expected to boost WMC adoption along with an expanding bioeconomy, yet the future prospects of WMC are typically explored with an empirical focus on the actors that are already active in WMC. To address the possible bias, this paper elicits the views of nonwood actors (i.e., construction company managers and executives in the areas of procurement and project planning with no prior experience in WMC), through 10 semistructured interviews. The results indicate that the nonwood actors do not necessarily oppose WMC as such, but there remain competitive barriers for a major market growth of WMC related to, for example, lack of standardization and significant enough productivity benefits to motivate adopting a new potentially risky construction practice. Based on comparisons with previous literature, the most notable differences in opinions between wood actors and nonwood actors regarded the direction and strength of the impact of consumer preferences on WMC demand. While acknowledging that this is a crude comparison without statistical significance, one can observe similarities in the distribution of answers for the questions unrelated to WMC, but more dispersion for those addressing WMC. Yet, while the attitudes toward wood as a construction material seem to differ, both the wood and nonwood actors seem to regard the doubling of the market share of WMC in Finland by 2030 as feasible.

Wood construction markets have attracted a great deal of attention both in bioeconomy strategies (e.g., Ministry of Employment and the Economy 2014, Finnish Government 2019) and in peer-reviewed journals, both in terms of the environmental impacts (e.g., D'Amico et al. 2020, Gustavsson et al. 2021) and policies and strategies for the market uptake (Vihemäki et al. 2019, Baldwin 2020, Toivonen et al. 2021). The past decade also shows significant market growth in engineered wood products (EWP) such as Cross Laminated Timber (Gaston and Pahkasalo 2020) that fuel growth in sectors such as multistory residential buildings in which the use of wood has been less customary outside North America.

Despite the sustained and growing interest in multistory wood-frame construction (WMC), the rate of market uptake has been modest. For example, a foregone Finnish government program targeted achieving a market share of 10% for WMC in a matter of few years (Finnish Government 2011), but the market share has remained below 5% because of the lack of a common vision among

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the actors in the technological innovation system (Toivonen et al. 2021). Generally, developers remain unwilling to introduce new construction practices if the perceived risks outweigh the possible gains (Mahapatra and Gustavsson 2008, Roos et al. 2010). The established concrete-based sociotechnical regime creates a lock-in through cognitive rules regarding structural frame options and the alignment of skills of construction professionals (Hemström et al. 2017a). Also Toppinen et al. (2019) conclude that, when looking forward to 2030, the strong cognitive rules founded in the concrete-based building culture are likely to inhibit major deviations in the socio-technical regime. Lazarevic et al. (2020) argue that WMC presents an incumbent building regime, but that up to now the existing institutions have been destabilized only to the extent that it now permits building technologies to compete on a more even playing field.

Previously published literature contains analyses of the insights of experts in different parts of the wood-construction value chain (e.g., Roos et al. 2010; Hemström et al. 2011, 2017a, 2017b; Riala and Ilola 2014) and future trends in wood construction (Hurmekoski et al. 2015, Toppinen et al. 2018). However, few studies analyze the perceptions of construction industry stakeholders at large as pertains to the barriers and opportunities for WMC (Ijäs 2013). According to Hemström et al. (2017a), studies relating to structural material preferences typically have not discerned, or compared, the views of experts with experience in WMC from those that have no experience in WMC.

Franzini et al. (2018) conducted a survey on the personal perceptions of Finnish civil servants as related to WMC and showed increasing support for WMC enabled by EWPs, but also barriers associated with inadequate information distribution, a limited number of WMC industry actors, and inefficient policy measures. Franzini et al. (2020) found that Finnish civil servants perceive that WMC possesses positive environmental attributes and supports economic development, but has higher construction and maintenance costs and is more susceptible to fire (see also Hemström et al. 2017a). Our study does not elaborate on how the perceptions compare with actual properties of wood for building. For the technical properties of wood, please see, for example, Karacabeyli and Douglas (2013).

In a case study of a Finnish construction firm, Matinaro and Liu (2015) found implications of low implementation of innovations due to the industry's cyclical characteristics, project-oriented working methods, and organizational cultures. In another case study, Matinaro and Liu (2017) found that a lack of long-term innovation culture is due to a more stringent focus on short-term cost and result-oriented actions. Similarly, Riala and Ilola (2014) found that the main barriers in the construction value chain associated with the adoption of WMC in Finland relate to the more advanced construction process of concrete buildings and the concrete industry's robust establishment.

According to Roos et al. (2010), developers in Sweden possess the most influence over material selection in the construction value chain, followed by authorities and contractors, yet their attitude toward timber range from neutral to slightly negative. Hemström et al. (2017a) adhered to the findings of Roos et al. (2010) by pointing to several sources of cost disadvantages for WMC, including the inexperience of construction workers. Moreover, although environmental benefits of wood were seen among the majority of respondents, it was not expected to affect the choice of the frame material. However, if further impetus were to be placed on environmental aspects in buildings and wooden-framed solutions were to become more competitively priced, most respondents anticipated an increasing demand for wooden frames in the future (Hemström et al. 2017a). Markström et al. (2018) argue that architects in general have a positive attitude toward using EWPs and think that their use will increase in the future, yet architects have limited possibilities to influence material selection. Wang et al. (2014) found that experts who have sound knowledge of wood as a building material agree on its superior environmental credentials while consumers lacking information often show strong prejudice against its use.

Academic literature tends to paint a fairly positive picture of the future potential of WMC, despite the various path dependencies. For example, Toppinen et al. (2018) conclude that the sustainability megatrend in housing is perceived to gain further impetus when looking forward to 2030, both in terms of consumer demand for sustainable living and wood construction as a modern way of living. Hurmekoski et al. (2018) indicate that while a tripling of the market share of WMC by 2030 in Finland is reckoned improbable, major growth in WMC would be feasible by developing industrial prefabrication methods and taking more responsibility for the construction value chain. Lazarevic et al. (2020) call for placing greater efforts to develop regime destabilizing functions, such as establishing low-carbon public procurement criteria, and changing the organizational practices of municipalities to reconfigure the institutions that structure the construction regime to be more favorable to WMC.

Summarizing the existing literature, it appears that there are major hindrances for the uptake of new construction practices in the path-dependent construction sector, yet changing environmental values and regulation are expected to boost WMC adoption along with an expanding bioeconomy. One possible source of bias for the growth prospects is the restricted empirical setting of the studies focused on the wood value chain and missing the view of the construction sector at large. It is possible that such biased sampling influences the conclusions drawn regarding the future prospects of WMC. Thus, there is a clear need to explore the perceptions of nonwood actors as they relate to WMC as well as their likely responses to planned sustainability regulation for the construction sector.

This study aims to address this knowledge gap through the following research questions:

- What are the perceptions of construction industry experts as they relate to the productivity and environmental regulation for multistory construction in Finland?
- How is the growth potential of wood-frame multistory construction seen by nonwood actors when looking forward to 2030?
- How do the perceptions and expectations of nonwood actors compare with those of the actors within wood value chains?

To make the scope more relevant and the results comparable to previous literature on wood sector perceptions, the study focuses on the Finnish multistory building sector.

Contextual Framework

The study aims to elicit views from nonwood actors regarding, firstly, how the tightening construction regulation and the stagnating productivity is going to affect the construction business at large in the next decade; and secondly, how the sector perceives the role of prefabricated WMC as one possible response to addressing these major issues.

Productivity development

The productivity development of the construction sector has been significantly lower when compared with other manufacturing sectors or the total economy in the past few decades, both globally and in Finland (Barbosa et al. 2017). For example, Koskenvesa et al. (2010) examined 12 construction tasks and their labor productivity from 1975 to 2008 in Finland and found that the progress has been in the range of 1% annually, which is clearly below the average across economic sectors.

Barbosa et al. (2017) identify 10 root causes for the low rates of productivity in the global construction sector: (1) project and site complexities, (2) extensive regulation, (3) land fragmentation and the cyclical nature of public investment, (4) informality and potential for corruption, (5) high fragmentation, (6) misaligned contractual structures and incentives, (7) suboptimal owner requirements, (8) inadequate design processes and investments, (9) poor project management, (10) insufficiently skilled workforce, and industry underinvestments in digitalization, innovation and capital. Not all these aspects are relevant for all regions or subsectors.

Offsite construction and prefabrication have been considered as one way of enhancing productivity through standardized work conditions and lower level of value chain fragmentation (e.g., Malmgren 2014). The beneficial strength-to-weight ratio and ease of handling make wood well-suited for industrial prefabrication. Besides potentially increasing productivity by reducing the construction time and overall costs, it could also mitigate the impact of onsite construction to surroundings (e.g., lower dust and noise emissions) and improve the safety and convenience of workers through standardized indoor working conditions.

Environmental regulation

The national construction regulations and construction cultures vary significantly from one region to another, depending, for example, on the climate and availability of raw materials. Thus, the European Union (EU) may mostly influence through information provision and harmonization of standards. For example, the roadmap to a resource efficient Europe aims at strengthening the national resource and energy efficiency policies in the construction sector (European Commission 2011).

The EU has also established a voluntary Level(s) framework to enhance the comparability of environmental impact estimates and thereby enhance the uptake of environmentally less harmful construction practices. The Level(s) framework comprises six domains, namely greenhouse gas (GHG) emissions, resource efficiency, water use, health and comfort, resilience and adaptation to climate change, and cost and value (Dodd et al. 2017). The implementation of the voluntary framework is up to the Member States. Finland plans not only to adopt the voluntary harmonized environmental indicator framework, but also establish binding national regulation based on it by determining maximum limit values for the environmental impacts of new construction by mid-2020s (Ministry of the Environment 2021), as outlined in Figure 1. The roadmap—available in Finnish only—navigates the means of incorporating the carbon footprint of construction and building products into construction regulation. The aims, scope, and timing of the regulation remain open and subject to the decisions of the Finnish government.

Based on meta-analyses, there is strong evidence that WMC has lower embodied fossil emissions than a functionally equivalent concrete-frame building over the life cycle of the building (Sathre and O'Connor 2010, Leskinen et al. 2018, Myllyviita et al. 2021). In relative terms, WMCs are often estimated to cause approximately 30% less emissions in the manufacturing stage and 5–10% less emissions over the entire life cycle in Finnish conditions (e.g., Pasanen et al. 2012), though the impact depends on building designs, system boundaries, and other assumptions for the life-cycle assessment. The regulation of the energy efficiency of new construction is already very advanced, and the choice of materials has minor influence on energy efficiency; therefore, more attention will be placed in the future on the production and end-of-life stages of the life cycle (i.e., the emissions originating from the manufacture of construction products and their disposal) as well as reducing the operational energy demand of the existing building stock through renovation. This is thought to lend a competitive advantage for wood construction, among other low-carbon building designs.

Methods and Data

Data were gathered through semistructured interviews targeted to construction industry actors and experts with no prior experience in WMC. Semistructured interview was chosen as the most suitable method because it allows two-way communication between the interviewer and interviewee to explore also themes not originally considered by the researchers (Edwards and Holland 2013, Franzini et al. 2018). The main reason for the lack of studies involving nonwood actors in the assessment of wood value chains was hypothesized to be lack of interest or even opposition against WMC, so particular emphasis in the design of the survey was given to the wording for approaching the interviewees. The tone of the cover letter and survey itself was formulated to be as neutral as possible, with an emphasis on the changes in the operating environment of the construction sector, and with only a few direct questions related to wood construction. This allowed elicitation of responses that would portray either interest in the emerging prefabricated WMC practices or reasoning for possible barriers to innovation diffusion. However, to acknowledge the primary motive of the research, it was explicitly mentioned in the cover letter that the aim of the survey was to contribute to WMC literature specifically, which is currently dominated by the views of the actors from the wood value chain itself and which may lead to biased conclusions.

The selection of respondents was done by purposeful sampling. Initial searches of potential interviewees were carried out in the member database of the Confederation of Finnish Construction Industries. The search was limited to residential building, which returned 54 companies for

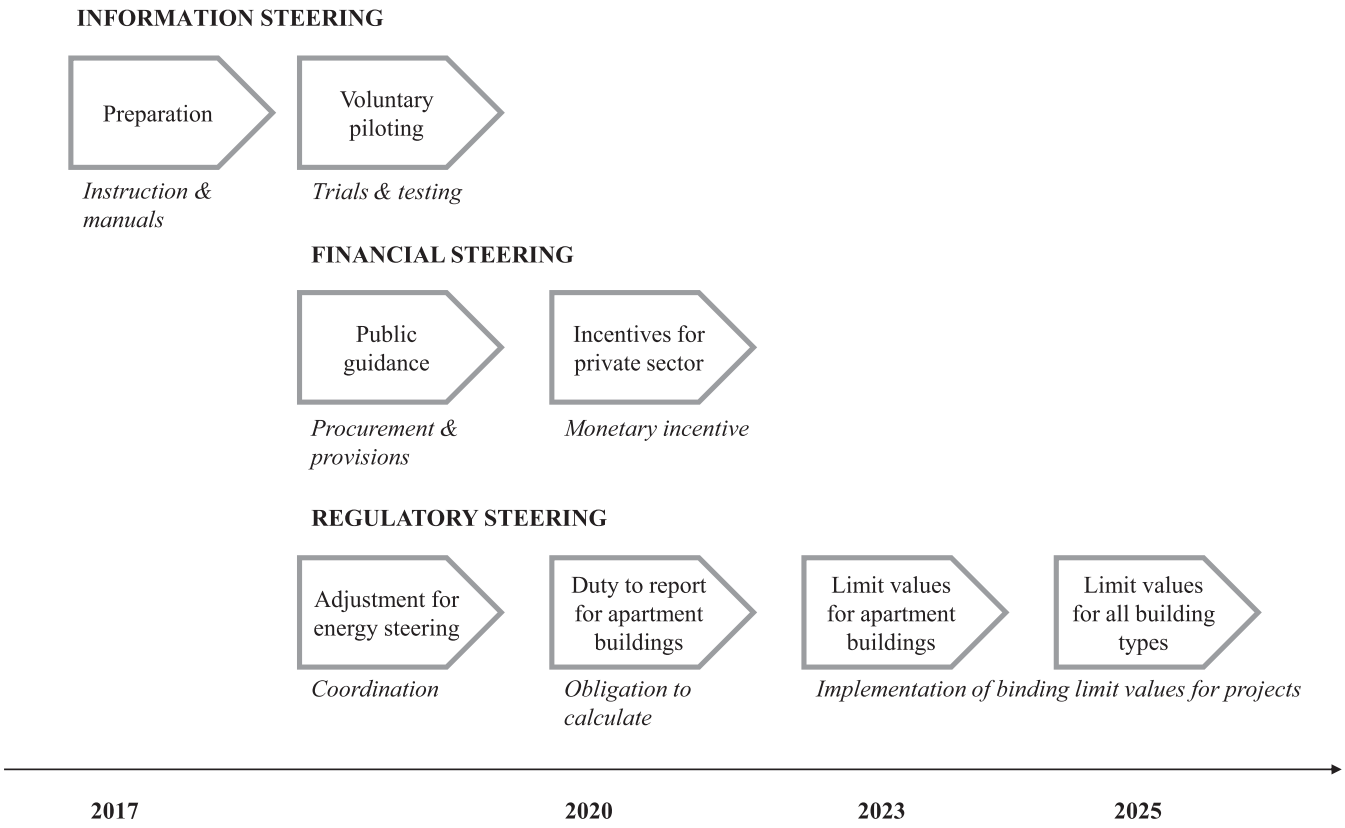

Figure 1.—Roadmap for low-carbon building regulation in Finland. Translated from Bionova (2017).

further sampling. First, companies currently involved in WMC and companies only active in single family building were manually excluded, by examining the companies' web pages for completed reference projects. Second, a final set of firms to be contacted was defined by including those that fulfilled at least one of the following criteria: (1) environmental values or sustainable development referred to in the company's mission, vision, values, or strategy; (2) completion of a Building Research Establishment Environmental Assessment Method, Leadership in Energy and Environmental Design [LEED], or other comparable sustainability-certified project; or (3) implementation of innovative processes or products in the area of the construction industry.

If no response was obtained after a phone call and two follow-up e-mail messages, the firm was excluded from the final sample. The final sample, characterized as a 'convenience' sample, consisted of 10 construction industry executives, managers, or people with an equivalent status mainly in areas related to procurement and production (Table 1).

The interview frame is given in Appendix 1. The frame consisted of three sections focused on productivity, environmental regulations, and expectations pertaining to WMC outlook up to 2030. In the final section, the respondents were asked to rate the probability of seven statements on a 5-point Likert scale. The statements were adopted from two previous studies (Röhr 2016, Toppinen et al. 2018), in which the WMC outlook was studied among Finnish and Swedish experts mainly from the fields of wood industry or forestry. This allowed direct comparison of the responses. For brevity, when making the comparisons we refer to 'wood actors' when it comes to the answers provided in Röhr (2016) and Toppinen et al. (2018) and 'nonwood actors' when it comes to the responses given in this study.

One test interview was carried out before the actual interviews, and is not reported in Table 1. The received feedback was positive in terms of the overall subject and questions. The only change that was made after the test interview was adding two additional statements to the questionnaire. The test interview results were only used in compiling Figure 2. Thus, the results in Figure 2 comprise 11 nonwood actor responses, except for the last two questions comprising 10 responses.

The interviews were recorded and transcribed to allow initial coding of the responses and extraction of quotes.

Table 1.—The sample of respondents. Respondents with identifiers 4 and 5 were from the same firm and were interviewed at the same time.

ID	Current position	Years of experience
1	Head of production	27
2	Production and development director	20
3	Area manager	34
4	Executive vice president	38
5	Area manager	30
6	Member of the board of directors	21
7	Environment and energy director	31
8	Technical director	25
9	Land acquisition director	32
10	Production manager	19

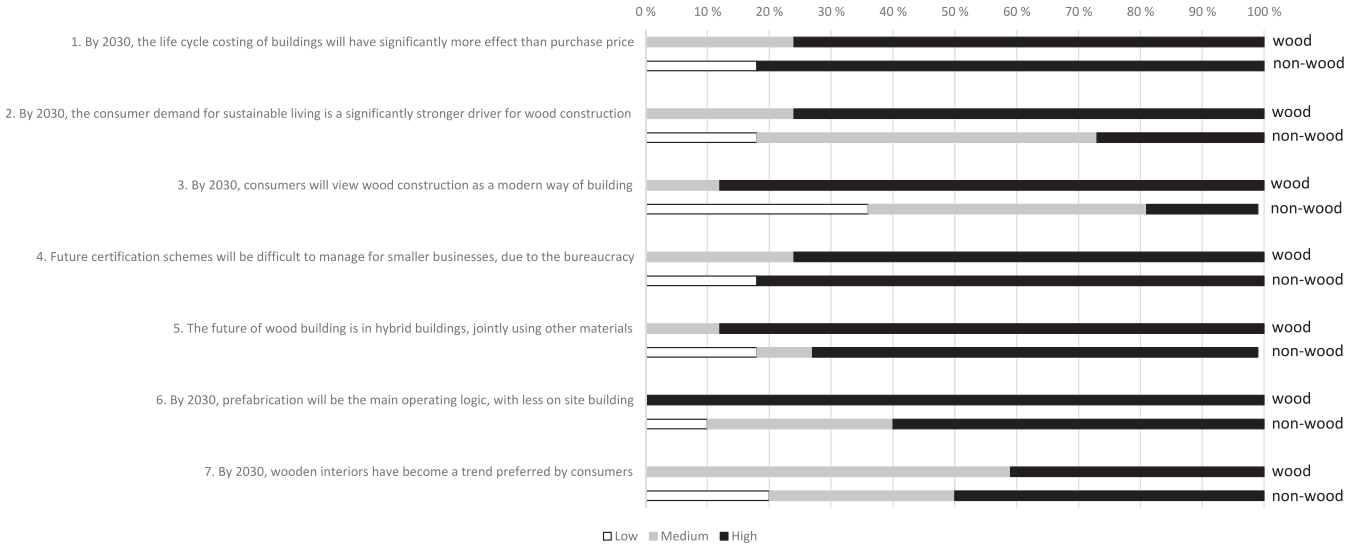

Figure 2.—Comparison of results of the statements of this study with the results of Röhr (2016) and Toppinen et al. (2018). The scale refers to the perceived likelihood of the statements (with 1 + 2 = low, 3 = medium, and 4 + 5 = high on a 5-point Likert scale). N*(wood) = 17;* N*(nonwood) = 11.*

Recording lengths ranged from 35 to 60 minutes. The data were analyzed by qualitative content analysis. The Likert-scale responses allowed calculation of summary statistics and direct comparison with the previous studies with a different set of interviewees.

Results and Discussion

Perceptions of productivity

Almost all respondents mentioned that the productivity growth in the construction sector has been lower compared with other industries. Overall, the answers related to productivity imply a wider scope of issues than labor productivity. Part of the stagnating productivity was thought to arise from increased regulation and bureaucracy. One respondent noted that different countries, or even cities, have different regulations, which partly explains the lack of global competition in the sector and was seen to restrict the development of company-wide standardization processes including manufacturing and project administrations (e.g., businesses based on prefabrication of construction product element). Thus, room for improvement exists despite a notable increase in the level of prefabrication:

> *''It has not been a ''glory story,'' but we have very much transitioned into industrial prefabrication nowadays; however, there is still much manual labor involved in different techniques as well.''* [ID 7]

> *''I would say that productivity has not risen at all, more like it has decreased. The reason being that bureaucracy, documentation, and all this type of red tape eats up a lot more resources than before. The administrative side in construction is being overemphasized nowadays [. . .] moreover, building techniques have not significantly changed from the '70s. Masonry is identical and concrete elements are practically the same as they were in the '70s.''* [ID 8]

Three respondents referred to the car manufacturing industry when discussing the theme of productivity, highlighting the lack of accumulation of knowledge in actor networks around a building projects:

> *''It is always discussed why automobile industry is so seamless, etc., but if you think that we have different locations, designs, 'planning orchestras,' and employees, then the construction company leading the project has nothing to do with the automobile industry, but are always in need of new solutions when a project is meant to be begun. You really cannot standardize it.''* [ID 5]

> *''Not every Mercedes-Benz is different. In practice, it is always the same car, so I do not understand why it is thought that the building must be always different. This is the largest obstacle that you cannot have two identical buildings where learning, manufacturing methods, or other would develop.''* [ID 8]

In line with the identified hindrances for productivity growth, these were viewed as addressable by developing better synchronization among the different parts of a building project, allowing more stories to be built, lessening bureaucracy, and allowing more freedom for standardization:

> ''*It could work as a driver that authorities would bit by bit give opportunities for some repetitive production [. . .] taking it further, we could use component technology to build an apartment*.'' [ID 2]

Perceptions of environmental regulation

In general, environmental aspects were not overly emphasized in business operations outside the legislative or regulatory regime. Environmental certificates were considered relevant only in the real estate sector, where investors drive the demand, although Finnish regulations were noted in many cases to be stricter than in international certification schemes. In contrast to the visible demand of the investor side, consumer demand for more environmen-

tally friendly solutions was not as visible in general for the respondents, with few exceptions:

> ''*The firm does not count on environmental matters as such yet. In commercial real estate business, however, investors give value for, e.g., LEED certifications [...], but in residential side there practically are no comparable concepts that could be used in a project-level*.'' [ID 2]

> *''When we look at our consumers, very few are willing to pay anything for energy-efficiency. We see that it actually comes from the regulatory side. The regulations are so tight and strict and they have become stricter every year, which makes the buildings so good on their own''* [ID 6]

A partial reason for the hesitancy to adopt metrics in addition to those required by law is the extra documentation required. This is not to say that environmental aspects are not considered or taken into account. On the contrary, many respondents approached the theme from a standpoint of efficient material use, recyclability, and energy efficiency perspectives. Although recycling is mandatory, efficient material use is a win–win situation for the companies because accurate calculations for purchasing materials minimizes purchasing costs and later recycling costs in tandem with minimizing waste. Energy efficiency also has been improved beyond the minimum threshold required by law.

The respondents were presented with the low-carbon construction roadmap (Bionova 2017). A few respondents had seen the figure before, with varying degrees of familiarity. The key issues that stood out when reviewing all the answers were related to the schedule, regulatory guidance, and calculation methods. The respondents who had previously been acquainted with the report emphasized the issues with quantifying the environmental impacts:

> *''We see that [the right way] is specifically in information and the figure's statutory steering of norms does not work. Frankly, it can lead to intentionally influencing free and fair competition, because life-cycle assessment is pretty much tinkering with parameters.''* [ID 7]

> *''This is not a new thought and of course carbon footprint is possibly somewhat problematic as there should be pretty clear rules of how it is calculated.''* [ID 1]

Thus, the general viewpoint was to oppose additional regulation and let the market determine what is needed. The respondents also raised the concern of costs, which the end-user will eventually carry:

> ''*I argue that this regulatory steering is the Achilles heel in Finland [...] If you ask this from building professionals or the building materials industry you'll get various opinions of which is actually better. Is it concrete or is it wood and they [lobbyists] both have really good arguments [...] the question is then that which one puts more money toward that they get more pleasant norms*.'' [ID 9]

> ''*I would preferably let the market steer this rather than begin forcibly do something on a regulatory level, which are not necessarily thought through*.'' [ID 6]

> ''*This will affect simply the price of the product. Building costs will increase*.'' [ID 10]

Rather than forcing compliance with regulation, the industry proposed easing some regulatory demands and zoning requirements or allowing other design liberties in exchange for a better environmental performance compared to baseline.

Future trends in wood-frame multistory construction

When we enquired about survey participants' perceptions of general trends in multistory residential building when looking forward to 2030, the most frequently mentioned trend was prefabrication. Additionally, some mentioned specifically that the trend would be in modular building. Only a few respondents made direct reference to wood construction as a trend, due to increased prefabrication:

> *''I would assume that firstly, industrial prefabrication will increase substantially [...] it would enable building modules in dry conditions, which would then be hauled sheltered on-site. Wood construction is probably the other [trend], because it is possible to reach reasonably strong, durable and yet relatively lightweight structures [...] It cannot be heavy concrete or steel stuff.''* [ID 3]

Other trends mentioned included digitalization, robotics, smart materials, further improvements in building information models (BIMs), focus on indoor air quality, urbanization, affordability, and energy efficiency. Some of the often-remarked-upon concerns included a shortage of labor, continued consolidation, and the effect of urbanization on apartment price level particularly in the capital region, which leads to the production of smaller sized apartments.

The respondents were presented with seven statements on a 5-point Likert scale. The statements were adopted from a previous study (Röhr 2016), which allowed direct comparison of answers between actors within and outside the wood-based-construction value chain (see Fig. 2), here referred to as 'wood actors' and 'nonwood actors.' Overall, one can observe similarities in the distribution of answers for the questions unrelated to WMC, but more dispersion for those addressing WMC. That is, the majority of respondents in both groups ranked the following statements as having a high likelihood: ''*By 2030, the life-cycle costing of buildings will have significantly more effect than purchase price*'', ''*Future certification schemes will be difficult to manage for smaller businesses, due to the bureaucracy*'', and ''*The future of wood building is in hybrid buildings, jointly using other materials*''. In contrast, the majority of actors in the wood value chain ranked the following statements as highly likely, while the majority of actors outside the wood value chain ranked them as medium or low likelihood: ''*By 2030, the consumer demand for sustainable living is a significantly stronger driver for wood construction*'' and ''*By 2030, consumers will view wood construction as a modern way of building*''. All wood-value-chain actors regarded the following statement as highly likely: ''*By 2030, prefabrication will be the main operating logic, with less on-site building*''. However, only 60% of the nonwood actors ranked it as highly likely, with the rest ranking it as medium or low likelihood. There was no major difference for the statement ''*By 2030, wooden interiors have become*

a trend preferred by consumers'', and only few nonwood actors regarded it as low likelihood.

The two statements that divided the two actor groups the most were also the ones that had the most ''neither agree nor disagree'' selections by nonwood actors. For the statement ''*by 2030, the consumer demand for sustainable living is a significantly stronger driver for wood construction*'', it was not disagreed upon as such, but rather this trend was seen to apply to other materials or building solutions as well:

> *''Environmental consciousness will definitely affect consumer demand and will it be driver for WMC, it can be that maybe, but it depends also to what direction WMC will go and what other solutions we will have, because there are other good options which we are not necessarily aware of.''* [ID 1]

> ''*It may be a driver for product development, but . . . it will drive all production equally . . . surely for WMC as well, but I think consumer demand . . . concerns everything*.'' [ID 2]

The statement ''*By 2030, consumers will see wood construction as a modern way of building*'' had the most answers of nonwood actors not supporting the view, with 36% ($n = 4$) considering it unlikely, although for different reasons. One respondent thought it is already a modern way of building. One mentioned that 2030 will be too soon for WMC to break through and become in that sense modern. Two respondents mentioned that WMC is not favorable when stories (i.e., height of building) increase:

> ''*Let's put it this way: it should not be mixed everywhere. There should be reserved own areas for it where they form an own ensemble, own neighborhood or something like that*.'' [ID 8]

For the statement ''*The future of wood building is in hybrid buildings, jointly using other materials*'', one respondent explicitly emphasized that it was better to favor one material in a project because whenever many materials are combined more contractors are at play, which may increase inefficiencies in production, and different behavior of material can lead to structural and quality problems. The source of general disagreement between wood and nonwood actors for this statement may also have partly arisen from a different definition of hybrid construction, as shown by this quote:

> ''*One example of this could be a building, where the frame could be concrete and facades from wood. There could be a large likelihood for that sort of hybrid construction*.'' [ID 8]

For the statement ''*By 2030, prefabrication will be the main operating logic, with less on-site building*'', the only opposing argument related to the adoption of modular building specifically, because prefabrication has been the main building logic for a long time in the form of using precast concrete.

When explicitly asked whether WMC actors are seen more as competitors or co-operators, the responses varied but the range of responses was inclined toward co-operation. The only opposing arguments related to the lack of experience and budgeting problems and the need for more detailed design requirements for WMC:

> *''We see it [WMC] as cooperative possibility without question, we just do not have a lot of experience with it yet''* [ID 1]

> *''Definitely a possibility [. . .] all of these forest industry companies have their own desire for ''we would do it this way'' and then they sort of do it the hard way. There is no comprehensive standard.'' [ID 9]*

> ''*I think it is all the same . . . from contractor's view it does not matter*.'' [ID 3]

> ''*It is not a threat nor a competitor. Every once in a while someone does a WMC and after that they leave it [at that]*.'' [ID 10]

Some respondents also questioned the benefits of WMC in the current state of evolution:

> *''I don't believe that even toward the year 2030 this WMC will substantially make progress. . .in Finland. The challenge in WMC is that I do not believe that you will find easily a construction company, which would be prepared to build a WMC for private buyers [. . .] the feedback from construction companies is currently that budgets have not realized, the buildings have not become any cheaper than concrete buildings and that they have not been built any faster than concrete buildings''* [ID 2]

> ''*If you could, e.g., halve the [construction] time with wooden panels, it would be 2 months from the [total] 14–16 months. We don't see that there is a huge relevance there. Moreover, the probability for errors increase fast . . . then the benefits diminish. So it is really not that much faster*.'' [ID 6]

Somewhat surprisingly, when asked about the market share development of WMC when looking forward to 2030, none of the respondents expected WMC to lose market share, and the maximum expected market share was up to 20%, as compared with currently around 5%. The respondents anticipated that further development in processes and cost structure should occur for a wider adoption of WMC:

> *''Not more than 20% of MC production volume. I predict that it will fluctuate in the range of 5–10%.''* [ID 2]

> ''*From a life-cycle view its carbon footprint is positive and advantageous in that way and it is a natural material, but it should also have a clear cost-advantage, which would be a driver that would boost it forward and currently that is not visible at least in my opinion*.'' [ID 1]

> *''If large construction companies will adopt the process so that it would become cost-competitive, because now it is not competitive regarding the price. This is why concrete is used*.'' [ID 4]

Study limitations and avenues for future research

The careful selection and invitation of respondents was given particular emphasis because of the difficulty of recruiting nonwood actors to participate in a study on

WMC. Although the case study does not allow generalizing the results to a wider population because of the limited sample size and inductive approach, the convergence of some of the responses indicates that it could be indicative of possible similarities and differences in opinion across a variety of wood and nonwood actors. Despite the efforts to formulate the interview invitations in as neutral a manner as possible, there is a possibility of a biased sample in that those with least interest in innovation might have purposefully ignored the invitation to take the survey. If a connection was successfully established, the acceptance rate for participating in the interview was high. Thus, the results open a systematic glimpse into the views of nonwood construction professionals on WMC, yet it remains unknown how these views compare with the average views within the sector.

More generally, the limitations of qualitative research relate primarily to the personal biases and skills of a researcher, the ability to rigorously process large amounts of data, and the lack of established modes of analysis (Anderson 2010). Even though the research process in itself is replicable, the data collection and analysis might lead to unidentical results depending, for example, on personal abilities and interpersonal skills of the interviewer. Moreover, the results leave some room for interpretation. For example, while the responses of wood actors and nonwood actors were similar to the Likert-scale question on the increasing relevance of hybrid construction, it could be that the actors' groups had different definitions for hybrid construction, not necessarily involving any usage of wood in structural frames.

Given the case study nature and the generic scope of the study, this type of study should be repeated in varying scopes and forms to allow more reliable conclusions (e.g., by applying the theory of planned behavior to elicit the intentions of nonwood actors in engaging in WMC; cf. e.g., Franzini et al. 2020). Future research could also address some of the most significant uncertainties identified in the study, such as whether it would be preferable for the construction sector to comply with the tightening environmental regulation by adopting available WMC practices or, for example, low-emission concrete or steel. Related to this, it remains unclear whether it would be preferable for the industry to perfect the current products and practices (e.g., through increased digitalization) or if there is a chance of adopting novel construction techniques to address concerns pertaining to productivity and environmental footprint. On the consumer side, the Covid-19 pandemic may have influenced consumer perceptions of housing in general; that is, more spacious apartments may become desirable in the long-term. Furthermore, future outlook and productivity of the construction sector could be influenced by labor shortages resulting from the ageing population and high demand for competent workforce across different fields.

Concluding Remarks

The study conducts—to our knowledge—the first survey focusing purely on the views of nonwood actors (i.e., construction company managers and executives in the areas of procurement and project planning with no prior direct experience in wood construction) as they relate to wood-frame multistory construction in Finland. The survey focused on the productivity of residential multistory construction, expected changes in the environmental regulation of new construction, and the outlook of WMC in Finland. This allowed comparison of the views of nonwood actors with the existing body of literature, with clear emphasis on the views of actors that are already active in the wood value chain. The research questions were as follows: (1) What are the perceptions of construction industry experts as relates to the productivity and environmental regulation for multistory construction in Finland? (2) How is the growth potential of wood-frame multistory construction seen by nonwood actors when looking forward to 2030? And (3), how do the perceptions and expectations of nonwood actors compare with those of the actors within wood value chains?

Firstly, almost all respondents agreed that the trend in productivity growth in the construction sector was sluggish. The project-driven nature of the industry was seen to inhibit obtaining the benefits of learning and standardization as compared with, for example, car manufacturing. Building more repetitive designs based on the individual firm's internal solutions is also hindered by land zoning, which is why WMC was not perceived as a cure, particularly without further standardization of the WMC practices. Thus, according to this study, rather than opposition to WMC as such, the lack of standardization and higher price were identified as the main barriers for WMC, which is in line with the findings of, for example, Gosselin et al. (2017), Hurmekoski et al. (2015), and Toppinen et al. (2019). That is, the standardization of WMC was not deemed complete enough even though this need had been recognized much earlier (Karjalainen, 2002, Ijäs 2013) and was still recognized very recently (Hurmekoski et al. 2018, Toppinen et al. 2019).

The results further suggest that the environmental impact assessment and management of residential construction in Finland is driven by regulation rather than the use of voluntary indicators, certificates, or consumer demand, unlike in the real estate business. The industry actors were familiar with the roadmap aiming to establish emission limit values by mid-2020s (Bionova 2017) and wished for more cooperation with regulators as opposed to lobbying to make certain solutions look more beneficial within the calculation framework to be adopted. That is, the nonwood actors emphasized the need for an objective calculation framework, which will be difficult to implement in practice because of various system boundary and allocation decisions involved in life-cycle assessment. To balance the perceived higher cost in implementing the roadmap, the possibility of regulatory relief in some other regard was brought up. That is, municipalities ought to act more as enablers than as a hindrance.

Secondly, apart from productivity and environmental regulation, some of the most frequently mentioned future trends when looking forward to 2030 included prefabrication, digitalization, and the impact of urbanization on housing costs, with WMC as such receiving only a couple of mentions. However, the results do not fully support a hypothesis of negative attitudes of nonwood actors toward WMC or co-operation with WMC actors. Instead, the views expressed by nonwood actors remained neutral with very little confrontation on the use of different materials. Interestingly, though the attitudes toward wood as a construction material seem to differ, both the wood and nonwood actors seem to regard the doubling of the market share of wood by 2030 as feasible.

Thirdly, when comparing the responses of wood actors in Toppinen et al. (2018) and nonwood actors in this study with statements on the future of construction and WMC, the results indicate similar expectations in statements regarding hybrid buildings, certifications schemes, and effects of life-cycle costing in the decision-making process. In contrast, the most notable differences in opinions regarded the statements concerning whether consumer demand for sustainable living would boost wood construction and whether consumers will view WMC as a modern way of building, with the nonwood actors rating these aspects as less likely. While acknowledging that this is a crude comparison that cannot be generalized beyond the 'convenience' sample, the views of nonwood actors on the role of WMC appear more varied.

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Appendix I.—Interview Frame (translated from Finnish)

1. How would you describe the productivity development of the construction sector in the past decades? How do you think that productivity ought to be measured?
2. What kind of development needs do you foresee to increase the productivity?
3. How do environmental viewpoints guide your business? Do you use specific indicators?
4. Please give 1–2 examples of how your firm has responded to environmental demands either from consumers or from regulation?
5. ''The Ministry of the Environment aims to establish new regulation on the lifecycle GHG emissions of construction by mid-2020s. The Ministry has commissioned a roadmap to reduce the carbon footprint of construction and particularly the production of construction materials and contribute to the climate targets of the construction sector. (Ministry of the Environment)'' Please see Figure 1. How do you foresee that this will influence your business?
6. Please mention 2–3 future trends for the construction sector toward 2030. Please justify your selection.
7. Please consider the following seven statements [print outs handed over] taken from a previous study (Toppinen et al. 2018). How likely do you regard the statements from a scale from 1 to 5, where 1 = small likelihood and 5 = high likelihood.
   (1) By 2030, the life-cycle costing of buildings will have significantly more effect on decision-making in large-scale building projects than purchase price.
   (2) By 2030, the consumer demand for sustainable living is a significantly stronger driver for wood construction.
   (3) By 2030, consumers will view wood construction as a modern way of building.
   (4) Future certification schemes will be difficult to manage for smaller businesses, due to the bureaucracy involved.
   (5) The future of wood building is in hybrid buildings, jointly using other materials, such as concrete and steel, where they bring the most benefits.
   (6) By 2030, prefabrication will be the main operating logic, with less on-site building.
   (7) By 2030, wooden interiors have become a trend preferred by consumers.
8. Do you regard wood-frame multistory construction more as a competitor or co-operator? In which areas would co-operation be justified?
9. How do you see the market share development of wood-frame multistory construction to 2030?