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Consumer housing values and prejudices against living in wooden homes in the Nordic region

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Highlights

- Consumers in the Nordic region are similar in their housing value expectations and prejudices against building with wood.
- Physical properties of houses seem to be less important as constituents of housing value for the consumers compared to intangible factors related to lifestyles and milieus.
- Urban consumers are the most prejudiced against wood building, and thus supply of homes meeting their value expectations is of a critical importance for sustainable urbanization.

Abstract

So far, consumer housing values have not been addressed as factors affecting the market diffusion potential of multi-storey wood building (MSWB). To fill the void, this study addresses different types of consumer housing values in Denmark, Finland, Norway, and Sweden (i.e., Nordic region), and whether they affect the likelihood of prejudices against building with wood in the housing markets. The data collected in 2018 from 2191 consumers in the Nordic region were analyzed with exploratory factor analysis and logistic binary regression analysis. According to the results, consumers' perceptions on ecological sustainability, material usage and urban lifestyle were similar in all countries, while country-specific differences were detected for perceptions on aesthetics and natural milieus. In all countries, appreciating urban lifestyle and living in attractive neighborhoods with good reputation increased the likelihood of prejudices against wood building, while appreciation of aesthetics and natural milieus decreased the likelihood of prejudices. In strengthening the demand for MSWB and sustainable urbanization through actions in businesses (e.g., branding) and via public policy support (e.g., land zoning), few messages derive from the results. In all, abreast with the already existing knowledge on the supply side factors (e.g., wood building innovations), more customized information is needed on the consumer-driven issues affecting the demand potential of MSWB in the housing markets. This would enable, e.g., both enhancing the supply of wooden homes for consumers appreciating urban lifestyle and neighborhoods and fortifying positive image of wood among consumers especially appreciating good architecture and pleasant environmental milieus.

Keywords housing markets; industrial building; structural material; sustainable urbanization; timber structures; urban construction; value expectations
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1 Introduction

Multi-storey wooden building (MSWB) was hindered for decades by fire regulations, which originated from city fires in the 1800s and early 1900s (Waugh 2015; Kuzman and Sandberg 2017). The market diffusion of the MSWB speeded up in the 1990s when innovations made in engineered wood products (e.g., cross-laminated timber and glulam) enabled prefabrication and development in construction technologies. As a part of public policy support, changes in building codes were made (Hildebrandt et al. 2017; Vihemäki et al. 2020), which also enhanced increasing societal interest towards sustainable urbanization (Bulkeley 2010).

MSWB is expected to bring new business opportunities both for wood and building industries, increase resource-efficiency of the building processes and in the use of houses, and enhance well-being of builders and residents (Lähtinen et al. 2016; Evison et al. 2018; Rhee 2018). Due to industrialized processes (e.g., prefabrication, off-site production) (Brege et al. 2013; Kuzman and Sandberg 2017) wood building may renew the whole construction sector (Stehn et al. 2020), if companies have capabilities to adjust their strategies to meet the changing expectations in the business environment (Toppinen et al. 2019).

Like building technologies, also housing markets are affected by path dependencies (e.g., physical structures, features of ownership) (Ruonavaara 2012). Wood construction has strong traditions in the forest-rich countries of Finland, Norway, and Sweden, where 90% of the detached houses are built with wood (Schauerte 2010). In comparison, in Denmark the most common structural materials in the detached houses are bricks and concrete, although wood is being used, e.g., in roof structures (Oropeza-Perez and Østergaar 2014). Regarding housing stock, in Finland and Sweden the proportion of homes in multi-storey houses (Andersson et al. 2007) is higher compared to Norway and Denmark (Lujanen and Palmgren 2004; Kristensen 2007; Andersen 2012). By countries the ownership structures in multi-storey apartments also vary; while in Finland and Norway a large proportion of multi-storey apartments are in direct ownership of the occupants, in Sweden and Denmark larger shares of them are rental apartments or co-operatives (Ruonavaara 2012; Kristensen 2007).

So far, most of discussions on MSWB marketent potential has focused on the regulations with effects on the possibilities to use wood as the load-bearing material, the technological properties of timber and engineered wood products (e.g., fire resistance, acoustics), and process development (e.g., prefabrication and off-site building) (Coggins 1989; Johansson 1995; Stehn and Bergström 2002; Lattke and Lehmann 2007; Mahapatra and Gustavsson 2008; Roos et al. 2010). Compared to those aspects related to supply of MSWB and adaptation to circumstances in the markets (Lähtinen 2007), customers' preferences and attitudes to MSWB have gained less attention, although customer value-added has been recognized as crucial for the competitiveness of any wood industry especially since the early 2000s (Wagner and Hansen 2004; Lähtinen and Toppinen 2008).

During the 2010s, research interests towards the MSWB demand (e.g., perceptions of the general audience and experiences of end-users) have increased (Høibø et al. 2015; Larasatie et al.

2018; Viholainen et al. 2020a). Despite this, there are still considerable gaps in understanding how different types of citizens perceive the value of wood in building structures, and what kind of housing value MSWB could provide for residents (Lähtinen et al. 2019a; Viholainen et al. 2020a). In Germany, Gold and Rubik (2009) noted that while consumers may rank high so-called soft criteria to use wood in housing (such as well-being, aesthetics and material eco-friendliness), these are insufficient alone to drive up significant demand for wood in home building. For example, there are also country-specific cultural differences in appreciation of wood in building between different European countries (Viholainen et al. 2020b).

For example, according to Antikainen et al. (2017) and Toppinen et al. (2018b), wood building provides solutions for sustainable urbanization and circular bio-based economy. Thus, although wood as a renewable building material brings possibilities to enhance the sustainability of all types of houses (e.g., single-family homes) (Jussila and Lähtinen 2020), in this study industrial wood construction is looked especially from the perspective of MSWB. Enhancement of market diffusion potential of MSWB especially as a solution for sustainable urbanization requires connecting the discourse on wood construction with the findings made in housing market studies especially in relation to factors affecting the demand of homes.

Lifestyle (e.g., habits, attitudes and sense of self-identity) strongly affect consumer housing preferences abreast with socio-demographic issues (e.g., household income and family size) (Coolen and Hoekstra 2001; Gram-Hanssen and Bech-Danielsen 2004; Gibler and Tyvimaa 2014). Furthermore, self-identities such as profession and lifestyle also affect consumer expectations on both houses and their locations in specific residential milieus (Mahmud et al. 2009; Savolainen 2009; Frenkel et al. 2013).

To strengthen the MSWB business in the growing urban housing markets, more information is needed on how consumers perceive building with wood (Høibø et al. 2018) especially as a structural material of their homes. So far, most of the research related to the topic has addressed positive attitudes towards wood as a construction material (Gold and Rubik 2009; Burnard et al. 2017; Viholainen et al. 2020a). Although prejudices and attitudes towards wood construction was studied among German consumers by Gold and Rubik (2009), no cross-country information exists about the types of prejudices against building among consumers with differing housing values.

In previous studies, the potential for market diffusion for MSWB has not been addressed in the context of housing markets, where both physical properties of houses and their surroundings affect the consumer demand for homes (Kauko 2006a; Gram-Hanssenand and Bech-Danielsen 2004; Gibler and Tyvimaa 2014). Due to this, it is neither known how consumer housing values might affect prejudices against building with wood, which affects the demand of homes built with wood (Lähtinen 2019a). To fill this void, the first aim of the study is to explore consumer housing values in Denmark, Finland, Norway and Sweden (i.e., the Nordic region) both from the perspective of houses and their locational properties. The second aim is to analyze how the consumer housing values are connected to the likelihood of consumer prejudices against building with wood in each of countries.

The two aims of the study are addressed with the following research questions: 1) What types of consumer housing values may be identified in each of the countries, and do the expectations resemble or differ from each other between different countries? 2) Do different types of consumer housing values increase or decrease the likelihood of prejudices against building with wood, and do the prejudices affect similarly or differently attitudes towards building wood between different countries? As a definition of prejudice in our study (i.e., negative perception, which is not supported by knowledge) we follow the definition of Cambridge dictionary online, which defines prejudice as "....an unfair and unreasonable opinion or feeling, especially when formed without enough thought or knowledge." (https://dictionary.cambridge.org/dictionary/english/prejudice).

2 Analytical framework to assess consumer housing values

Structures of Housing Provision (SHP) describe supply and demand in the housing markets in specific geographical areas at a specific point of time through spheres of consumption, production and exchange (Ball and Harloe 1992; Ball 1998; Burke and Hulse 2010). Consumer housing values are a part of the consumption sphere comprising consumer preferences and processes to rent, purchase and choose homes, which are linked, e.g., through path dependencies with the ownership of housing stock in specific regions. In comparison, the production sphere is composed of choices of construction companies to build houses and decisions of public authorities to zone land for building and give associated regulations.

Thus, not only companies (e.g., the ones in MSWB businesses) and consumers making choices on their homes affect the sustainability of housing. Through decisions in land zoning connected to MSWB (Lähtinen et al. 2019b) and practices to grant building permits (Jussila and Lähtinen 2020), market demand for houses built in attractive locations and milieus supporting local livelihood and citizen well-being can be enhanced in line with United Nations Sustainable Development Goals (SDGs) (for connections between housing choices and SDGs in the European context see Wolff et al. 2017).

Abreast with production and consumption spheres, the exchange sphere relates to governance of monetary instruments within financial institutions enabling renting, selling and use of houses in the markets (Ball 2003; Burke and Hulse 2010). According to SHP, consumption, production and exchange are conducted in networked relationships between the actors (Burke 2012). Thus, SHP perspective creates a more comprehensive understanding of how different actors (e.g., home purchasers and renters, building developers and builders, public authorities and urban planners, banks and insurance companies) affect the potential for sustainable urbanization through housing market mechanisms.

In reference to SHP, so far the existing research on wood building and especially MSWB, has mainly focused on supply sphere, i.e., the innovations and business models (Goverse et al. 2001; Stendahl and Roos 2008; Brege et al. 2013; Hurmekoski et al. 2015; Toppinen et al. 2018a; Lazarevic et al. 2020), and the role of land use planning (Franzini et al. 2018; Lähtinen et al. 2019b). In comparison, issues related to consumption sphere, i.e., resident perceptions, expectations and lifestyle encompassing both the building material and the neighborhood have attracted less attention. Yet, it has been found that lifestyle strongly affects consumer choices in the housing markets (Hasu et al. 2017).

Furthermore, the wood building studies addressing the consumption sphere have mainly centered on consumer views on the properties of wood in houses (e.g., building structures, facades or interiors) instead of addressing the expectations as an entity composed of both the characteristics of houses and other housing preferences regarding perceptions on, e.g., attractiveness of the location (e.g., Winston 2009). By focusing broadly on different constituents of consumer housing values affecting the consumption sphere, understanding the demand for MSWB may be enhanced.

From the perspective of economics, choosing a home is driven by complex behavioral issues, such as social environment, and thus consumer choices are not based only on, e.g., characteristics of houses (Marsh and Gibb 2011). Conceptually, Gram-Hanssenand and Bech-Danielsen (2004, p. 25) have described the difference between a house and a home in the context of Danish single-family house owners: “A house and a home are not the same… A house is a physical frame for its residents, while at the same time the residents mark the house and give it a special meaning by the way they maintain, use and equip it, by their daily activities and through social relations in the house and in the neighborhood.…. and to others again it could be the forest nearby that they

mostly related to.". Additionally, the relative importance of properties of houses and their location may differ by countries (Kauko 2006a).

In this study consumer housing value is defined as a combination of the preferences on houses and the living environment, affected by other expectations in life related either to individuals or their family members (Gram-Hanssen and Bech-Danielsen 2004; Kauko 2006a; Winston 2009; Marsh and Gibb 2011; Hasu et al. 2017). Compared to traditional approach on process of home selection assuming that consumers have stable, well-defined preferences and perfect knowledge (Marsh and Gibb 2011), especially during the 2000s the complexity of undefined and unmeasurable factors such as consumer personalities, lifestyle, and roles of family members have gained more attention in the housing market studies. As a result of this, socio-psychological aspects have become an integral part in assessing consumer housing values (Coolen and Hoekstra 2001; Sirgy et al. 2005; Mahmud et al. 2009) addressed also in this study in reference to market diffusion potential of MSWB.

The aggregate demand in the housing markets (Maclennan and Tu 1996) is a result of individual consumption choices within households affected both by economic (e.g., house prices, labor market) and social environment (e.g., consumption patterns in the reference groups, characteristics of households) (Marsh and Gibb 2011). The impacts of social environment on housing preferences and choices is connected to consumer self-images and how they would like to be perceived among the people they consider as their reference groups (Sirgy et al. 2005). As a result of that, decision-making processes on the housing market not only concern choices between materials or design of houses, but also comprise decisions on, e.g., living environment (Kauko 2006a) connected to consumers' lifestyles (Hasu et al. 2017). In addition, abreast with rational considerations, final decisions on housing are affected by more intuitive factors such as social norms, attitudes, emotions, and impacts from reference groups (e.g., family-members, friends and professionals like real-estate agents) (Coolen and Hoekstra 2001; Levy et al. 2008; Brinkmann 2009).

The analytical framework of this study to classify different components of consumer housing value is based on the hierarchical structure illustrated by Kauko (2004, 2006b) (Fig. 1). The model has been employed with an analytical hierarchy process approach in the context of the Netherlands (2004) and Finland (2006b) to empirically assess the components of property value formation among citizens.

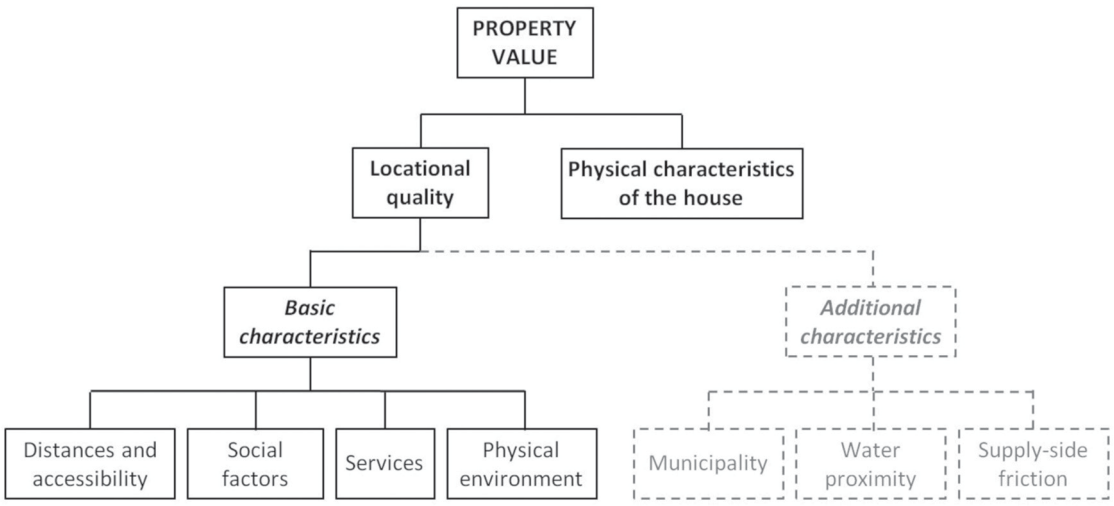

Fig. 1. Analytical framework of this study employed to define the dimensionality of consumer housing value (mod. from Property Value Formation model of Kauko 2004, 2006b) (characteristics excluded from the empirical assessments of this study are illustrated with light grey).

The model illustrates consumer housing value as a combination of physical characteristics of houses, and attributes describing the locational quality of homes (i.e., basic and additional characteristics). The additional characteristics of location do not directly address housing preferences, but the availability of dwellings (i.e., supply-side friction), circumstances in municipalities (e.g., taxation), or proximity of water (assessed also through physical location). Thus, only the basic attributes on locational quality were employed in the empirical analysis of this study to evaluate the consumer housing values and how do those values affect likelihood of being prejudiced against living in homes built with wood.

3 Material and methods

3.1 Data gathering in reference to Property Value Formation model and connections with prejudices against building with wood

The material of this study was collected as a part of a broader pre-tested questionnaire based on a dataset originally gathered in the Nordic NOFOBE-project (http://nordicforestresearch.org/nofobe/) in seven countries during November and December 2018. As a method of data collection, internet-based consumer panel was employed. The focus of the survey was to assess citizens' housing material preferences especially in the context of MSWB with several quantitative multiple-choice questions and an open-ended question (for the qualitative part of the data, see results of Viholainen et al. 2020b). Most of the quantitative questions were assessed with a nine-point Likert scale measurement (e.g., 1 = Not important… 9 = Very important) including also the "Don't know" option (value 10).

A demographically (i.e., age, gender, geography) representative sample was ensured by distributing the survey in pre-defined quotas to the panels in each country until the representative demographic characteristics of the sample were obtained. Although the use of a consumer panel has its limitations and comes with some concerns in data collection (i.e., self-selection, sample integrity and data quality) (Smith et al. 2016; Chandler et al. 2019) in the context of multi-country comparisons, it was considered to be the most reasonable option due to quick response time, cost-efficiency and ability to ensure a large sample (Hays et al. 2015) (more detailed description of data collection process, see Viholainen et al. 2020b).

This study relies on data from the four Nordic countries, Denmark, Finland, Norway and Sweden. Prior to the implementation of analysis, to be congruent with the analytical framework and empirical objectives of the study, information in the broader dataset on the four target countries of this study (n = 4004) was refined to include in the dataset only those respondents, whose opinions on the usage of wood as a structural material of their homes could be defined unambiguously.

In the data refinement procedure, two types of respondents were removed from the dataset: the ones without any opinions on the usage of structural materials in their homes, and the ones preferring wood in combination with other materials (i.e., ones choosing statements options "I do not know/remember" and "…wood in combination with other materials" in Question (10A) "If I could choose freely, I would prefer the structural (load-bearing) material in the building I live in to be…"). "I do not know/remember" indicated that respondent had no opinion on the topic, while statement "…wood in combination with other materials" (i.e., "hybrid" structures) may have meant both positive attitude (e.g., willingness to advance the usage of wood through combining it with other materials) or negative attitude (e.g., compliance to accept the usage of wood if combining it with other materials) of a respondent towards the usage of wood in building structures of their homes.

As a result of the data refinement procedure, the material comprises altogether 2191 responses from Denmark (n = 571, 26.1%), Finland (n = 573, i.e., 26.1%), Norway (n = 490, i.e., 22.4%), and Sweden (n = 557, i.e., 25.4%). Since the current form of housing does not directly reflect future housing preferences even in the short term (e.g., people may move from multi-storey houses to single-family houses and vice versa), data comprises respondents living in all types of dwellings.

As the first step in implementation of the exploratory factor analysis (EFA) (e.g., Harman 1976) variables in the survey Question 14 (14B, 14C, 14D, 14E but excluding 14A which concerned ranking of attributes) connected to the analytical framework (Fig. 1) were selected in the analysis. The selection procedure was needed, since in the original data gathering, information on Question 14 was planned to be utilized also for other research purposes than assessment of housing value of respondents. Due to this, the number of variables related to physical characteristics of houses was considerably higher than the quantity of variables describing their locational qualities. Thus, to condense the overlapping information on the physical characteristics, variables assessing preferences on the novelty of houses and recent renovations were omitted, since both of them are measures of the condition of the house assessed through other variables in Question 14 (e.g., solidity and durability, maintenance frequencies and cost, and materials used in structures, indoors and outdoors).

In addition, variables describing aspects ensured by the legislation i.e., fire safety, sound proofing, healthy indoor air, and energy-efficiency of building (Gold and Rubik 2009; Høibø et al. 2015) were also excluded from the models. Compared to variables reflecting individual preferences (e.g., design, types of materials, or attractiveness of location), fulfillment of the housing needs connected to regulation represent issues defined by legislators not to be compromised no matter how individual respondents may value them. Furthermore, since fire safety, acoustics and healthy indoor air are also aspects causing concern or perceived as benefits of MSWBs (Burnard et al. 2017), individual perceptions on those issues were also assumed to be reflected in the further analysis of the study (i.e., prejudices against the usage of wood in building). Table 1 illustrates the linkages between the analytical framework, statements in the survey related to the theory on the property value formation and the variables chosen in the data of the study to evaluate consumer housing values.

As the second step of the data refinement procedure, and for the execution of the binary logistic regression (BLR) analysis (Pampel 2000), the existence of prejudices towards the usage of wood as a structural material in buildings among the respondents was defined. As described in Fig. 2, it was implemented as the combination of the level of acceptance towards the usage of wood as the primary structural material in the homes of respondents (Question 10A) the level of interest and knowledge on wood building (Question DEMO1).

To be defined as prejudiced (i.e., person with negative perception, which is not supported by knowledge) in line with the definition of Cambridge dictionary online presented in Introduction, the respondent both had to 1) prefer other materials than wood in building (10A), and 2) be without any interest and knowledge in wood buildings (DEMO1). On the contrary, respondents who had selected 1) "…primary wood" (10A) AND 2) "I find wood construction interesting, but have limited knowledge" or "I have deep interest in and knowledge of wood construction" or "I don't know" (DEMO1) were classified as ones with no prejudices. Therefore, people at least with some level of interest in wood construction were supposed to have more positive attitudes towards different types of building solutions (e.g., the usage of wood in building structures) and thus they were classified into the group of respondents with no prejudices. As a result of this procedure, the respondents categorized as the ones with prejudices were given the value 1 (i.e., phenomenon exists), and the other respondents the value 0 (i.e., phenomenon does not exist) for implementation of the regression analysis.

Table 1. Categories from the analytical framework (bolded) and the survey variables on Statement 14 employed in the empirical analysis on consumer housing value dimensions in Denmark, Finland, Norway, and Sweden.

PROPERTY VALUE	Survey statements related to the analytical framework on property value formation (the variables excluded in the analysis are in parentheses)	
Physical characteristics of the house	"For the house or apartment in itself, indicate the importance of…	
	14 C2	… the amount of natural light indoors"
	14 C3	… functional floorplan"
	14 C6	… design and visual appeal of the building (architecture)"
	(14 C4	… newly built")
	(14 C5	… recently renovated")
	"For environmental and sustainability aspects related to the building you live, indicate the importance of…	
	14 D1	…the building consists mainly of renewable materials (construction, interior, exterior)"
	14 D2	…the building has a low carbon footprint in construction"
	14 D3	…the building has a low carbon footprint in use"
	14 D5	…recyclability at end-of-lifetime of building"
	(14 D4	…the building is well insulated and use little energy for heating or air-conditioning")
	"For construction and material attributes related to the building you live, indicate the importance of…	
	14 E1	…solidity and durability"
	14 E2	…maintenance (frequencies and costs)"
	14 E6	…materials used in load-bearing construction (non-visible materials)"
	14 E7	…indoor visible materials (floors, walls and ceilings)"
	14 E8	…outdoor visible materials (outdoor cladding)"
	(14 E3	…fire safety/vulnerability to fire")
	(14 E4	…insulation regarding sound")
	(14 E5	…healthy indoor environment (e.g. air quality)")
Locational quality Basic characteristics	"For the location and neighborhood of your home, indicate the importance of…	
Distances and accessibility	14 B3	…short distance to day-care "
	14 B4	…short distance to schools"
	14 B6	…short distance to family or friends"
Social factors	14 B8	…located in an attractive community with a good reputation"
Services	14 B2	…short distance to city center (shops and other services)"
	14 B5	…short distance to leisure facilities (sports parks/training center/pool etc.)"
Physical environment	14 B1	…nice view from the area"
	14 B7	…short distance to recreational areas: parks/forests/water"
	*14 C1	…nice view from the house or apartment"

*In the original survey questionnaire this was classified as "Physical attribute of the house", but since it relates more to the environment than to physical attributes of the house, it was re-categorized into the "Physical environment".

In interpreting the BLR analysis results, positive coefficients in the models for particular consumer housing value dimensions formed as a result of country-wise factor analysis were to be considered to increase the likelihood in the existence of prejudices against the usage of wood as the main structural material in building. In contrast, negative coefficients were to be regarded as a decrease in the likelihood of prejudices against building with wood among specific consumer housing value dimensions. As indications of statistical significance of the results, the following threshold values were employed: $0.05 \leq$ p-value < 0.1 = suggestive evidence on statistical significance, $0.01 \leq$ p-value < 0.05 = moderate evidence on statistical significance, and < 0.01 p-value = very strong evidence on statistical significance.

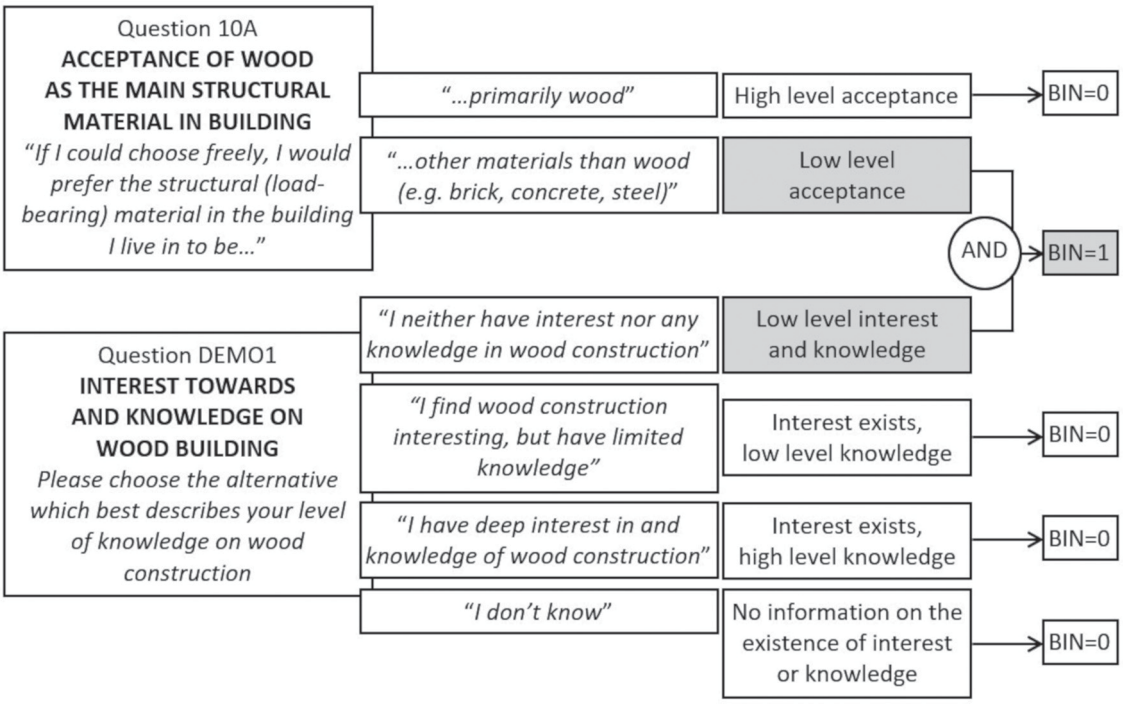

Fig. 2. Procedure of defining respondents with prejudices against the usage of wood as a structural material in building.

3.2 Exploratory factor analysis and binary regression analysis to assess formation of property value components and their impacts on the prejudices against MSWB

As methods of analysis, EFA (Harman 1976) and BLR analysis (Pampel 2000) run with IBM SPSS Statistics 25.0 software. As the first stage of the analysis, factor analysis with Kaiser normalization, Maximum Likelihood Estimation and Varimax rotation (i.e., seeking for factor solution with original variable loadings, which are either as large or as small as possible) was employed (see Table 1 for the 21 variables). As the fundamental objective of EFA is to investigate whether the large set of variables can be represented more parsimoniously (Fabrigar and Wegener 2011), it was employed to identify underlying dimensions of consumer housing value in the demand sphere of the housing markets (e.g., Ball 2003) from the perspective of their expectations on the physical characteristics of houses and their locational quality as components for property value formation.

In EFA, Kaiser's eigenvalue >1 rule was employed as a background criterion, to decide the number of factors to be retained. At this phase, the results of the Kaiser-Meyer-Olkin measures (a minimum value of 0.50 for sampling size adequacy) and Bartlett's test of sphericity (i.e. correlation among original variables) were scrutinized. In constructing the country-wise models, all one variable factor cases and original variables with loadings below 0.4 were removed from the factor solutions combined with scrutiny of Cronbach alphas to check the reliability of the analysis. In addition, to find a valid solution, both empirical and theoretical consistency of the original variable loadings in factors was examined with additional scrutiny of their signs. As a result of the EFA, country-specific latent variables explaining respondents' expectations on the physical characteristics of houses and the locational quality of the houses were formed. Identified latent variables (i.e. dimensions) were saved as factor scores that were employed in the BLR analysis.

As the second stage of the analysis, a BLR analysis applicable to model relationships between a dichotomous dependent choice variable and independent variables was utilized. Evidence of prejudice was thus captured as a categorical binary variable $\left(y_i \in \{0,1\}\right)$ where 1 = prejudice and

0 = otherwise. Analysis of responses was motivated by a latent function where prejudice (y^*) is unobservable but a function of a vector of explanatory variables (X):

$$y^* = f(X)\,. \tag{1}$$

Observable binary variable y is an expression of an underlying latent relationship:

$$y = \begin{cases} 1, \; if \; y^* < 0 \\ 0, \; if \; y^* \leq 0 \end{cases}, \tag{2}$$

that allows the estimation of the odds of $y = 1$ as a linear prediction of explanatory variables with a logit link as:

$$\log \frac{prob\;(y=1)}{1-prob\;(y=1)} = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_j X_j + \varepsilon\,, \tag{3}$$

where α is an intercept term, β are parameters associated with and j explanatory variables, and ε a random error of logistic distribution symmetric about zero (Wooldridge 2010). Parameters and standard errors were estimated using maximum likelihood. In the BLR analysis factor scores on consumer housing value dimensions in Denmark, Finland, Norway and Sweden were employed as independent variables for modelling the likelihood of the existence of prejudices (see Section 3.1). Positive parameters indicate an increase in the association with the likelihood of prejudice against building with wood, while negative coefficients indirect decrease in the likelihood of prejudice. The statistical significance of each β coefficient was tested with Wald's χ^2 and the models' general goodness of fit was tested using the χ^2, Cox & Snell's R^2 and Nagelkerke's R^2 tests-statistics. Odds ratios (i.e. odds of prejudice over non-prejudice) were calculated after exponentiating regression parameters.

Predictive model accuracies were additionally evaluated by comparing their predicted group membership (i.e., prejudices against building with wood predicted by the models) with observed group membership (i.e., information on prejudices as recorded in the data) (Pampel 2000). As a result of the second and final stage of our analysis, factor scores derived from factor solutions representing different consumer housing value dimensions by countries within the Nordic region (i.e., physical characteristics of houses and the locational quality of the house) were tested in reference to the existence of prejudices against building with wood.

4 Results

4.1 Overview on the responses by questionnaire statements

As background results for the EFA and BLR analysis, the frequencies of the responses on the statements presented in Table 1 were evaluated by Likert scale measures. The results in Table 2 show that by statements the Likert scale responses on the statements related to consumer housing value differed considerably. In general, respondents shared quite similar opinions, e.g., on the importance of the basic physical properties of houses (e.g., on functional floor plan, maintenance, indoor and outdoor materials, solidity and durability) when considering relevant aspects in expectations on housing. Especially solidity and durability of houses was an issue, which none of the respondents considered to be without any importance.

Table 2. Frequencies for responses for each questionnaire statement (percentages in parentheses) for Denmark, Finland, Norway, and Sweden, at levels 1–9 (where 10 stands for "Don't know") (n = 2191). The frequencies with highest percentages by statements are **bolded**.

STATEMENT		1	2	3	4	5	6	7	8	9	10
14 C2	… the amount of natural light indoors"	25	14	42	96	268	437	576	343	381	9
		(1.1)	(0.6)	(1.9)	(4.4)	(12.2)	(19.9)	(**26.3**)	(15.7)	(17.4)	(0.4)
14 C3	… functional floor plan"	19	7	28	63	175	337	600	439	502	21
		(0.9)	(0.3)	(1.3)	(2.9)	(8.0)	(15.4)	(**27.4**)	(20.0)	(22.9)	(1.0)
14 C6	… design and visual appeal of the building (architecture)"	100	63	163	207	388	455	410	211	181	13
		(4.6)	(2.9)	(7.4)	(9.4)	(17.7)	(**20.8**)	(18.7)	(9.6)	(8.3)	(0.6)
14 D1	…the building consists mainly of renewable materials (construction. interior. exterior)"	141	70	157	207	399	373	323	164	149	208
		(6.4)	(3.2)	(7.2)	(9.4)	(**18.2**)	(17.0)	(14.7)	(7.5)	(6.8)	(9.5)
14 D2	…the building has a low carbon footprint in construction"	169	71	142	177	405	334	307	177	146	263
		(7.7)	(3.2)	(6.5)	(8.1)	(**18.5**)	(15.2)	(14.0)	(8.1)	(6.7)	(12.0)
14 D3	…the building has a low carbon footprint in use"	129	64	128	156	364	349	375	212	216	198
		(5.9)	(2.9)	(5.8)	(7.1)	(16.6)	(15.9)	(**17.1**)	(9.7)	(9.9)	(9.0)
14 D5	…recyclability at end-of-lifetime of building"	209	80	160	170	336	328	315	184	162	247
		(9.5)	(3.7)	(7.3)	(7.8)	(**15.3**)	(15.0)	(14.4)	(8.4)	(7.4)	(11.3)
14 E1	…solidity and durability"	6	4	14	30	135	297	511	506	651	37
		(0.3)	(0.2)	(0.6)	(1.4)	(6.2)	(13.6)	(**23.3**)	(23.1)	(29.7)	(1.7)
14 E2	…maintenance (frequencies and costs)"	10	5	23	59	221	333	585	434	473	48
		(0.5)	(0.2)	(1.0)	(2.7)	(10.1)	(15.2)	(**26.7**)	(19.8)	(21.6)	(2.2)
14 E6	…materials used in load-bearing construction (non-visible materials)"	60	32	76	121	333	360	441	292	321	155
		(2.7)	(1.5)	(3.5)	(5.5)	(15.2)	(16.4)	(**20.1**)	(13.3)	(14.7)	(7.1)
14 E7	…indoor visible materials (floors. walls and ceilings)"	24	11	43	74	266	383	545	429	367	49
		(1.1)	(0.5)	(2.0)	(3.4)	(12.1)	(17.5)	(**24.9**)	(19.6)	(16.8)	(2.2)
14 E8	…outdoor visible materials (outdoor cladding)"	64	28	65	130	311	407	509	345	263	69
		(2.9)	(1.3)	(3.0)	(5.9)	(14.2)	(18.6)	(**23.2**)	(15.7)	(12.0)	(3.1)
14 B3	…short distance to day-care "	748	153	152	127	232	208	227	142	162	40
		(**34.1**)	(7.0)	(6.9)	(5.8)	(10.6)	(9.5)	(10.4)	(6.5)	(7.4)	(1.8)
14 B4	…short distance to schools"	663	147	160	141	223	248	272	151	152	34
		(**30.3**)	(6.7)	(7.3)	(6.4)	(10.2)	(11.3)	(12.4)	(6.9)	(6.9)	(1.6)
14 B6	…short distance to family or friends"	154	69	201	175	435	365	384	199	196	13
		(7.0)	(3.1)	(9.2)	(8.0)	(**19.9**)	(16.7)	(17.5)	(9.1)	(8.9)	(0.6)
14 B8	…located in an attractive community with a good reputation"	120	51	104	137	326	382	470	297	297	7
		(5.5)	(2.3)	(4.7)	(6.3)	(14.9)	(17.4)	(**21.5**)	(13.6)	(13.6)	(0.3)

Table 2 continued.

STATEMENT		1	2	3	4	5	6	7	8	9	10
14 B2	…short distance to city center (shops and other services)"	99	60	133	148	296	355	488	298	309	5
		(4.5)	(2.7)	(6.1)	(6.8)	(13.5)	(16.2)	(**22.3**)	(13.6)	(14.1)	(0.2)
14 B5	…short distance to leisure facilities (sports parks/training center/ pool etc.)"	241	119	214	262	396	364	290	151	143	11
		(11.0)	(5.4)	(9.8)	(12.0)	(**18.1**)	(16.6)	(13.2)	(6.9)	(6.5)	(0.5)
14 B1	…nice view from the area"	62	42	111	159	346	377	486	289	311	8
		(2.8)	(1.9)	(5.1)	(7.3)	(15.8)	(17.2)	(**22.2**)	(13.2)	(14.2)	(0.4)
14 B7	…short distance to recreational areas: parks/forests/water"	54	25	80	96	263	355	539	331	441	7
		(2.5)	(1.1)	(3.7)	(4.4)	(12.0)	(16.2)	(**24.6**)	(15.1)	(20.1)	(0.3)
14 C1	…nice view from the house or apartment"	70	45	128	189	359	427	422	286	263	2
		(3.2)	(2.1)	(5.8)	(8.6)	(16.4)	(**19.5**)	(19.3)	(13.1)	(12.0)	(0.1)

In comparison to basic physical properties of houses, responses related to lifestyle (e.g., distances to family and friends or leisure facilities) and attitudes and values (e.g., ecological sustainability of housing) showed more variation. Furthermore, ecological sustainability (14D1–14D5) was also the issue, together with structural materials (14E6) were respondents were most likely not to have formed a preference or opinion (proportion of "Don't know" responses 9.5–12.0% and 7.1%, respectively), while for other variables the proportion of unsure respondents was considerably lower (0.1–3.1%). Table 2 also shows through variables related to children (i.e., distances to day-care and schools) how family structure affects consumer expectations on housing: while for the majority of the respondents the availability of services for children was not important at all, there were still respondents who considered the accessibility of those services as significant for housing choices.

4.2 Exploratory factor analysis results on the consumer housing value dimensions in four countries

The country-specific exploratory factor models resulted in four-factor (Finland with 18, Norway with 16 and Sweden with 16 original variables) and five-factor (Denmark with 16 original variables) solutions. As a background for presenting the country-specific factor analysis results, Table 3 illustrates the similarities and differences between countries in occurrence of the original variables in the final exploratory factor models. As a general description, especially the variables on the physical characteristics of houses appear to a quite similar extent in country-wise models, while there are more differences between countries on the variables describing locational properties of houses.

During the EFA modeling, variables on children-related services (i.e., short distance to day-care, short distance to schools) were removed from the analysis. First, employed as two separate variables they formed factors of their own for Finland and Norway indicating to be empirically describing the same phenomenon (i.e., services for daily life with children). Second, when combined into one variable by averaging the values given by the respondents on the importance of distances to day-care and schools, for all country-wise models they received loadings below 0.4.

Table 3. Original variables employed in the final exploratory factor analysis models by countries.

Property value	Survey statement	Denmark	Finland	Norway	Sweden
Physical characteristics of the house	… the amount of natural light indoors"		X		
	… functional floor plan"	X	X	X	X
	… design and visual appeal of the building"	X		X	X
	…the building consists mainly of renewable materials"	X	X	X	X
	…the building has a low carbon footprint in construction"	X	X	X	X
	…the building has a low carbon footprint in use"	X	X	X	X
	…recyclability at end-of-lifetime of building"	X	X	X	X
	…solidity and durability"	X	X	X	X
	…maintenance"	X	X	X	X
	…materials used in load-bearing construction"	X	X	X	X
	…indoor visible materials"	X	X	X	X
	…outdoor visible materials"	X	X	X	X
Locational quality	…short distance to day-care "				
	…short distance to schools"				
	…short distance to family or friends"		X		
	…located in an attractive community with a good reputation"	X	X	X	X
	…short distance to city center"	X	X	X	X
	…short distance to leisure facilities"	X	X	X	X
	…nice view from the area"	X	X	X	X
	…short distance to recreational areas: parks/forests/water"		X		
	…nice view from the house or apartment"	X	X	X	X

By countries, EFA solutions on the consumer housing value (see Supplementary file S1, available at https://doi.org/10.14214/sf.10503, for Tables on detailed results for Denmark, Finland, Norway, and Sweden) evaluated according to the physical characteristics of houses and the location of houses explain about 63% (Denmark), 63% (Finland), 70% (Norway), and 67% (Sweden) of the variation in the data. The Kaiser-Meyer-Olkin measures of factorability for the model results are 0.826 (Denmark), 0.860 (Finland), 0.843 (Norway), and 0.843 (Sweden) giving evidence on the applicability of the data in factor analysis. Bartlett's test of sphericity rejected the null hypothesis that no correlation among the original variables existed ($p = 0.000$) for the models of all countries.

Overall, country-specific factor solutions fill the assumptions of the well-functioning EFA due to the solutions' relatively high explained variance, minor number of cross-loadings between variables and a clear interpretability of the formed factors. For all countries, EFA consistently resulted in one factor with identical original variables related to the Life-cycle ecological sustainability of the houses. In addition, the factor "Apartment layout, maintenance and building materials" was similar among Finnish, Norwegian and Swedish consumers, but was divided into two factors in the case of Denmark ("Apartment layout and maintenance" and "Building materials"). In a similar way for locational issues, the factor describing urban lifestyle (i.e., "Urban life in a good neighborhood") had the same variable loadings for Denmark and Sweden, while for Finland it also included a variable describing the proximity of family and friends and for Norway the quality of architectural design (i.e., variable on design and visual appeal).

In connection with the design and visual appeal of the house and the surrounding milieus, there were country-specific differences in how the original variables were loaded in the factor models. In the cases of Denmark and Sweden, the variables concerning the visual appeal of the building and pleasant views compose a factor of their own named as "Pleasant architecture and aesthetic milieu". Contrastingly, for Norway, variables describing a pleasant view compose a factor

of their own ("Aesthetic milieu"), while for Finland pleasant views are clearly linked with nature connectedness through loading within a factor comprising also variables on natural light indoors and short distance to outdoor recreational areas ("Connection with nature").

Fig. 3 illustrates a summary on the country-specific factor analysis solutions on the consumer housing value dimensions. Although only one consumer housing value factor is identical for all four countries (i.e., "Life-cycle ecological sustainability") and very similar regarding expectations on "Apartment layout, maintenance and building materials" (exactly the same variable loadings for Finland, Norway, and Sweden within one factor, and for Denmark in two factors), there are strong thematic similarities in the consumer housing values in the Nordic region. Consumers perceive urban lifestyle and living in a neighborhood with a good reputation rather similarly, and in all countries, appreciation of attractiveness of milieus and connection with nature can be detected. In Fig. 3, the thematic connections between different consumer housing value dimensions (i.e., exploratory factor analysis solutions) are depicted as connected circles.

Fig. 3 concretizes the similarities of the latent variables in the housing value among Nordic consumers (i.e., preferences for urban lifestyle, functionality and material aspects, ecological sustainability, and aesthetic natural milieu). In addition, the less the latent variable connects with intangible issues, the less there are country-wise differences in the factors. For example, life-cycle ecological sustainability, or functional and material aspects and even proximity of urban services (i.e., characteristics of urban life) are more measurable than perceived aesthetics or connectedness with nature.

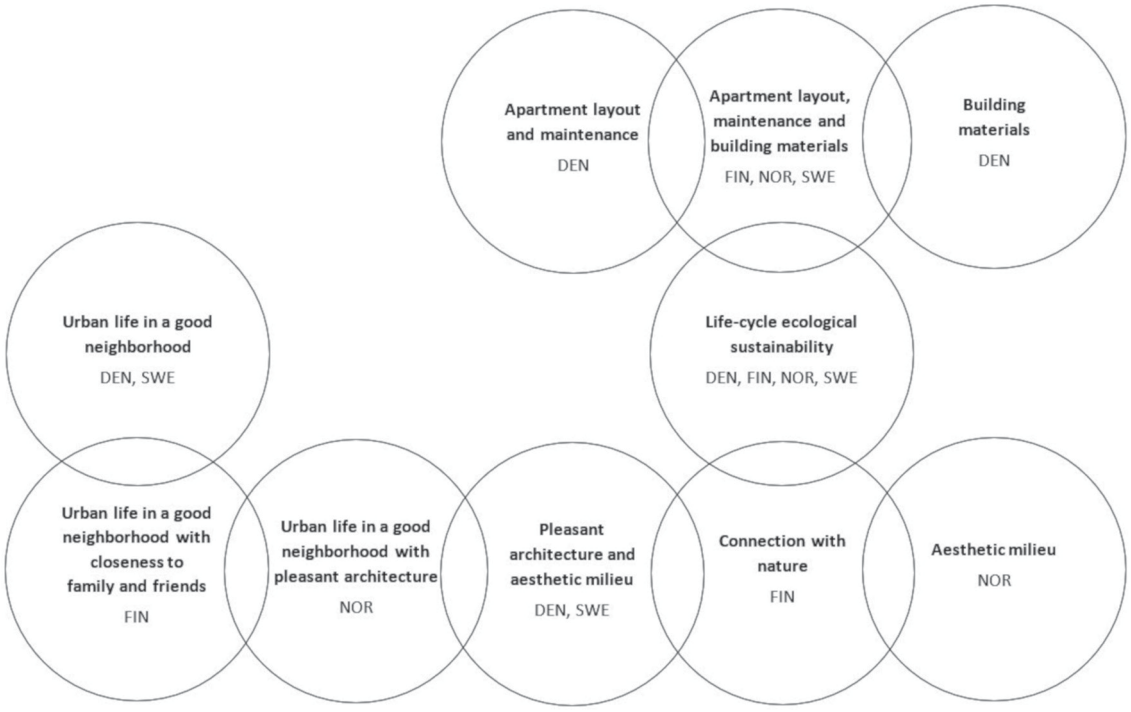

Fig. 3. Simplified illustration of the country-wise exploratory factor solutions for consumer housing value dimensions in Denmark, Finland, Norway and Sweden.

4.3 Binary regression analysis results on the prejudices against building with wood among consumer housing value dimensions in four countries

Prior to implementing the BLR analysis, the frequencies of the prejudiced respondents were assessed in reference to their current type of home (i.e., multi-storey house or other type of house like single-family house or apartment in a house with less than three storeys). In addition, the statistical significance of the observed and expected differences by categories were checked with χ^2-test. The motivation for this was to gain insights on how the BLR results might be particularly related to multi-storey house dwellers, who are from the perspective of MSWB market diffusion an especially interesting group of consumers.

The results in Table 4 show country-specific differences in the proportions of respondents with prejudices by countries. In the group of multi-storey dwellers, the proportion of respondents with prejudices was in Denmark 43%, Finland 39%, Norway 49% and Sweden 36%. Among respondents living in other types of houses, the country-specific differences in prejudices were more notable between Denmark and other countries: In Denmark 45% of the respondents had prejudices against usage of wood as the primary structural material in building, while it was in Sweden and Norway 18% and 12% respectively, and in Finland 13%. The proportions of prejudiced connect to traditions in single-family housing in the four countries: while in Denmark there are no strong traditions to use wood as a structural material for detached houses, in Finland, Norway and Sweden building with wood has always been the dominant technology in them. In addition, the proportions of respondents with prejudices among respondents living in other types of houses in all of countries concretize well, how from the perspective of MSWB both the path dependencies in building technologies and other housing values may also affect opinions on living in homes made of wood.

The country-specific results of the BLR models on the impacts of consumer housing value dimensions are illustrated in Tables 5, 6, 7 and 8. All non-significant β coefficients (Wald's χ^2 $p \geq 0.1$) were omitted from the reported final model, following the principle of parsimony. According to all country-wise BLR model results, respondents' expectations on housing (i.e., physical characteristics of houses and locational quality) seem to be connected with likelihood in the increase (outside from Sweden, evidence on the existence of prejudices was found in all countries) or decrease of prejudices (evidence in all four countries).

Table 4. The number of respondents living in multi-storey houses and other types of houses, and the amount and proportion of prejudiced in both categories. The χ^2-test p-value shows the statistical significances in the number of prejudiced between housing types.

Country	# of respondents in multi-storey and other types of houses	# of prejudiced in multi-storey and other types of houses	% of prejudiced in multi-storey and other types of houses	χ^2-test p-value
Denmark	99/472	43/212	43%/45%	0.788
Finland	198/375	55/44	39%/13%	0.000***
Norway	99/391	49/45	49%/12%	0.000***
Sweden	201/356	73/64	36%/18%	0.000***

*suggestive evidence on statistical significance, **moderate evidence on statistical significance, ***very strong evidence on statistical significance.

Table 5. Logistic regression model on the linkages between the dimensions of CMVE and prejudices against building with wood among **Danish** consumers.

Predictor factor	β	SE β	Wald's χ^2	df	p	eβ
Intercept	–0.218	0.085	6.568	1	0.010**	0.804
Apartment layout and maintenance	0.144	0.102	1.978	1	0.160	1.155
Building materials	0.001	0.106	0.000	1	0.989	1.001
Life-cycle ecological sustainability	–0.126	0.092	1.865	1	0.172	0.882
Pleasant architecture and aesthetic milieu	–0.224	0.090	6.145	1	0.013**	0.800
Urban life in a good neighborhood	0.201	0.108	3.460	1	0.063*	1.223

*suggestive evidence on statistical significance, **moderate evidence on statistical significance, ***very strong evidence on statistical significance χ^2 = sig. 0.022; Cox & Snell R^2 = 0.023; and Nagelkerke R^2 = 0.031; Predictive accuracy = 55.3%.

Table 6. Logistic regression model on the linkages between the dimensions of CMVE and prejudices against building with wood among **Finnish** consumers.

Predictor factor	β	SE β	Wald's χ^2	df	p	eβ
Intercept	–1.731	0.127	186.494	1	0.000***	0.177
Apartment layout, maintenance and building materials	0.052	0.133	0.153	1	0.696	1.053
Life-cycle ecological sustainability	–0.507	0.120	17.700	1	0.000***	0.602
Connection with nature	–0.350	0.129	7.339	1	0.007***	0.705
Urban life in a good neighborhood with closeness to family and friends	0.589	0.160	12.958	1	0.000***	1.801

*suggestive evidence on statistical significance, **moderate evidence on statistical significance, ***very strong evidence on statistical significance χ^2 = sig. 0.000; Cox & Snell R^2 = 0.063; and Nagelkerke R^2 = 0.105; Predictive accuracy = 82.9%.

Table 7. Logistic regression model on the linkages between the dimensions of CMVE and prejudices against building with wood among **Norwegian** consumers.

Predictor factor	β	SE β	Wald's χ^2	df	p	eβ
Intercept	–1.468	0.118	155.614	1	0.000***	0.230
Apartment layout, maintenance and building materials	0.007	0.131	0.003	1	0.959	1.007
Life-cycle ecological sustainability	–0.085	0.124	0.466	1	0.495	0.919
Aesthetic milieu	–0.229	0.114	4.018	1	0.045**	0.796
Urban life in a good neighborhood with pleasant architecture	0.259	0.152	4.018	1	0.089*	1.295

*suggestive evidence on statistical significance, **moderate evidence on statistical significance, ***very strong evidence on statistical significance χ^2 = sig. 0.078; Cox & Snell R^2 = 0.015; and Nagelkerke R^2 = 0.023; Predictive accuracy = 80.8%.

Table 8. Logistic regression model on the linkages between the dimensions of CMVE and prejudices against building with wood among **Swedish** consumers.

Predictor factor	β	SE β	Wald's χ^2	df	p	eβ
Intercept	–1.163	0.102	129.872	1	0.000***	0.313
Apartment layout, maintenance and building materials	0.069	0.113	0.370	1	0.543	1.071
Life-cycle ecological sustainability	–0.113	0.105	1.144	1	0.285	0.893
Pleasant architecture and aesthetic milieu	–0.335	0.136	5.853	1	0.002***	0.715
Urban life in a good neighborhood	0.329	0.136	5.853	1	0.016**	1.390

*suggestive evidence on statistical significance, **moderate evidence on statistical significance, ***very strong evidence on statistical significance χ^2 = sig. 0.002; Cox & Snell R^2 = 0.029; and Nagelkerke R^2 = 0.044 Predictive accuracy = 75.9%.

Although the explanatory power of the BLR models assessed with statistical goodness-of-fit measures (χ^2 test, Cox & Snell's R^2 and Nagelkerke's R^2) was not particularly high (illustrated below Tables 5, 6, 7, 8), the results illustrate whether different consumer housing values seem to associate with prejudices against building with wood. In addition, the ability of the models to predict respondents' statistically modelled group membership (i.e., prejudices against building with wood present or not) compared to the actual data (i.e., the actual responses of the consumers in the data) are reasonable for Finland (82.9%), Norway (80.8%) and Sweden (75.9%), while in case of Denmark (55.3%) some cautiousness is needed in the interpretation of results. The difference in the BLR model of Denmark may be caused by the higher proportion of respondents with prejudices against building with wood compared to other three countries (see Table 4). However, the model results of Denmark are similar with the BLR results of other three countries. Thus, there are grounds to expect that also in the case of Denmark there are statistically identifiable patterns between consumer housing values and prejudices against building with wood.

Fig. 4 summarizes the country-specific results of the impacts of consumer housing values on the likelihood of prejudices against building with wood. Green circles illustrate the dimensions of consumer housing values, in which statistical evidence on the decrease in the likelihood of prejudices to exist was found. In contrast, red circles show dimensions within statistical indications on the increase in the probability of prejudices. Grey circles are factor solutions on consumer housing values, which according to BLR do not show any significant connections with the likelihood of prejudices in one direction or another (please note Finland as an exception in the "Life-cycle ecological sustainability").

Fig. 4. Simplified illustration of the impacts of consumer housing values on the likelihood of prejudices (red increase, green decrease, grey no evidence against building with wood). For Life-cycle ecological sustainability, only in Finland statistical evidence on the decrease of likelihood for prejudices was received.

According to the results, appreciation of aesthetics, attractiveness of milieu and connection with nature decreased the likelihood of prejudices against building with wood both in Denmark, Finland, Norway, and Sweden. In addition, valuing life-cycle ecological sustainability of housing significantly decreased the probability of Finnish consumers to have prejudices towards use of wood in building, while for other three countries such evidence was not found. Contrastingly, based on the results, appreciating urban lifestyle and living in an attractive neighborhood with good reputation increased the probability of prejudices both in Denmark, Finland, Norway, and Sweden. From the perspective of advocating MSWB especially as a solution to enhance sustainable urbanization, the adverse attitudes towards building with wood among consumers with an urban lifestyle is an important finding.

5 Discussion

This study aimed at filling the gap in understanding the linkages between consumers' housing values and the likelihood of having prejudices against building with wood in the Nordic region. In relation to production and consumption structures of housing production (SHP) (Burke and Hulse 2010). By better recognition of consumer housing value expectations, businesses may enhance their competitiveness within the production sphere through development of brands (Choi et al. 2017) to meet specific value expectations of home seekers within the consumption sphere and also manage their acceptability risks related to the use of wood in building (Lähtinen et al. 2019a).

Together business actors, also public authorities have power to affect through land zoning the production sphere (i.e., enablers to build houses in with specific design in particular neighborhoods and milieus), which further also has an impact on consumption sphere (i.e., willingness of residents to choose particular types of homes in specific locations) (Hasu et al. 2017). Thus, information on consumers with different types of consumer housing values is also important in urban planning to enhance sustainable urbanization through impacts on the factors of demand and supply in the SHP (Hasu et al. 2017; Jussila and Lähtinen 2020).

The results of the EFA models revealed that latent variables on describing consumers' appreciation of different physical characteristics and locational qualities in their housing values were rather similar between Finland, Sweden, Norway and Denmark. Especially consumer housing values for life-cycle ecological sustainability, materials and urban lifestyle were very similar for all countries (Denmark and Sweden were identical, for Finland closeness to family and friends and for Norway pleasant architecture variables had high loadings). Contrastingly, for more culturally-dependent issues (i.e., perceptions on aesthetics and natural milieus) more differences between Denmark, Finland, Norway and Sweden were detected.

Although urban forestry is recognized as important in all Nordic countries (Randrup and Persson 2009), there are country-wise differences in how they are emphasized from the viewpoint citizen experiences in nature and outdoors. For example, recreation possibilities in the urban forests have been especially well recognized in the Finnish National Forest Programmes (Mann et al. 2010). Thus, it may be that public discourse on the recreational use of forests, supported by forest policy narrative, has shaped the Finnish consumers' view of distance to recreation areas. In the same way, differences in EFA modeling results on consumer housing values regarding appreciation of aesthetics and design are likely to be connected to country-wise cultural traditions. Thus, although "Nordic design" brand is characterized with common ideals for, e.g., simplicity of design, social equality and welfare, and close connection with nature, there are differences in how these themes are perceived in different countries (Skou and Munch 2016). Thus, the composition and relative importance of various attributes making a living environment attractive in the eyes of Danish, Finnish, Norwegian or Swedish consumers may also differ.

Like found in the EFA models on different types of consumer housing values among consumers in the Nordic region, also the impacts of different types of consumer housing values on the likelihood of prejudices against building with wood were similar in BLR results by countries. First, appreciation of urban lifestyle and living in attractive neighborhoods with good reputation was found to increase the likelihood of prejudices against living in wooden houses. Second, consumers appreciating strongly natural milieus and aesthetics were detected to be less likely to be prejudiced against use of wood as a building material for their homes. In addition, among Finnish consumers, valuing life-cycle ecological sustainability decreased the likelihood of being prejudiced toward building with wood, while for Denmark, Norway and Sweden statistical indications of such phenomenon were not found.

The differences in consumer views on life-cycle ecological sustainability of building may be related to national aims on how sustainable building is to be initiated, e.g., from the perspective of future market potential. For example, by Denmark, Finland, Norway and Sweden the aims of sustainable building initiatives have been alike, while there have been differences in the discourses on the relative importance of the utilization of wood, technological solutions related the energy and water usage, and recycling as solutions for sustainable construction (Sand et al. 2012). Connected to individual variables in the data, life-cycle ecological sustainability (Q14) received most of the "Don't' know" responses (9.5–12%). It seems that for consumers the ecological sustainability of wooden materials may be a complex matter (e.g., origin of wood, forest management practices) (Zubizarreta et al. 2019) emphasizing the need for up-to-date and reliable communication of life-cycle impacts of wood-based materials.

The statistical strength of the linkages between consumer housing values and the likelihood of prejudices differed between countries. By statistical measures, the results from Finland were the most unambiguous, i.e., the evidence both for the likelihood of increase and decrease in prejudices was very strong both for consumers valuing urban lifestyle, for the ones appreciating connection with nature, and for those valuing life-cycle ecological sustainability. For Sweden, results on the likelihood of decrease in prejudices among consumers appreciating pleasant architecture and aesthetic milieu were similar with Finland (i.e., very strong evidence on statistical evidence). However, among Swedes the evidence for the increase in prejudices against building with wood was not as strong as in Finland (i.e., moderate evidence on statistical significance). In case of Denmark and Norway, the strength of the statistical evidence between different types of consumer housing values and prejudices was either moderate (i.e., decrease in prejudices among consumers appreciating pleasant architecture and aesthetic milieu) or suggestive (i.e., increase in prejudices among consumers appreciating urban lifestyle).

The cross-country differences in the statistical power of BLR model results may be connected both to physical structures and features of ownership (Ruonavaara 2012) in their housing markets. In wood building traditions and housing stock structures, Finland and Sweden are more similar (i.e., traditions in wood building, larger proportion of multi-storey homes) than Denmark (i.e., no strong traditions in wood building, smaller proportion of multi-storey homes) and Norway (i.e., traditions in wood building, smaller proportion of multi-storey homes). In Denmark, almost half of the respondents (45%) had prejudices against wood as a primary structural material of the building, while in other countries the share of prejudiced respondents was 12–18%. The latter observation may be associated not only with the weak traditions on wood building but also with more protective role of forests and the climatic conditions that may rise doubts on durability of wood. However, especially the results from Finnish and Swedish consumers show that wood building traditions do not save from prejudices, if building with wood does not match with broader consumer housing values (e.g., lifestyle) in the housing markets (for the impacts of lifestyle, see Hasu et al. 2017).

In Sweden, e.g., the choices of future homeowners for MSWB apartments are limited by the deficiencies in the availability of apartments with requested size and price range in desired locations (Jansen et al. 2011; Mark-Herbert et al. 2019). In Finland and Norway similar research has not been implemented, but it is likely that the supply of MSWB apartments has not been in congruence with multi-storey housing markets of those countries in general. Compared to Sweden the proportion of occupant ownership both in Finland and Norway is even higher (Ruonavaara 2012). In all countries, the supply of the MSWB apartments has focused on rental markets (e.g., student houses). The association between MSWB and low-income residents may have limited the prestige image of wood housing among the public, especially in countries like Finland, where the multi-storey housing markets (and consumer value expectations) are very much connected to ownership structures of homes (Andersson et al. 2007).

As an analytical framework for identifying latent variables on dimensions of consumer housing values with EFA models, a hierarchical classification on Property Value Formation (PVF) model (Kauko 2004, 2006b) was employed (Fig. 1). According to the findings of this study, the PVF provided interpretable results for exploring consumer housing values, although PVF has been originally developed to be applied in the analysis based on analytic hierarchy process (Kauko 2004) and in qualitative approaches (in Kauko 2006b).

For evaluating the benefits of constructing latent consumer housing value variables with EFA and testing the methodological validity of the chosen approach, sensitivity analysis was conducted by employing individual consumer housing value attributes (Q14) as explanatory variables in the BLR models. As an outcome of the sensitivity tests it was concluded that compared to individual variables, the latent variables received with EFA revealed better themes of consumer housing values, and they were more congruent between countries supporting also empirical interpretation of results. Employment of EFA also showed that PVF is a feasible framework to model country-specific structures in consumer housing values, and how they may affect prejudices against homes with different types of physical characteristics and locational qualities. For enhancing the applicability of the PVF model to make cross-country comparisons, consumer housing value scales based on Kauko (2004, 2006b) could be developed and tested in different cultural and socio-economic contexts.

As a limitation of this study it should be kept in mind that consumer housing values were not measured in the context of actual home purchasing or renting situations. Thus, results on housing expectations of the panel of consumers represented their general desires on housing and did not address, e.g., the actual availability of dwellings (i.e., supply-side friction in Kauko 2006b). Regarding the quality of the panel data, it is worth of remembering that the survey respondents were recruited in the data gathering and thus the they did not represent a random sample of the population (Chandler et al. 2019). However, the issues addressed in this study (i.e., preferences for housing or home building materials, interest towards wood building or knowledge of it) may be considered as themes, which do not distinctively require, e.g., any specific background information. Thus, it can be assumed that the respondents have not had particularly selective opinions of those aspects compared to citizens in the Nordic region in general, which is also supported by the variety in the empirical EFA and BLR results.

In addition, for the BLR models the definition of prejudices was based on respondents' own statements on their preferences on the structural materials in their homes, and their level of knowledge and interest in wood construction. Thus, the measures for prejudices did not include, e.g., measurement of actual experiences or knowledge of respondents on wood construction. By that information, it would have been possible to implement more profound evaluations on to what extent, e.g., perceived material properties and experience from living in wooden houses influence the outcomes. However, due to the novelty of MSWB in the markets most of the consumer experiences in wooden homes would have been related to single-family houses, which are not comparable

with MSWB (e.g., use of building technologies, location of houses, lifestyle issues). The situation is similar in the housing markets, where most of consumers do not have actual experiences in MSWB apartments and their past experiences, e.g., on wood building in single-family houses may be trivial compared to their past experiences on housing value received in living multi-storey houses made of different types of materials.

In line with Gram-Hanssenand and Bech-Danielsen (2004), the results of this study show that consumer housing values concern choices of homes, not buildings. Although the data employed in the analysis of this study were not connected to actual decision-making situations (i.e., purchasing or renting home), the findings of the analysis concretize the multi-dimensionality of choices made by consumers in the housing markets. In addition, the path dependencies in the building traditions and forms of ownership demonstrate that cross-country differences must be considered when addressing different types of consumer housing values (Choi et al. 2017). Yet, the results of this study also showed similarities in housing expectations especially among consumers in the Nordic region appreciating urban lifestyle. Thus, with consideration of country-specific consumer housing values, there may be opportunities to identify common branding and communication strategies in the Nordic MSWB especially in relation to sustainable urbanization initiatives accelerated through urban planning.

In all, the findings of this study indicate that prejudices against building with wood may not be related directly to the properties of wood or building technologies, but more to the supply of urban MSWB apartments meeting, e.g., ownership preferences and lifestyles of different types of consumers. For future development of MSWB it must be kept in mind that building materials or technologies alone do not make a business competitive in the modern housing markets. In fact, especially from the perspective of prejudices against building with wood, physical properties such as materials of houses seem to be less important for the consumers in their housing than intangible factors related to lifestyles and milieus. To increase the attractiveness of wooden living among urban consumers, MSWB shall be embraced in surroundings that are generally appreciated by urban dwellers and fit with their general life choices.

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Authors' contributions

Katja Lähtinen: Survey design for original data gathering, original idea of the article, selection of the theoretical framework, formulation of the research questions, design of the analysis, implementation of the analysis, interpretation of data and the results, scientific writing of the article,
Liina Häyrinen: Selection of the theoretical framework, design of the analysis, implementation of the analysis, interpretation of data and the results, scientific writing of the article,
Anders Roos: Survey design for original data gathering, design of the analysis, interpretation of data and the results, scientific writing of the article,
Anne Toppinen: Survey design for original data gathering, design of the analysis, interpretation of data and the results, scientific writing of the article,
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Supplementary files

S1.pdf; Consumer housing values and prejudices, available at https://doi.org/10.14214/sf.10503.

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