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ARTICLE

Citizen views on wood as a construction material: results from seven European countries

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Abstract: Multi-story wooden buildings are hailed as a favorable means toward reducing the embodied energy of the construction sector. However, the sector's path-dependent nature hinders acceptance of using wood in multi-story construction. As a result, research predominantly focuses on examining the perceptions of construction professionals to identify means of breaking the path dependency. We propose using citizens' perceptions about the use of wood to inform professional decision makers. Our research thus aims to answer two questions: What are citizens' perceptions about using wood as a construction material, and are there country-based cultural differences between these perceptions? To elicit this spectrum of citizen views, an online survey was deployed in Austria, Denmark, Finland, Germany, Norway, Sweden, and the United Kingdom. Qualitative content analysis was used to analyze 6633 open-ended responses to the survey. Respondents held multi-faceted opinions about the physical properties, environmental, social, and economic aspects of using wood as a construction material. Citizens from Finland, Norway, and Sweden expressed discernably different perspectives about the acceptability of using wood than did citizens from Austria, Denmark, Germany, and the United Kingdom. Overall, respondents from all countries expressed high approval for the use of wood in construction.

Key words: citizen, end user, perception, multi-story wooden buildings, wood construction.

Résumé : Les bâtiments en bois multiétagés sont considérés comme un moyen favorable pour réduire l'énergie grise du secteur de la construction. Cependant, la nature conservatrice du secteur de la construction fait obstacle à l'acceptabilité de l'utilisation du bois dans les constructions multiétagées. En conséquence, la recherche s'est concentrée principalement sur l'analyse des perceptions des professionnels de la construction pour déterminer les moyens de rompre cet ancrage dans le passé. Nous proposons d'utiliser les perceptions des citoyens en lien avec l'utilisation du bois pour informer les décideurs professionnels. Cette recherche vise ainsi à répondre à deux questions : quelles sont les perceptions des citoyens par rapport à l'utilisation du bois comme matériau de construction et existe-t-il des différences culturelles propres à chaque pays entre les perceptions? Pour recueillir cet éventail d'opinions citoyennes, un questionnaire en ligne a été déployé en Autriche, au Danemark, en Finlande, en Allemagne, en Norvège, en Suède et au Royaume-Uni. Une analyse qualitative de contenu a été utilisée pour analyser les 6633 réponses au sondage basées sur des questions ouvertes. Les répondants ont des opinions diversifiées sur les propriétés physiques, environnementales, sociales et économiques de l'utilisation du bois comme matériau de construction. Les citoyens de la Finlande, de la Norvège et de la Suède évaluent l'acceptabilité de l'utilisation du bois en fonction d'aspects qui diffèrent des citoyens autrichiens, danois, allemands et britanniques. Dans l'ensemble, les répondants de tous les pays sont très favorables à l'utilisation du bois dans la construction. [Traduit par la Rédaction]

Mots-clés : citoyen, consommateur, perception, bâtiments en bois multiétagés, construction en bois.

1. Introduction

Buildings account for 39% of global carbon emissions; 28% are generated during a buildings' operational lifetime (i.e., operational carbon), with the remaining 11% released during manufacturing, transportation, construction, and end-of-life stages (i.e., embodied carbon) (World Green Building Council 2019). Efforts to reduce the environmental impacts of the building sector concentrate on reducing operational carbon, thereby increasing the need to reduce embodied carbon (see e.g., Koezjakov et al. 2018). One method of reducing embodied carbon is to reduce emissions from raw material production by substituting the carbon-intensive raw materials used in construction — such as concrete or steel — with wood (e.g., see Takano et al. 2015; Hildebrandt et al. 2017). Though using wood is common in single-story buildings, countries in both Europe and North America support the use of wood in multi-story solutions (Hurmekoski et al. 2018*a*). These solutions are dubbed "multi-story wooden buildings" (MSWB).

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Table 1. Consumer perceptions towards wood as a construction material from select previous studies.

Perceptions of wood as a construction material	Reference
A survey indicates that German consumers connected wood to well-being, nice appearance, and eco-friendliness. They also recall concerns toward fire safety, durability, and stability of wood as a construction material.	Gold and Rubik 2009
In Norway, consumers who preferred urban living preferred concrete and steel to wood. Concrete was perceived to be more structurally sound and durable than wood. Consumers who have experience of living in a wooden building are more likely to have a positive view about wood constructions.	Høibø et al. 2015
Just over half of the Australian consumers responding to the survey indicated concern toward the durability of wood, especially in the case of fire. Additionally, the respondents showed a lack of knowledge regarding the emissions and energy consumption of wood use in construction; wood was not perceived to contribute to the overall "greenness" of the building.	Kremer and Symmons 2016
American survey respondents found multi-story wooden buildings to be aesthetically pleasing, use renewable material, and create a positive and healthy living environment. On the other hand, they also believed MSWB to have greater risk for fire, require more maintenance and upkeep, and have shorter life spans than tall buildings made from concrete or steel.	Larasatie et al. 2018
Two types of Finnish consumers could be identified: (*i*) people who appreciate ecological and physio-technological benefits of wood as a construction material and (*ii*) people who appreciate the aesthetic and the well-being benefits of wood as a construction material. Regarding their prejudices against technological properties of wood (e.g., fire resistance), the two types of consumers differed from each other.	Lähtinen et al. 2019
In a comparing Swedish and German consumers, it was found that Germans emphasized the importance of environmental issues (most importantly, energy savings) in MSWB. This was not be found to be so important in the perceptions of the Swedish respondents. The Swedish respondents, on the other hand, regarded MSWB to cause higher construction costs, which was a financial disadvantage.	Schauerte 2010*a*
Focus group discussions in Austria, Finland, France, Norway, and Sweden found that professionals and laypeople have mostly positive perception about wood use in interior applications. Wood was regarded to provide improvements in ambiance, air quality, and soundscape. The study connected these perceptions to wood's physical properties, for example, perceived improved indoor air quality and wood's hygroscopic properties. The results are similar across the studied countries.	Strobel et al. 2017
Based on homeowner interviews before occupancy and after 1 year of habitation in a Finnish multi-family wooden building, the study indicates the importance of considering the everyday usability of wooden homes. Communicating sustainability and physical properties of wood is suggested to be done by connecting them to issues that are more meaningful to the end users' daily lives, such as pleasant ambiance and nostalgic aspects of living in wooden buildings.	Viholainen et al. 2020

MSWB are a class of high-rise buildings with two or more floors and structural load-bearing frames composed primarily of wood products (Hurmekoski et al. 2018*b*). MSWB provide opportunities for renewability, recyclability, and carbon storage that multi-story buildings of other frame materials do not (e.g., Hurmekoski et al. 2015; Liu et al. 2016; Santi et al. 2016). In addition, wood construction technologies enable industrialized prefabrication — the off-site manufacturing of construction elements and components. This practice can increase material efficiency (Ruuska and Häkkinen 2016) throughout various construction phases (Brege et al. 2014) and enables the meeting of the ever-increasing global need for affordable dwellings (e.g., Rhee 2018). In light of such opportunities, MSWB were declared one of the housing megatrends of the near future (Toppinen et al. 2018).

However, despite its many advantages, wood is an uncommon material in multi-story building construction (Gosselin et al. 2017). This is largely because the path-dependent culture of the construction sector favors well-established traditional materials, namely concrete and steel (see e.g., Mahapatra et al. 2012; Hurmekoski et al. 2015). A large body of research investigating MSWB has thereby focused on the outlook of professionals in the construction sector (Gosselin et al. 2017) who possess a high degree of influence over material decision making (e.g., see Roos et al. 2010; Hemström et al. 2017; Toppinen et al. 2018). Meanwhile, end-user perceptions — as in, the process by which individuals select, organize, and interpret sensations according to their own unique biases, needs, and experiences (e.g., Madichie and Kapoor 2012) — go mostly unapprised (see Table 1). Studies of end users' preference for load-bearing materials in multi-story and urban housing suggest that people tend to perceive concrete and steel as more structurally sound than wood frames; however, end users also acknowledge benefits of using wood for construction (e.g., Gold and Rubik 2009; Kremer and Symmons 2016; Høibø et al. 2015, 2018; Larasatie et al. 2018; Lähtinen et al. 2019).

Although research suggests that end users possess limited opportunities, or interest, in influencing the structural materials used within apartments (e.g., Hurmekoski et al. 2015), end-user perceptions — and ergo preferences — are nevertheless valuable for informing the professionals implementing decisions about construction materials (Høibø et al. 2015). Given that end-user perceptions about wood vary vastly within a country (Table 1), a large-scale study comparing and contrasting the perceptions of end users across countries would provide invaluable information to construction professionals and decision makers. More specifically, this paper aims to investigate end-user perceptions about wood as a construction material by exploring how citizens in Austria, Denmark, Finland, Germany, Norway, Sweden, and the United Kingdom (UK) describe wood as a construction material.

Because both forest resources and the relative importance of the forest sector differ among the seven countries included in the study, each country's citizens are expected to have different experiences with wood. Figures 1 and 2 depict forest harvest statistics for these seven European countries as well as differences in wood use for construction purposes, respectively. These differences play a role in shaping building traditions within each country. In Finland, Sweden, and Norway, the impact of easily accessible domestic forest resources and a high consumption of solid wood products is evident, as up to 90% of detached houses are made of wood (Schauerte 2010*b*; Hurmekoski et al. 2015). Sweden is also recognized as a leader in MSWB construction (Hurmekoski et al. 2015).

Austria is recognized for its alpine log houses (Klein and Grabner 2015), and together with the Alpine regions of Germany (and Switzerland), it has the highest global production capacity of cross-laminated timber (Muszynski et al. 2017). While it maintains

Fig. 1. Annual harvest of roundwood per capita in 2018 in seven European countries (FAO 2020).

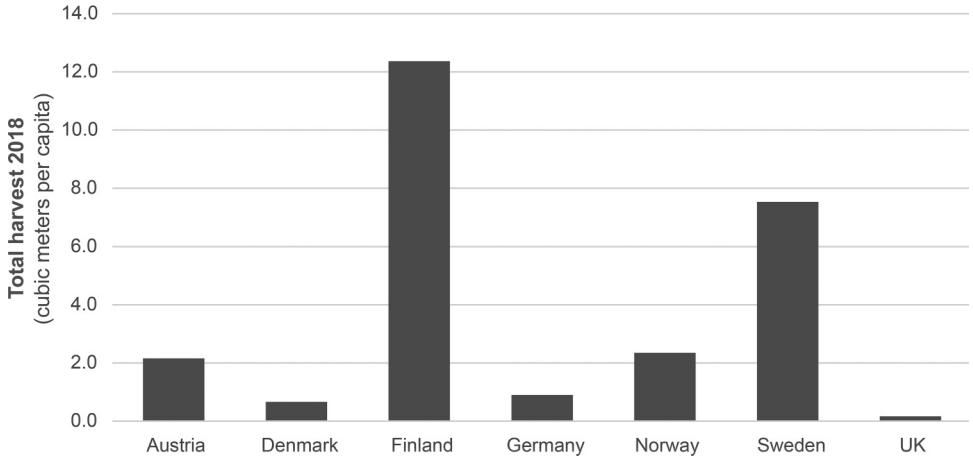
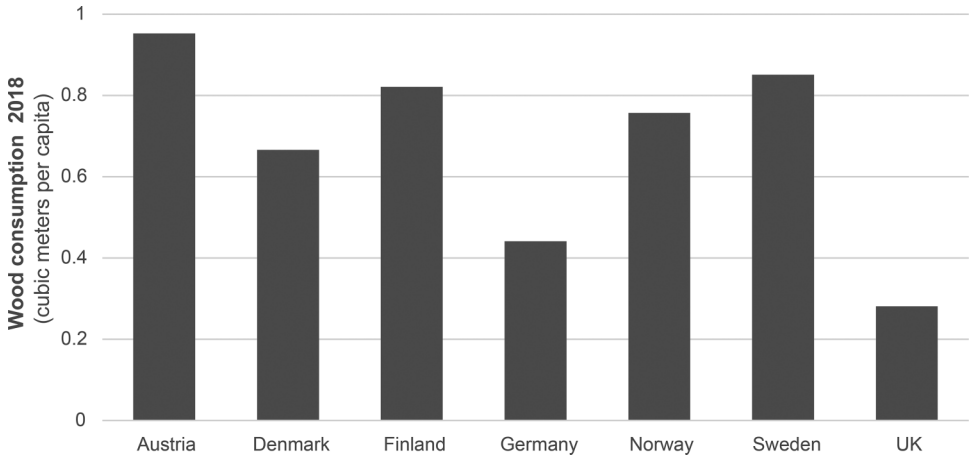


Fig. 2. Consumption of solid wood products per capita in 2018 in seven European countries. Solid wood products are defined as sawnwood, wood-based panels, and fibreboards; apparent consumption is calculated as domestic production + imported quantity – exported quantity (FAO 2020).



rather large forest resources and harvest, a high consumption of wood products (Figs. 1 and 2), and a keen interest in developing the national wood products industry (including MSWB) (Vihemäki et al. 2019), Austria possesses a 40% reported market share of wooden detached houses.

By contrast, Denmark, Germany, and the UK have lower annual harvest and relatively low consumption of solid wood products (Figs. 1 and 2), and they do not commonly use wood in construction. In Denmark, there is a minor use of wood in the building stock (Schauerte 2010*b*). Wood use in Germany is marginal compared with the use of brick (Gold and Rubik 2009), and the market share of wood in single detached houses is reported to be 14% (Hurmekoski et al. 2015). The UK has both the smallest annual harvest of roundwood and the smallest consumption of solid wood products (Figs. 1 and 2). Only 25% of detached houses in the UK are made of wood (Hurmekoski et al. 2015), yet the country's use of wood for construction is continuously increasing (Wang et al. 2014).

Given the forest resource trends within and building cultures of these countries, a forecast study on the potential for MSWB to penetrate markets by 2030 suggests that the likelihood is high in Finland, Norway, and Sweden, intermediate in Austria, Southern Germany, and the UK, and intermediate to low in northern Germany (Hurmekoski et al. 2015). The role of MSWB in Denmark has been estimated as minor (Schauerte 2010*b*).

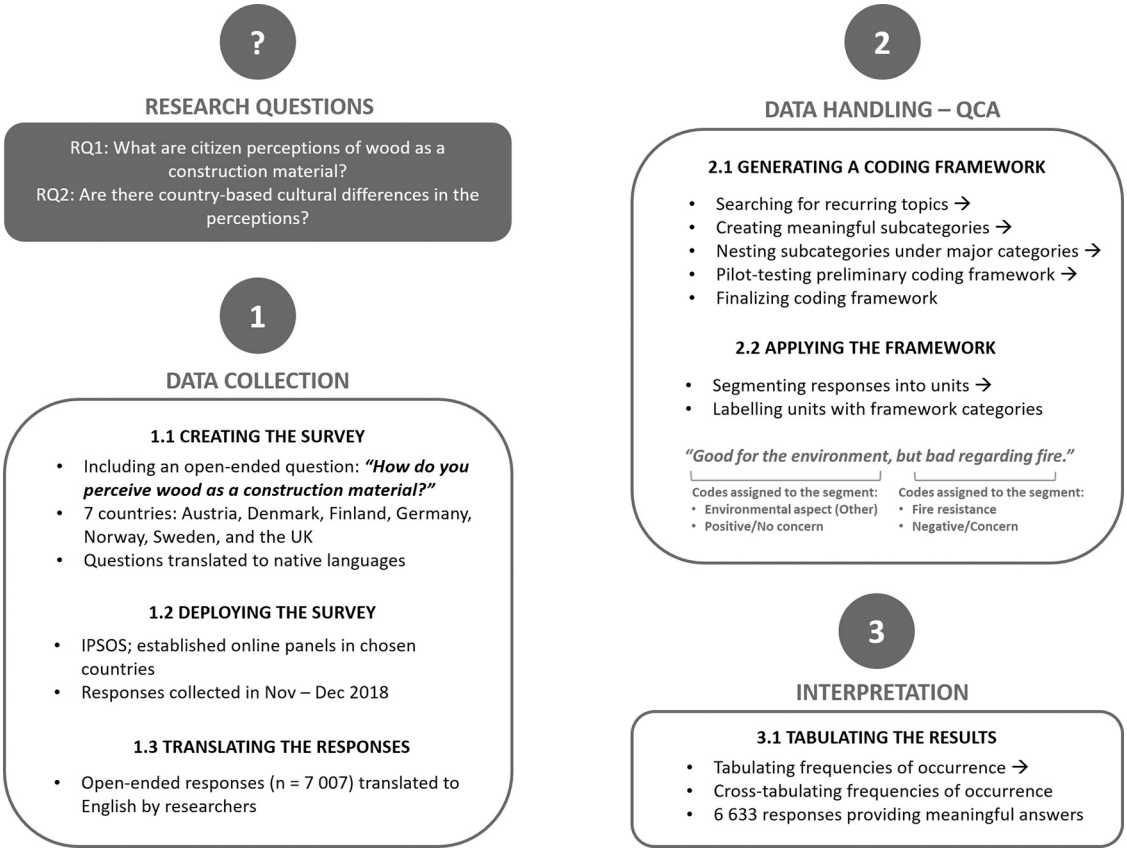
This research provides an opportunity to understand how geographical differences in culture affect citizen perceptions about wood. We aimed to answer two research questions: (1) What are citizen perceptions about wood as a construction material, and (2) are there country-based cultural differences in the perceptions? To our knowledge, no such comparative, large-scale country approach to studying these issues exists in the literature.

2. Data and methods

2.1. Data collection

We deployed an Internet-based survey to a multi-country consumer panel from Austria, Denmark, Finland, Germany, Norway, Sweden, and the UK (Fig. 3). The survey, which consisted of multiple parts, elicited citizens' housing material preferences with an emphasis on wood as a housing material. The questionnaire included 35 multiple-choice questions (including a set of demographic questions), and one open-ended question: "How do you perceive wood as a construction material? Describe with 2–3 sentences." The open-ended question was designed to allow responses based on perceptions (e.g., feelings and opinions), rather than factual knowledge. The questionnaire was jointly formulated by the co-authors and a larger team of researchers. Because the targeted countries exhibit different building

Fig. 3. Method used in the study: data collection, handling, and interpretation.



traditions, considerable effort was made to capture differences in responses between the countries' respondents.

The survey was generated in English and then translated into the native language of each country by a commercial translation company. Final language edits were conducted by the native speaking co-authors. IPSOS (https://www.ipsos.com, 2019), a market research and consulting company, assisted with testing the questionnaire, administering the survey, and collecting the data. IPSOS distributed the survey to members of their online panels who were aged 18 years and older. To obtain a demographically (i.e., age, gender, geography) representative sample from each country, the questionnaire was distributed in predetermined quotas to the panels until a representative country demographic was obtained. Approximately 1000 survey responses were collected from each country between November and December 2018 (n = 7007).

The use of online panels has its limitations (see e.g., Chandler et al. 2019; Hays et al. 2015). For example, there is bias stemming from respondents' requiring Internet access to participate, as well as a risk of low-quality data generated by unmotivated respondents who provide false answers or answer too fast. These limitations, however, are weighed against the various strengths of online panels, including their cost effectiveness, quick collection speed, and guaranteed large and demographically representative sample size.

2.2. Data handling and analysis

The dataset analyzed in this article constitutes the responses to the open-ended survey question. All the open-ended responses were translated into English by bilingual researchers, and the translations were cross-checked by various co-authors. Of the 7007 surveys collected, 6633 open-ended responses were usable; 374 responses were omitted because they were blank, nonsensical, or otherwise did not answer the open-ended question.

The dataset (n = 6633) was analyzed using Schreier's (2012) method of qualitative content analysis (QCA). We first developed a coding framework from the data, and then applied the framework to the data (Fig. 3). All data were processed using ATLAS.ti (v. 8) software. The coding framework applies the grounded theory method (see Schreier 2012, p. 111). The premise of grounded theory is to create theories — or discover meaning — from a collection of data. This method is the opposite of the traditionalist research approach, where data are collected in the pursuit of testing whether a theory is applicable to a phenomenon (see Goulding 2002). Therefore, in grounded theory, no previous theoretical framework is applied; one is instead created (i.e., the coding framework).

The coding framework development started with the two primary authors randomly selecting 20 responses from each country, resulting in a total of 140 responses. Each response was analyzed line by line to detect recurring topics (e.g., "I think wood is *healthy*"). These topics were grouped to create subcategories (e.g., "well-being"). As subcategories emerged, overarching major categories were also developed (e.g., "Social aspects"). Each subcategory was nested under an appropriate major category, thus creating a preliminary coding framework that provided an interpretive and meaningful answer to each research question. Co-authors provided comments and suggestions for subcategory development throughout this process. Finally, the preliminary framework was pilot tested by the two primary authors on 700 randomly chosen responses. Framework modifications were necessary to ensure a satisfactory framework that follows the QCA rules outlined by Schreier (2012). After the pilot test was conducted, the final QCA coding framework was derived (Table 2).

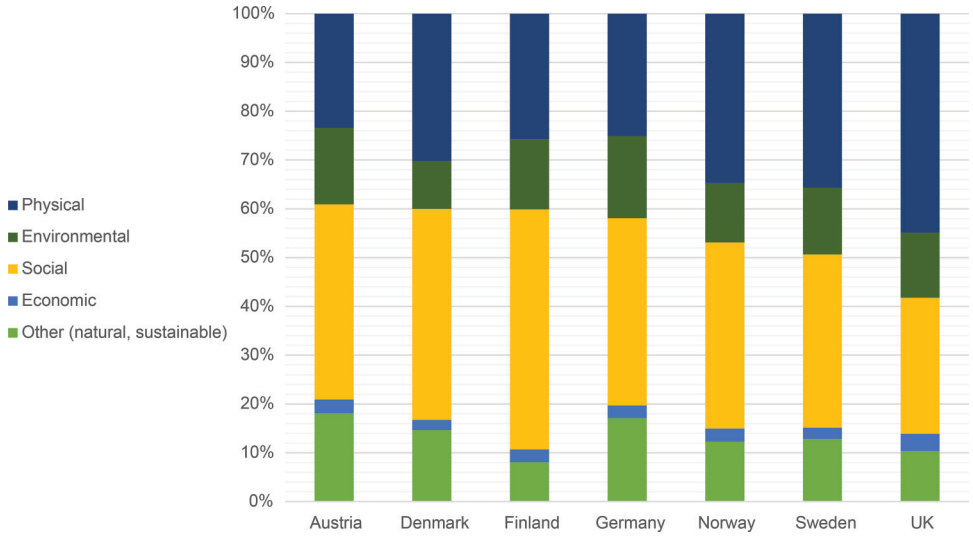
The final coding framework was systematically applied to the 6633 open-ended responses. The first step involved segmenting

Table 2. The qualitative content analysis (QCA) coding framework discussing wood as a material according to major categories and respective subcategories.

Major category	Subcategory	Illustrative examples from the data
Physical aspects	Sturdiness	Sturdy, solid, weak
	Durability	Durable, requiring maintenance
	Water resistance	Prone to rot
	Fire resistance	Flammable
	Natural events resistance	Able to endure earthquakes, prone to pests
	Work easability	Easy to work with, modifiable
	Insulation	Heat or sound insulation
	Other	Lightweight
Environmental aspects	Carbon and energy	Carbon neutral
	Renewability	Renewable
	Bio-circularity	Recyclable
	Procurement practices	Managing forests for timber used in construction
	Origin of wood	Locality of forests sourced for timber used in construction
	Other	Environmentally (un)friendly
Social aspects	Well-being	Healthy, safe, dangerous
	Air quality	Breathable, able to provide clean air
	Heritage using wood	Traditions building with wood, experiences living in wood
	Trendiness	Future, unwanted, suitable for [what] application
	Ambient lifestyle	Beautiful, cozy, warm, ugly
	Other	Provides jobs
Economic aspects	Affordable	Expensive, cheap
	Other	Good for economy
Other aspects	Sustainability	Sustainable
	Naturalness	Natural, lively
	Other	Other aspects
Supporting categories	**Subcategories**	**Illustrative examples from the data**
Position on aspect	Yes/positive/no concern	Sturdy
	No/negative/concern	Weak
Comparing materials	Positive comparison	Wood breathes better than concrete
	Negative comparison	Wood houses must be cared for more than brick houses

Note: The full list of category and subcategory is available upon request from the authors.

Fig. 4. Frequency of occurrence of perceptions about wood as a construction material for five major categories across seven European countries. [Colour online.]



each open-ended response into units that could be labeled with a subcategory. Afterwards, each unit was coded with an appropriate subcategory from the QCA coding framework. Ultimately, this process allowed for a tabulation of frequencies listing how often each category came up across all the data (see Appendix A, Table A1). Categorical frequencies of occurrence were also cross-tabulated against countries to create additional comparative information (Figs. 4–9).

Fig. 5. Physical aspects that respondents related to wood as a construction material. [Colour online.]

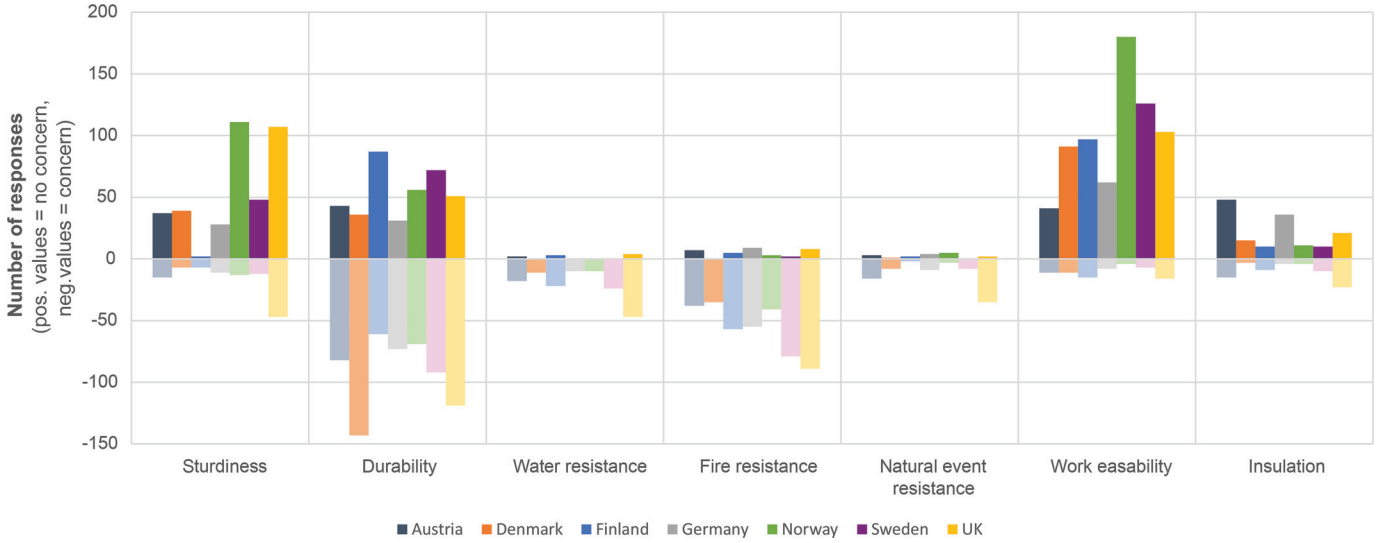
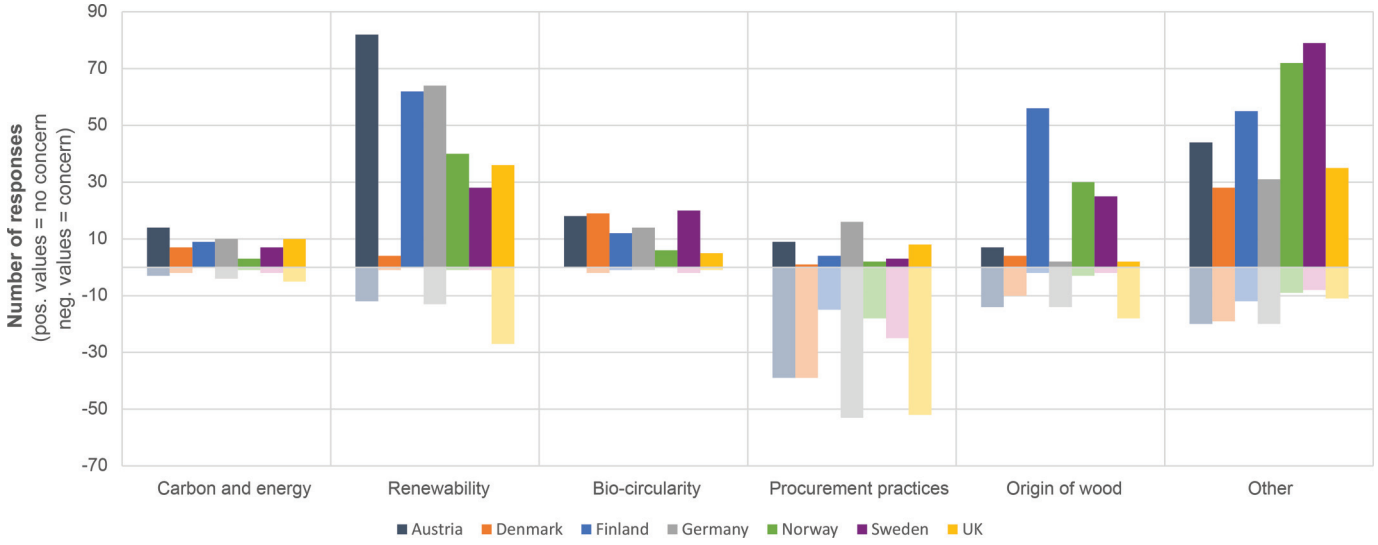


Fig. 6. Environmental aspects that respondents related to wood as a construction material. [Colour online.]



One major advantage of using QCA is that the reliability of the framework can be tested when different individuals apply the framework to the same data. A more reliable framework will result in individuals consistently categorizing a segment of data with the same category label (see Schreier 2012, p. 167). The reliability of the framework was tested by recoding 100 responses from each country (n = 700) 6 months after conducting the original coding. The responses were coded identically in 93% of the cases, and thus the coding framework was deemed to be 93% reliable.

Limitations of the QCA method are attributed to validity, a common concern in qualitative research. Despite the interpretative method associated with developing the coding framework, Schreier (2012, p. 30) has argued that "Different interpretations of the same material can be equally valid." A more critical limitation specific to this research concerns the coding of translated open-ended responses. Segmenting data into units and labeling units with appropriate codes both require subjective interpretation of the language used in the responses. Responses that were translated incompletely or incorrectly are subject to misinterpretation and miscoding. We attempted to reduce these sources of error by cross-checking the translations.

3. Results

The 6633 open-ended responses to the question "How do you perceive wood as a construction material?" were categorized into five major categories: "physical," "environmental," "social," "economic," and "other" aspects of wood as a construction material (Table 2; Appendix A). Additionally, we recorded whether these aspects were discussed in a negative, positive, or neutral tone. Likewise, sometimes aspects of using wood as a material were compared with those of other building materials. These two characteristics resulted in the creation of two supportive categories for analysis: "position on the topic" and "comparing materials." Table 2 presents brief examples of the major categories, supportive categories, and their respective subcategories.

Of the major categories, "social aspects" and "physical aspects" were mentioned most often across all countries (Fig. 4). "Physical aspects" was most often brought up among UK citizens, while

Fig. 7. Social aspects that respondents related to wood as a construction material. [Colour online.]

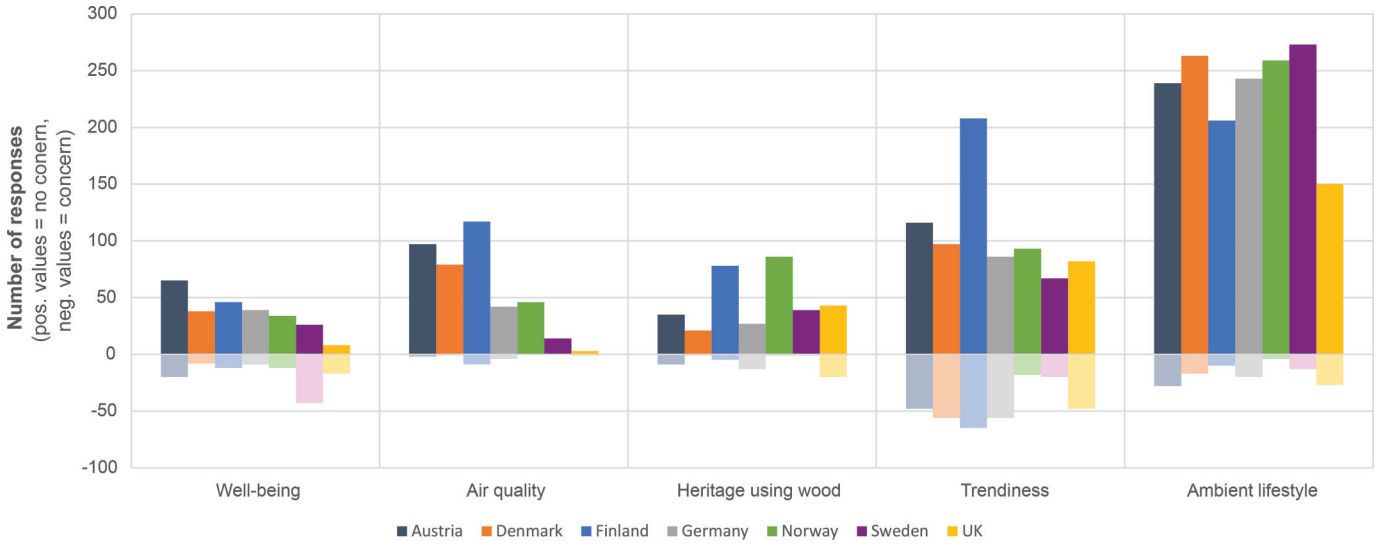
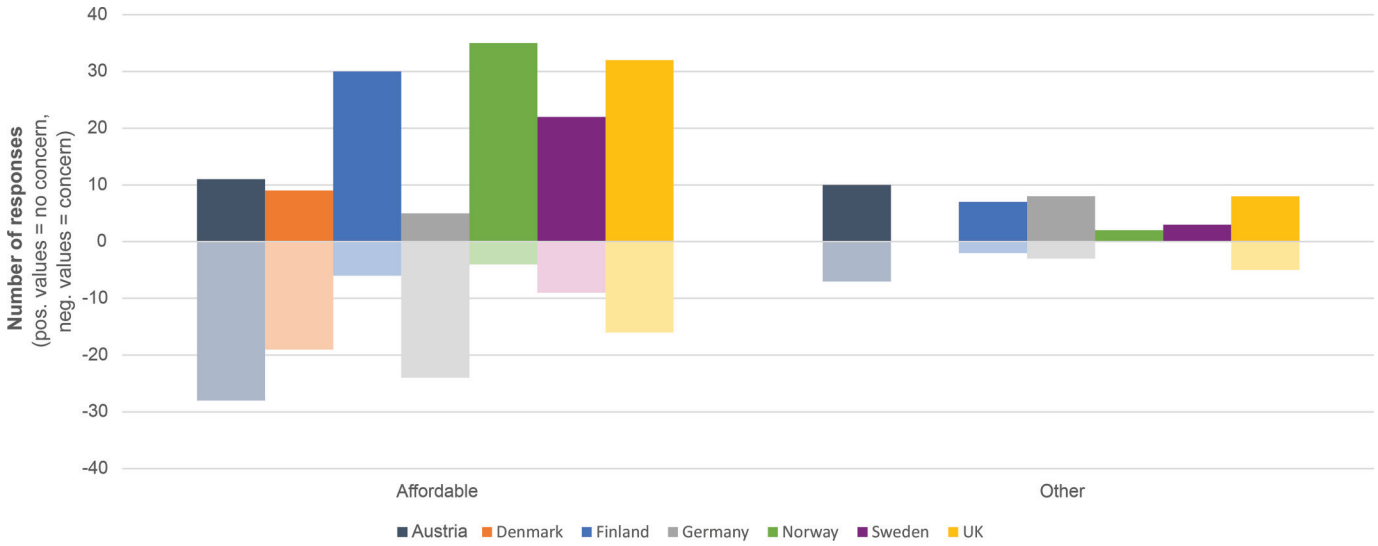


Fig. 8. Economic aspects that respondents related to wood as a construction material. [Colour online.]



Finnish citizens elaborated "social aspects" most often. "Environmental aspects" gained modest attention with German and Austrian citizens; they mentioned environmental topics most often. "Economic aspects" was seldom discussed in any country. In the following sections, we present the subcategories identified under each major category and discuss the differences between the responses. When reading the results, it is important to recall that the respondents are describing their perceptions about wood as a construction material; these may or may not be based on factual truths about the properties of wood and wooden buildings.

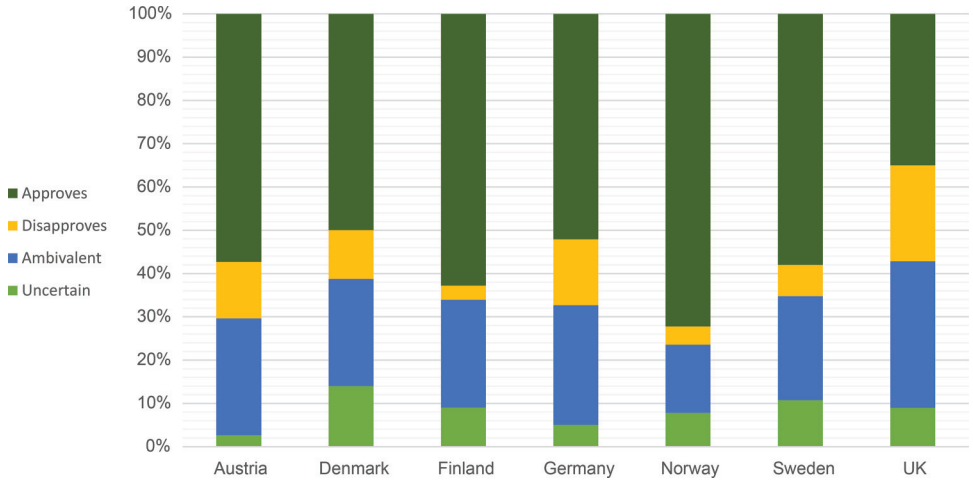
3.1. Physical aspects

Nearly a third of all open-ended responses were about the "physical aspects" of wood as a construction material. The most cited physical aspects included the durability and resistance of wood (Fig. 5). In this study, durability indicates descriptions about the service life of wood. Resistance indicates references to wood becoming damaged by fire, water, or other natural events.

Respondents from all countries, especially Denmark, expressed concerns about the maintenance needed to enhance the service life of wood. The hesitance toward the flammability of wood was discussed especially in the UK and Sweden. UK respondents mentioned apprehension toward using wood in construction owing to poorly perceived resistance toward water in the face of the UK's wet climate: "I don't understand why areas that have extreme weather would want to use wood in their construction" (UK598). Furthermore, UK citizens verbalized that they are "not confident about its [wood's] durability, especially as an outdoor material" (UK234). On the other hand, not all responses emphasizing durability and resistance were negative; respondents also described wood as "durable" and "long-lasting."

Where respondents voiced their concerns regarding the durability of wood, they tended to mention the sturdiness of wood in a positive manner. Descriptors such as "strong," "stable," and "sturdy" were common among the responses. A few opposing claims labeled wood as "unstable," especially in the UK. But the results indicate that respondents mostly regarded wood as an

Fig. 9. Acceptance of wood use in construction arising from open-ended survey responses. "Approve" of wood construction demarks that respondents shared discussions with only a positive tone. "Disapprove" demarks that respondents shared discussion with only a negative tone. "Ambivalent" demarks that respondents shared aspects of wood construction that held both positive and negative tones. "Uncertain" demarks that respondents themselves shared they were unsure or uncertain about different aspects of wood. [Colour online.]



inherently sturdy construction material, albeit one that is susceptible to damage over time and requires ample maintenance.

Despite the maintenance required to enhance its service life, the handling of wood was described as "easy" and even "fun" (SWD42), especially in Norway. Few individuals described maintenance as being difficult; instead, wood was often mentioned in a positive way owing to its workable qualities. For example, the comments "flexible and [having] more ability to alter during design and build" (UK74) and "simple maintenance for non-professionals" (NWY3) counterbalance the mentioned shortcomings of wood maintenance.

A less frequently mentioned topic was the insulating properties of wood. While some explained that wood has "good soundproofing ability" (DNK79), others claimed the exact opposite, saying that wood has "relatively poor soundproofing" (AST50). In this same way, wood was said to have "good thermal properties" (UK300), yet also require insulation.

The subcategories mentioned under physical aspects prompted several comparisons of wood against other construction materials. This was especially the case with UK respondents, who voiced their relative concern toward the durability, sturdiness, and fire resistance of wood versus brick and mortar. Amidst these doubts, one respondent indicated that combining wood with other construction materials is a feasible solution to overcoming such concerns while incorporating the benefits of using wood materials: "I believe [wood] is a much more sustainable building material. However, I do feel it needs to be combined with either some steel or concrete to be stable and for last a long time." (UK345).

3.2. Environmental aspects

Many respondents put forward a collection of support, opposition, and ambivalent concerns about the relationship between using wood in construction and its impact on the environment (Fig. 6). Support and approval for using wood in construction arose from wood being considered a renewable or "environmentally friendly" material. Wood garnered approval for its bio-circular properties, such as its recyclability, whereby wood construction materials can be recovered postdemolition. Also mentioned was that using decomposable, natural materials such as wood is better for the environment than using synthetic materials. Wood was infrequently mentioned as a carbon storage or low carbon emissions material, yet when acknowledged, these were considered favorable aspects for supporting the use of wood as a construction material.

Many answers — especially those from Austria, Denmark, Germany, and the UK — carefully cited approval for the use of wood as a building material when the timber sourced for wood was subject to responsible forest management practices with a high level of environmental consciousness or when it was sourced from sustainably managed forests. Clear-cutting was deemed problematic, and many respondents expressed concerns about using wood sourced from rainforests. In the same vein, some respondents shared outright disapproval of using wood in construction because they identified environmental degradation as being unequivocally associated with wood products; these concerns specified deforestation and negative impacts on wildlife habitats. "Equilibrium between the harvested wood and the planted trees" (DNK82) was called for on more than one occasion. Others simply stated that wood construction is "not environmentally friendly."

Topics related to the locality of sourced timber were brought up frequently in Finland, Norway, and Sweden. These respondents showed overwhelming approval for the use of domestically sourced timber (Fig. 6). For example, one respondent said, "In Norway we have large amounts of forest that can be used for construction, this gives us local materials" (NWY641). Respondents seemed to be accepting toward the sourcing of timber from "local cultivations," as "favoring domestic wood is an ecological action" (FIN307). On the other hand, most respondents from Austria, Germany, Denmark and the UK expressed strong concerns regarding the origins of wood. This topic was closely connected to concerns about the procurement of timber from abroad in "tropical forests" where "there are illegal loggings" (AST15) or "monocultures of greed" (AST839).

3.3. Social aspects

Most responses under "social aspects" were mentioned with a positive tone. "Social aspects" constituted beliefs about the social acceptability of using wood in construction, specifically statements about national heritage using wood or whether using wood was trendy. The remaining views connected how wood materials impact the resident's quality of life, such as through well-being, health, safety, or ambient lifestyles (i.e., the perceived atmosphere that wood creates through tactile perceptions) (Fig. 7).

The most popular topic of conversation throughout the open-ended responses reflected personal opinions about the ambient lifestyle wood is perceived to provide. Wood was often described as aesthetic or invoking an intangibly pleasing atmosphere.

Respondents used adjectives such as "beautiful," "warm," "friendly," "attractive," and "comforting" to positively describe wood; the word "beautiful" was recorded altogether 350 times. Wood was typically described as creating a more pleasant living environment compared with that offered by other materials; for example, "Houses built of wood are cozier than houses built of concrete" (NWY237).

Alternatively, a minute portion of individuals (i.e., 35 individuals) disapproved of the ambience provided by wood. Some thought too much wood in an interior could be "overwhelming" (GRY339), and others felt "[wood] should not be on display everywhere" (UK 376). Wood was also defined as "noisy" (UK486; UK586). One respondent simply noted, "I do not like wood. It looks so farmlike and old-fashioned" (AST 940). Notably, the dislike toward the visual appearance of wood was sometimes connected to wood having poor durability and requiring regular maintenance, particularly in examples where wood is used outdoors. For example, "[Wood] must constantly be oiled, glazed or varnished, otherwise it rots or looks awful. In the indoors very cozy and warm" (GRY743). Another mentioned that wood "weathers unattractively" (AST990).

While personal perceptions about the beauty of wood were almost exclusively positive, respondents were polarized when discussing socially acceptable uses of wood. For some, wood qualified as a "trendy" or "future" material they would like to see used "in all types of construction" (FIN87). Respondents approved of using wood "in single detached home construction (a most superb material and the best choice)" (FIN64) and in holiday homes. Approval for using wood in floors, decks, beams, trusses, window trims, roofs, and as other visually striking accents was also mentioned, indicating wood's versatile nature as a construction material.

On the other end of the spectrum, wood was demarcated as "dated" and "old-fashioned." Some respondents criticized wood as suitable for only a limited number of construction applications: "I only really see wood as a construction material for fences, gates and maybe sheds" (UK331). Others indicated that wood was best suited to specific geographic areas, such as "regional building material for small holiday homes" (AST30). In one extreme case, a respondent claimed that "it's wrong that it's legal in parts of the world for homes to be built from wood" (UK256).

Using wood as a construction material specifically for tall MSWB was brought up a few times, and opinions were of two minds. Some responses indicated hesitance due to concerns with structural integrity, as one respondent answered that they were "not sure if wood is strong enough as structural material in large structures and buildings" (FIN773). Another respondent was concerned with flammability and "would not like to live in a wooden high-rise building as they have a fire risk" (FIN614). On the other hand, respondents supporting the use of wood in tall MSWB believed "the strength of wood is also well suited for high-rise buildings using modern technology" (NWY645). Moreover, some respondents highlighted future expectations for developing new wood construction opportunities. For example, one respondent said that "especially in Finland, the skilled and respectful use of wood material [of the past] should be brought back to construction, and at the same time we should heavily invest in studying new opportunities for wood utilization" (FIN405).

Apart from whether individuals found wood to be a socially acceptable construction material, respondents also shared examples of their national heritage and traditions using wood in construction. Wood was sometimes labeled "historical" or "traditional," and some individuals shared personal experiences living in wooden homes. Positive aspects related to cultural heritage were mentioned most by Finnish and Norwegian respondents (see Fig. 5). Contrarily, UK citizens held poor social acceptability for wood, occasionally linking their views to perceptions about the national heritage of wood construction as leading to the country's mass deforestation. One respondent stated, "We used up all the trees in UK a couple of centuries ago and started to use mud bricks (clay) and mineral resources-steel, slate, glass cement, [and] breeze blocks" (UK 977). Furthermore, this perception alludes to why procurement and origin of wood were so negatively discussed, especially in the UK (see Fig. 6).

The final "social aspects" subcategory captures perceptions linking wood to well-being and safety. Wood construction gained positive recognition for having good indoor air quality, which was linked to positive well-being. Many responses praised wood as being "breathable" or having a pleasant "climate." Some respondents thought air quality was superior when using wood than when using brick or concrete; for example, "Wood has breathing qualities that the other building materials do not have" (GRY777). While most respondents did not provide explanations for how wood provides good air quality, a few respondents connected their praise to the hygroscopic properties of wood. For example, "[Wood] refreshes rooms, can absorb [and] release humidity" (AST726).

When considering safety, there was both approval and skepticism toward using wood. There were fears and uncertainties associated with certain technical characteristics of wood; for example, "mold risk, risk of fire" (SWD881) and "fear for instability in natural catastrophes" (AST258). On the other hand, positive notions labeling wood plainly as "safe" or "healthy" were also recorded. A few responses provided additional insights into the topic; for example, "[Wood] does not cause allergies and other health issues" (FIN798). Note that singular statements of the word "safe" might more aptly describe intangible feelings akin to wood being "cozy" as opposed to qualifying as an opinion about safety risks.

3.4. Economic aspects

Remarkably, topics related to the economic aspects of wood construction were rarely mentioned (Fig. 8). Responses largely concerned wood's affordability and usually included singular statements such as "cheap," "affordable," or "expensive." Austrian, German, and Danish citizens most often stated that wood is an expensive construction material. Occasionally, expensiveness was linked to the need to maintain wood, as "[wood] requires more work, time, and money to upkeep" (UK348). Affordability was sometimes connected to wood's superior heat insulating properties, as wood "brings savings in heating costs, compared to tiles" (AST323), and to wood's availability as a domestic product, because "proximity to the manufacturers give small transport costs" (SWD498).

3.5. Other aspects: naturalness

The "other aspects" major category included unique responses with singular statements. Nearly 10% of all descriptions mentioned the naturalness of wood (Appendix A). These responses used plain, singular statements such as "natural" or "lively," which made it impossible to analyze the response as either positive or negative. While "natural" and "lively" carry seemingly positive connotations, some responses indicated negative tones, such as when stating that wood is "a living material that makes me a little doubtful of expansion, shrinkage, cracking, etc." (FIN415), or when saying that wood is "a natural material that needs some care to be in top condition over time" (SWD276). Nevertheless, the phrase "natural" was typically used alongside positive aspects, such as health, renewability, breathability, recyclability, and pleasant ambiance. For example, one respondent said that wood is a "natural raw material, which is healthy when not treated with any non-organic matter" (FIN173), and another claimed that wood "radiates naturalness and comfort. Does not seem so 'sterile', but alive!" (AST553).

3.6. Linking citizen acceptability for wood construction to country countenance

Among all the aspects of wood, the top five most mentioned subcategories were "ambient lifestyle," "trendiness," "naturalness," "durability," and "work easability" (Appendix A). These

Table 3. Subcategories mentioned most frequently in each country.

	All countries combined	Austria	Denmark	Finland	Germany	Norway	Sweden	UK
1	Ambient lifestyle	Ambient lifestyle	Ambien lifestyle	Trendiness	Ambient lifestyle	Ambient lifestyle	Ambient lifestyle	Ambient lifestyle
2	Trendiness	Naturalness	Durability	Ambient lifestyle	Naturalness	Work easability	Naturalness	Durability
3	Naturalness	Trendiness	Trendiness	Durability	Trendiness	Naturalness	Durability	Trendiness
4	Durability	Durability	Naturalness	Air quality	Durability	Sturdiness	Work easability	Sturdiness
5	Work easability	Air quality	Work easability	Work easability	Renewability	Durability	Trendiness	Work easability

aspects were discussed across all countries, indicating that wood has certain characteristics, such as a pleasant visual appearance, that are appreciated regardless of respondents' cultural geography. Meanwhile, durability was mentioned negatively, especially in connection to wood requiring maintenance. Table 3 summarizes the five subcategories most frequently discussed in each country.

Based on the distribution of citizen views (Figs. 5–9), geographically based cultural differences between the countries were detected regarding how frequently certain aspects were discussed, as well as the tones used throughout the responses.

The UK stands out with the highest number of overall negative responses, delineating disapproval toward wood in construction (Fig. 9). Specifically, respondents were skeptical about whether wood can resist the UK's wet climate (Fig. 5) as well as materials such as brick and mortar can. Norwegian respondents were the most approving of wood use (Fig. 9), describing it as a sturdy material that is easy to work with (Fig. 5).

Respondents from Finland, Norway, and Sweden held high approval about locally sourcing timber for building materials, while citizens from Austria, Germany, and the UK frequently reported concerns about forest management practices and sourcing timber for building materials (Fig. 6). Finland and Norway often described wood as a traditional material and said that wooden buildings fit well in the landscape. Note, however, that Sweden does not follow this trend (Fig. 7). Conversely, Swedish and Norwegian citizens were less critical about the trendiness of wood, unlike Austrian, Danish, German, and UK citizens who more frequently connotated wood as untrendy or unacceptable in construction. Finnish citizens were extremely polarized with regard to wood's trendiness, giving both more positive and more negative examples than any country (Fig. 7).

With so few respondents discussing affordability, it is hard to draw geographical comparisons; however, Finland, Norway, and Sweden frequently delineated economic aspects positively (Fig. 8). Exceptionally, UK citizens showed positive regard for the economic aspects of wood, but the categorization of "cheap" as a positive economic classification may be incorrect. "Cheap" might instead entail inferiority as opposed to economic boon.

4. Discussion and limitations

Having been given the opportunity to describe wood as a construction material in their own words, citizens from the studied countries were surprisingly like-minded in their responses. Based on the tone of their responses, most respondents exhibited a positive stance toward using wood in construction. Norwegian citizens showed the most approval toward wood, while UK citizens were the most apprehensive. Danish citizens shared the most uncertainty about the topic.

The results from our study indicate that citizen concerns and preferences differ from what is considered important by professionals in the construction sector. Professionals usually focus on economic performance, environmental performance, or technical qualities like structural performance, durability, and fire susceptibility (see Hemström et al. 2011; Gosselin et al. 2017). Citizens from this study placed importance on these aspects as well, but they also strongly emphasized the social aspects related to wood construction, such as indoor environmental quality, tradition, and trendiness. Respondents expressly connected a positive association between indoor environment and occupant health to wood materials. Similar results are seen in the study by Gold and Rubik (2009).

Although respondents approved of wood as being aesthetic, natural, warm, and comforting, there is a tradeoff in that wood lacks durability and requires frequent upkeep and maintenance, especially in outdoor uses (see similar results in Larasatie et al. 2018). Weathering can affect aesthetic qualities, making improperly maintained wood unattractive over time. But despite these shortcomings, respondents also answered that wood was easy to modify, renovate, and maintain. Approval for the everyday usability of a wooden home, such as the ability to easily drill paintings into a wall, was found to be important for homeowners in a recent study by Viholainen et al. (2020).

Differing geographical cultures noticeably impacted citizen responses. In particular, the responses from Finland, Norway, and Sweden were overall more positive about wood than the other countries. When discussing the "environmental aspects" of wood, respondents from Finland, Sweden, and Norway were less worried about deforestation and the detrimental environmental impacts of procuring timber resources. "Social aspects" frequently cropped up as positive responses within Finland and Norway, as these citizens shared especially positive remarks about the social acceptability of using wood, and positive personal experiences and traditions with using wood in construction.

Austria, Denmark, Germany, and the UK mostly conveyed experiences using wood in applications such as floors, furniture, and roofs. This negative emphasis on the "social aspects" related to trendiness and national heritage is likely owing to limited personal experiences with wood in housing applications. For example, the market share of wood used in single detached houses is roughly 80%–90% in Finland and Sweden, while it is 40% in Austria, 25% in the UK, and 14% in Germany (Hurmekoski et al. 2015).

Interestingly, Swedish citizens did not embrace the cultural heritage or social acceptability of wood use in construction to the same degree that Finland or Norway did. In fact, they also discussed the physical aspects of wood more negatively. One possible explanation is that Swedish citizens struggle with the memories of past multi-story fires; Swedish citizens, along with UK citizens, most frequently shared concerns about fire safety. In both these countries, apprehensions may be prompted by the recently well-documented multi-story building fires in Clientage in Luleå, Sweden (Björkman 2013) and Grenfell Tower in London, UK (BBC 2018).

Notably, discussions about fire resistance and fire safety sparked fewer mentions than expected when compared with the results of previous studies (e.g., Larasatie et al. 2018). Conversely, previous studies specifically examined citizen perceptions toward tall wooden buildings, whereas in our study respondents were asked about wood in construction. It is possible that fires are perceived as less problematic among our respondents because they

considered wood use in another context apart from MSWB, such as a single detached house.

Finally, we would like to outline two main limitations to our study. First, while the questionnaire elicited information about the perceptions of wood as a structural material in multi-story construction, the open-ended question provided citizens with a lower threshold to describe their overall thoughts and experiences regarding wood as a construction material. It is therefore worth recalling that a proportionally large share of the respondents brought up nonstructural properties of wood in their open-ended responses. Thus, we acknowledge that we cannot always be certain what kind of wood construction edifice a participant is referring to in their response, and that this may be related to the observed polarity among preferences and beliefs. For example, MSWB and single-family detached homes use different wood components and construction technologies, which creates different consumer experiences with maintenance, acoustics, and cost. Notwithstanding this finding, we maintain that country-specific aspects and traditions, such as climate and availability of local material, play a role in consumer preferences. Second, we acknowledge that we cannot assess the impact of previously asked parts of the long questionnaire on the open-ended responses. Nevertheless, clear differences exist between the major categories and topics of discussions among participants.

5. Conclusions and future directions

While perceptions about the use of wood among construction industry professionals have been studied, citizen attitudes toward the use of wood in construction have received limited research attention. Nevertheless, citizen perceptions can provide invaluable information to key stakeholders involved in construction material decision making. Therefore, we elicited a broad spectrum of citizen perceptions about wood as a construction material via an online survey deployed in Austria, Denmark, Finland, Germany, Norway, Sweden, and the UK. In this paper, we aimed to answer two questions: (1) How do citizens in seven European countries describe wood as a construction material, and (2) are there country-based cultural differences in their perceptions?

The results indicate that citizens across these different countries shared many similar views, although cross-country cultural differences were also present. The UK stood out as the country whose citizens were most often concerned about the suitability of wood as a construction material in their humid climate. Citizens of Finland, Norway, and Sweden were most approving of wood use, likely because of the strong tradition of building with wood and the availability of domestic raw material. Citizens of Austria, Denmark, Germany, and the UK were concerned about responsible forest management practices as a prerequisite for accepting wood as a construction material.

Based on these results, building professionals should focus on marketing positively perceived qualities of wood, such as naturalness, visual appearance, and a healthy indoor environment. Speculations about fire should be addressed with up-to-date information on the fire performance of wood in construction. The perceived tedious maintenance requirements of wood might be overcome by advertising how relatively easy and manageable maintenance is. While questions about the ability of wood to help lower the environmental burden of the construction sector have been widely discussed among building professionals, this environmental aspect has yet to be acknowledged by citizens as a key characteristic of wood construction. Furthermore, cross-country cultural differences, such as traditions and availability of domestic raw materials, should be acknowledged when informing professionals about the perceptions of citizens.

Further research is needed on architects and construction industry professionals to understand how the use of wood is included in urban planning, but also how wood is marketed to end users. This should entail research questions related to attitudes toward the environmental, economic, and social sustainability of wood value chains all the way to end users. Additionally, end-user preferences and attitudes toward national building traditions and housing conditions overall may also affect their perceptions about wooden buildings. Studying in more detail the formation of user perceptions, especially in terms of how to engage their views on the building development processes, would seem pertinent to promoting the business case of MSWB. Therefore, the qualitative cross-country results presented here provide future opportunities to conduct large-scale quantitative research on how integrating end-user perceptions among the professionals working with wood materials can be used, as well as in the context of emerging MSWB business ecosystems in North America and beyond the case countries in Europe.

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Appendix A

Appendix Table A1 appears on the following page.

Table A1. Statistics for survey responses.

	Total	Austria	Denmark	Finland	Germany	Norway	Sweden	UK
Total number of collected responses	**7007**	**1000**	**1000**	**1000**	**1001**	**1001**	**1003**	**1002**
Responses included in analysis (i.e., usable)	**6633**	**941**	**957**	**931**	**915**	**969**	**967**	**953**
Physical aspects	**3409**	**402**	**423**	**415**	**367**	**543**	**540**	**719**
Sturdiness	490	52	46	9	39	127	62	155
Durability	1022	125	184	148	105	125	165	170
Water resistance	151	20	11	25	10	10	24	51
Fire resistance	428	45	35	62	64	44	81	97
Natural events resistance	98	19	9	4	13	8	8	37
Work easability	780	52	104	113	70	187	135	119
Insulation	224	65	18	19	40	16	21	45
Other	216	24	16	35	26	26	44	45
Environmental aspects	**1494**	**268**	**137**	**233**	**246**	**190**	**206**	**214**
Carbon and energy	83	20	10	9	15	4	9	16
Renewability	372	94	5	62	77	41	29	64
Bio-circularity	101	18	21	13	15	6	22	6
Procurement practices	287	48	40	19	69	20	29	62
Origin of wood	197	22	14	59	17	35	30	20
Other	454	66	47	71	53	84	87	46
Social aspects	**4226**	**686**	**606**	**794**	**561**	**596**	**537**	**446**
Well-being	380	86	47	58	49	46	69	25
Air quality	417	100	80	126	47	46	14	4
Heritage using wood	399	50	22	86	44	89	41	67
Trendiness	1153	175	167	287	145	122	101	156
Ambient lifestyle	1797	269	284	217	271	270	298	188
Other	80	6	6	20	5	23	14	6
Economic aspects	**293**	**49**	**29**	**43**	**38**	**42**	**35**	**57**
Affordable	255	39	29	36	30	40	32	49
Other	38	10	0	7	8	2	3	8
Other aspects of wood	**1447**	**310**	**205**	**130**	**250**	**192**	**194**	**166**
Is sustainable (generally)	284	66	48	22	47	33	7	61
Naturalness	1045	190	153	98	185	156	186	77
Other	118	54	4	10	18	3	1	28
Comparing wood to other materials	**415**	**76**	**33**	**56**	**48**	**36**	**38**	**128**
Negative comparison	235	40	21	15	26	11	24	98
Positive comparison	159	32	11	40	20	24	12	20
Neutral comparison	21	4	1	1	2	1	2	10
Position on aspect	**9741**	**1562**	**1228**	**1460**	**1311**	**1392**	**1317**	**1471**
Yes/positive/no concern	6457	1007	787	1127	785	1106	893	752
No/negative/concern	2656	406	378	299	404	207	324	638
Unknown	628	149	63	34	122	79	100	81
Approval of wood use in construction	**6218**	**911**	**865**	**895**	**875**	**874**	**883**	**915**
Approves	3435	522	432	562	456	631	512	320
Disapproves	683	119	98	29	133	37	64	203
Ambivalent	1585	246	214	223	242	138	212	310
Uncertain	515	24	121	81	44	68	95	82