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Attractiveness of wood-frame multi-storey buildings in seven European countries: consumer segmentation and the effect of fire safety information

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Highlights

- There are significant differences in the perceived attractiveness of wooden multi-storey construction between consumer segments.
- According to the survey results, young consumers living in urban areas have the most interest in wooden multi-storey construction.
- Targeted marketing efforts are needed to inform potential consumers of wooden multi-storey construction.

Abstract

Wooden construction has the potential to contribute to climate change mitigation, and it is being promoted by the EU and national governments. However, several market barriers to wood-frame multi-storey building (WMSB), have been recognized, including obstacles in national building codes, lack of expertise in wood construction, and material durability concerns among end-users as well as other technical aspects. Given that increased wood construction is a target, understanding consumer perceptions of WMSB is crucial. In this study, consumer attitudes on WMSB were studied through consumer segmentation relying on demographic attributes. Further, the effect of providing fire safety information was explored. To this end, an online survey was deployed in seven European countries, with 7007 responses. The results show that in general, the awareness and attractiveness of WMSB is low amongst European consumers. Out of all respondents, 46% had not heard of WMSB before and only 12% stated that they are interested in the subject and know something about it, showing a clear lack of information and awareness within the general public. Significant differences in the perceived attractiveness of wooden multi-storey construction between consumer segments exist, with younger consumers and urban consumers being more attracted to living in WMSB than older or rural consumers. Fire safety was an important attribute affecting overall attractiveness, yet updated information regarding fire safety and control in WMSBs had a small but statistically significant negative effect on the perceived attractiveness. The results indicate that targeted marketing efforts are needed to inform potential consumers of WMSB and aspects related to fire safety effectively.

Keywords consumer perceptions; consumer segmentation; fire safety; wood construction
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1 Introduction

Wooden construction has the potential to mitigate climate change via long-term carbon storage in harvested wood products (HWPs), substitution impacts (avoided fossil emissions), and stimulating forest management to produce timber suitable for construction (Werner et al. 2010; Gustavsson et al. 2017). The European Bioeconomy Strategy (European Commission 2018) states that the use of forest-based products should be promoted in the construction sector in order to reduce greenhouse gas emissions. In terms of volume, engineered wood products such as wood fiber insulator boards, cross-laminated timber and glulam products have had a steady annual growth in recent decades (Hildebrandt et al. 2017). However, the total market share of wood in the construction sector seems to be remaining at a few percent in Europe (Trinomics et al. 2021).

Structural applications in the built environment for living and commercial purposes are in general subject to regulations such as national building codes and standards. National building legislation and building codes are influencing the design of timber structures and differ between countries. Moreover, there are harmonized EU standards that aim to remove technical barriers for marketing and trading construction products and to ensure the free movement of these products across the EU (König 2005). European standards include product standards, which are specific standards for building products, and a European wide standard for building design, the Eurocode (EN 1990). Eurocode 5 (EN 1995) applies to the design of timber structures (European Committee for Standardization 2004a, 2004b). It addresses issues such as safety and indoor environment, along with issues of structural fire safety. Requirements for acoustic properties in buildings, as well as requirements regarding the release of emissions and of potentially harmful substances, are also covered.

The European standards are harmonized for all countries in EU and associated European countries such as Norway, Iceland and Lichtenstein (the European Economic Area, EEA). European Standards themselves are not legislative regulations or directives and are therefore voluntary. Deviations and additions to these standards at a national level through national building codes and regulations are also allowed. However, European Standards are a harmonized way of demonstrating compliance with legal requirements set in the EU regulations and directives. The scope of building legislation and harmonized construction and product standards is to enforce safe solutions, to make construction more transparent and to enhance standardization in production and manufacture of building products throughout Europe. The information provided on building standards, codes and legislation can be expected to make the built environment safer, also ensuring the safety of tall timber buildings. Therefore, standardization does not only address technical barriers and trade but is potentially an important measure for enhancing public trust in the safety and viability of buildings, including wood-frame multi-storey buildings (WMSBs) that are in the specific focus of this study.

WMSBs are generally defined as residential or non-residential buildings of three stories or more, with a structural load-bearing frame made primarily out of wood products (Hemström et al. 2011; Franzini 2022). Several market barriers have been recognized for WMSB. These include difficulties in national building codes, lack of expertise in wood construction, higher building costs

in comparison to conventional buildings, material durability concerns among end-users and other technical aspects, cultural issues in the construction sector, and availability of materials (Gosselin et al. 2017). The durability concerns, especially in terms of fire safety, have often been raised by consumers in previous studies (Gold and Rubik 2009; Thomas et al. 2014; Hu et al. 2016; Larasatie et al. 2018; Ranacher et al. 2018; Kylkilahti et al. 2020). This applies to both residential and non-residential construction. In a study by Gold and Rubik (2009), over 60% of studied German consumers stated that wooden buildings are very or rather disadvantageous with regard to fire safety, and Larasatie et al. (2018) found that nearly 80% of consumers in the US Pacific Northwest think that WMSBs are more of a fire risk than others. Moreover, consumers think that wooden buildings can require a lot of maintenance, have relatively high costs, and are not as long-lasting as other alternatives (Gold and Rubik 2009; Larasatie et al. 2018; Nyrud et al. 2023).

However, based on previous studies, consumers seem to strongly value the environmental aspects and aesthetic benefits of wooden buildings – when wood is exposed (Gold and Rubik 2009; Larasatie et al. 2018). They are seen to promote wellbeing by being natural and cozy. Wooden buildings are considered to be environmentally friendly, visually pleasing and healthy in terms of indoor air quality (Larasatie et al. 2018). Hu et al. (2016) and Gold and Rubik (2009) detected that consumers regard these "soft attributes" such as living comfort and health aspects as important and decisive as quality, durability and safety attributes when they are making purchase decisions.

When the traditions of building with wood are strong, consumers are more experienced and have more knowledge about wooden construction. In turn, knowledge and familiarity typically have a strong positive impact on perceptions (Larasatie et al. 2018). Therefore, consumers' perceptions of wooden buildings and their durability and safety may vary highly when comparing consumers from different regions and backgrounds, for example Northern European consumers to Central Europeans. Previous studies have shown that in Finland, where the forest industry has a long history, opinions about the durability of wooden buildings are more positive among consumers and municipal civil servants than in other countries (Franzini et al. 2018). Finnish consumers who have experienced living in WMSBs can even consider fire regulations to be inflexible, as they constrain the use of wood on visible interior surfaces (Harvio 2020). In many regions, it has been found that consumers lack knowledge of WMSB, which can negatively affect the attractiveness of WMSBs (Høibø et al. 2015; Hu et al. 2016; Lähtinen et al. 2019; Lähtinen et al. 2021). For example, in China, where the market share of wood-frame buildings is low, consumers have strong prejudices against the fire safety, durability, and acoustic properties of wooden buildings (Hu et al. 2016). Many studies point out that consumers require more information about WMSB, especially in terms of safety, before choosing them over other options (Ranacher et al. 2018).

In order to identify those consumer groups that are the most promising targets for WMSB related marketing and information, the process of consumer segmentation can become useful. Segmentation refers to classifying consumers into meaningful and manageable groups based on certain attributes and variables (Amine and Smith 2009). In general, segmentation can be used to explain market behaviour and is therefore a common practice in marketing research. In construction, segmentation can be used to mass customize buildings for selected groups of customers, for example, those willing to pay for certain attributes or, conversely, preferring more restricted options at a lower price (Gibler and Tyvimaa 2014).

In the previous studies focusing on consumer perceptions of WMSBs, consumer segmentation based on demographic variables has rarely been used, or authors have been unable to detect meaningful consumer segments based on demographic variables (Gold and Rubik 2009). It is not known how different consumer segments perceive WMSB, what the differences between segments are, and how WMSB marketing strategies could be directed based on that information. Moreover, while it has been recognized that more information on WMSB and their attributes regarding especially

fire safety issues is needed by consumers (Ranacher et al. 2018), the potential effect of receiving fire safety information on consumer perceptions towards WMSB has not been widely examined.

The overall aim of this study is to contribute to filling in these research gaps by exploring consumer attitudes to WMSB through segmentation, as well as by studying the effect of fire safety and regulation information on these perceptions. The research questions are the following:

i. How attractive do European consumers, and different consumer segments based on demographic attributes, regard living in WMSB?
ii. What are the preconceptions about the fire safety of WMSBs in different consumer segments and are strong preconceptions affected by providing updated information about fire safety and control?
iii. How does information provision on fire safety regulation in WMSB change the perceived attractiveness in the consumer segments identified?

A number of publications with specific focuses have been written utilizing the same survey data. Nyrud et al. (2023) have provided a general description of the survey and its results, exploring the awareness of WMSB in several European countries. Lähtinen et al. (2021) focused on the Nordic region in their analyses of values and prejudices regarding WMSB, focusing on latent psychographic variables. Viholainen et al. (2021) applied qualitative content analysis to open-ended responses regarding perceptions of WMSB. Finally, Aguilar et al. (2023) explored preferences for wood as a load-bearing material in residential buildings through stated choices of preferred building types. While Nyrud et al. (2023) studied the relationship between the ranked importance of fire safety and the attractiveness of living in a WMSB, the effect of information was not explored. Moreover, Nyrud et al. (2023) analyzed these results on the level of the whole sample and did not utilize any segmentation to explore differences between consumer groups. Thus, the main novelty of this study is that it has applied consumer segmentation based on demographic attributes and examined the effect of fire safety information on the attractiveness of WMSB among people in the consumer segments identified. Moreover, the results are reflected against the theory of innovation diffusion (Rogers 2003) to support the theoretical and practical contribution of this study.

2 Conceptual background

As WMSB is still a relatively new concept in many countries and a niche in the construction sector, and can be considered as an innovation (Lazarevic et al. 2020). The term innovation refers to any novel or significantly improved product, process, service or practice (Boons and Lüdeke-Freund 2013; Varadarajan 2017). In particular, the adoption of industrial prefabrication and off-site manufacturing has allowed wood to increasingly compete with steel and concrete in large-scale construction (Hildebrandt et al. 2017), while potentially resulting in productivity and quality gains (Malmgren 2014). WMSBs can thus be characterized as a process innovation, as well as an eco-innovation due to the potential for enhanced environmental performance compared to relevant alternatives (Varadarajan 2017). The term eco-innovation is often used interchangeably with terms such as sustainable innovation, environmental innovation, and green innovation (Boons and Lüdeke-Freund 2013; Varadarajan 2017).

The theory of innovation diffusion, first created by Rogers in 1962, describes how innovations are spread, communicated and adopted in the society, and which aspects impact this process. According to Rogers (2003), innovation diffusion is a specific type of communication where the members of a social system create and share information about a novel idea. Innovation diffusion therefore has four elements: the *innovation* itself and its attributes; the *social system* in which the

innovation is being distributed; *time* over which the diffusion is taking place; and the *communication channel* through which distribution of information is taking place (Rogers 2003).

The adoption of innovation strongly depends on the attributes of the innovation (Rogers 2003). It is important to note that instead of focusing on the technical characteristics of an innovation, understanding how consumers perceive the attributes is crucial. For example, innovations that are more compatible with existing values, experiences and needs are adopted quicker, as familiarity increases the adoption rate (Wejnert 2002). On the other hand, complexity can decrease the adoption rate (Rogers 2003). Moreover, when the results of an innovation are visible, i.e., observable in the life of a consumer, the adoption rate is increased (Rogers 2003). In terms of WMSB, this can be an important aspect.

Communication channels have a critical role in innovation diffusion. For example, what is being shared on mass media channels has a great impact as these channels can rapidly reach a large number of consumers (Rogers 2003; Karakaya et al. 2014). Recently, the role of online news and social media channels has been increasing. However, interpersonal communication is often the most effective form of communicating when it comes to forming and changing attitudes (Rogers 2003).

The diffusion of innovations takes place in a certain social system over time (Rogers 2003). Therefore, the norms and values distinctive for the social system also affect the process. In terms of WMSB, this can be seen as increased adoption in countries where the traditions of building with wood are long, and wooden buildings the norm (Larasatie et al. 2018). However, adoption rates vary between innovations and between different groups of consumers. Rogers (2003) has identified five distinguished categories of adopters: innovators, early adopters, early majority, late majority, and laggards. When supporting the diffusion of eco-innovations specifically, targeting early adopters is especially effective (Ramkumar et al. 2022). Moreover, consumer segmentation may be required to reach those most susceptible to innovation adoption, as consumers generally tend to emphasize the size, location and price of the apartments rather than materials or environmental attributes.

In order to identify these adopter groups in a specific context, consumer segmentation can be utilized. Consumer segmentation is a process of classifying consumers into groups based on different variables. It is used to identify differences between different types of consumers and group consumers into manageable segments, and therefore a common method in marketing and consumer research (Amine and Smith 2009). Segmentation can be utilized when identifying those consumers that are the most relevant targets for marketing and communication efforts. Attributes explaining market behaviour may be broadly divided into sociodemographic and psychographic variables (Kilbourne and Beckmann 1998; Sarti et al. 2018). Demographic variables such as age and gender are fixed and directly measurable, while psychographic variables such as personality, values, and lifestyles are latent and may vary over time and depend on the context.

While the most common variables in studies assessing sustainable consumption have been sociodemographic such as gender, age, and education, these tend to be insufficient in explaining consumer behavior exhaustively (Verain et al. 2021). However, demographic variables tend to be easier to measure and apply, even if at the expense of detailed understanding of consumer profiles. Moreover, while psychographic attributes may predict green purchase behavior better than socio-demographic attributes (Akehurst et al. 2012), variables such as income or family size can limit the realization of attitude or lifestyle variables measured by stated preferences (Newton and Meyer 2013). Thus, this study focuses on demographic variables instead of latent psychographic variables (i.e., variables that can only be measured indirectly using other variables) to enable as wide as possible practical use of the results. This will allow businesses, e.g., to identify development project areas with a higher rate of population preferring wood construction, or to target marketing efforts using commonly available and unambiguous consumer data. A review of the consumer literature suggests that typical consumer profiles based on demographic attributes

overlap in regard to single attributes (Park and Lee 2014) and include DINKs (double income, no kids, i.e., married couples with no children and high household income and high education) and green consumers (highly educated women in their forties) (Akehurst et al. 2012). The literature provides no clear hypotheses on the segments, and mixed support even for individual variables (Diamantopoulos et al. 2003).

When data can be assumed to be heterogenic, one simple method for segmentation is *the a-priori* approach where segments are simply divided based on for example, age. However, typical consumer segment studies utilize multi-step explorative modelling process adopting e.g. multinominal regression like in the study of Huang et al. (2023), or for example hierarchical cluster analysis when the dataset is more limited (e.g. Gibler and Tyvimaa 2014). These approaches are generally called *a-posteriori*, where segments are explained by a variety of elements including e.g. psychographic variables. These approaches fit when studying living preferences directly related to consumer's life phase, and the selected variables form higher and logical correlations with living preferences, such as dwelling size, surrounding environment, services, and safety. Generally, housing choice is driven by the goal to maximize living benefits, limited by the price and budget and e.g. perceived house maintenance costs. In this study setting, a purely explorative approach is less feasible since the material of the house does not directly affect consumer's personal needs such as dwelling size and surrounding environment. Explorative models in this context likely offer poor explanation on housing material attractiveness. In other words, individual variable testing fails to make a clear distinction if the variable indicates attractiveness towards wooden house or overall attractiveness towards multi-storey building (MSB) regardless of the material. Thus, in this study we utilize a semi-explorative approach, wherein we create, and test consumer segments based on existing literature on typical segment types that may hold varying opinions regarding housing choice in general. In addition, we use literature to form preliminary assumptions of the background variables that can potentially increase or decrease attractiveness of WMSB.

3 Material and methods

3.1 Data collection

The data were gathered through a comprehensive online survey conducted in seven European countries: Austria, Denmark, Finland, Germany, Norway, Sweden, and the UK. The survey was conducted in a Nordic network project (NOFOBE). It included 35 multiple-choice questions and an open-ended question divided into several sections, aimed at studying consumers' housing material preferences focusing especially on wood as a construction material (Lähtinen et al. 2021; Viholainen et al. 2021). Quantitative questions were mostly assessed with a nine-point Likert scale (1 = Not important… 9 = Very important) including "Don't know" as an option (value 10). The master questionnaire was written in English and professionally translated into the other languages. The master questionnaire is included as Supplementary file S1, available at https://doi.org/10.14214/sf.23035.

The survey was administered by the market research and consulting company IPSOS which collected the data by distributing the survey to their online panelists (18 years and older). As the aim was to gather a representative sample in terms of age, gender, and geographic location from each country, the survey was sequentially shared in predetermined quotas to the panelists until a representative sample based on these demographics was acquired from each country. The predetermined quotas were generated using population statistics of each country. No post-stratification (i.e., assigning adjusted weights to individual responses) was utilized in this study. The responses were gathered in November and December 2018. Approximately 1000 responses were gathered from

Table 1. Descriptive statistics of the respondents of a survey exploring attitudes towards wooden multi-storey building (WMSB) in seven European countries. Populations Eurostat (2023).

	Austria	Denmark	Finland	Germany	Norway	Sweden	United Kingdom	All
Population								
n (million)	9.1	5.9	5.6	84.4	5.5	10.5	67*	188
Survey respondents								
n	1000	1000	1000	1001	1001	1003	1002	7007
Average age	46.6	48.4	48.4	48.9	47.2	48.4	46.9	47.9
Respondents gender								
Male	48%	49%	49%	49%	50%	49%	49%	49%
Female	52%	51%	51%	51%	50%	51%	51%	51%
Size of population in area where respondents live								
>1 000 000	23%	22%	22%	16%	13%	21%	15%	19%
100 000–1 000 000	13%	18%	27%	24%	22%	26%	23%	22%
10 000–100 000	23%	33%	32%	33%	29%	29%	38%	31%
Village < 10 000	26%	18%	9%	18%	20%	13%	20%	18%
Countryside	16%	9%	10%	8%	16%	11%	4%	11%
Children in household (under 18 years)								
None	73%	75%	81%	74%	70%	74%	71%	74%
1 child	14%	12%	10%	14%	14%	11%	14%	13%
2 children or more	13%	13%	9%	12%	16%	15%	15%	13%
Experience of WMSB								
Visited WMSBs built in the 2000's	3.6%	2.9%	6.6%	1.5%	7.8%	7.0%	3.7%	4.7%
Lived in WMSBs built in the 2000's	0.9%	1.8%	1.0%	1.3%	5.1%	1.9%	1.1%	1.9%

*Population in 2020. Newer data for United Kingdom was not available through Eurostat.

each of the seven countries, the total sample size being 7007 individual responses. The descriptive statistics of the total sample are summarized in Table 1.

IPSOS uses multiple sources (text ads and banner ads on different websites, search engines, emails) to recruit panelists, who create an account and provide their background information, i.e., registration variables, which are later used when choosing whom to invite as survey respondents. IPSOS conducts eligibility and validity tests for new recruits, and targets recruitment campaigns to sources that are known to provide representative demographics. The response rates and quality of responses are monitored, and if needed, panelists are removed to ensure honest and thoughtful responses. The panelists earn points for completing surveys, and after a certain number of points they receive a gift card for globally known brand stores.

3.2 Analysis

3.2.1 Analyzing the attractiveness scoring by consumer segments

A set of consumer segments was formulated by grouping respondents sharing two or more of the background variables as presented in Table 2. This was based on the hypothesized impacts of independent variables presented in Table 3. The first segmentation is formed between rural and urban residents. In the study of Huang et al. (2023) it was detected that access to green coverages in the surrounding environment was important for people in the middle- and inner urban areas, thus we assume urban residents may prefer natural elements in living choices as well. On the other hand, people living in rural areas might be more familiar with natural elements such as wood in construction regarding e.g. single-family houses, but in general may prefer detached housing in calm environment over MSB in city areas (Jansen 2012). Secondly, age is expected to be an important

Table 2. Background variables and variable types utilized in this study.

Variable	Variable type
Attractiveness of WMSBs	Likert scale: 1 = not attractive, 9 = very attractive (10 = I don't know)
Country	Choice (categorical): Denmark; Finland; Norway; Sweden; Germany; UK; Austria
Region	Choice (categorical): Type of living environment: the capital region or a metropolitan area (> 1 million inhabitants); in a large city (100 000–1 000 000 inhabitants); in a small or medium sized city (10 000–100 000 inhabitants); in a village (<10 000 inhabitants); in the countryside
Age	Numerical, range 18–99. Divided into two groups, "young" (<35 years) and "older" (35+ years)
Home ownership type	Choice (categorical): Owning, renting, other
Type of housing	Choice (categorical): Detached, single-family house; semi-detached house; townhouse/ row house; apartment-building (1–2 stories (floors)); apartment in a multi-storey building (minimum 3 stories (floors)); other
Forest-related job	Choice (yes/no): Have you ever had, a job (work) connected to the forest-based, the building or the real estate sector?
Building and real estate related job	Choice (yes/no): Have you ever had, a job (work) connected to the forest-based, the building or the real estate sector?

Table 3. List of variables and their expected impact on the attractiveness of wooden multi-storey building (WMSB) (adapted from Roos et al. 2023).

Variable Attractiveness of WMSB	H_0 and rationale Dependent variable
Country: Existing wood construction culture	+ The relative extent of wood resources increases the likelihood of a country to favor wood in construction, increasing familiarity (Hurmekoski 2016; Ranacher et al. 2020)
Region: Rural	+ Less urban surroundings may mean more direct relationship with forests and sustainable resource extraction, as well as increased familiarity towards wood construction (Lindkvist et al. 2012; Hemström et al. 2014; Kylkilahti et al. 2020)
Age	+/– Generally, younger consumers are more environmentally conscious and support wood construction (Toppinen et al. 2018), although the impact could also be non-linear, peaking in the middle age (Fisher et al. 2012; Ranacher et al. 2020)
Home ownership type: Rental	+ Less risk when not owning an apartment
Type of housing: Detached	+/– Detached houses are more likely to be built of wood, which increases familiarity (Kylkilahti et al. 2020). However, some residents currently living in a detached house may dislike apartments in multi-storey buildings regardless of material, decreasing the attractiveness of WMSB.
Forest-related job: Yes	+ Increases familiarity
Building and real estate related job: Yes	+ Increases familiarity

factor for segmentation, since it highly defines living activities and income- and budget-related possibilities (e.g. Gibler and Tyvimaa 2014). To further distinguish the opinions of consumers who generally prefer detached housing over multi-storey buildings, we create a subgroup for consumers currently living in detached houses versus multi-storey buildings. The literature suggests that familiarity with wood could influence the perceptions, in that those familiar with WMSB tend to evaluate it slightly more positive (Larasatie et al. 2018). Familiarity could also arise more indirectly, such as by living in a wooden building, in the countryside or working in the construction sector or the forest sector. Thus, we create another sub-group for forest sector professionals.

Table 3 summarizes the hypotheses for the expected impact of each socio-demographic variable on the attractiveness of wood construction, based on a review of earlier studies (see also Roos et al. 2023).

Final consumer segments were formulated in an explorative bottom-up exercise, firstly by testing the impact of each individual background variable. This resulted in combining two demographic variables that were found to have a significant impact on the attractiveness scoring: age and living conditions (urban vs rural surroundings). For this study, we defined urban consumers as those living in a large city or metropolitan area (i.e., > 1 000 000 inhabitants) and rural consumers as those living in a village (i.e., < 10 000 inhabitants) or in the countryside. Respondents living in a semi-urban or semi-rural environment were excluded from the segmentation. Secondly, three further attributes were added to specify a number of potential sub-segments, namely home ownership status, the type of home that the respondent currently lives in, and potential familiarity about WMSB, approximated by a job related to forest sector or construction. These were not relevant for all four primary consumer segments but were considered case by case. It should be noted that there is overlap in the consumer segments identified, i.e., one respondent can be in more than one segment, but not all survey respondents fall into these consumer segments.

Standard descriptive and summary statistics (mean, median, minimum and maximum values) were initially used to explore data and identify differences in attractiveness scoring between segments based on a variety of background variables. To test the statistical significance of differences between consumer segments and between the experienced and non-experienced respondents, Kruskal-Wallis H Tests (for comparing multiple groups) and Mann-Whitney U Tests (for comparing two groups) were used ($\alpha = 0.05$) due to the ordinal nature of our data (Bergmann et al. 2000; Guo et al. 2013).

3.2.2 Analyzing the effect of fire safety information

After the respondents had answered the question about the attractiveness of living in a WMSB, they were provided with factual information on operative regulations and standards regarding fire safety in WMSBs. The respondents were informed how the fire regulations in many countries have been revised to allow greater use of wood in buildings after extensive research and testing related to fire design in wood structures and the safe use of wood. After they had received the information, the same question on attractiveness was repeated for the second time. Moreover, respondents were asked to rank a number of factors or attributes for their importance in deciding the respondents' answer to the question regarding the attractiveness of living in an apartment in a multi-storey wood building (see Q19 in Suppl. file S1). This question was also asked before and after showing the information on the fire safety of WMSBs.

We studied whether the information given to the respondents affected attractiveness scoring and if there were differences between the consumer segments in their propensity to change perception after receiving information. Moreover, one attribute affecting attractiveness, fire safety, was chosen for further analysis because the information provided for the respondents was related

to fire safety issues. Wilcoxon signed rank tests ($\alpha = 0.05$) were used to study differences between attractiveness and fire safety scoring before and after information (related, i.e. paired, samples) (Woolson 2005).

All statistical analyses were conducted using IBM SPSS statistics versions 25 and 27. Strictly interpreted, it is questionable whether the used Likert-type response scale can be regarded as an interval scale rather than an ordinal scale. However, we consider here that the responses are at least in "good ordinal scale" because of the high number of points on the scale, and can thus be used to calculate means (Wu and Leung 2017).

4 Results

4.1 Attractiveness of wooden multi-storey buildings per consumer segment

The results show that overall, the respondents' attitudes towards wooden multi-storey construction – before given any further information – were strongly divided (Fig. 1). The mean value given for attractiveness was 4.8 on a 9-point Likert-type scale, 1 = not attractive, 9 = very attractive. While 15% of respondents rated the attractiveness to be 8 or 9, 17% of respondents stated that they do not find WMSBs attractive at all (score 1). Moreover, a relatively high proportion (8.2%) of the respondents answered, 'Don't know'.

Overall, the knowledge about WMSB among respondents was very limited. Approximately 46% of respondents stated that they had not even heard of wooden multi-storey construction before, and only 12% said that they are interested in the subject and know something about it. Consequently, respondents' knowledge and experience on WMSB seemed to have a strong effect on the perceived attractiveness. A Mann-Whitney U Test showed that there was a statistically significant

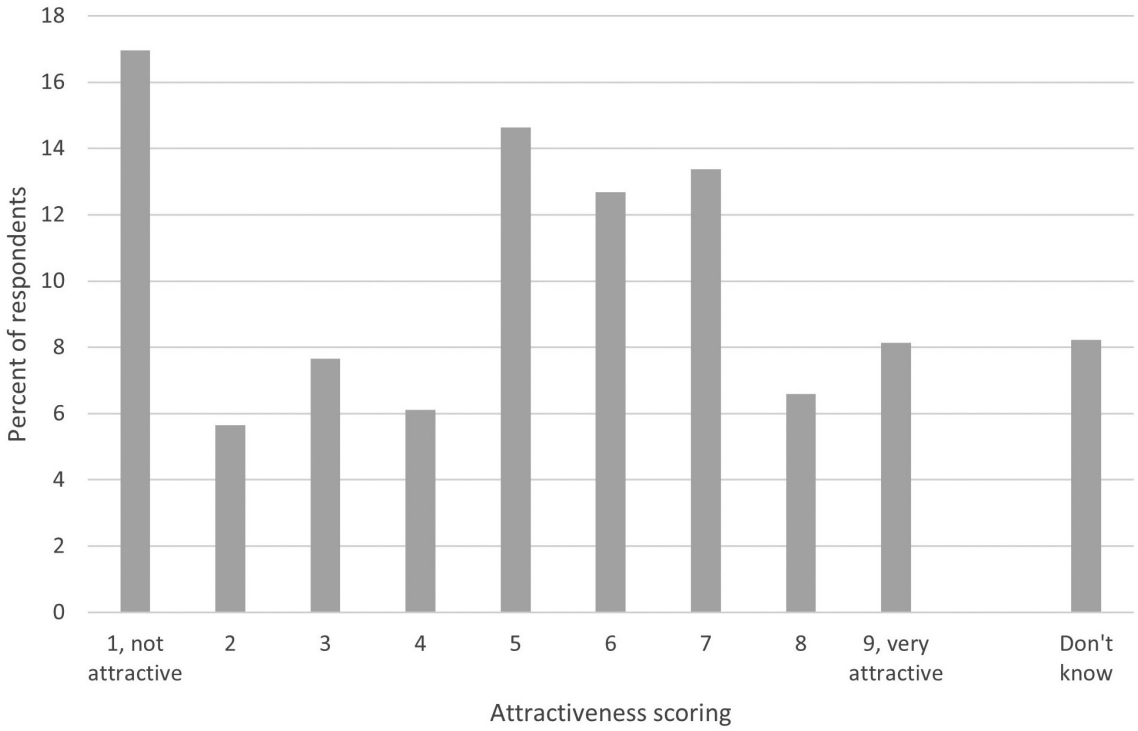

Fig. 1. Overall attractiveness scoring of wooden multi-storey buildings (WMSBs) among all respondents (n = 7007), 1 = not attractive, 9 = very attractive.

difference at $p \leq 0.05$ in attractiveness scoring between respondents who had experienced living in a wooden multi-storey building (mean score 5.5, n = 131) and respondents who had not (mean score 4.8, n = 6876). Similarly, respondents who stated that they are interested in the subject and know something about it (mean score 6, n = 852), or that they are familiar with wooden multi-storey buildings through their studies or work (mean score 5.7, n = 349), found WMSB more attractive than those who did not find it interesting (mean score 4.7, n = 6155) or were not familiar with it through education or work experience (mean score 4.8, n = 6658).

Table 4 summarizes the consumer segments we identified. When comparing the attractiveness scoring between the consumer segments with the Kruskal-Wallis H test, the results show that there were statistically significant differences in perceived attractiveness of living in wooden multi-storey building between segments ($\chi 2(7) = 261.6$, $p < 0.001$). However, not all the differences were statistically significant at $p \leq 0.05$ when comparing two individual segments (Suppl. file S2, available at https://doi.org/10.14214/sf.23035). In general, younger consumers found living in WMSBs more attractive than older consumers living in a similar environment, and consumers living in an urban environment were more attracted to WMSBs than consumers living in rural surroundings (Fig. 2). Young professionals (i.e., current or previous job connected to the forest-based, the building or the real estate sector) living in an urban environment found living in WMSBs to be the most attractive, the mean value for attractiveness being 6.0. On the other hand, older homeowners living in a rural area found it least attractive, the mean value for attractiveness among the segment being 3.9. Typically, people who were already living in a multi-storey building found WMSBs to be a more attractive option than those who currently had a single-family detached house.

Table 4. Consumer segments identified in this study and their proportion of all respondents.

Segment name	Sub-segment name	Segment characteristics	n	% of all respondents
Young urbans		Young (under 35 years) consumers living in a big city or metropolitan area	939	13%
Young urbans	Young urban detached	Young urban consumers living in a detached house	115	2%
Young urbans	Young urban MSB	Young urban consumers living in a multi-storey building	484	7%
Young urbans	Young urban professionals	Young urban consumers with a job related to forest sector or construction	128	2%
Older urbans		Older (35 years and above) consumers living in a big city or metropolitan area	1919	27%
Older urbans	Older urban detached	Older urban consumers living in a detached house	356	5%
Older urban	Older urban MSB	Older urban consumers living in a multi-storey building	869	12%
Older urban	Older urban homeowners	Older urban consumers owning a home	1118	16%
Young rurals		Young (under 35 years) consumers living in a village or countryside	406	6%
Young rurals	Young rural detached	Young rural consumers living in a detached house	198	3%
Young rurals	Young rural MSB	Young rural consumers living in a multi-storey building	37	1%
Older rurals		Older (35 years and above) consumers living in a village or countryside	1569	22%
Older rurals	Older rural detached	Older rural consumers living in a detached house	999	14%
Older rurals	Older rural MSB	Older rural consumers living in a multi-storey building	110	2%
Older rurals	Older rural homeowners	Older rural consumers owning a home	1209	17%

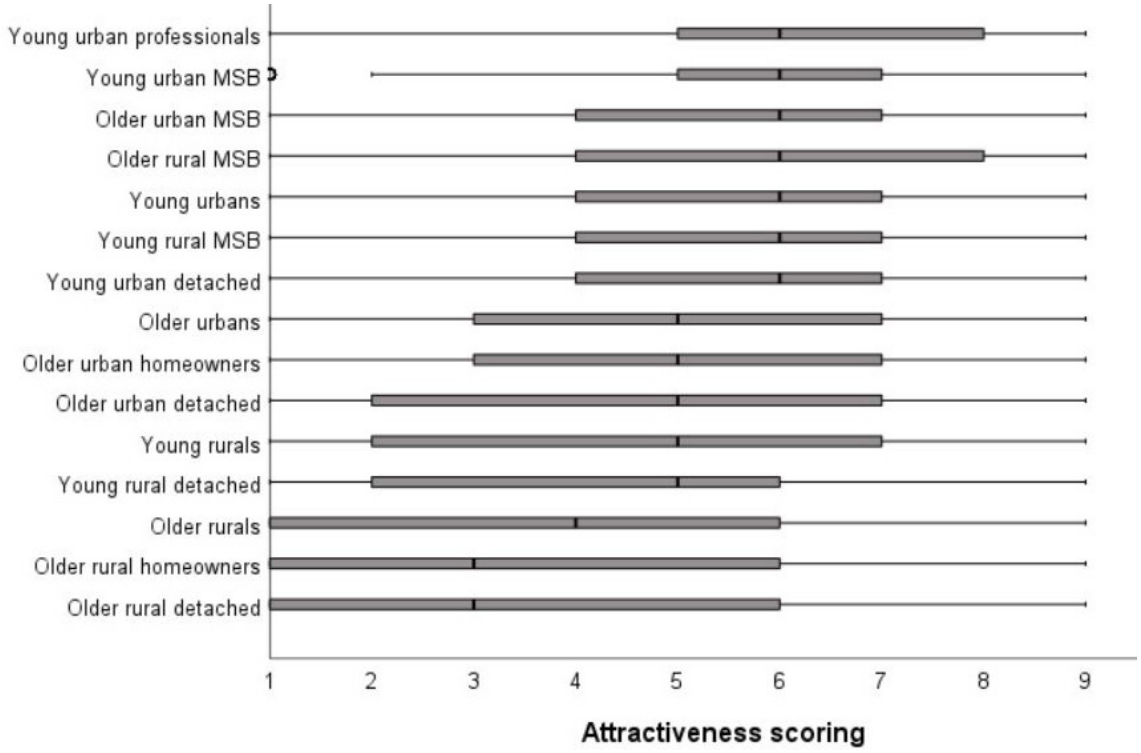

Fig. 2. Box and whisker plot visualizing the attractiveness scoring of WMSBs by consumer segments, 1 = not attractive, 9 = very attractive. The vertical lines inside the boxes indicate the median value. The left boundary of the box is the 1st quartile, Q1 and the right boundary the 3rd quartile, Q3. The length of the box is the interquartile range, IQR. Whiskers represent the minimum (on the left) and maximum (on the right) values above Q1–1.5×IQR and below Q3+1.5×IQR.

4.2 Attributes affecting the attractiveness and the importance of fire safety

The respondents were asked to rank the importance of nine factors or attributes in deciding their response to the question about how attractive it would be for them to live in an apartment in a multi-storey wood building. The attributes included in the question were:

1. Solidity and durability
2. Maintenance (frequencies and costs)
3. Vulnerability to moisture (decay and mould)
4. Fire safety/Vulnerability to fire
5. Insulation regarding sound / Soundproofing
6. Healthy indoor environment (e.g. air quality)
7. Materials used in load-bearing construction (non-visible materials)
8. Indoor visible materials (floors, walls and ceilings)
9. Outdoor visible materials (outdoor cladding)

The results show that fire safety was an important attribute affecting the attractiveness scoring (Fig. 3). Altogether, 24% of respondents rated fire safety to be the most important attribute affecting the attractiveness of WMSB (the second most important attribute for 15% of respondents and the third most important attribute for 11%). For 3%, fire safety was the least important attribute, and for 14% it had no importance.

The mean score for the importance of fire safety was 3.5 on a 9-point Likert-type scale (1 = the most important attribute, 9 = the least important attribute). The differences between groups were small. Young consumers find fire safety slightly less important than older consumer segments (Fig. 4).

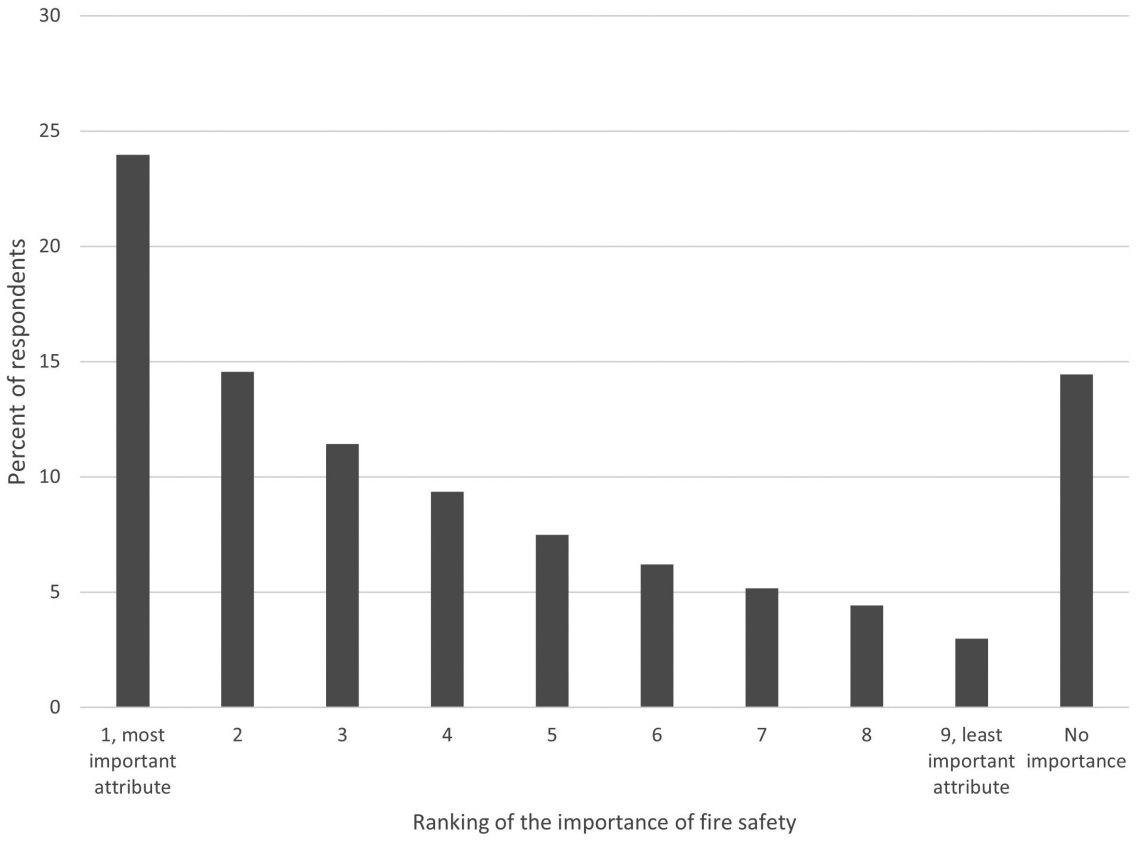

Fig. 3. The importance of fire safety when determining the attractiveness of WMSBs as ranked by all respondents (1 = the most important attribute, 9 = the least important attribute; 0 = attribute of no importance).

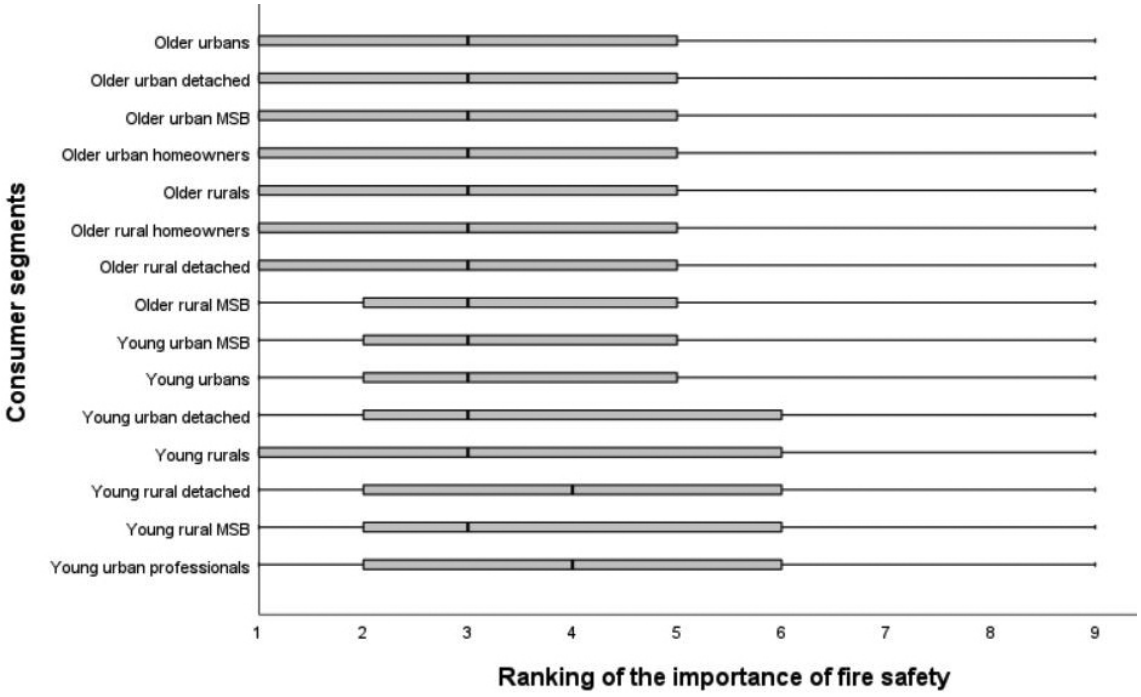

Fig. 4. Box and whisker plot visualizing the importance of fire safety when determining the attractiveness of WMSBs by consumer segments. The left boundary of the box is the 1st quartile, Q1 and the right boundary the 3rd quartile, Q3. The length of the box is the interquartile range, IQR. Whiskers represent the minimum (on the left) and maximum (on the right) values above Q1–1.5×IQR and below Q3+1.5×IQR.

Young professionals living in an urban environment especially ranked fire safety less important than other segments (mean score 4.2).

4.3 The effect of fire safety information on the attractiveness of WMSB

A Wilcoxon signed rank test revealed that taking all responses into account, the information given had a statistically significant but negative effect on the perceived attractiveness of WMSB ($Z = -2.576$, $p = 0.01$). The mean attractiveness score of 4.84 decreased to 4.78 after information had been provided. Of all respondents, 57% did not change their score after receiving information, while 22% lowered their score and 20% raised it.

Considering all respondents, within those individuals who did not find WMSB to be very attractive (score 1–4), attractiveness scoring generally increased after the information. The information had no effect on those who did not have a strong opinion to begin with (score 5). Within those who found WMSB quite or very attractive (score 6–9), attractiveness scoring generally decreased after the information had been provided.

When comparing the consumer segments, young urban professionals and young consumers living in a rural environment changed perception the most (Fig. 5). Segments of young consumers were more likely to change perception than the segments of older consumers. When considering the direction of change in attractiveness, the change was slightly more often towards increased attractiveness in the segments of young consumers and towards decreased attractiveness in others.

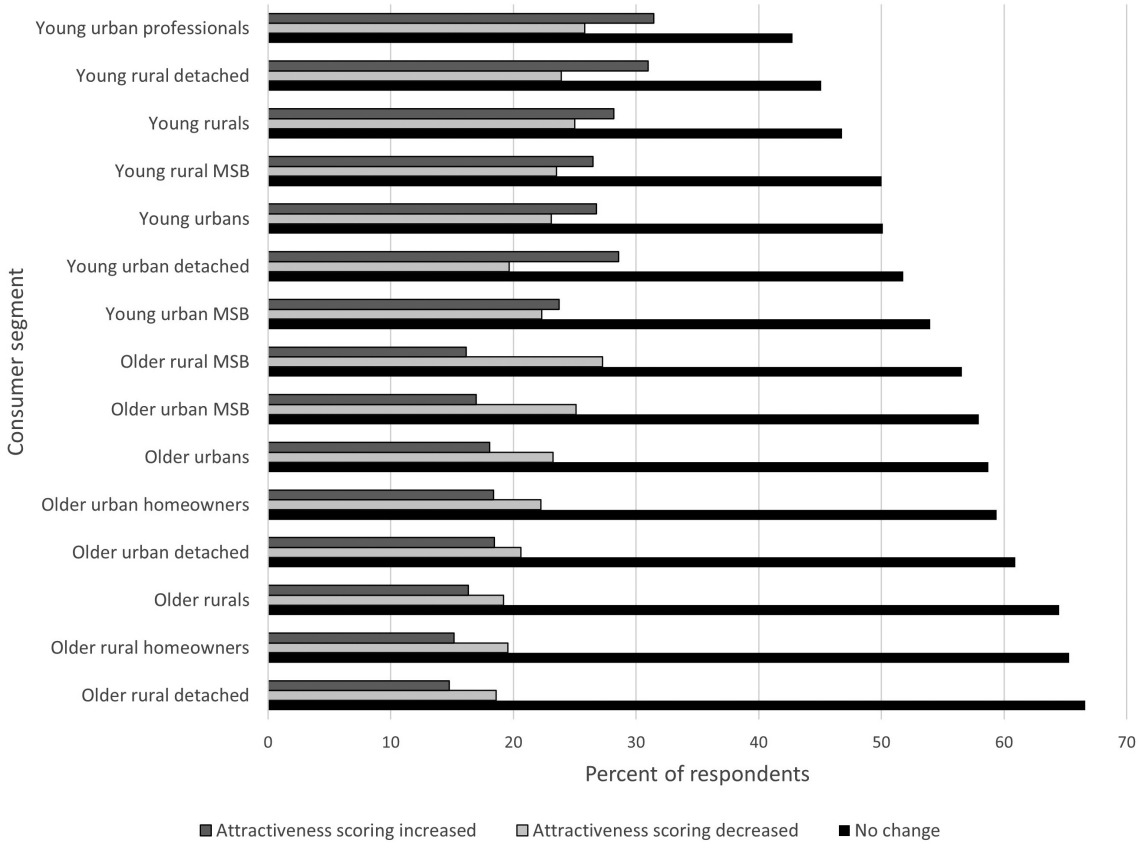

Fig. 5. Changes in the scoring of the attractiveness of WMSBs after receiving information on fire safety, organized by consumer segments. Dark grey bar indicates that the attractiveness scoring of WMSBs increased after receiving information, light grey indicates the attractiveness scoring decreased after receiving information, and black bar indicates there was no change in the attractiveness scoring of WMSBs.

However, these changes in the average rating are very small and statistically insignificant in most segments. The magnitude of change in attractiveness scoring was typically low, from one to two steps in the 9-point Likert scale.

4.4 The effect of information on the importance of fire safety

Considering all respondents, for those individuals who found fire safety to be a very important attribute (original score 1–3 on a 9-point Likert scale, 1 being the most important factor and 9 being the least important), its importance decreased after information. The information had no effect on the importance of fire safety when the original score was 4. For those who rated fire safety to be less important (original score 5–9), its importance increased after information. However, a Wilcoxon signed rank test revealed that when considering all responses, the information given did not have a statistically significant effect on the perceived importance of fire safety ($Z = -1.815$, $p = 0.7$).

When comparing the consumer segments, information caused only very small (statistically insignificant) changes in fire safety rankings in all segments. This change is the biggest in the segments of older rural consumers, older rural homeowners, and older rural consumers living in a detached house. For all these segments, the change is towards increased importance.

5 Discussion and conclusions

5.1 Evaluation of results

This study explored consumer attitudes on WMSB across demographic consumer segments and tested the effect of presenting information on fire safety and regulations on the attractiveness of WMSB. The results suggest that younger consumers and urban consumers are more attracted to living in WMSB than older or rural consumers. The consumer segment that found living in WMSBs the most attractive was young urban people who were already familiar with WMSB through their profession. This may relate to younger generations' desire to live in the urban setting in general, combined with previous experience or knowledge on WMSB received through profession or education and within the professional community. In terms of the theory of innovation diffusion (Rogers 2003), these groups of young consumers can be seen as potential 'early adopters' more willing to adopt WMSB than other groups. Targeting early adopters can be beneficial in supporting the diffusion of eco-innovations (Ramkumar et al. 2022), and therefore identifying them and focusing communication and marketing efforts towards them can be valuable.

The consumer segment that found living in WMSB the least attractive was older homeowners living in a rural setting. A part of the unattractiveness towards living in WMSB of people living in rural surroundings might be related to living in a multi-storey building in general, regardless of the building material. This was supported by a lower average attractiveness scoring among those who live in a detached house, and vice versa. According to the theory of innovation diffusion (Rogers 2003), these groups can be seen as laggards, who are not eager to adopt the innovation in question.

Presenting information on fire safety related to WMSB did have a significant, though mixed impact on the attractiveness of WMSB. Our hypothesis was that presenting information on fire safety would relieve the anxiety of those uninitiated to WMSB. However, while the attractiveness score increased for those who initially regarded WMSB as less attractive, a decrease was observed for those who regarded it as being more attractive. Presenting the information had no impact on those without a strong initial opinion. Thus, presenting information on fire safety and regulations seemed to raise concern among those who were not considering fire safety as an issue before pre-

senting the information, while reassuring to those who regarded it as an issue. A similar pattern was found when looking at the stated relative importance of fire safety when choosing a home, in that for those individuals who found fire safety to be a very important attribute, its importance decreased after information was provided, for those individuals who found fire safety to be a less important attribute, its importance increased after information, while the information had no effect on the importance of fire safety when fire safety was rated to be of medium importance.

While the study could not fully explain the mechanism behind this "averaging effect", a partial explanation may be that if one has a strong opinion, either negative or positive, a piece of additional fire safety information tends to make the opinion less extreme. It is possible that presenting the information either increases or reduces cognitive dissonance created by conflicting views on wood construction (cf. Gaspar et al. 2016). This explanation may be stronger for those initially not preferring WMSB, due to their unwillingness to look for information challenging their prior views at one's own initiative (Gaspar et al. 2016). A convincing source of the information may have further facilitated this (Dursun et al. 2013). In contrast, for those who had initially a higher preference for WMSB, the information provided may have planted a seed of suspicion. Naturally the effect can also be more mundane and be related to, e.g., questionnaire fatigue or that the rather short and concise information in the questionnaire was too brief and limited to support massive changes in perception. In the absence of further proof, the averaging effect phenomenon represents an important avenue for future research.

5.2 Implications

The previous literature has adopted a mix of demographic, psychographic, personality and lifestyle-based variables to determine environmental behaviour segments, due to often not being able to distinguish between consumer preferences based on demographic variables only (Ozanne and Smith 1998; Akehurst et al. 2012; Verain et al. 2012). This study succeeded in distinguishing between a few consumer segments based on demographic variables, which allows more efficient targeted marketing based on commonly available and unambiguous consumer data. However, it is important to note that the sizes of consumer segments included in this study vary greatly. For example, the segment of young urban professionals – which showed great interest in WMSB – consists of 2% of the surveyed population, and therefore its relative importance can be less significant (Fig. 6). This is however expected, as based on the theory of innovation diffusion (Rogers 2003), the group of early adopters typically represents a small portion of the population.

As shown in this study, consumer segments might respond differently to marketing efforts containing detailed information. On one hand, information provision can facilitate addressing negative consumer perceptions, i.e., reassuring information might be able to alleviate the concern of those initially unattracted. On the other hand, one should not over-emphasize the role of fire safety for those already attracted to WMSB, as it could reduce the interest expressed by those initially attracted to WMSB. Thus, it is crucial to tailor the information of WMSB to each consumer segment, i.e., different age groups and backgrounds. Consumers having negative perceptions of the fire safety of WMSB should be informed about the current state of fire safety and regulation, which can have an important impact on the desirability of living in a WMSB. However, information provided for the least interested segments detected in this study (older rural population) may not have an impact if the residents prefer living in detached- and semi-detached houses in the first place. These respondents may even prefer wood as a material in detached houses, regardless of how highly they have ranked fire safety.

The results can also be applied inversely: Targeted marketing efforts even to relatively small consumer segments are recommended as long as budget allows. With targeted communication,

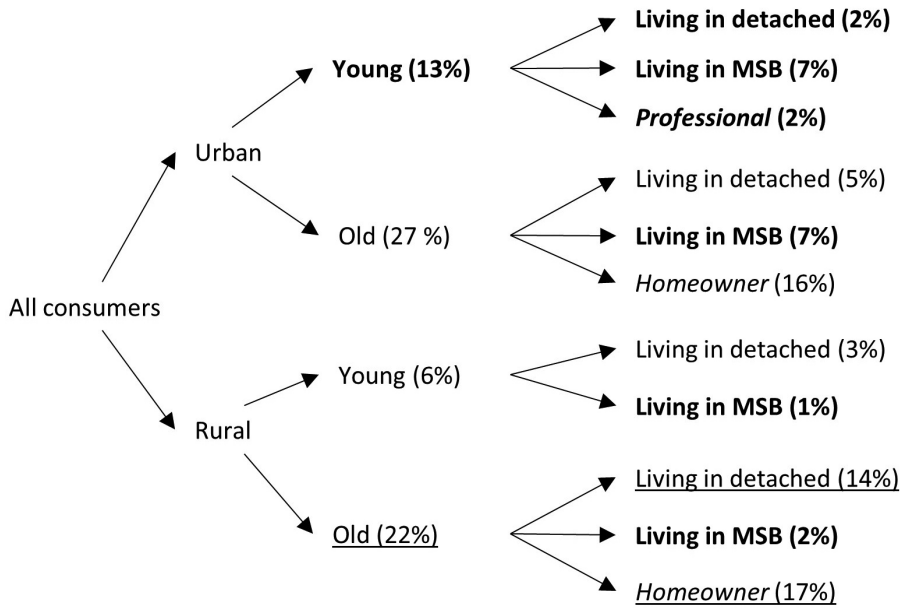

Fig. 6. Consumer segments identified in the study. The percentages refer to the proportion of all respondents. The segments in Italics overlap with the other sub-segments. Bolded font indicates the segments that scored the attractiveness of WMSBs on average highest, while underlined font indicates the segments that scored the attractiveness of WMSB on average lowest.

the groups of early adopters can be reached more effectively. In innovation diffusion, communication channels play a critical role (Rogers 2003). Thus, selecting the appropriate channels for each target group is crucial in order to create impactful communication and marketing of WMSB. However, it should also be noted that given the low rate of MWSB market penetration, limited number of people have first-hand experience or knowledge of WMSB. Therefore, the perceptions of the consumers may currently remain intangible. If WMSB becomes more common, a larger proportion will have experience of it, which may be reflected in more positive attitudes. Nonetheless, the diffusion of MSWB is unlikely to be driven by early-adopter consumers only, but more likely through legislation and construction sector decision-makers, such as developers and major contractors (Nagy 2023).

Naturally, more nuanced and targeted marketing will require considering additional attributes. For example, Lähtinen et al. (2019) found that the perceptions on sustainability benefits of wood can be divided into two groups, namely those who favor the ecological and physio-technological benefits of wood and those who favor the aesthetic and well-being benefits of wood. However, one of the essential factors explaining the initial attractiveness of WMSB is the traditions and the familiarity with WMSB, which has also been found by Høibø et al. (2015).

5.3 Limitations and future research

The survey had very comprehensive coverage with a large number of observations, which allows for the findings of the study to be generalized. While differences between consumer segments were rather small on average, several statistically significant (at the 5% confidence level) differences were identified.

The observed changes in attractiveness scoring when repeating the same questions after presenting information on fire safety and regulations suggest that the respondents had considered the text, and that the information had a non-random effect. However, the reason for the changes

remains subject to speculation and could be partly related to the study setting – it is plausible that a proportion of the respondents who had originally a more positive attitude about wood became annoyed when presented with the information selected and scored the attractiveness lower as a form of protest. Moreover, an additional question would have been required to control for the possible differences in perceptions about WMSB and multi-storey building in general, although these may correlate to some extent with the current mode of living or the divide between those living in rural/urban surroundings. In the future, consumer trust in standards such as the EU standards for timber construction could be studied further, including differences in trust between consumer segments and countries.

The data for this study were collected by a consulting company IPSOS using a panel of voluntary survey respondents who are self-recruited by online advertisements and targeted online recruitment campaigns, including eligibility tests. It is important to acknowledge that there are general drawbacks in using such panels for data collection. First, the panel can be a bit biased towards citizens who are internet users above average or those who tend to click ads. In a more trustworthy panel recruitment, phone and mail recruitment among stratified random samples of population would be used. Second, while the respondents fill in the surveys voluntarily, they do not necessarily have the motivation to spend much time filling in the survey with thought. The reward policy unrelated to the 'quality' of the response might be their biggest driver (Brosnan et al. 2021). This can lead to technically valid responses that are filled in quickly with limited processing of the questions. A large proportion of the respondents of this study were not very familiar with WMSB, nor interested in it, and they therefore might not have been motivated to fill in the survey carefully. It is important to acknowledge this potential issue when assessing the results. However, the advantage is a realistic sample representing the general public, not biased towards only those interested, which serves the objectives of this study. With the response rate and quality monitoring, however, IPSOS can mitigate this type of panelists and keep the responses trustworthy. Further, the lack of information and awareness is an important finding that highlights the need for further studies regarding e.g., the most relevant information channels and sources. Overall, using the international panel data provider enabled gathering data for this study with a similar procedure in several countries at the same time, making it comparable across the seven national subsamples. It must be noted though that the data only contains responses from citizens who are 18 years or older. This means that learning about the opinions of people younger than that would require further research with new data.

In this study, meaningful differences between countries were not identified. Differences between countries have been explored by Nyrud et al. (2023) who found that the attractiveness of WMSB was rated higher in countries with long traditions of wood construction, namely Austria, Finland, Norway and Sweden. Moreover, the overall proportion of all MSBs in the country could explain the general attractiveness of MSB, regardless of the materials used. For example, in Denmark detached and semi-detached houses make up 93% of all residential buildings (number of buildings) whereas MSB make up only a 7% share (Statistics Denmark 2023), thus residents may find living in multi-storey buildings less familiar and less preferred. More research on differences between countries should be carried out in the future. Moreover, it would be important to study factors other than fire safety more closely (such as acoustics or indoor air quality) that affect the desirability of WMSB, in order to find out how providing information regarding these other attributes affects attitudes in different countries. Qualitative methods could be combined with quantitative studies to gain a holistic view of how and why information is affecting consumers perceptions and preferences in different segments.

5.4 Concluding remarks

The study shows that it is possible to distinguish between consumer segments with all levels of attraction to WMSB based on common demographic variables. Moreover, the level of attraction may be negatively correlated to the change in perception when presenting a consumer with information on fire safety of WMSB. Thus, the results suggest that untargeted marketing efforts using information on fire regulation might not be effective, as it may have a positive influence on certain consumer segments and a negative one for others: In particular, consumers who rank fire safety as a highly important attribute for housing, may perceive information about fire regulation to be reassuring. Young consumer segments had the most propensity to change perception. The change was positive (towards increased attractiveness), even though differences in mean scores were small. Thus, the study suggests that marketing efforts involving information on fire safety of WMSB could be targeted especially at young rural and urban consumers.

Supplementary files

S1.pdf; Survey questions,
S2.pdf; Statistical analyses,
Metadata of research data.pdf,
available at https://doi.org/10.14214/sf.23035.

Declaration of openness of research materials and data

The dataset is not publicly available due to being generated under the ownership of multi-country project NOFOBE.

Authors' contributions

Venla Wallius: conception of research questions, designing and implementing the analysis, interpretation of data and the results, scientific writing of the article.
Janni Kunttu: conception of research questions, designing and implementing the analysis, interpretation of data and the results, scientific writing of the article.
Elias Hurmekoski: survey design, conception of research questions, designing the analysis, interpretation of data and the results, scientific writing of the article.
Teppo Hujala: survey design, conception of research questions, interpretation of data and the results, scientific writing of the article.
Anders Q. Nyrud: survey design, interpretation of the results, scientific writing of the article.
Hans Fredrik Hoen: survey design, interpretation of the results, critically revising the article.

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