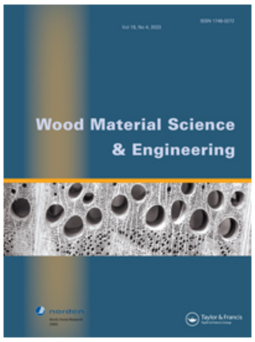

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Impact of prospective residents' dwelling requirements on preferences for house construction materials

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ABSTRACT

This study investigated people's requirements for multi-story housing attributes and preferences for apartments in wooden-structure versus steel/concrete-structure multi-story buildings. Data came from an online survey conducted in Finland and Sweden that screened for respondents who expressed a preference for living in an apartment, as compared with a low-rise dwelling. Responses were analyzed using exploratory factor and regression analyses. Swedish respondents assigned significantly higher requirements to factors related to environmental and social sustainability performance than Finnish respondents. Requirements in both countries were described across three factors: *environmental and social sustainability, quality,* and *design*. Factor scores differed between socioeconomic sub-groups, particularly regarding *quality,* between urban and non-urban respondents. Preferences to live in an apartment in a wooden building were positively associated with respondents' requirements for *environmental and social sustainability*, and negatively with requirements for *quality*-related attributes. Opposite relationships were found in the Swedish sample for apartments in non-wooden structure houses. Design requirements had no significant association with preferences for a specific material in load-bearing structures for multi-story buildings, in either country. The findings can contribute toward enhanced marketing efforts and customized value propositions to increase the social acceptability of multi-story wooden buildings and advance climate-related goals within the housing sector.

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Introduction

The construction sector accounts for 38% of the world's total global energy-related CO_2 emissions, including both operation and construction (IEA 2020a, 2020b). Efforts to reduce the climate impact of construction have targeted enhanced energy efficiency of building operations and reduced greenhouse gas emissions from the manufacturing of construction products (Röck *et al.* 2020). The European Union (EU) is committed to reducing greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels, and to being climate neutral by 2050 (European Commission 2021a). Albeit contingent on particular system assumptions and boundaries (Hart *et al.* 2021), wooden-structure construction has the potential to reduce global warming by avoiding carbon emissions when replacing steel and concrete and accumulating biogenic carbon in the building stock (Cabeza *et al.* 2014, Geng *et al.* 2017, Churkina *et al.* 2020).

Apartment housing can lead to lower climate impact per square meter compared to single-family houses (Lavagna *et al.* 2018), and multi-story wooden buildings (MSWBs) have been identified as a climate-friendly alternative for urbanized housing in many countries (Churkina *et al.* 2020). Consequently, the market development of MSWBs is gaining interest in Finland and Sweden owing to a long-standing wood tradition in the low-rise building sector, a viable wood construction industry, and extant climate policies in these two countries (Toppinen *et al.* 2019). Furthermore, the MSWB construction industry has over recent decades introduced new methods and developed innovations that have improved both cost-efficiency and quality (Hurmekoski *et al.* 2015, Lazarevic *et al.* 2020).

The wider adoption of MSWBs to effectively support climate goals will depend on, in addition to supply-side improvements, the demand-pull determined by how potential residents expect MSWBs can meet dwelling requirements (Brege *et al.* 2014, Hynynen 2016). Potential residents' housing requirements refer to the dwelling properties that they anticipate will affect their satisfaction (Matzler and Hinterhuber 1998). The literature shows that the housing decision is a complex evaluation process wherein a customer's requirements and

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needs are contrasted against the perceived properties of a specific housing option (Coolen and Hoekstra 2001, Gibler and Tyvimaa 2014, Hasu *et al.* 2017). The real choices for homes are affected by both the physical properties of the buildings and their locations (Kauko 2006, Lähtinen *et al.* 2021). However, this study focuses on the preferences for the structural material in multi-story houses.

Several previous studies on perceptions and preferences for living in homes made of wood have sought to identify and describe customers' segments (Gold and Rubik 2009, Aguilar and Cai 2010, Høibø *et al.* 2015, Larasatie *et al.* 2018, Petruch and Walcher 2021, Aguilar *et al.* 2023). Despite several important findings, it has been challenging to define distinct customer segments based on observable socioeconomic attributes (Aguilar *et al.* 2023), although categories based on preferred housing priorities are discernible. For example, Hasu *et al.* (2017) found lifestyle issues to strongly affect the choices for homes and to be more important than age or family size.

Generally, studies on dwelling preferences reported wood-related attributes that were particularly appreciated, such as usability, soundscape, naturalness, aesthetic appearance, comfort, and healthiness (Mahapatra *et al.* 2012, Lähtinen *et al.* 2019, Kylkilahti *et al.* 2020, Viholainen *et al.* 2021). Other surveys indicate that some categories of young respondents prefer wood over other construction materials because of its environmental advantages (Høibø *et al.* 2015, Petruch and Walcher 2021), which may be reflective of increased consumer awareness of environmental and social sustainability in choices (De Medeiros *et al.* 2014). In contrast, not all residents in MSWBs are aware of the fact that their dwellings have wooden structures (Mark-Herbert *et al.* 2019). Public doubt has also been reported about the wooden construction material's environmental credentials based on perceived harmful forest management methods (Petruch and Walcher 2021, Viholainen *et al.* 2021).

Another strand of research has explored the views on wood construction among professional stakeholders in the building sector. In a study of municipal civil servants (Franzini *et al.* 2021), MSWBs were believed to possess positive environmental attributes and support local economic development, while multi-story buildings in concrete were regarded to have lower construction and maintenance costs and low susceptibility to fire. Moreover, different actors in the construction value chain —building material suppliers, architects, and structural engineers— present a range of diverse views and beliefs concerning wood in construction (Roos *et al.* 2010, Markström *et al.* 2018).

Key findings in the cited studies indicate that the environmental profile of wooden materials has a positive effect on preferences. Past results also suggest that wooden material is viewed by many as more attractive and harmonious than, for instance, concrete, but that it presents downsides for some groups of respondents, related to concerns over fire safety properties, general durability, maintenance costs, and stability (Gold and Rubik 2009, Viholainen *et al.* 2021). However, market demand drivers for MSWB development remain unknown to a large extent (Jussila *et al.* 2022).

Like other industries, the wood construction providers strive to meet the customers' expectations on the dwellings' attribute level performances (Matzler *et al.* 2004). To date, few studies have attempted to identify how consumers' requirements influence the preference for apartments in multi-story residential buildings (versus the alternatives). Further, this knowledge gap also concerns the target group members who are either planning or prefer to live in an apartment. Such specific knowledge would improve strategic decisions in the wood construction sector, both for its market communication and in setting innovation priorities.

This study responds to this knowledge gap on prospective apartment dwellers' requirements and preferences, and it attempts to shed light on MSWB preferences (Jussila *et al.* 2022).

This research aimed to present the following:

1. Identify potential dwellers' requirements for apartments located in multi-story residential buildings
2. Analyze the association between dwellers' requirements and preferences for wooden, versus non-wooden, materials in construction.

We focused on multi-story residential housing, excluding commercial and public buildings, such as schools and detached or semi-detached houses. Further, the study mainly considered the structural and apartment-specific properties related to the specific features of the building material. This implies that it did not cover housing attributes linked with the neighborhood, outdoor milieu, landscape, accessibility, or services (Coolen and Hoekstra 2001, Kauko 2006, Lähtinen *et al.* 2021). Although these aspects are important for where people choose to live, they are not directly linked with the selection of load-bearing building materials.

Conceptual background

There is no one universal definition for assessing and evaluating housing attributes and, therefore, different sources and standards provide elements of the conceptual framework for this study. Peer-reviewed studies on preferences for wooden housing typically indicate the importance of physical features, environmental and social sustainability performance, resident safety, and housing design (Gold and Rubik 2009, Aguilar and Cai 2010, Høibø *et al.* 2015). These criteria correspond partly to dwelling assessment frameworks that cover structural features, design, fire safety, and ventilation (Keall *et al.* 2010). Similar aspects are mirrored in building standards and regulations, for instance, in Sweden (Swedish National Board of Housing, Building and Planning 2021). The EU's housing policies and initiatives also emphasize aesthetic aspects as one central factor for good housing (European Commission 2021b).

Furthermore, our analysis was influenced by the means-end framework indicating that preferences are formed on, and reflect, users' needs (Gutman 1982, Zeithaml 1988). Hence, this study's conceptual model describes how the preference for a housing attribute depends on its perceived ability to meet specific ends or utilities (Gutman 1982, Coolen and Hoekstra 2001). Supporting assumptions posit that people's requirements and needs indeed influence decision-making, and customers believe that their preferences and choices can impact how their needs are met (Gutman 1982).

In the terminology of the means-end theory, this examination assumes that people host housing requirements, or *ends* that they believe can be met by the choice of construction material, which stand for *means* in Figure 1. Hence, people's housing requirements translate into preference ratings for different structural housing materials.

The conceptual model in Figure 1 encompasses dwelling requirements for attributes (*ends*) that can be described as different requirement dimensions. These requirements are expected to be associated with the preference to live in an MSWB. The preference for a certain construction material reflects whether it is perceived as a means to respond to the stated ends. The model is restricted to functional consequences, and this study does not probe further into psychological consequences for the subject (Claeys *et al.* 1995, Peter and Olson 2010). Furthermore, based on the literature, we expect that dwellers' apartment preferences (i.e. preference for an apartment in a wooden apartment building) are associated with requirements as shown in Table 1. We hypothesize that MSWBs are perceived to meet ends regarding environmental and social sustainability and good design, although previous studies show inconsistent views. Non-wooden construction material, which in most cases is concrete, is according to the studies perceived by potential residents to perform better on general building quality aspects.

Methods

Approach and data collection

Analyses were based on empirical survey data on housing requirements (*ends*) and preferences for housing alternatives (*means*). A quantitative approach was selected as the study aimed to uncover general patterns in a population. This approach enabled the statistical estimation of parameters and associations, and of distributions, as per our study objectives (Bryman and Bell 2011).

The study was conducted with an online consumer panel in Finland and Sweden on experiences and preferences regarding MSWB construction. A master questionnaire was designed in English based on a previous survey round in 2018 and multiple review rounds among Scandinavian researchers. It was translated into Finnish and Swedish and expert-validated by researchers with a thorough knowledge of wood construction. Questions covering housing requirements and preferences on wooden housing were presented as statements with a 9-point

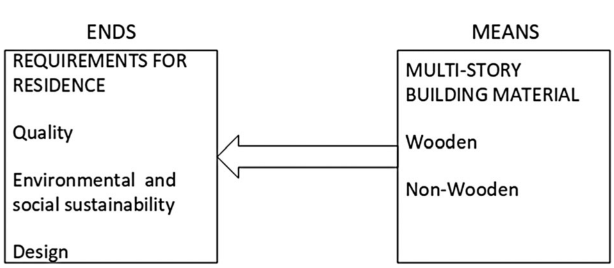

Figure 1. Conceptual framework for the analysis of dwellers' requirements and preferences for apartments (Gutman 1982).

Likert scale for the answers (e.g. 1 = not important to 9 = very important), in addition to the "Don't know" option. Questions were also asked on demographic and socioeconomic background, respondents' housing plans, and preferences for materials used in multi-story buildings.

Primary data collection was carried out by the global market research and consultancy company Syno International UAB. All data collection activities and archiving followed European General Data Protection Regulation. The survey was distributed in May-June 2021 among a representative sample through a consumer panel approach of the general public in Finland and Sweden. Participants were at least 18 years of age. The original samples comprised 1009 respondents in Finland and 1008 in Sweden. The respondents were in compliance with population data from the two countries based on key socio-demographic variables such as gender, age, and education level (Statistics Finland 2021, Statistics Sweden 2021). The differences in sampling probabilities due to total population numbers in Finland and Sweden do not affect the power levels of statistical tests (Lohr 2010, Cowles and Nelson 2015).

Further, separate analyses were conducted for Finland and Sweden. The external validity of the research based on online panel data has been questioned on grounds of possible sampling bias or measurement errors (Porter *et al.* 2019, Walter *et al.* 2019). However, online panel research has developed and improved and is widely used in marketing research owing to its advantages of speed, convenience, and costs (Evans and Mathur 2018). Walter *et al.* (2019) found that online panels generated similar psychometric outcomes as those obtained from conventionally collected data.

The target population for this study was further defined to include only those respondents who gave answers that included "Apartment-building" to the question "If you can choose freely, which of the following housing types do you prefer the most?" This distinction was crucial to studying housing requirements and building materials preferences in multi-story buildings for the most relevant target segment (as opposed to the segments that preferred other housing alternatives such as a townhouse or single-family house). Further, it implied that irrelevant questions were not asked to respondents planning to live in a low-rise building (Bryman and Bell p. 234). The screened final sample included 208 respondents in Finland and 290 in Sweden. Answers were then examined for consistency and reliability. Observations that reflected a low degree of real deliberations by the respondents (e.g. identical ratings over a set of questions) were removed. Unreasonable answers were also deleted, such as respondents giving contradictory answers to combinations of sub-questions. The final sample of usable observations amounted to 200 in Finland and 279 in Sweden, resulting in a total of 479 observations.

Potential apartment residents

Table 2 presents descriptive statistics of our sample including a socioeconomic breakdown of comparative data of the respondents in the two countries.

Table 1. Hypothesized associations between apartment requirements and frame construction material preferences.

Requirement/"end"	Preference for frame construction material: Wooden	Non-Wooden	References
Quality	Negative	Positive	Gold and Rubik 2009, Høibø et al. 2015, Larasatie et al. 2018,
Environmantal and social sustainability	Positive	Negative	Gold and Rubik 2009, Høibø et al. 2015, Larasatie et al. 2018, Lähtinen et al. 2019, Kylkilahti et al. 2020, Petruch and Walcher 2021,
Design	Positive	Negative	Gold and Rubik 2009, Larasatie et al. 2018, Lähtinen et al. 2019, Viholainen et al. 2021, Petruch and Walcher 2021, Lähtinen et al. 2022

There was a higher percentage of individuals preferring to live in an apartment in the Swedish original sample compared to that of the Finnish respondents (sum of respondents preferring dwelling in apartments or low-rise buildings). The Finnish sample showed a slightly higher mean age, reflecting national differences in average age. It also presented a larger share of one-person households and households without children compared to the Swedes.

Multi-variate analysis

Separate statistical analyses were carried out on the Finnish and Swedish samples. The set of variables used in the research steps is described in Table 3. Mean importance ratings describing respondents' requirements and preferences were compared. Based on the variables describing the respondents' requirements, exploratory factor analyses were conducted (Fabrigar and Wegener 2012, Finch 2020). The factor analysis followed the maximum likelihood procedure with oblique rotation because non-orthogonal factor solutions could be expected (Sass and Schmitt 2010). Factor loadings of 0.4 or above were considered significant (Hair et al. 2010).

The Kaiser-Mayer-Olikin test for sampling adequacy Bartlett's test of sphericity were conducted to find whether the variable correlations indicated the presence of underlying factors. The inspection of communalities secured a robust factor analysis solution. A level of commonality reflects the proportion of variance in each indicator that is accounted for by the factors and can be calculated as the sum of the squared factor loadings associated with that variable (Finch 2020). The analysis led to the removal of four variables that did not load significantly on any factor or that cross-loaded.

Generated factor scores were thereafter used as independent variables in linear regressions analyses wherein the dependents consisted of two manifest response variables: 1) preference for an apartment in a wooden structure multi-story building and 2) preference for an apartment in a multi-story building in concrete or steel, not wood, as the load-bearing structure. For these estimations, it was assumed that the 9-point scale responses could be considered as continuous variables. Ordinal regression was also conducted with similar results in terms of model fit and significant independent coefficients.

Outlier inspections were conducted through Mahalanobis distance and Z-scores (Thompson 2006, Hair et al. 2010). Two observations were removed from the Finnish sample and three from the Swedish sample based on the analysis. The final number of observations was 198 for Finland and 276 for Sweden. Heteroscedasticity could not be rejected for the Finnish dataset based on the Breusch–Pagan Test, while this was not the case for the Swedish dataset. Generalized linear model estimations with robust standard errors were computed in the Finnish case to avoid incorrect significance indicators (Astivia and Zumbo 2019). There was no statistically significant evidence of multi-collinearity since the variance inflation factor values stayed below critical levels (Hair et al. 2010). Additionally, low correlation coefficients between the factors did not support specific concern for possible multi-collinearity. Graphs are available as supplementary material.

Table 2. Sample description.

	Country: Finland $n = 200$	Sweden $n = 279$	Significant between-country difference at 0.05 level, *. test statistic
Respondents preferring apartment, of the whole sample (%)	20.0	28.5	*, Chi-squared
Average age (years)	49.8	46.6	*, ANOVA and Mann-Whitney
Age groups (%)			
18–22 years	8.0	5.7	
23–35 years	15.5	28.7	*, Chi-squared
36–55 years	32.0	27.6	
56–99 years	44.5	38.0	
Men (%)	50.5	50.2	
One-person households (%)	50.5	37.6	*, Chi-squared
Households with children aged 0–17 years (%)	10.0	29.4	*, Chi-squared
Respondents with university degree (%)	42.0	34.8	
Respondents living in city with >100,000 inhabitants (%)	66.5	60.9	

ANOVA: analysis of variance

Results

The survey results on requirement and preference variables are shown in Table 4. Fire safety, noise insulation, and a healthy indoor environment received the highest scores for both countries. The use of renewable materials, low carbon footprint in the construction phase, and domestic material sourcing received relatively low scores in the Finnish sample. For Sweden, relatively low scores were noted for design and visual appeal and renewable building materials.

Swedish respondents scored significantly higher than Finnish respondents on the stated importance of housing attributes related to environmental and social sustainability, such

Table 3. Variables describing dwelling requirements.

Variable name	Description
Requirements: *When choosing a place to live how important are the following dwelling items to you?*	
View	Nice view from the house or apartment
Natural light indoors	Amount of natural light indoors in the dwelling
FuncFloorplan	Dwelling functional floor plan
Aesthetics	Design and visual appeal of the building (architecture)
Renewable_materials	Dwelling consists mainly of renewable materials (construction, interior, exterior)
Lowcarbon_constr	Dwelling had a low carbon footprint in its construction phase
Lowcarbon_heating	Dwelling has a low carbon footprint in its heating and cooling
Recycle_materials	Dwelling recyclability at end-of-lifetime of building
Domestic	Dwelling building materials came from domestic sources
Work conditions	Dwelling construction and material supply offered decent and fair working conditions
Lowpollution	Dwelling construction and material supply minimized environmental pollution
Soliddurable	Solidity and durability
Lowmaintenance	Low maintenance (costs)
Firesafety	Fire safety/Vulnerability to fire
Noiceinsulation	Noise insulation
Healthy_indoor	Healthy indoor environment (air quality)
Preference: "If I had the option to live in a multi-story building … ":	
Prefer MSWB	"I would choose an apartment in a multi-story wooden building"
Prefer multi-story steel/concrete structure	"I would prefer an apartment built of concrete or steel, not wood"

as lower carbon footprint and minimizing environmental pollution. Few significant differences were found between the two countries for variables describing the design or general quality aspects. Concrete or steel construction was more preferred than wood in both Finland and Sweden, which is reflected in the average score and the proportion of respondents giving positive ratings (6–9 on a 9-point scale). Preferences for wooden or non-wooden construction materials were not significantly different between the countries.

A high Kaiser-Meyer-Olkin measure of sampling adequacy (0.899 in Finland and 0.926 in Sweden) supported the suitability of the dataset for factor analysis. This conclusion was also supported by the Bartlett's test of sphericity (Hair *et al.* 2010). The respective solutions in Finland and Sweden generated significant loadings on four or more variables per factor (Fabrigar and Wegener 2012, p. 26).

In both countries, three-factor solutions were extracted, explaining 69% of the variance for Finland and 71% of the total variance for Sweden. The solutions with oblimin rotations are presented in Table 5. Although factor loadings differed between the two countries, they were characterized by identical sets of variables.

The factors were labeled *environmental and social sustainability* (Factor 1), *quality* (Factor 2), and *design* (Factor 3). *Environmental and social sustainability* accounts for environmental aspects, including climate impact, and social sustainability. *Quality* is used as a label for different attributes related to performance, durability, safety, and comfort. *Design* captures attributes related to impression, light, and perceived aesthetic properties. These three labels reflect the factor analysis outcome, although they may be interrelated and also reflect specific aspects of overall quality. Hence, *environmental and social sustainability* may attract customers who perceive this dimension as a quality mark (Roos and Nyrud 2008) while good design has been presented as a seal of quality by Garvin (1984). Furthermore, high-quality products reduce waste and may, therefore, be perceived as good for the environment (Piercy and Rich 2015). Finally, it may be claimed that all three factors refer to different aspects of sustainability (UN-Habitat 2021). However, it was concluded that the selected labels were reasonably simple but accurate for the further analysis.

All correlation coefficients among the factors were positive (Table 6). A high correlation was found between quality and design not only in Finland but also in Sweden. Environmental and social sustainability factor scores correlated in the Swedish sample with the other two factors. This connection was less pronounced among the Finnish respondents who perceived the environmental and social sustainability dimension as a separate dimension in relation to quality and design. It should, however, be noted that the factors were not defined as absolutely identical in Finland and Sweden, as the variable loadings differed for country-level factor solutions.

Table 7 presents average factor scores for sub-populations in the two countries. No differences between sub-groups were found for Factor 1, environmental and social sustainability. Quality presented significant differences between rural and urban respondents in both countries. For Finland, quality requirements were also associated with (female) gender and higher education. In both countries, design aspects were more important for urban than rural respondents.

Linear regression

Two rounds of linear regressions were conducted for each country in which factor scores were independent variables and the dependent variables were ratings on questions about the preference for an apartment in an MSWB and preference for an apartment built using concrete or steel. The regression results are provided in Tables 8 and 9.

In both Finland and Sweden, high requirements for environmental and social sustainability positively influenced the preference for apartments in MSWBs (Table 8). This connection was particularly pronounced for the Swedish sample (based on significance levels and model fit). Conversely, quality requirements were negatively associated with preference for MSWBs. The coefficient for design requirements was insignificant in both country-samples.

A second analysis examined the factors affecting the preference for apartments built in construction materials other than wood ("I would prefer an apartment built of concrete or steel, not wood") (Table 9). The F-value for the Finnish estimation did not indicate a model with a good fit. Additionally, none of the estimated coefficients in this regression were

Table 4. Variables for respondent requirements.

Question	Average ratings: Finlandn (*n* = 200)	Average ratings: Sweden (*n* = 279)	Significant difference (*p*< 0.05, ANOVA and Mann-Whitney)
Requirements: "When choosing a place to live, how important are the following dwelling items to you?"			
View	6.63	6.71	
Natural light indoors	6.99	7.02	
FuncFloorplan	7.19	7.18	
Aesthetics	5.85	5.92	
Renewable_materials	4.78	5.84	*
Lowcarbon_constr	4.88	6.08	*
Lowcarbon_heating	5.32	6.34	*
Recycle_materials	5.08	5.97	*
Domestic	5.04	5.97	*
Work conditions	5.64	6.49	*
Lowpollution	5.30	6.23	*
Soliddurable	7.11	7.35	
Lowmaintenance	6.95	7.24	
Firesafety	7.44	7.57	
Noiceinsulation	7.54	7.50	
Healthy_indoor	7.63	7.77	(*,only significant in Mann-Whitney test)
Preference			
Prefer MSWB (% negative, i.e. <5; % positive, i.e. >5)	4.79 (38%; 40%)	4.98 (34%; 37%)	
Prefer multi-story steel/concrete building (% negative; % positive)	5.61 (25%; 48%)	5.35 (28%; 42%)	

MSWB: multi-story wooden building

significant. Two significant coefficients were observed in the estimation based on Swedish observations. Environmental and social sustainability requirements showed a negative coefficient and quality requirements had a positive association with a preference for building materials other than wood. Hence, in this aspect and for the Swedish sample, the coefficients in Table 9 presented opposite signs compared to Table 8.

Discussion

This study on potential apartment dwellers' housing requirements and their preferences for living in an apartment in an MSWB or in a non-wood building was conducted in Sweden and Finland, two countries characterized by developing wood building sectors and traditions and interest in wood construction among policymakers and stakeholders. The housing material preferences were similar in Finland and Sweden, although national differences were also found concerning requirements for environmental and social sustainability-related properties. In both countries, apartments with concrete or steel as a structural material were on average more preferred than apartments in MSWBs. Multivariate analysis for both countries generated three positively correlated dweller requirement dimensions: *Environmental and social sustainability*, *quality,* and *design*. The main socioeconomic differences in terms of requirement dimensions (as drawn from country-wise factor scores) were found between inhabitants in large cities and respondents living in the countryside or small towns. In the Finnish sample, quality requirements also differed between men and women and between respondents with and without a university degree. The urban/rural difference can be explained by a potential association of wood construction in detached housing being more common in rural areas compared to urban areas in both countries, leading to greater familiarity with the wood material.

Results from linear regressions showed that preference for MSWBs was associated positively with the environmental and social sustainability dimension, negatively with the quality dimension, and insignificantly with the design dimension.

Table 5. Factor solutions for residents' requirements on prospective dwelling in Finland and Sweden.

Variable	Finland, *n* = 200: Factor 1 Environmental and social sustainability	Finland: Factor 2 Quality	Finland: Factor 3 Design	Sweden *n* = 279: Factor 1 Environmental and social sustainability	Sweden: Factor 2 Quality	Sweden: Factor 3 Design
Nice view			0.718			0.759
Natural light indoors			0.759			0.659
FuncFloorplan			0.620			0.439
Aesthetics			0.574			0.580
Renewable_materials	0.898			0.834		
Lowcarbon_constr	0.861			0.884		
Lowcarbon_heating	0.783			0.786		
Recycle_materials	0.899			0.862		
Domestic	0.712			0.778		
Work conditions	0.710			0.666		
Lowpollution	0.903			0.837		
Soliddurable		0.744			0.674	
Lowmaintenance		0.499			0.628	
Firesafety		0.851			0.783	
Noiceinsulation		0.694			0.699	
Healthy_indoor		0.729			0.817	
Variance explained (%)	41	21	7	50	14	8
Eigenvalue	6.6	3.3	1.1	7.9	2.1	1.2
Cronbach's alpha	0.941	0.852	0.796	0.941	0.889	0.789

Maximum likelihood, oblique rotation

Table 6. Factor correlations in Finland and Sweden.

Factor	Factor 1 Environmental and social sustainability	Factor 2 Quality	Factor 3 Design
Finland			
Environmental and social sustainability	1	0.202	0.394
Quality		1	0.609
Design			1
Sweden			
Environmental and social sustainability	1	0.470	0.475
Quality		1	0.546
Design			1

The corresponding analysis of the preference for apartments in a non-wooden multi-story building yielded an insignificant model solution in the Finnish sample. For the Swedish sample, a negative association was established between preference and environmental and social sustainability dimension, and a positive association with the quality factor. The impact of design requirements was indeterminate also in this case. The regression findings provided expected signs for the dimensions of environmental and social sustainability and quality for both countries in the analysis of wooden building preference, and for Sweden in the analysis of concrete/steel preference. However, design requirements did not, in any case, connect to a specific material preference.

The low model fit for the estimation of preference in Finland for non-wooden buildings can be explained, in part, by the limited sample size. It may also be reflective of MSWBs' lower market share in Finland, than in Sweden, and the dominance of concrete as the structural alternative in this building segment (Jussila *et al.* 2022). This may have implied that the choice between apartments in wooden versus non-wooden multi-story houses appears less plausible in Finland. The good model fit for both estimations in the Swedish case may reflect that MSWBs are becoming more common than in Finland.

The findings show that high requirements for environmental and social sustainability-related properties of the building, including the construction process, were associated with a preference for wood, which conforms to the motives behind the pro-wood policy agendas in these two countries (Toppinen *et al.* 2019). Non-wooden materials in the building structure have, in contrast, in the eyes of the public, a comparative advantage over wood in terms of safety and convenience, which may partly arise from the lack of experience of living in a wooden building and possible prejudices toward multi-story wood construction (Lähtinen *et al.* 2021).

The results are consistent with several previous analyses wherein respondents express a preference for wood and wood is perceived as a natural and environment-friendly material (Gold and Rubik 2009, Aguilar and Cai 2010, Høibø *et al.* 2015, Petruch and Walcher 2021). In contrast, this survey also supports results in studies that documented people's concerns over the general quality of wooden apartments (Gold and Rubik 2009, Petruch and Walcher 2021, Viholainen *et al.* 2021). The unexpected lack of association between design requirements and preference for wood construction may be due to the circumstance that design aspects are less tied to the construction materials. This viewpoint—that good or bad design is uncorrelated with the structural material choice of a multi-story house—could consequently overshadow the positive aesthetic perception of wooden material found in earlier studies (Gold and Rubik 2009, Larasatie *et al.* 2018, Lähtinen *et al.* 2019, Petruch and Walcher 2021, Viholainen *et al.* 2021).

Our findings have direct implications for the development of multi-story buildings, and MSWBs in particular. The MSWB industry could develop and strengthen its perceived environmental and social sustainability advantages. This can be supported by applying relevant metrics and indicators of climate impact and environmental and social sustainability performance. Conversely, established construction industry companies using concrete need to improve their perceived environmental and social sustainability rating to improve their competitiveness against MSWBs. The entire construction sector could also, based on this study's results, re-consider combining materials in hybrid solutions to acquire a higher overall customer acceptance.

The wood construction industry sector needs to overcome people's hesitance to choose wood if the quality is a high priority. Several showcase building projects in wood may increase the awareness of MSWBs and reduce public reluctance and mistrust. This may be the case also concerning the established construction industry whose attitude is equally important for the uptake of MSWBs as a mainstream construction technique. Businesses associated with the wood construction industry sector can furthermore continue to incrementally improve the housing quality aspects. If consumer hesitance against wood can be reduced and the needs of future residents are better met, there are prominent

Table 7. Average factor scores in Finland and Sweden.

	Finland			Sweden		
	Factor			Factor		
	Environmental and social sustainability	Quality	Design	Environmental and social sustainability	Quality	Design
Women	0.074	0.138*	0.045	0.107	0.076	0.082
Men	−0.085	−0.140*	−0.056	−0.108	−0.077	−0.083
Age <35 years	0.007	0.055	−0.045	−0.136	−0.127	−0.092
Age ≥35 years	−0.002	−0.017	0.014	0.071	0.067	0.048
Rural or small city	−0.080	−0.211*	−0.209*	−0.087	−0.167*	−0.160*
City with >100,000 inhabitants	0.040	0.106*	0.105*	0.056	0.107*	0.102*
Up to university education	−0.054	−0.099*	−0.082	−0.029	0.011	−0.010
University education	0.074	0.137*	0.113	0.054	−0.020	0.019

* indicates significant differences between sub groups. The significant differences are based on non-parametric Mann-Whitney test ($p < 0.05$).

Table 8. Regression results for prospective residents' preferences for an apartment in an MSWB*.

	Finland: Robust estimation ($n = 198$)			Sweden: Linear regression ($n = 276$)		
Coefficient	Coefficient	Robust Std. Error	*p*-value	Coefficient	t-value	*p*-value
Intercept	4.722	0.149	<0.001	4.895	0.120	<0.001
Environmental and social sustainability	0.338	0.165	0.042*	0.878	0.156	<0.001**
Quality	−0.539	0.251	0.033*	−0.523	0.172	0.003**
Design	0.283	0.279	0.311	0.026	0.192	0.891
	$F = 3.709$; $p = 0.013$			$F = 11.806$; $p = 0.001$		
	$R^2 = -0.054$			$R^2 = 0.115$		
	Adj $R^2 = -0.040$			Adj $R^2 = 0.105$		

"If I had the option to live in a multi-story building, I would choose an apartment in a multi-story wooden building"
*$p < 0.05$, **$p < 0.01$, two-tailed.

opportunities for increased customer value creation and branding for MWSB businesses (Lähtinen *et al.* 2022).

The indeterminate role of design-related requirements for preferences offers the potential to develop and feature wooden buildings as "beautiful housing designs." Although preferences among potential residents seem to be divided on this aspect, proactive strategies for functional and aesthetically pleasing wood design may capture market advantages. However, this should be combined with an increased rate of standardization for the multi-story wood construction process to maintain cost-efficient processes. The potential for good wood design complies with studies characterizing wood as an attractive material (Jonsson *et al.* 2008), and with the vision statement on wood building in the New European Bauhaus initiative (European Commission 2021b).

The results of this study can guide both product development, in instances where preferences reflect real performance gaps concerning prospective dweller requirements, and market communication, where reluctance to choose wood is based on misconceptions. A targeted application of the findings on these two actions can lead to increased customer value and market share growth of MSWBs.

However, the study could not identify distinct segments of potential residents in multi-story houses that motivate customized information or marketing efforts. Conversely, preferences spanned different socioeconomic categories, which is consistent with previous research (Aguilar *et al.* 2023). Only geographical differences (between urban and rural markets and between the two countries) seem to have an impact on requirements.

This study does not investigate all aspects of housing preferences. It explores the relationship between requirements and preferences for apartments built with wooden versus non-wooden construction materials. Other possible factors for the selection of construction materials may include experiences, the significance of local building traditions, and the availability of different structural materials in the housing stock. Location is another important factor in the choice of residence. However, this consideration was not within the scope of this study and was not expected to be connected to the building material.

The results from regression models need to be interpreted with caution, and their low R^2 values indicate that, although prospective residents' requirements influence the material preference, this association is not strong. That is, the respondents' preferences for a building material may not always be so much of a prioritized issue. Nevertheless, our findings indicate that the preferred building material correlates significantly with a set of resident requirements. Another limitation is that our study used a selection from a consumer panel-based data set. However, the effects of the explanatory variables were, in most estimations (except one), reasonable which may support their validity. Although the use of a limited but more targeted respondent group (prospective apartment dwellers) may have improved reliability, it is advisable to exercise caution when the findings are generalized.

Future research could use more elaborate models for assessing various classes of factors that influence the preferred housing choice in addition to material-based variables. Another avenue for research in this nascent MSWB area would be to use qualitative approaches, such as multi-stage means-end methodologies, to discern the decision processes preceding housing choices and to create narratives based on residents' experiences of living in MSWBs and how the appropriation process may change their perspectives (e.g. see case study by Viholainen *et al.* 2021).

Conclusions

This study is novel and relevant in its focus on potential apartment dwellers' primary requirements and their associations with preferences for structural housing material. The study's

Table 9. Regression results for prospective residents' preferences for an apartment in steel or concrete*.

	Finland, Robust estimations			Sweden, Linear regression		
Coefficient	Coefficient	Robust Std. Error	*p*-value	Coefficient	Std Error	*p*-value
Intercept	5.577	0.151	<0.001	5.338	0.117	<0.001
Environmental and social sustainability	−0.004	0.177	0.983	−0.669	0.152	<0.001**
Quality	0.347	0.229	0.132	0.364	0.168	0.031*
Design	−0.154	0.276	0.576	0.347	0.187	0.065
	$F = 0.922$; $p = 0.431$			$F = 7.617$; $p = 0.001$		
	$R^2 = -0.014$			$R^2 = 0.078$		
	Adj $R^2 = -0.001$			Adj $R^2 = 0.067$		

*If I had the option to live in a multi-story building, I would prefer an apartment built of concrete or steel not wood.
*$p < 0.05$, **$p < 0.01$, two-tailed.

main contribution is to establish the association between customers' expectations and preferences for construction materials, which potentially determines market share development for MSWBs. The findings identify three latent requirement dimensions: environmental and social sustainability, quality, and design. Preference to live in an MSWB apartment was positively associated with respondents' requirements for environmental and social sustainability, and negatively associated with requirements for quality-related attributes. Opposite relationships were found in the Swedish sample for non-wooden preferences. Design expectations had no significant association with preferences for MSWBs or steel/concrete housing in either country. The findings can help the development of a sustainable and competitive MSWB sector through increased customer value and targeted marketing.

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