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The future of wooden multistory construction in the forest bioeconomy – A Delphi study from Finland and Sweden☆

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ABSTRACT

The rise of wooden multistory construction (WMC) in the Nordic countries has turned out to be the most evident construction-related new business opportunity in the emerging bioeconomy. Based on earlier literature, the future growth prospects for the rise of WMC are rooted in the concerns regarding environmental issues, as witnessed in a plethora of studies focusing on carbon footprinting. But do new (performance-based) regulations 'favor' WMC or do they give a more 'just' comparison of alternative building concepts? Therefore, more information is needed on the role of growing environmental awareness and preferences for wood as a renewable and recyclable material in the markets. Our paper presents results from a two-round Delphi study focusing on the relative strength and perceived interplay between likelihood and the desirability of environmental concerns in driving WMC in Finland and Sweden. Using qualitative analysis of expert interviews in the first Delphi round, the issues related to sustainable development appear to have growing importance in the marketplace. However, the panelists perceive that the emphasis on sustainability is mainly driven by the changing regulation reflecting societal needs, and only few experts saw it as echoing directly from changing individual consumer needs. In the second Delphi round, implemented with an online survey, the likelihood and desirability of sustainability as a megatrend in housing was perceived to gain further impetus toward 2030, both in the form of consumer demand for sustainable living and wood construction as a modern way of living. However, future research is needed to get a better understanding on the strength and scope of these drivers.

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Introduction

Sustainable construction is a way for the building industry to contribute toward sustainable development, where according to Bourdeau (1999, p. 364) the main challenge is "to transform the demand for sustainable development into an opportunity, to create and access new markets, and to innovative responses which satisfy traditional industry demands and the new societal demands for sustainable development". The building sector contributes to as much as 42% of final energy consumption, 35% of total GHG emissions, 50% of the utilization of extracted materials, and 30% of water consumption in the European Union (EU) (European Commission, 2011). Thus, construction and housing play a fundamental role when aiming at enhancing societal goals for sustainable development. For example, by developing the construction and utilization of buildings in the EU, it is claimed that the total final energy consumption could be decreased by approximately 40%, total greenhouse gas (GHG) emissions by 35%, and the use of building materials by 50%, respectively (Herczeg et al., 2014).

In recent years, the positive trend of the spread of wooden multistory construction (WMC) in the Nordic countries has turned out to be among the most interesting new business opportunities in the emerging forest bioeconomy. Also according to Bosman and Rotmans (2016), in the Finnish national level transition to bioeconomy, bio-built environment based on wooden buildings and the use of renewable construction materials is among the focal activities.

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The market share of wooden multistory apartments completed in Finland was only 1% in 2010, whereas the share had grown to 10% by 2015. In Sweden, local examples exist of strategic targets where even up to a 50% market share in WMC may be gained by 2020. Many reasons exist behind the increase of WMC in Nordic countries, but for Finland some studies (e.g. Hurmekoski et al., 2015b) mainly credit the increased popularity to a change in building regulations in 2011, which allowed the construction of WMCs up to eight stories high compared to the earlier three-story limit. Thus, in addition to environmental issues, changing building regulations are also bound to be one key driving force for the future of WMC.

According to Hurmekoski et al. (2015a), environmental impacts of construction practices are associated with material renewability and recyclability, as well as in the possibilities for contribution of the construction material choice into climate change mitigation. Recently macro objectives encompassing not only resource efficiency considerations, but also other significant environmental or functional performance aspects that have an influence on the lifecycle of buildings have been emphasized. While addressing sustainable development is a key topic in reaching the acceptability of solutions based on building and living with wood in the forest bioeconomy (Pätäri et al., 2016), in the background there is a larger environmental change in societal values toward sustainability and sustainable development. From this point of view, the relationship of environmental concern and consumer behavior regarding food, mobility, or general environmental attitudes can be useful in framing the research on the role of consumer lifestyle regarding sustainability (e.g. Autio et al., 2009; Maniatis, 2015).

The impact changes caused by construction and the utilization of buildings can be affected e.g. by the selection and transportation of raw materials and products in construction projects, along with the utilization of renewable energy during the usage of buildings to maintain the intended indoor climate and air quality (Häkkinen, 2007). The positive prospects for the rise of wood in multistory constructions lay in the concerns regarding environmental impacts and the long carbon storage option of wood, as witnessed in a plethora of life cycle assessment studies focusing on carbon footprints (e.g. Cabeza et al., 2014; Gustavsson et al., 2010; Upton et al., 2008). Improving material efficiency, which in WMC can be achieved through industrial prefabrication, is one of the key issues in construction, which affects global warming through reduced greenhouse emissions (Ruuska and Häkkinen, 2014). However, based upon a backcasting study, Hurmekoski et al. (2016) concluded that only more stringent regulatory push for green building, and the courage of wood element suppliers to take new roles in the construction value chain could effectively boost the further diffusion of WMC. Nevertheless, these authors were rather pessimistic that even the most effective measures could only have a gradual impact, and mainly through an increasing number of successful reference projects.

In previous WMC studies, Roos et al. (2010) found that architects and structural engineers in Sweden value wood because of its strength, environmental friendliness, easy handling, and appropriateness for use in conjunction with other materials. Hemström et al. (2011) assessed the perceptions, attitudes, and interest of Swedish architects in using wood frames in multistory buildings, and found that architects and contract managers also associate it with several disadvantages and uncertainties, primarily with respect to fire safety, stability, durability, and acoustic properties. In addition, contract managers were found to have stronger faith than architects in the prospects of wood frames. Richelieu and Kozak (2012) found, when studying the views of architects on using wood in the US for non-residential buildings, that several information requirements must be met to enhance the usage of wood in the markets, including design possibilities, regulations and standards, environmental footprints, and sustainable design. Regarding the changing trends in wood construction affecting the entire business, Wang et al. (2014) found in their study of the UK market that, as a part of the rise of the green building concept, the trend in wood construction increasingly includes the use of hybrid structures (e.g. combinations of wood and steel) or composites (such as wood and plastic).

According to Toivonen (2011, 2012), both consumers and construction material companies consider the environmental quality of wood to be important. In a study by Toppinen et al. (2013), elements related to the environmental sustainability of wooden products in housing, the social acceptability of products, and the esthetic characteristics of wood can all be associated with a distinct consumer lifestyle, consisting of a complex interplay between consumer backgrounds, values, and behavior. According to Toivonen and Hansen (2003), wood is additionally an attractive material compared to many other materials. However, environmental quality is typically not the main quality attribute driving consumers or organizational customers in their choice of construction materials. From the perspective of existing literature, only a few studies have directly linked the future of WMC to its key driver, i.e. changing societal values toward sustainable development, and the future perceptions of WMC value chain actors have scarcely been studied (see, however, Hurmekoski et al., 2015b, 2016; Wang et al., 2014).

Although the consumer perceptions of the environmental quality of wooden products can be identified and logical (Toivonen, 2012), the practical meaning of environmental attributes can still be vague for the majority of consumers. In a recent study by Hoibo et al. (2015) from Norway, younger people with strong environmental values were found to be the best target for increasing wood-based urban housing. The domestic origin of wood materials has been found to associate with environmental quality in Europe (Rametsteiner, 1998), and also in particular in Finland (Toivonen, 2012). Also in other contexts, the environmental quality of wood has been found to connect with consumer willingness to buy and even to pay premiums for products of higher environmental quality (Hansmann et al., 2006; O'Brien and Teisl, 2004). Overall, consumer knowledge probably is yet likely to be relatively low when it comes to building materials impact on human health (Keith, 2011).

To gain a better understanding on the role of perceived environmental sustainability and building regulations as the two driving forces for the future of WMC, we will study the value chain contexts in Finland and Sweden. These countries are of interest, not only because of their increasing shares of WMC, but also because of their national bioeconomy strategies strongly related to forests and the use of wood in construction. More precisely, a special focus of our study is on evaluating the perceived interplay between the likelihood and desirability of environmental value changes and regulatory factors in the context of WMC. Our two specific research questions are: (1) *How do value chain actors perceive the role of various environmental concerns when characterizing the sustainable future of WMC*; and (2) *What is the likelihood and desirability of sustainability-related demand and regulatory aspects for the future of WMC toward 2030*? Our study draws from a two-round Delphi study among Finnish and Swedish experts. Based on the analysis, we are able to more specifically point out potential pathways regarding the future development of WMC, and make more elaborate suggestions for future research needs in this emerging topic area within the forest bioeconomy.

Material and methods

Among various foresight approaches, the Delphi methodology has established a position as an effective tool for gathering expert opinions on a variety of problems in various domains under market and technology forecasting, especially in situations where expert

opinions and views are the only source of information (Blind et al., 2001). The use of Delphi approaches is also gaining more ground in forest economics to complement quantitative approaches, as pointed out by Hurmekoski and Hetemäki (2013). For example, Pätäri (2010) explored the future of forest bioenergy in the interface between the forest and energy industries. In a recent work aiming for packaging industry foresight, Olsmats and Kaivo-oja (2014) mapped the general trends and drivers, and evaluated potential future demands, opportunities, and threats for packaging. Sjølie et al. (2015) used expert information in analyzing the future development of Norwegian forest industry, finding that short-term shifts in economic and policy factors (such as lower emphasis on environmental issues and cheaper fossil fuels due to a prolonged global recession) may crucially impact respondent's assumptions concerning the significance of these factors for the forest sector in the future. Pätäri et al. (2016) used an industry expert Delphi panel to identify a greater demand for energy, volatility in the fossil fuel markets, and increasing material resource scarcity as the most significant sustainability megaforces shaping the European pulp and paper industry until 2030. Nuutinen et al. (2016) studied the adaptation of the Finnish sawmill industry in the changing market environment and policies related to climate change mitigation to better understand the drivers of change and their possible interaction effects using various foresight methods.

Iteration, participant and response anonymity, controlled feedback, and group statistical response are recognized as the key characteristics of a Delphi study (Blind et al., 2001; Landeta, 2006). Some variants of the methodology, such as Policy Delphi or Argument Delphi, highlight the importance of finding reasons for dissensus rather than striving for consensus among the Delphi panelists. This appears to be particularly valuable in situations characterized with changing industry strategies and market environments such as in our study. One of the key benefits of the Delphi method is that it is both easy to use and practical (Hatcher and Colton, 2007), allowing us to bring together geographically dispersed experts at least during two iterative rounds. On the other hand, Delphi requires real commitment from the expert panel due to the expectations of being involved in multiple information gathering rounds. Also finding the experts may prove difficult, as solid relevant expertise is required from each panelist. Anonymity of the respondents allows argumentation beyond the roles of the panel members, and personal viewpoints can be brought up easily without group pressure (Linstone and Turoff, 2002).

Throughout the years, the Delphi method, along with many other foresight approaches, has faced a lot of criticism (e.g., Hung et al., 2008; Jiang et al., 2017; Winkler and Moser, 2016). According to Piirainen et al. (2012, p. 464), "ethics of futures studies, the nature of knowledge about the future, and futures methodology, which together contribute to the quality, validity and credibility of futures studies" have evoked discussions within the existing literature. As regards the Delphi method, the major critique has concerned the method's reliability and judgmental and forecasting accuracy, especially when long-term future is examined (Winkler and Moser, 2016, see also Lin et al., 2014; Parente and Anderson-Parente, 2011). However, it seems that much of this critique stems from the fact that there is some "greyness" in the technique (Hasson and Keeney, 2011) indicating that the method is quite flexible and there are no strict general guidelines on how to conduct an overall Delphi process (Wakefield and Watson, 2014; Winkler and Moser, 2016). For example, one may question what is the right sample size or sampling technique. The flexibility of the approach in general does not however mean that a carefully planned and executed Delphi study would not be scientifically respectable (Hasson and Keeney, 2011). Like Jiang et al. (2017, p. 2), for example, have put it, the key idea of forecasting is to "facilitate a discussion among decision makers and topical experts to better understand the trajectories and possible futures". Thus, instead of providing accurate descriptions of the future and indisputable facts, foresight approaches inform thinking and help in anticipating future developments especially in situations where objective factual data does not exist (Hasson and Keeney, 2011; Jiang et al., 2017; Winkler and Moser, 2016).

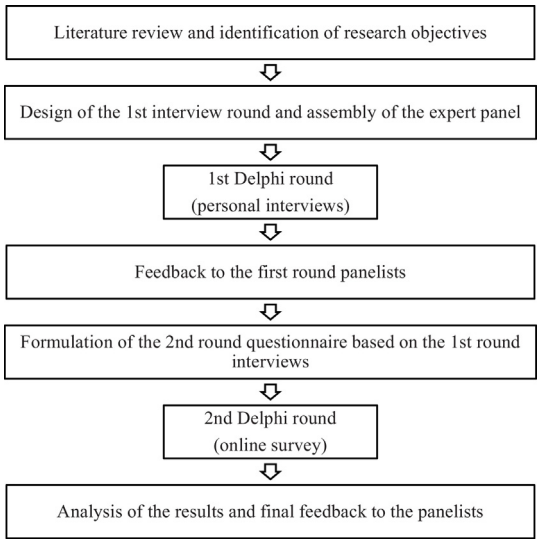

Fig. 1. Stages of data collection and analysis.

To feed on our two research questions, we conducted a dissensus-based expert Delphi study consisting of interviews (Round 1) and an online survey (Round 2). The time scale of the study was targeted toward year 2030, which is a suitable length (15 years) for this method. Additionally, 2030 is a target year in several EU and international policy agendas, including a European-wide goal for reaching a 30% rise in wood construction (for more discussion, see Hurmekoski et al., 2015b).

In order to study the experts' insights and ideas of the future development of wood construction, the panelists involved in our study were of Finnish and Swedish origin, and were required to have in-depth knowledge and experience of the usage of wood in multistory construction in the Nordic region. In Delphi rounds 1 and 2, the WMC value chain was broken into (1) forest ownership and raw material purchases, (2) wood products industry and primary processing, and (3) building industry. Thus, this study has excluded for example consultants and architects. Also, the main goal in gathering the panel was to gain access to industry stakeholders. We made an effort to ensure sufficient and diverse expertise in the panel, but encountered some difficulties in finding experts for the personal interviews with the targeted high level of professional background for our study on the future of WMC.

A total of 18 experts were interviewed in round 1 during October–December 2015, and 17 responded to our round 2 online survey in January 2016. As an exception to this, two panelists participated only in round 1 and one panelist only in round 2, as shown in Table 1. Thus, only two out of 18 interviewed panelists did not reply to the second round online questionnaire, which indicates respondents' level of commitment to the study. Despite our best efforts, the panel is more of Finnish origin (12 versus 7), male-dominated (16 versus 3), and the highest number of panelists represent the mid-category of the value chain (Group 2 of the wood industry experts). As can be seen, 15 of out of 19 experts had over ten years of experience from either the forestry, wood industry or construction sectors, and acted in leadership or high professional expertise positions, which improves the validity and reliability of our results.

Fig. 1 elaborates the research process initiated by a careful literature review and formation of the expert panel. Round 1 consisted of

Table 1
Composition of the Delphi panel.

Country	Gender	Years of professional experience	Profession	Type of organization	Participation in rounds
Finland	Male	14	Senior Vice President	Wood industry	1 and 2
Finland	Female	22	Director of CSR	Wood industry	1 and 2
Finland	Male	31	Managing Director	Forestry	1 and 2
Finland	Female	1	Executive	Building Industry	1 and 2
Finland	Male	16	Owner	Forestry	1 and 2
Finland	Male	15	Research Manager	Forestry	1 and 2
Finland	Male	3	Field manager	Forestry	1 and 2
Finland	Male	26	Production Director	Building Industry	1 and 2
Finland	Male	5	Senior Vice President	Wood industry	1 and 2
Finland	Male	22	Sales Executive	Wood industry	1 and 2
Finland	Female	16	Planning Executive	Building Industry	1 and 2
Finland	Male	23	Managing Director	Wood Industry Association	1
Sweden	Male	21	Senior Advisor	Forestry	1 and 2
Sweden	Male	15	Managing Director	Wood industry	1 and 2
Sweden	Male	11	Managing Director	Wood industry	2
Sweden	Male	11	President	Wood industry	1
Sweden	Male	17	Vice President Market Development	Forestry	1 and 2
Sweden	Male	12	Academic expert	Building Industry Expert	1 and 2
Sweden	Male	8	Sales manager	Wood industry	1 and 2

personal interviews, and the qualitative data were analyzed using thematization. The interviews addressed overall state of the forest industries, end-use markets, sustainable development, raw material markets, and structure and cooperation of the value chain. In the second Delphi round, the emphasis was given to the themes and topics that were seen as the most thought provoking or controversial in the first phase. For example, where the first round focused more on the raw material market, the second round comprised more of statements regarding the raw material in general, as the first round showed that the respondents were more vocal and interested in the raw material itself rather than the markets for it. Similarly, the statements regarding the current state of the industry were kept to a minimum, as the key focus of the study was in the future of WMC rather than on its current state.

The personal interviews in round 1 lasted from 30 min to more than an hour, and were conducted either face-to-face or by telephone, depending on how each expert was encountered. A summary of the findings from round 1 was sent as feedback to the respondents before sending them a link to the online questionnaire in the second round, approximately a week later. After preliminary processing of the results from the first round, feedback was given to the panelists by summarizing the key findings of the Delphi results, and also thanking the panelists for their active participation in the Delphi process and reminding them about participation in the forthcoming second round survey. The second round questionnaire was formulated based on the most important issues that emerged during the first round, along with areas needing further clarification. The second round was more structured and consisted of 42 statements with a 5-point Likert scale. A few open-ended questions were additionally used (see Röhr, 2016).

While both first and second round questionnaires (full content available upon request from the authors) consisted of five themes, our analysis here focuses on one major section of sustainability-related issues, although some general market environment and industry strategic issues were also interlinked with these. As regards the sustainability, we were interested in finding commonalities and differences regarding the experts' perspectives on sustainability, and to shedding light on topics that the experts discussed when generally asked about sustainability within the context.

In Delphi studies, and especially in situations characterized with high requirements for an in-depth level of expertise, the composition of the expert panel is more vital than its size. Moreover, the data collected during the personal interviews in the first stage saturated to a large extent, and the findings are therefore likely to represent a sufficient body of information for the analysis of the two research questions at hand. Nevertheless, it is important to keep in mind the limits to the generalizability of our findings, and for example, no comparison across the two countries can be made, mainly due to the limitations in panel composition and its background characteristics and the qualitative nature of our analysis.

Results of the Delphi rounds

Round 1 personal interviews

Sustainability is a very broad topic, which can be discussed e.g. from the viewpoints of its various dimensions (e.g. environmental, social, cultural, and economic), or by the level of various decision-making bodies (e.g. society, organizations, individuals) (for linkages to construction and living, see e.g. Hodge, 1997). In our study, sustainable development/sustainability was approached with a rather wide angle and during the interviews we were not aiming to provide an exact definition of the term. The goal was not only to find commonalities and differences in perspectives among the panelists on sustainability issues, but also to shed light on which topics the interviewees discuss when generally asked about sustainability.

Overall, the conversations showed that climate change -related regulation and general attention to these matters was seen as the main driver for the growing popularity of the WMC. For the most part the discussions were only concerned with the environmental aspects of sustainability, although one interviewee did discuss social aspects as well. However, this panelist talked about employee safety as a topic that used to have greater importance in the WMC value chain. The effect of WMC on both biodiversity and climate change were identified, but for the most part, the panelists saw potential in the aspects related to climate change and overall 'greenness' of the WMC. One panelist stated that wood building in general is a positive matter in terms of carbon storage for consumers most concerned about climate change, whereas those concerned about biodiversity might not positively view the wood-based construction industry. Coherence of regulation and a range of existing environmental policies driving societal sustainability was not elaborated in more depth at all. This was slightly unexpected, but perhaps simply associated with the practical or professional orientation of our experts.

All interviewees viewed sustainability as an area that was either already important, or at least growing in importance, but the under-

lying cause of this importance was an area in which the panelists held differing views. When enquired about how the environmental consciousness of consumers affects the industry, some considered there to be an effect, whereas others saw institutions, such as governments and NGOs, as drivers for the demand for more environmentally friendly products. However, due to the nature of the construction industry overall, the end users and their views were seen to only have marginal importance in the construction planning process. Several panelists did consider the consumer demand for green building to be growing, and possibly having more importance in the future, as the following example shows: "*It just may be that the demand from consumers will direct our actions more in the future. – This is important to younger people*" (***Sustainability executive from a wood industry company, 22 years of professional experience, Finland)***

More skepticism toward sustainability as a driver was identified by the interviewees working in the building industry. One of them perceived green building certificates merely as a tool to 'keep property owners calm', while another one stated that they 'only build green because that is what they personally wish to do', and a third one observed that 'environmental aspects are merely an undercurrent, and that quality and esthetics matter the most'. The decision regarding which projects are undertaken depend on the end user and their willingness to pay for certain aspects of a building, at least from the perspective of the builder. This is elaborated by the following quotes: "*It begins with the consumer, what the consumer is willing to pay for is what we will do*" (***Executive from a building company, 26 years of professional experience, Finland)***; *and "I wish to believe that consciousness is growing through positive things. – Being ecological in combination with comfort [of living] will create pleasure."* (***Executive from a building company, 1 year of professional experience, Finland)***

The most potential aspect linked with sustainability was seen as stemming from the ecological nature of the wooden building material. Very few panelists believed this potential to currently be well captured in WMC marketing and communication, while others explicitly observed that it is not utilized sufficiently. For example, two panelists blamed the wood processing industry for not using [forest] certificates more effectively as a sales tool. One panelist saw sustainability as a competitive advantage of WMC, but only after technical building requirements are first met, and once wood-based solutions in construction are placed at the same level as alternative materials in terms of competitiveness. The following quote illustrates this stance: "*It [sustainability] is something that will help us surpass [other materials]) if we can get to the same level in terms of competitiveness and technical knowhow.*" (***Executive from a wood industry company, 5 years of professional experience, Finland)***

Overall, panelists expect the importance of sustainability and the use of green building schemes to grow in the future, as well as offering potential for spreading WMC. The main issues were concerned with how to capitalize on sustainability in the marketplace. Some panelists believe the wood industry itself is incapable of building successful products that utilize positive environmental aspects to their advantage. Some interviewees perceived that the positive effects that WMC has on the issues discussed under the sustainability umbrella are taken for granted within the industry itself. Others perceived with some arrogance that 'the end users do not properly understand sustainability, or that it is only a small part of the decisions that go into the process of choosing housing'. One Swedish panelist felt that 'there are too few positive examples that could build consumer understanding'. At the very extreme, some panelists were sceptical about whether consumers are actually willing to pay anything for sustainability, as the quote below demonstrates: "*It [the choice of material] is only a discussion about price*" (***Sales manager for a wood industry company, nine years of professional experience, Sweden).***

In a few cases, locally produced food was seen as one channel toward improving consumer alignment with sustainable living. This was brought on by the growth of environmental awareness based on everyday choices, as elaborated by an interviewee: "*. . .a more natural way of living, such as locally produced food, a certain kind of lifestyle., . . . for these people, wood has a certain status.*" (***Academic expert, 12 years of professional experience, Sweden***), and "*I think sustainability will enable a stronger local industry. Swedish milk is one example, as it is almost sacred to consumers, and it is somewhat similar as the wood industry operating with low margins. If we don't find support for local products, then we are drying out the industry.*" (***Executive at a wood industry company, 15 years of professional experience, Sweden)***

To sum up, the growing interest in sustainability was seen to emerge as a major market opportunity for the wood and wood-building industries. However, the main difference between the views of panelists was regarding where and through which mechanisms this potential could be transformed from an interest into a viable business, as clearly summarized by the following quote: "*There is a difference between interest and when it [the importance of sustainability] actually happens. . . But the direction is toward more green building, and it is the future.*" (***Field manager at a forestry organization, three years of professional experience, Finland)***

Round 2 online survey

Sustainability-related aspects in the WMC were further evaluated in Round 2 by elaborating both the likelihood and desirability of ten statements (the rest of the Delphi survey is not reported here, but the reader is referred to Röhr (2016). Most of the statements in Delphi Round 2 were based on issues commonly raised in the Round 1 interviews. As very little spontaneous speech occurred concerning regulatory aspects around sustainability, these were not emphasized in more depth during the second stage of our study. In addition, some new issues raised by only a few panelists in Round 1 were also taken into account, as they opened up possibilities for more general reflection.

According to the breakdown of responses in Table 2, the sustainability aspects were expected to increase significantly in importance toward 2030. In general, the desirability aspect was given a higher value than the likelihood of its occurrence, indicating the role of uncertainty in the external market environment.

Overall, the panelists considered it both highly likely and desirable that consumers of 2030 will be driven by the aim to find more sustainable solutions for housing. However, there still appears to be room for sustainability to grow as a driver of purchasing decisions regarding housing, and this avenue as a selling argument was seen as very desirable among the industry professionals. Regarding statement "*By 2030, the life cycle costing of buildings will have significantly more effect on decision-making in large-scale building projects than purchase price*", the panelists fully agreed that it is desirable and its' likelihood was also very high (76%). This topic was already discussed in Round 1, and it appeared to cause diverse opinions as some respondents felt that it is currently difficult for wood to compete on a purchase price only. The main channels through which the competitiveness of wood material -based building solutions could increase in the future were growing consumer demand for sustainable living and the emergence of wood construction as a modern way of living. A regulatory environment was also seen as a necessary factor for creating favorable development in the building sector, e.g. via the emergence of hybrid building material -based solutions.

Regarding building certification, and specifically the complexity of future schemes, an issue raised by a couple of respondents in Round 1, a clear majority (76%) of the panelists felt that the bureaucracy involved in the certification schemes will be difficult to

Table 2
Likelihood and desirability of the WMC toward 2030. Scale: low 1–2, medium 3, high 4–5 on the 5-point Likert scale.

Statement		Likelihood (%)	Desirability (%)
By 2030, the consumer demand for sustainable living is a significantly stronger driver for wood construction	Low	0	0
	Medium	24	12
	High	**76**	**88**
By 2030, consumers will view wood construction as a modern way of building	Low	0	0
	Medium	12	6
	High	**88**	**94**
By 2030, the housing regulation has become more suited for large-scale wooden buildings	Low	6	6
	Medium	35	0
	High	**59**	**94**
By 2030, the life cycle costing of buildings will have significantly more effect on decision-making in large-scale building projects than purchase price	Low	0	0
	Medium	24	0
	High	**76**	**100**
By 2030, most building renovation in urban space will involve wooden building solutions	Low	0	0
	Medium	29	18
	High	**71**	**82**
By 2030, large-scale wooden construction, such as wooden multistory building projects, has become the most important segment within wood construction	Low	12	0
	Medium	29	29
	High	**59**	**71**
By 2030, sustainability has become a megatrend in the housing market	Low	0	0
	Medium	29	6
	High	**71**	**94**
The future of wood building is in hybrid buildings, jointly using other materials, such as concrete and steel, where they bring the most benefits.	Low	0	0
	Medium	12	24
	High	**88**	**76**
Future certification schemes will be difficult to manage for smaller businesses, due to the bureaucracy involved	Low	0	**65**
	Medium	24	18
	High	**76**	18
The importance of wood as a construction material will be mainly based on its environmental impact	Low	24	**41**
	Medium	35	24
	High	**41**	35

manage for smaller businesses in the future. In fact, no respondent considered this an unlikely future. Simultaneously, 65% of respondents felt this future to be either undesirable or very undesirable. The last claim in Table 2 "*The importance of wood as a construction material will be mainly based on its environmental impact*" received highly varying responses. As the question discussed below regarding environmental impact vs. personal health suggested, the health issue was seen as a stronger driver when only these two choices were presented.

The discussion concerning the main reasons why an end user would prefer living in a wooden building was something that was frequently approached during the Round 1 interviews. To further highlight this topic, Round 2 included a specific question that was aimed at understanding more of the two alternative marketing viewpoints: "*Which of the following do you see as the main rationale for consumers to choose living in a wooden building: A. The building is environmentally friendly* or *B. The building has significant health benefits in comparison with other alternatives*". Based on interviewee responses, personal health benefits surpassed generic environmental benefits as the main rationale for choosing wood over other possible materials in housing (see Fig. 2).

Based on Fig. 2, environmental aspects appear to be a more important choice criteria amongst the professionals identified as mid-category wood-industry processors: four out of six panelists identified it as their main rationale. The majority of panelists, identified as forestry professionals and representatives of the building industry, assumed consumer rationale for choosing a wooden building to be "the health benefits arising from wood"-argument. Due to the small number of panelists, the insights in Fig. 2 are naturally just indicative and the topic deserves further research.

Discussion

Sustainable development is a key topic in reaching the acceptability of bioeconomy in the forest sector and in society in general. Despite this, quite limited understanding exists on the interlinkage between environmental sustainability and building regulations as driving forces for the future of wood use in the multistory construction business, which due to the long-standing role of building as a carbon storage is a core for developing sustainable forest bioeconomy. As environmental attitudes in society tend to develop through increased knowledge and even experienced discomfort and harm from environmental problems, it is also foreseen that in the future a greater proportion of consumers is likely to seek more environmentally friendly alternatives in housing. Regarding all these aspects, wood material in modern urban construction has some definitive advantages, which has become visible especially among younger consumer segments (see Hoibo et al., 2015). Our study has aimed at eliciting some new insights on the future of WMC based on a Delphi approach conducted among value-chain actors in Finland and Sweden, two Nordic countries in the forefront of advancing forest bioeconomy.

This background gives rise to our first research question: *How do value chain actors perceive the role of various environmental issues to characterize the sustainable future of WMC*? Overall, based on the results of Delphi Rounds 1 and 2, most panelists perceived the importance of the issues related to sustainable development to play an increasing role in the housing market, but it was not clear to what extent this would be originating from recognition of actual end user needs. According to the panelists, the growing emphasis of wood as a sustainable building material in WMC is mainly driven by changing building regulation, and only a few of them voiced it as echoing from changing more sustainability-oriented consumer values. It also became quite evident that the panelists with dominantly practical professional backgrounds wished for a favorable regulatory environment toward 2030 to enhance positive development for the use of wood in the multistory building sector. Despite this, the actual uptake of wood in multistory construction could still take considerable time and effort (see also Hurmekoski et al., 2016), and happen, for example, via the emergence of hybrid building material-based solutions (Wang et al., 2014). Coherence of building regulations, such as the mismatch between topical energy

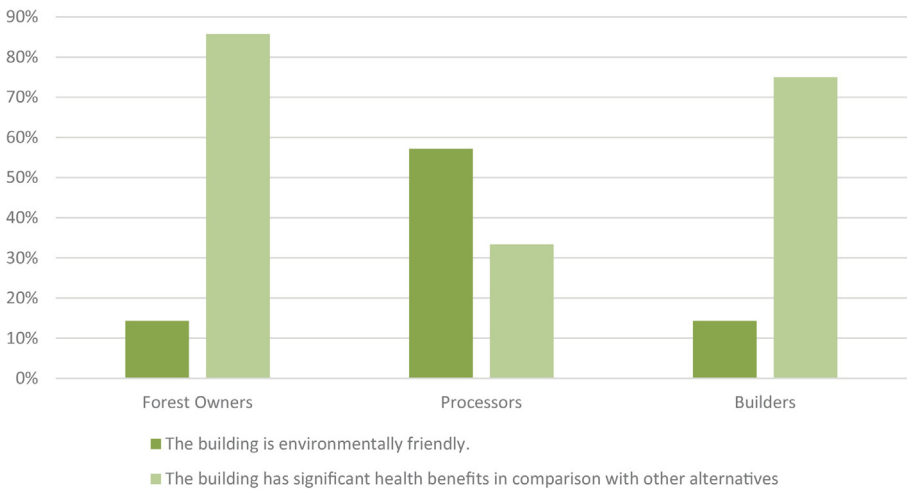

Fig. 2. Assumed main rationale for consumers to choose between alternative benefits arising from WMC.

efficiency questions and the role of buildings as a long-standing carbon storage, were examples of issues not discussed in Round 1, possibly due to panel composition including a rather limited input from e.g. the competing concrete based building sector.

Regarding our second research question of What is the likelihood and desirability of sustainability-related demand and regulatory aspects for the future of WMC toward 2030?, our Round 2 results confirmed the weight of perceived likelihood of sustainability-driven WMC to be lower than the desirability of the foreseen development. However, the panelists saw it as both highly likely and desirable that consumers in 2030 will be increasingly driven by the aim of finding sustainable solutions for housing. In parallel, as mentioned, there was a high uniformity that a favorable regulatory environment "pro-wood" is also needed to create positive development in the WMC sector. When it comes to health issues and materials used for housing, consumers may have limited knowledge (Keith, 2011), while increased use of fire sprinkler systems in buildings is an issue of concern. There was also some indication that higher age panelists are more skeptical on whether consumers are actually willing to pay for higher level of sustainability in housing per se. This could reflect the traditional (or conservative) mind-set of our panelists with on average over 15 years of professional experience in forestry-wood-construction – value chain. However, our data was not sufficient to dwell this issue any further.

Our findings are somewhat in line with earlier consumer studies on generic wooden construction materials in the Nordic context. For example, Roos and Nyrud (2008) found that "green" consumers for Swedish and Norwegian DIY-markets for flooring and decking were more often women, had a higher level of education, and preferred items with product warranties. According to Toivonen (2011), consumers e.g. relate domestic origin as an interlinked attribute with the environmental quality of (wooden) products. Holopainen et al. (2014) found consumers of the Finnish outdoor decking market to associate their needs to acquire more information with environmental effects of wooden products to social aspects of sustainability, including legal origin and employee responsibility. These results point out that there is a segment of consumers associated with a sustainability-oriented lifestyle (such as LOHAS categorization, see e.g. Beltz and Peattie, 2012 or Häyrinen et al., 2016 in the context of forestry), and is likely to grow in the future. This would be in line with our results where sustainability-related concerns are more commonly brought up among younger age panel members.

Environmental and environment/human health -related wood product characteristics are currently gaining growing attention in consumer decision-making (see for example Burnard and Kutnar, 2015, Keith, 2011). This trend is supported by an increasing general interest in personal health and environmental problems already being of major scale in many heavily populated regions around the world. However, there is still likely to be a gap between sustainability-related attitudes and behavior regarding wooden products even among younger generation in the Nordic countries. Thus, one important road for future research would be to analyze in more detail how consumers actually decompose the multifaceted concept of sustainability around WMC, and to study how they value the various aspects of sustainability in connection with their personal housing and living decisions.

Interestingly, according to our study, one important channel to improve consumer alignment with sustainable living originated from locally produced food, and the growth of consumer environmental awareness based on these everyday choices. It would therefore be worthwhile for future research to more explicitly link the analysis of consumer behavior concerning wood and food products (e.g. Autio et al., 2009; Reisch et al., 2013), or of green products in general (Maniatis, 2015). Analysing sustainable construction not only from material choice point of view can be also worthwhile, for example including aspects related to social sustainability of production and consumption (see e.g. Toppinen et al., 2013; Wang et al., 2014).

Based on the observed few differences on how the future of WMC was perceived across the value chain stages, it would be interesting in future research to also focus on analyzing the future of WMC rather as a business ecosystem consisting of a richer network of actors than in our value-chain based set-up (Pulkka et al., 2016). Furthermore, various options for orchestrating new business model development (Brege et al., 2014; Lessing and Brege, 2015) should be further investigated. From this perspective, it would be necessary to draw evidence from practical examples on recent or on-going construction projects in certain locations to gather more specific and up-to-date understanding of the structure and functioning of the wood-based construction ecosystem in both countries and beyond them.

Finally, it is important to acknowledge that the Delphi approach has also received criticism and its reputation has been slightly tarnished due to examples from the literature where careless selection of experts, poorly formulated questions, or lack of time to carry out the study have taken place (for a review, see e.g. Landeta, 2006).

Therefore, we acknowledge that there would be scope in the future to combine various foresight approaches to build a more multi-faceted analysis of the future of WMC in the Nordic region.

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References

Autio, M., Heiskanen, E., Heinonen, V., 2009. Narratives of 'Green' consumers – the antihero, the environmental hero and the anarchist. J. Consum. Behav. 8 (1), 40–53.
Blind, K., Cuhls, K., Grupp, H., 2001. Personal attitudes in the assessment of the future of science and technology: a factor analysis approach. Technol. Forecast. Soc. Change 68 (2), 131–149.
Belz, F.-M., Peattie, K., 2012. Sustainability Marketing: A Global Perspective, second ed. Wiley, Chichester.
Bosman, R., Rotmans, J., 2016. Transition governance towards a bioeconomy: a comparison of Finland and the Netherlands. Sustainability 8 (1017), http://dx.doi.org/10.3390/su8101017.
Bourdeau, L., 1999. Sustainable development and the future of construction: a comparison of visions from various countries. Build. Res. Inform. 27 (6), 354–366.
Brege, S., Stehn, L., Nord, T., 2014. Business models in industrialized building of multi-storey houses. Construct. Manage. Econ. 32, 208–226.
Burnard, M., Kutnar, A., 2015. Wood and human stress in the built indoor environment: a review. Wood Sci. Technol. 49 (5), 969–986.
Cabeza, L., Rincon, L., Vilarino, V., Perez, G., Castell, A., 2014. Life cycle assessment (LCA) and life cycle energy analysis (LCEA) of buildings and the building sector: a review. Renew. Sustain. Energy Rev. 29, 394–416.
European Commission, 2011. Roadmap to a Resource Efficient Europe, COM/2011/571.
Gustavsson, L., Joelsson, A., Sathre, R., 2010. Life cycle primary energy use and carbon emission of an eight-storey wood-framed apartment building. Energy Build. 42 (2), 230–242.
Häkkinen, T., 2007. Assessment of indicators for sustainable urban construction. Civ. Eng. Environ. Syst. 24 (4), 247–259.
Hansmann, R., Köllner, T., Scholz, R.W., 2006. Influence of consumers' socio ecological and economic orientations on preferences for wood products with sustainability labels. For. Policy Econ. 8, 239–250.
Hasson, F., Keeney, S., 2011. Enhancing rigour in the Delphi technique research. Technol. Forecast. Soc. 78, 1695–1704.
Hatcher, T., Colton, S., 2007. Using the internet to improve HRD research: the case of the web-based Delphi research technique to achieve content validity of an HRD-oriented measurement. J. Eur. Ind. Train. 31 (7), 570–587.
Hemström, K., Mahapatra, K., Gustavsson, L., 2011. Perceptions, attitudes and interest of Swedish architects towards the use of wood frames in multi-storey buildings. Resour. Conserv. Recycl. 55 (11), 1013–1021.
Herczeg, M., McKinnon, D., Milios, L., Bakas, I., Klaassens, E., Svatikova, K., Widerberg, O., 2014. Resource efficiency in the building sector. Final report for DG Environment. ECORYS and Copenhagen Resource Institute, pp. 128, http://ec.europa.eu/environment/eussd/pdf/Resource%20efficiency%20in%20the%20building%20sector.pdf (accessed 15.08.16).
Hodge, T., 1997. Towards a conceptual framework for assessing progress toward sustainability. Soc. Indicat. Res. 40, 5–98.
Hoibo, O., Hansen, E., Nybakk, E., 2015. Building material preferences with a focus on wood in urban housing: durability and environmental impacts. Can. J. For. Res. 45 (11), 1617–1627.
Holopainen, J., Häyrinen, L., Toppinen, A., 2014. Consumer value dimensions for sustainable wood products: results from the Finnish retail sector. Scand. J. For. Res. 29 (4), 378–385.
Hung, H.-L., Altschuld, J.W., Lee, Y.-F., 2008. Methodological and conceptual issues confronting a cross-country Delphi study of educational program evaluation. Eval. Program Plann. 31 (2), 191–198.
Hurmekoski, E., Hetemäki, L., 2013. Studying the future of the forest sector: review and implications for long-term outlook studies. For. Policy Econ. 34, 17–29.
Hurmekoski, E., Hetemäki, L., Linden, M., 2015a. Factors affecting sawnwood consumption in Europe. For. Policy Econ. 50, 236–248.
Hurmekoski, E., Jonsson, R., Nord, T., 2015b. Context, drivers, and future potential for wood–frame multi-story construction in Europe. Technol. Forecast. Soc. 99, 181–196.
Hurmekoski, E., Pykäläinen, J., Hetemäki, L., 2016. Assessing long-term targets for green building: the case of Finnish wood-frame multi-story construction. In: Manuscript.
Häyrinen, L., Mattila, O., Berghäll, S., Toppinen, A., 2016. Lifestyle of health and sustainability of forest owners as an indicator of multiple use of forests. For. Policy Econ. 67, 10–19.
Jiang, R., Kleer, R., Pillera, F.T., 2017. Predicting the future of additive manufacturing: a Delphi study on economic and societal implications of 3D printing for 2030. Technol. Forecast. Soc. Change (in press).
Keith, K., M.Sc. thesis 2011. Dangerous decor: consumer knowledge of health risks within interior spaces. San Jose State University.
Landeta, J., 2006. Current validity of the Delphi method in social sciences. Technol. Forecast. Soc. Change 73 (5), 467–482.
Lessing, J., Brege, S., 2015. Business models for product-oriented house-building companies – experience from two Swedish case studies. Construct. Innov. 15 (4), 449–472.
Lin, V.S., Goodwin, P., Song, H., 2014. Accuracy and bias of experts' adjusted forecasts. Ann. Tour. Res. 48, 156–174.
Linstone, H.A., Turoff, M., 2002. The Delphi Method – Techniques and Applications., pp. 616.
Maniatis, P., 2015. Investigating factors influencing consumer decision-making while choosing green products. J. Clean. Prod., 1e14, http://dx.doi.org/10.1016/j.jclepro.2015.02.067 (online first version).
Nuutinen, T., Kärkkäinen, L., Toppinen, A., 2016. The future operating environment of the Finnish sawmill industry in an era of climate change mitigation policies. For. Policy Econ. (online first article).
O'Brien, K.A., Teisl, M.F., 2004. Eco-information and its effect on consumer values for environmentally certified forest products. J. For. Econ. 10, 75–76.
Olsmats, C., Kaivo-oja, J., 2014. European packaging industry foresight study – identifying global drivers and driven packaging industry implications of the global megatrends. Eur. J. Fut. Res. 2, 39.
Parente, R., Anderson-Parente, J., 2011. A case study of long-term Delphi accuracy. Technol. Forecast. Soc. 78, 1705–1711.
Piirainen, K.A., Gonzalez, R.A., Bragge, J., 2012. A systemic evaluation framework for futures research. Futures 44 (5), 464–474.
Pulkka, L., Ristimäki, M., Rajakallio, K., Junnila, S., 2016. Applicability and benefits of the ecosystem concept in the construction industry. Construct. Manage. Econ. 34, 129–144.
Pätäri, S., 2010. Industry- and company-level factors influencing the development of the forest energy business — insights from a Delphi Study. Technol. Forecast. Soc. 77 (1), 94–109.
Pätäri, S., Tuppura, A., Toppinen, A., Korhonen, J., 2016. Global sustainability megaforces in shaping the future of the European pulp and paper industry towards a bioeconomy. For. Policy Econ. 66, 38–46.
Rametsteiner, E., 1998. The Attitude of European Consumers Towards Forest and Forestry. FAO, Available from http://www.fao.org/docrep/x0963e/x0963e0a.htm.
Reisch, L., Eberle, U., Lorek, S., 2013. Sustainable food consumption: an overview of contemporary issues and policies. Sustain. Sci. Pract. Policy 9 (2), 7–25.
Richelieu, A., Kozak, R., 2012. Wood use in non-residential construction: an exploratory research of the roles of media and content in direct marketing. Wood Fiber Sci. 44 (4), 1–18.
Roos, A., Nyrud, A., 2008. Description of green versus environmentally indifferent consumers of wood products in Scandinavia: flooring and decking. J. Wood Sci. 54, 402–407.
Roos, A., Woxblom, L., McCluskey, D., 2010. The influence of architects and structural engineers on timber in construction – perceptions and roles. Silva Fenn. 44 (5), 871–884.
Ruuska, A., Häkkinen, T., 2014. Material efficiency of building construction. Buildings 4, 266–294.
Röhr, A., 2016. Building together – future of Nordic wooden multistory construction business. Master's thesis at University of Helsinki, Finland, pp. 86.
Sjølie, H.K., Bysheim, K., Nyrud, A.Q., Flæte, P.O., Solberg, B., 2015. Future development of the Norwegian forest industry, based on industry expectations. For. Prod. J. 65 (3–4), 148–158.
Toppinen, A., Toivonen, R., Valkeapää, A., Rämö, A., 2013. Consumer perceptions on environmental and social responsibility of wood products in the Finnish markets. Scand. J. For. Res. 28 (8), 775–783.
Toivonen, R., 2012. Product quality and value from consumer perspective—an application to wooden products. J. For. Econ. 18 (2), 157–173.
Toivonen, R., Academic dissertation 2011. Dimensionality of quality from customer perspective in the wood industry. Dissertationes Forestales 114, pp. 71, http://www.metla.fi/df114.htm.
Toivonen, R., Hansen, E., et al., 2003. Quality dimensions of wood products – perceptions of German organizational customers. In: Helles (Ed.), Recent Accomplishments in Applied Forest Economics Research, vol. 74. Kluwer Academic Publishers, Forestry Sciences, pp. 2019–2226.
Upton, B., Miner, R., Spinney, M., Heath, L., 2008. The greenhouse gas and energy impacts of using wood instead of alternatives in residential construction in the United States. Biomass Bioenergy 32, 1–10.
Wakefield, R., Watson, T., 2014. A reappraisal of Delphi 2.0 for public relations research. Publ. Rel. Rev. 40 (3), 577–584.
Wang, L., Toppinen, A., Juslin, H., 2014. Use of wood in green building: a study of expert perspectives from the UK. J. Clean. Prod. 65, 350–361.
Winkler, J., Moser, R., 2016. Biases in future-oriented Delphi studies: a cognitive perspective. Technol. Forecast. Soc. 105, 63–76.