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Consumer heterogeneity and willingness to pay for common reed insulation board: A choice experiment approach

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ABSTRACT

The growing demand for sustainable construction materials and the need to restore marginal lands have created opportunities for innovative bio-based solutions. Common reed (*Phragmites australis*) offers both ecological benefits and potential as a renewable insulation material, particularly when cultivated on underutilised land. However, the commercial success of such novel materials depends on consumer acceptance and willingness to pay. This study examines consumer preferences and willingness to pay for insulation boards made from common reed using a discrete choice experiment conducted in Finland in 2024 (N = 2974). Respondents evaluated four insulation boards, namely cellulose wool, stone wool, wood fibre and reed fibre, based on five attributes: thermal insulation, domestic origin, fire safety, environmental friendliness and price. A latent class model identified five consumer segments. One segment (10.7%) displayed a clear preference for reed fibre boards, valuing thermal insulation and environmental benefits while being the least price-sensitive, suggesting higher stated valuation for the material. A younger age, female gender, a background in construction and positive views on the utilisation of marginal lands increased the likelihood of segment membership. While excellent thermal insulation and domestic origin were important across all groups, their relative importance varied. The findings highlight that a distinct group of consumers has a clear preference for reed fibre insulation, especially if marketed with a focus on sustainability and renewability. The study underscores the importance of targeted communication and policy support to facilitate the adoption of novel bio-based construction materials.

1. Introduction

The EU Nature Restoration Regulation emphasises the urgency of restoring drained peat soils from agriculture, peat extraction and forestry to wetlands. This is crucial to convert these areas of high peat decomposition and greenhouse gas emissions into carbon-sequestering land ecosystems that support carbon neutrality. Simultaneously, the rising demand for biomass in industrial applications is increasing pressure on productive land, necessitating the sustainable use of degraded and marginal soils. Currently, an estimated 60–70% of European soils are damaged, presenting an opportunity for ecosystem-improving biomass cultivation (European Commission, 2021).

While hemp and woody biomass are well established, underexploited species such as the common reed (*Phragmites australis*) could offer additional potential for biomass production without encroaching on active food-production or forestry land (Köbbing et al., 2013; Burry et al., 2017). Beyond its biomass yield, common reed provides significant environmental benefits, including nutrient removal, invasive species prevention, biodiversity and reduced greenhouse gas emissions, while simultaneously creating new revenue streams for rural entrepreneurs (Kiviat, 2013; Köbbing et al., 2013; Rezania et al., 2019; Srivastava et al., 2014). However, these environmental benefits are not inherent to the material itself but are context-dependent, differing according to cultivation or harvesting practices, transport distances, processing requirements and potential land-use changes (e.g., Schulte et al., 2021). Consequently, their overall environmental performance should be assessed from a life-cycle perspective.

The increasing global emphasis on sustainable building materials has led to a surge in demand for eco-friendly insulation solutions (Abu-Jdayil et al., 2019; Schulte et al., 2021; Füchsl et al., 2022; Bourbia et al., 2023). Among various options, insulation boards made from common reed present an innovative alternative due to their promising thermal properties, renewability and low, or even positive, environmental impact (Shon et al., 2019). As the construction industry strives to reduce its carbon footprint, the utilisation of common reed as an insulation material represents a promising alternative to conventional,

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non-renewable insulation products (Asdrubali et al., 2015, 2016; Baly, 2023). However, the ultimate success of reed-based insulation depends on consumer acceptance and purchasing behaviour. Previous research suggests that price premiums for green or sustainable housing solutions may be feasible if consumers are willing to pay for environmental benefits (Portnov et al., 2018).

Here, we specifically focus on consumer preferences for insulation boards made from common reed through a discrete choice experiment (DCE) (Bateman et al., 2002), a widely used method for valuing both market and non-market goods. Traditional market analysis, based on actual transactions, often fails to provide insights into novel products that are not yet commercialised (e.g., Lizin et al., 2022). While some DCE studies have explored the environmental characteristics of construction materials (Katerusha, 2021; Sterk, 2023), few have focused on bio-based materials produced with explicit ecological benefits, such as utilising degraded land, an underexamined topic that this study seeks to explore.

The heterogeneity of consumer preferences regarding environmental attributes has been reported in previous literature, but applications to construction materials remain limited and have primarily investigated circular and bio-based materials (Dirx, 2024) and wood products (Cai and Aguilar, 2013). Existing literature suggests substantial variation in preferences for the use of bio-based materials in different building components (Dirx, 2024) and identifies socioeconomic factors, such as education, that are associated with higher preferences for bio-based materials (Cai and Aguilar, 2013). However, empirical studies identifying the consumer segment specifically interested in bio-based materials cultivated on marginal lands remain scarce, a gap that this study aims to fill.

Here, we focus on the heterogeneity of consumers and the segments interested in purchasing insulation material produced on marginal lands. We specifically aim to identify consumer groups with the highest interest in common reed products. We provide insights into the attributes of common reed insulation boards that interest consumers, their relative market value and the associated price premiums compared to alternative materials. Furthermore, we estimate the size of the consumer segment expressing a preference for common reed insulation boards based on stated preference data. We also examine consumer preferences under stated choice conditions and use the resulting evidence base to assess the potential for emerging bio-based products to enter the insulation board market.

2. Choice experiment studies on building materials

The theoretical basis for consumer choices of bio-based materials lies in the random utility model (RUM) (McFadden, 1974). Within this framework, consumer behaviour, including green consumer choices, can be interpreted as the outcome of individuals choosing the alternative that maximizes their utility. In the case of green behaviour, environmental attributes, such as eco-labels, low emissions or organic production, are considered alongside other product characteristics and contribute to overall utility. A consumer exhibits green behaviour when their preference for these environmental attributes is positive and sufficiently strong, such that the additional utility derived from them outweighs potential disadvantages, including higher prices or lower convenience.

While DCEs based on RUMs are widely used in valuing environmental goods that lack direct market prices (Johnston et al., 2017), their application to built environment contexts, such as green buildings and sustainable construction materials, has mainly focused on wood products (e.g., Vlosky et al., 1999; Cai and Aguilar, 2013; Shoji et al., 2014; Holopainen et al., 2017) and has only recently gained momentum in other applications, reflecting a growing interest in understanding consumer preferences in this area (Dirx, 2024).

Choice experiments have been applied to examine preferences for building materials, such as recycled concrete, as well as for sustainability attributes in construction (Katerusha, 2021; Sterk, 2023). For example, Katerusha (2021) investigated the willingness of engineering and architecture students to pay for recyclability and energy efficiency in recycled concrete. Similarly, Sterk (2023) assessed construction clients' WTP for recycled concrete and the factors influencing their choices, finding that all client groups demonstrated a positive WTP, with organisations willing to pay the most and private individuals the least. Friedrich (2022) explored building experts' WTP for bioplastic-based textile façades, finding that while acceptance was influenced by product information and normative factors, concerns about performance compared to conventional petroplastics remained a key barrier. However, DCEs solely focusing on consumer perspectives on building materials based on renewable natural resources, beyond wood products, remain scarce.

Numerous studies have examined stakeholders' willingness to pay a premium for environmentally sustainable features in construction, generally finding a positive attitude towards investing in green building attributes (Mandell and Wilhelmsson, 2011; Friedrich, 2022; Huang, 2022), although some contrasting evidence also exists (Riala and Ilola, 2014). Factors such as familiarity with the material, environmental awareness and a sense of responsibility for sustainable construction have positively influenced WTP (Portnov et al., 2018; Sterk, 2023). In consumer choices of bio-based materials, such as wood, other attributes, particularly fire safety, also play a significant role. In the context of wood construction, fire safety is often perceived as challenging, although modern treatment methods and technologies have significantly improved the fire safety of wood (Gold and Rubik, 2009). Additionally, the country of origin has been suggested to influence consumer choices. For instance, in the context of forest products, research indicates that the country of origin significantly affects consumer behaviour and preferences (Cai and Aguilar, 2013), which is often linked to perceptions of quality and environmental sustainability (Toivonen, 2011; Holopainen et al., 2017).

Insights from green consumer behaviour (Patiño-Toro et al., 2024) indicate that pro-environmental values, environmental beliefs and attitudes shape preferences for sustainable products. Generally, sociodemographic and psychographic factors can influence choices regarding environmentally friendly products (Diamantopoulos et al., 2003; Martinho et al., 2015; Gaffey et al., 2021; Ruf et al., 2022; Sharma et al., 2023) and can be considered in RUM-based modelling in explaining observed preference heterogeneity. Similar patterns of consumer heterogeneity in sustainable product choices, influenced by various demographic characteristics and attitudes (e.g., Liu et al., 2018), have also been noted in construction research. Research has demonstrated a positive association of female gender (Ozanne and Vlosky, 1997; Vlosky et al., 1999), age and income (Chau et al., 2010; Dirx, 2024) and higher educational levels (Holopainen et al., 2017; Dirx, 2024), as well as politically liberal views and membership in an environmental organisation (Ozanne and Vlosky, 1997; Vlosky et al., 1999), with purchasing environmentally friendly products or a preference for environmental product attributes. Fernandez-Luzuriaga et al. (2022) found that income, the type of heating system, the presence of children and age significantly influenced homeowners' decisions to make low-carbon housing choices. However, some demographic variables, particularly age and gender, have demonstrated inconsistent impacts on willingness to pay (WTP) and product purchases, with studies indicating that these factors influence consumer behaviour differently (Ruf et al., 2022). From attitudinal variables, environmental awareness and attitudes towards technology have shaped consumers' willingness to adopt zero-energy buildings (Choi et al., 2023).

Consumer choices related to construction materials differ markedly from routine decisions concerning food, health or transportation. For instance, in the case of insulation boards, many consumers are not actively involved in the selection process; such decisions are typically made by professionals or other household members. Nevertheless, Finland offers a particularly relevant context for this research due to its above-average proportion of detached housing in Europe and the widespread ownership of summer cottages, settings in which consumers often make building-related decisions themselves. However, these decisions remain infrequent in everyday life, and opportunities for experiential learning in material selection are limited. As this topic is likely to be unfamiliar to a substantial share of consumers, the applicability of DCEs may be constrained. Prior research has identified several methodological challenges and potential biases that may affect the validity of willingness-to-pay (WTP) estimates, including hypothetical bias, attribute non-attendance, choice complexity and cognitive load (e.g., Johnston et al., 2017; Caputo and Scarpa, 2022; Saija et al., 2023; Tadesse et al., 2025). For insulation board selection, in particular, hypothetical bias is especially relevant, as many consumers face this decision only once, or never, during their lifetime.

The estimated mean willingness to pay (WTP) in DCEs is typically derived from hypothetical scenarios, and its correlation with actual consumer behaviour is uncertain, a discrepancy known as hypothetical bias (HB). Studies have demonstrated that HB tends to increase with the value of the product being evaluated, particularly for specialty goods, which are often more complex and less familiar to consumers than convenience goods (Schmidt and Bijmolt, 2020). The impact of innovation embedded in a product on HB remains ambivalent, with some findings suggesting no effect (Schmidt and Bijmolt, 2020) and others indicating a positive correlation (Hofstetter et al., 2013). While indirect methods such as DCEs are often considered less prone to HB than direct valuation approaches, this assumption is not universally supported by empirical evidence (Little et al., 2012). Including follow-up certainty questions has demonstrated promise in mitigating HB, especially in high-stakes scenarios where inflated WTP estimates are more likely. Empirical calibration methods for WTP that compare hypothetical and real values, aiming to reduce or eliminate bias (Liljas and Blumenschein, 2000), have been tested and suggested. Here, we calibrate the WTP estimates against those for other insulation materials.

3. Materials and methods

3.1. Data collection

The target population for this study consisted of Finnish citizens aged 18 years and older. Data collection was conducted in two phases in 2024 through an online survey, using a respondent panel provided by the survey company Bilendi Oy. The sample was collected using stratified sampling based on age, gender and region to approximate the demographic structure of the Finnish population. The pilot phase in October 2024 involved a small group of participants (N = 200) to test the survey's measures and to design the choice experiment attributes. The pilot study also ensured that a target sample size of over 4000 respondents would be sufficient to capture a large enough number of individuals involved in construction or renovation decision-making. Feedback from the pilot was used to refine the survey questions and improve clarity, ensuring that the instrument would accurately capture consumer insights.

The pilot was also used to reduce respondent burden in the choice experiment by narrowing the literature-based set of attributes to a manageable number. Specifically, the pilot survey (N = 200) was conducted to assess the relative importance of a broader list of 15 attributes and to collect additional suggestions through an open-ended question. Several of the initially identified attributes proved difficult to operationalize in a simple and consistent manner due to strong product-specific or building-context variation (e.g., humidity performance, usability and durability). Although environmental attributes were not among the most highly ranked in the pilot, we included an environmental performance attribute because it represents a key characteristic of fibre boards made from renewable organic materials. The pilot was also used to test a preliminary choice experiment. The results, including significance tests from a conditional logit model, together with insights from the literature and considerations of interpretability and policy relevance, informed the selection of the final attributes.

The main data collection phase in November 2024 successfully gathered 4300 valid responses, which constituted the final realised sample size. A response rate of 16% was achieved through three reminder messages.

The survey comprised multiple sections addressing various aspects related to housing, construction and environmental attitudes. It included questions on housing and the living environment, as well as construction-related decisions and intentions (Supplementary Material 1). Participants were asked about their experiences and perceptions of insulation materials, the importance of different insulation material attributes and the acceptability of various insulation types. The survey also featured a choice experiment section exploring preferences for insulation materials. Additionally, it examined alternative uses for common reed, the utilisation of unproductive lands and respondents' environmental attitudes through the New Ecological Paradigm (NEP) scale. Finally, the survey collected respondent background information to support demographic analysis.

Overall, the data represented the Finnish population reasonably well in terms of mean age, gender and completion of higher education (see Table 1). Compared to both all respondents and the general Finnish population, the choice experiment participants were slightly older, included fewer women and had a higher proportion of individuals who had completed higher education.

To avoid hypotheticality, the eligibility of respondents to proceed to additional sections, including the choice experiment, depended on their involvement in decision-making concerning home or second-home construction or renovation. Those affirming their participation (N = 2974) were selected for subsequent survey sections, including the choice experiment. Therefore, the results specifically apply to respondents involved in construction or renovation decision-making and should not be interpreted as representative of the general population.

3.2. Choice experiment design

For those who met the initial criteria, the choice experiment section included six choice tasks per respondent. The attributes were introduced to the respondents (Supplementary Material 1), along with a brief presentation of the insulation materials. Three of the materials, namely cellulose wool board (CWB), stone wool board (SWB) and wood fibre board (WFB), are already available on the Finnish market, whereas reed fibre board (RFB) is not yet commercially available and was presented as a potential insulation material.

Respondents were provided with a short description of each material, including its origin, typical applications and key properties, such as thermal insulation performance. For reed fibre board, in particular, the description included information on its production from common reed and its key characteristics, such as breathability and suitability for use in building structures. In addition, respondents had access to a link providing further background information on all four insulation materials (see Supplementary Material 1). This supplementary information

Table 1
Sociodemographic characteristics of all respondents (N = 4300), the choice experiment participants (N = 2974) and the Finnish population.

Variable	All respondents in the survey, % (N = 4300)	Respondents in the choice experiment section, % (N = 2974)	[a]Finnish population, %
Mean age, years	49.8	51.3	50.6
Female	50.4	47.9	50.5
Higher education (bachelor's degree or higher)	44.4	49.1	35

[a] https://stat.fi/en.

presented each material in a comparable and structured manner, including the characteristics, applications and environmental aspects.

The experiment followed a labelled choice design, as the alternatives were presented with their material-specific names. The attributes and levels used in the choice experiment are presented in Table 2.

After introducing the attributes and insulation materials, respondents completed six choice tasks. Each task included four insulation material alternatives: CWB, SWB, WFB and RFB. Each alternative was described based on four attributes, their levels and a cost attribute. An example of a choice task is presented in Table 3. Respondents were asked to select one preferred material or, alternatively, to choose none of the options. After the choice tasks, the uncertainty of respondents regarding the choices was assessed.

We applied an efficient experimental design to assign attribute levels to the choice tasks in the survey. Efficient designs seek to produce parameter estimates with the lowest possible standard errors, ensuring that maximum information is extracted from each choice situation (e.g., Rose and Bliemer, 2009). To generate an efficient design, prior values for parameter estimates must be specified. In the pilot survey, zero priors were used, and the parameter estimates obtained from the pilot study helped shape the final experimental design. For the final study, a Bayesian D-efficient design was employed using Ngene (v. 1.0.2), incorporating 500 Halton draws for prior parameter distributions. Bayesian designs account for uncertainty in parameter priors, utilising random priors instead of fixed values by defining a mean and standard deviation.

In designing the experiment, we sought to balance realism and statistical identification, ensuring that attribute-level combinations remained credible to respondents while still allowing sufficient variation across alternatives. Some alternatives could only have certain levels due to their physical characteristics (Table 2). For example, a stone wool board cannot realistically be assigned the levels ‘burns slowly’ or ‘burns very slowly’, as it is a non-combustible material. Additionally, the lowest price levels were not feasible for reed fibre board and were excluded, and the highest levels were excluded from the other alternatives. Despite these constraints, the design retained substantial independent variation across most attributes. Several key attributes, such as thermal insulation, domestic origin and environmental friendliness, were varied across all or most alternatives, enabling identification of their effects independently of the material labels.

A total of 36 choice tasks were created, divided into six subsets, allowing each respondent to encounter six choice situations. Each respondent was randomly assigned one of the six versions of the choice experiment. The final design achieved a D-error of 0.096, while estimation started with an error level of 0.124. A no-choice option was provided for respondents in each choice task.

Table 2
Attributes and levels used in the insulation board choice experiment.

Attribute	Levels
Thermal insulation	Fairly good (0) Good (1) Excellent (2)
Domestic origin	Non-domestic (0) Domestic (1)
Fire safety[a]	Burns slowly (0) Burns very slowly (1) Non-combustible (2)
Environmental friendliness[b]	Weak (0) Fair (1) Excellent (2)
Price: €/m^2/100 mm[a]	€8, €12, €16, €21, €32, €43

The stone wool board does not have fire safety ratings at levels 0 and 1, a thermal insulation rating at level 0, an environmental friendliness rating at level 2 or prices of €32 or €43.
The reed fibre board does not have a fire safety rating at level 2, an environmental friendliness rating at level 0 or prices of €8 or €12.

[a] The cellulose wool board and the wood fibre board do not have a fire safety rating at level 2, an environmental friendliness rating at level 0 or prices of €32 or €43.

[b] The “environmental friendliness” attribute refers to multiple environmental aspects, including the renewability and recyclability of raw materials, impacts on biodiversity through land-use change, climate and water impacts of production and the recyclability of demolition waste (see Supplementary Material 1).

Table 3
Example of a choice set.

Insulation type	Cellulose wool board	Stone wool board	Wood fibre board	Reed fibre board
Thermal insulation	Good	Excellent	Excellent	Fairly Good
Domestic production	No	Yes	No	Yes
Fire safety	Burns very slowly	Non-combustible	Burns slowly	Burns slowly
Environmental friendliness	Excellent	Moderate	Moderate	Excellent
Price: €/m^2 (100 mm thick)	€12	€12	€8	€16
My Choice	( )	( )	( )	( )

I would not choose any of these options ( ).

3.3. Statistical methods

We applied a latent class model that allows for heterogeneity in consumer preferences. This heterogeneity of preferences is typically unobservable or latent, but it can be inferred from consumer choices in a DCE when there is variation across products and their characteristics. In the latent class model, preferences are assumed to be homogeneous within each segment but to vary between segments. Heterogeneity was statistically incorporated into the latent class model by simultaneously dividing individuals into behavioural groups or latent segments and estimating a choice model for each of these classes.

In the modelling, price was treated as a continuous variable and the other attributes were dummy-coded, with the lowest quality serving as the reference level. Alternative-specific constants (ASCs) were included for all alternatives to allow for systematic choice tendencies not explained by the parameters describing the attributes.

Model selection was primarily guided by the Akaike information criterion (AIC) and the Bayesian information criterion (BIC). Entropy was examined to evaluate the clarity of class separation (Vermunt and Magidson, 2005). These measures informed the determination of the appropriate number of latent classes. If the coefficient of the price attribute in a group is significant and negative, the latent class model enables the calculation of WTP for the attributes for each consumer segment.

To further investigate heterogeneity among respondents who preferred reed fibre, we applied an extension of the latent class approach based on the approach proposed by Song et al. (2024) and Lagarde (2013). Specifically, we estimated a new latent class model within an existing class, a strategy we refer to as subclass analysis. The exploratory subclass analysis was implemented as a targeted diagnostic tool to uncover latent behavioural patterns, particularly regarding the price response, that were not identifiable in the aggregate segment. Individuals were first assigned to the reed-preferring class using modal class assignment, after which a separate latent class model was estimated for this subset to assess whether additional unobserved heterogeneity remained beyond what the original model captured. In addition, comparisons between subclasses were conducted using ANOVA (with Tukey HSD post hoc tests) for continuous variables and chi-squared tests for categorical variables to explore differences in sociodemographic, housing-related, and preference- and attitude-related characteristics across subclasses. Because the original classes were solely derived from product choices, without incorporating consumer characteristics, the relationship between individual traits and latent class membership was examined only after estimating the latent class model. This 'after-analysis' approach ensured that class formation was exclusively driven by preference patterns rather than sociodemographic factors. Respondents were assigned to latent classes based on their highest posterior probability. Class-specific mean posterior probabilities were generally high (approximately 0.86–0.99), indicating clear separation between the latent classes and supporting the use of modal class assignment in subsequent analyses. Once behavioural heterogeneity had been identified, the role of individual characteristics in predicting class membership was analysed using logistic regression. This analysis was exploratory in nature, aiming to characterise the identified segments in terms of respondents' background characteristics. For each model, the dependent variable was coded as 1 for membership in the focal segment and 0 for membership in all other segments.

To explain membership in the five identified consumer segments, a range of explanatory variables was included in the logistic regression models. These variables and their categories are presented in more detail in Table 5. Sociodemographic variables included gender (female), age group and region of residence. Each of these variables was statistically significant in at least one of the five models and was reported in the final model results. Level of education and employment status were also tested, but they did not reach statistical significance in any of the models.

Housing-related variables consisted of the type of dwelling (e.g., detached house or apartment), whether the respondent had an education, studies or work experience related to construction, and the number of different insulation materials with which they had prior experience (ranging from 1 to 12). In addition, the use of experts or sources of information on construction-related matters, knowledge of the current home insulation and having renovation or building plans were tested, but they were only statistically significant in explaining membership in the segment characterised by low preferences for all insulation materials (see Table 5). Other tested variables were housing tenure (owner-occupied/rented/right-of-occupancy housing), the type of residential area (urban/rural), second-home ownership and the types of renovations planned. However, none were found to be statistically significant in explaining segment membership.

Statements on insulation material attributes were used to assess how the respondents valued different characteristics of insulation materials. Fifteen statements were analysed using factor analysis, which identified three underlying dimensions: eco-cultural sustainability, technical safety and durability, and practicality and economy (Appendix A.1). In addition, attitudinal measures included responses to statements concerning the utilisation of marginal and degraded land (referred to as marginal land). Nine such statements were presented, and factor analysis revealed two distinct dimensions: marginal land utilisation and marginal land conservation (Appendix A.2). The environmental orientation of respondents was measured using the New Ecological Paradigm (NEP) scale (Dunlap et al., 2000; Hawcroft and Milfont, 2010). The scale includes six statements:

(1) The delicate balance of nature is easily disturbed by human activity;
(2) There is only limited space and resources on Earth;
(3) Plants and animals do not exist primarily for humans;
(4) Changing the environment for human use rarely causes serious problems;
(5) In countries like Finland, there are no limits to economic growth; and
(6) Humans have the right to control the rest of nature (Supplementary Material 1).

Based on the acceptable Cronbach's alpha (0.742), the final NEP score was calculated as the mean of these items, with higher scores indicating a more pro-environmental worldview.

4. Results

4.1. Choice experiment

The results revealed five distinct consumer segments with clearly differentiated preference patterns for insulation materials. Model fit statistics supported the selection of a five-class solution among models with one to ten classes: both AIC and BIC reached comparatively low values in the five-class solution, and improvements in these criteria diminished when additional classes were added. The entropy R^2 value (0.8216) indicated good classification accuracy, suggesting that the model effectively separated respondents into preference-based segments. Increasing the number of classes beyond five resulted in only marginal improvements in model fit while leading to more fragmented and less interpretable class structures. The selected five-class model provides a well-balanced representation of consumer preferences while maintaining interpretability (Table 4). The chosen model successfully identified distinct consumer segments based on their preferences for insulation materials, demonstrating meaningful differences in attribute valuation across groups. The overall pseudo R^2 value (0.4865) indicates a good level of explanatory power, suggesting that the model captures a significant proportion of variation in choices. Additionally, the Wald test p-value (<0.001) confirms that the included attributes are jointly significant in explaining consumer preferences. Moreover, the Wald test (=) p-value (<0.001) suggests that most attributes significantly vary across classes, supporting the decision to use a latent class approach rather than assuming a homogeneous population. While preferences for fire safety did not differ significantly, heterogeneity was evident in thermal insulation quality, domestic origin, environmental friendliness and price.

The largest segment, Class 1, consisted of respondents preferring WFB, who valued multiple attributes simultaneously. This group, accounting for 37.4%, was named WFB preferers due to the high coefficient of ASC for WFB. Environmental friendliness, thermal insulation quality and domestic origin had the highest coefficients, indicating their strong influence on the choice of insulation material. Domestic origin, in particular, played a more prominent role compared to other groups. While fire safety also had an effect, its influence was weaker than in Class 2. Price sensitivity was moderate, meaning that while cost was a factor, it was less decisive than for respondents in Classes 2 and 3.

A price-sensitive segment, Class 2, consisted of respondents preferring SWB, with a strong focus on thermal performance. SWB preferers, revealed by ASC, accounted for 27.4% of the sample. In addition to their strong preference for excellent thermal insulation, environmental friendliness was also a significant attribute, although its effect was weaker than in Classes 1, 3 and 4. A strongly negative price coefficient suggests high price sensitivity, indicating that cost was a major factor in their choices.

Respondents preferring CWB formed a price-sensitive segment with a particular emphasis on environmental friendliness. Class 3, CWB preferers, represented 17.1% of respondents. This group placed strong importance on most attributes, except for fire safety. Environmental friendliness had the highest coefficient among all groups, highlighting its central role in their preferences. Similarly to Class 2, this group exhibited high price sensitivity, suggesting that cost was a decisive factor compared to Classes 1, 4 and 5.

A smaller but distinct segment, Class 4, consisted of respondents preferring RFB, characterised by low price sensitivity and strong sustainability-related preferences. RFB preferers represented 10.7% of respondents. Their choices were primarily driven by preferences for thermal insulation and environmental friendliness, while domestic origin was also significant but played a smaller role compared to other preference groups. This group was the least price-sensitive among Classes 1, 2 and 3, as indicated by the minimal negative price coefficient. This suggests challenges in defining meaningful and feasible price premiums for RFB among this key buyer segment.

Table 4
Latent class models for insulation board choice.

	Class 1	Class 2	Class 3	Class 4	Class 5	Overall	
Pseudo R^2	0.312	0.525	0.550	0.190	0.858	0.487	
Class size, %	37.7	27.4	17.1	10.7	7.1		
Preference group	**Wood Fibre Board Preferers**	**Stone Wool Board Preferers**	**Cellulose Wool Board Preferers**	**Reed Fibre Board Preferers**	**No-Preference Respondents**	**Wald p-value**	**Wald (=) p-value**
Attribute	**Coefficients and significance levels**						
Good thermal insulation[a]	0.400***	0.579***	0.464***	0.003	0.597	<0.001	<0.001
Excellent thermal insulation[a]	0.805***	1.283***	0.615***	0.670***	1.049***		
Domestic origin[b]	0.662***	0.458***	0.413***	0.177**	0.475*	<0.001	<0.001
Burns very slowly[c]	0.180***	0.256***	0.070	0.028	0.136	<0.001	0.200
Fair environmental friendliness[c]	0.490***	0.193***	0.609***	0.145	−0.728	<0.001	0.007
Excellent environmental friendliness[d]	0.906***	0.393***	0.932***	0.559***	−0.644		
Price	−0.063***	−0.111***	−0.105***	−0.008*	0.018	<0.001	<0.001
ASC							
Cellulose wool board[e]	3.437	3.976	**5.912**	2.271	−4.055		
Stone wool board[e]	3.177	**6.078**	3.965	2.332	−5.028		
Wood fibre board[e]	**4.559**	3.9003	3.507	2.128	−3.865		
Reed fibre board[e]	3.184	3.316	3.492	**3.441**	−5.093		

z-test: *** 99% significance level; ** 95% significance level; * 90% significance level.
ASC: alternative-specific constant.
Attribute reference levels: [a]Fairly good thermal insulation; [b]Non-domestic origin; [c]Burns slowly; [d]Weak environmental friendliness; [e]No choice.

A small segment was characterised by the absence of a clear preference for any specific insulation material. No-preference respondents in Class 5, making up 7.1% of the sample, did not show a strong preference for any particular insulation material or attribute. However, thermal insulation and domestic origin remained significant factors in their choices. Unlike other classes, price did not play a significant role in their decision-making.

It should be noted that the share of respondents in each segment, including the 10.7% identifying as reed fibre preferers, represents preference-based group membership derived from stated choices and does not directly correspond to expected market demand.

4.2. Heterogeneity of consumer groups: logistic regressions results

Logistic regression analysis revealed statistically significant associations between consumer characteristics and segment membership. The results indicate that consumer segment membership was systematically associated with both sociodemographic characteristics and attitudinal factors (Table 5).

Individuals with stronger eco-cultural sustainability values and higher NEP scores were more likely to prefer wood fibre board. A positive association was also found with attitudes favouring marginal land utilisation. In contrast, those who prioritised technical safety and durability and individuals with a construction-related education, studies or work experience were less likely to belong to this group.

A preference for stone wool board was more common among respondents from southern Finland, those with higher incomes and individuals with a construction-related education, studies or work experience. Practical considerations, including technical safety and durability, as well as practicality and economy, also increased the likelihood of preferring this material. Conversely, those with stronger eco-cultural sustainability values and higher NEP scores were less likely to choose stone wool insulation.

Fewer statistically significant predictors were found for CWB preferers. However, respondents living in detached houses were more likely to favour cellulose insulation, while those from southern Finland and women were less likely to prefer it.

The model for RFB preferers, although limited in classification accuracy due to the relatively small segment size, indicates that a preference for RFB is strongly associated with eco-cultural sustainability and support for marginal land utilisation. Membership in this group was also more likely among younger respondents aged 18–24, women and those with a construction-related education or experience. In contrast, living in a detached house decreased the likelihood of preferring RFB, and lesser experience with insulation materials increased the likelihood.

Those who did not prefer any of the studied insulation boards were more likely to be over the age of 65 and less likely to have a background in construction. They were also less likely to be familiar with their homes' insulation material, less likely to have renovation or building plans and reported lower information use and NEP scores.

4.3. Subclass analysis

As the initial five-class model indicated exceptionally low price sensitivity among RFB preferers, posing challenges for deriving meaningful WTP estimates, we further examined within-group variation through subclass analysis. Specifically, we estimated a separate three-class model for the RFB preferers (Class 4) identified in the five-class model.

The subclass analysis revealed substantial heterogeneity within the reed fibre preferers, particularly in terms of price sensitivity. Table 6 presents the results for three subclasses with distinct responses to the price attribute. Only the first subgroup exhibited behaviour consistent with standard consumer choice theory, namely a significant and negative price coefficient, suggesting clear price sensitivity. For this group, only the constant term was statistically significant, indicating a preference for RFB regardless of other attributes, but not at any price. Class 2 displayed no significant response to price, implying indifference to cost. In contrast, Class 3 had a positive and significant price coefficient, suggesting that they perceived higher prices as an indicator of superior quality.[1]

[1] Additional analyses were conducted to further characterise this group. No significant differences were found between subclasses in continuous variables. However, some differences emerged in categorical characteristics, with a higher proportion of older respondents (particularly those aged 65 and over) and individuals living in apartment buildings in Class 3. Overall, differences between subclasses were limited.

Table 5
Logistic regression models profiling heterogeneous consumer segments. Each model compares one consumer group (coded as 1) against all others combined (coded as 0).

Variable	Coding	Mean (N = 1803-2974)	St. dev. (N = 1803-2974)	Class 1: Wood fibre board preferers	Class 2: Stone wool board preferers	Class 3: Cellulose board preferers	Class 4: Reed fibre board preferers	Class 5: No-preferers
Female	Dummy (ref: Male)	0.48	0.50			−0.317 *	0.410 *	
Age 18-24 y	Dummy (ref: other age groups)	0.06	0.24				0.851 **	
Age over 65 y	Dummy (ref: other age groups)	0.29	0.46					0.333 **
Southern Finland	Dummy (ref: other regions)	0.21	0.41		0.288 **	−0.338 **		
Construction education, studies or work	Dummy (ref: none)	0.24	0.43	−0.183 *	0.292 **		0.436 *	−0.513**
Income €6000 and over	Dummy (ref: lower income groups)	0.26	0.44		0.231 **			
Detached house	Dummy (ref: other dwelling types)	0.40	0.49			0.339 *	−0.682 ***	
Primary insulation known	Dummy (ref: no)	0.42	0.49					−0.362**
Information use	Dummy (ref: no)	0.87	0.34					−0.527**
Insulation material experience	Count (1–12)	3.66	2.20				−0.155 **	
Plans to build or renovate	Dummy (ref: no)	0.58	0.49					−0.674***
NEP	Mean index	3.84	0.71	0.201 **	−0.133 *			−0.496***
Eco-cultural sustainability	Factor score	0.00	0.95	0.293 ***	−0.516 ***		0.581 ***	
Technical safety and durability	Factor score	0.00	0.89	−0.158 **	0.227 ***			
Practicality and economy	Factor score	0.00	0.81		0.168 **			
Marginal land utilisation	Factor score	0.00	0.89	0.131 **			0.347 *	
Constant				−1.164 ***	−2.536 ***	−1.537 ***	−2.003 ***	0.081
N				1957	2138	2921	1279	2925
Nagelkerke R^2				0.044	0.099	0.016	0.136	0.067
Chi-squared				64.005	150.724	28.041	84.214	75.641
p-value				<0.001	<0.001	<0.001	<0.001	<0.001
Hosmer and Lemeshow p-value				0.391	0.550	0.939	0.837	0.048
Correctly classified (cut 0.5)				0.397	0.273	0.168	0.095	0.031
Model class size				0.377	0.274	0.171	0.107	0.071

*** 99% significance level; ** 95% significance level; * 90% significance level.
Notes: Dummy variables are coded as 1 = category indicated, 0 = reference group.
Age includes six groups (18–24, 25–34, 35–44, 45–54, 55–64, 65+ y).
Region includes Helsinki-Uusimaa, Southern, Western, and Northern/Eastern Finland.
Income includes four categories: <€2,000, €2000–3,999, €4000–5,999, ≥€6000.
Dwelling type includes detached houses, apartment buildings and terraced/semi-detached houses.
Insulation material experience is based on experience with 12 different insulation materials (used or known).
NEP is the mean score of six statements (higher = stronger environmental orientation).
Factor scores are derived from factor analyses of insulation material attributes and marginal land statements.

4.4. Willingness to pay for insulation boards

The WTP analysis builds on the first step five-class model, which identified four distinct consumer preference segments excluding the non-preferers group. WTP estimates were calculated using class-specific coefficients and reported for the class exhibiting the strongest preference for each material. As cost coefficients differed across classes, the resulting WTP values reflect both preference heterogeneity and differences in price sensitivity, and are therefore not directly comparable across materials.

Within this framework, respondents who preferred RFB exhibited extremely low price sensitivity. The WTP estimates for this group were therefore based on a latent class model (Table 6) focused specifically on these respondents. In this three-class model, only Class 1 displayed a negative and statistically significant price coefficient applicable for WTP calculation.

For each of the four groups preferring different board materials, a representative product was constructed using specific attribute levels to reflect plausible market alternatives (see Table 7 for attribute levels). To enable comparisons that are not confounded by differences in price sensitivity, WTP estimates were also examined within the RFB-preferring class. Because these were derived using a common cost

Table 6
Latent class models for reed fibre preferers.

	Reed fibre preferers				
	Class 1	Class 2	Class 3	Overall	
Pseudo R^2	0.139	0.307	0.894	0.387	
Class size, %	43.6	34.6	21.9		
	Price conscious	**Price indifferent**	**Price as a quality cue**	**Wald p-value**	**Wald (=) p-value**
Attribute	**Coefficients and significance levels**				
Good thermal insulation[a]	−0.023	0.039	0.608	<0.001	<0.001
Excellent thermal insulation[a]	0.1112	1.655***	0.467		
Domestic origin[b]	0.152	0.645***	0.603	0.002	0.001
Burns very slowly[c]	0.084	0.175	−0.001	0.460	0.870
Fair environmental friendliness[c]	0.080	0.582*	2.891	<0.001	0.031
Excellent environmental friendliness[d]	0.433	1.614***	3.898		
Price	−0.028***	0.013	0.104**	<0.001	<0.001
ASC					
Cellulose wool board	2.420***	1.485***	3.415		
Stone wool board	2.546***	2.117***	2.895		
Wood fibre board	2.246***	0.978**	4.704		
Reed fibre board	3.605***	1.972***	7.675		

z-test: *** 99% significance level; ** 95% significance level; * 90% significance level.
ASC: alternative-specific constant.
Attribute reference levels: [a]Fairly good thermal insulation; [b]Non-domestic origin; [c]Burns slowly; [d]Weak environmental friendliness.

Table 7
Estimated WTP and relative price ratios for insulation board types (per preferer group).

Insulation board	Attribute levels used in a basic product	WTP (€/m^2, 100 mm thick insulation board)	95% CI	Relative price ratio (vs. stone wool board = 1.00)
Wood fibre board (WFB preferers)	Good thermal insulation, non-domestic, burns slowly, excellent environmental friendliness	€93	84–102	1.41 (93/66)
Stone wool board (SWB preferers)	Excellent thermal insulation, non-domestic, non-combustible, weak environmental friendliness	€66	6–72	1.00
Cellulose wool board (CWB preferers)	Good thermal insulation, domestic, burns slowly, excellent environmental friendliness	€73	66–81	1.12 (73/66)
Reed fibre board (RFB preferers[a])	Good thermal insulation, domestic, burns slowly, excellent environmental friendliness	€130[a]	66–194	1.97 (130/66)

[a] An estimate of €130 for RFB, derived from Class 1 in the three-class latent class model, was used as the baseline value.

coefficient, differences across materials reflect underlying preferences rather than variation in price sensitivity. Within this class, WTP for the preferred material (€130) substantially exceeded that of alternatives (€81–92), corresponding to a premium of approximately 40–60% and indicating a strong, clearly differentiated preference.

While WTP estimates provide an indication of how these products are valued, their absolute magnitude should be interpreted with caution. The initial WTP estimates revealed exceptionally high values for all products among the preferers. To address potential HB in these absolute WTP figures, we proceeded with the following relative price comparison approach. Table 7 also offers relative price ratios, setting the market leader, stone wool, as a baseline. While absolute WTP estimates may be inflated due to HB,[2] the relative price ratios facilitate comparison of the perceived market value of each insulation type, although they may still partly reflect differences in cost sensitivity across classes.

RFB exhibited the highest relative price ratio among the insulation options. At 1.97 times the WTP for stone wool (SWB = 1.00), it was valued substantially higher than both wood fibre board (WFB, 1.41) and cellulose wool board (CWB, 1.12). This indicated that the WTP for RFB was nearly double that of the baseline stone wool and clearly exceeded the premium associated with the other bio-based alternatives. However, the wide confidence interval for RFB indicated greater uncertainty in this estimate compared to the other products, and part of the difference is the result of differing cost coefficients.

5. Discussion

The results of this study indicate that potential insulation board users can be divided into five distinct groups based on their insulation material choices in the labelled DCE. Among these, particular attention is given to those who preferred reed fibre board (RFB), as this group represents the primary focus of the study. While all attributes were important to nearly all groups when making decisions about material selection, the degree of importance varied, with each group emphasising these attributes to slightly different extents. For all identified groups, excellent thermal insulation and domestic origin were significant decision-making factors, but the importance of these attributes varied among the groups.

Excellent thermal insulation was important for RFB preferers, albeit to a lesser extent than for the wood fibre and stone wool board preferers, as well as the no-preference group. Additionally, for RFB preferers, the attribute of domestic origin was important but less significant compared to other groups. This finding is notable, as origin has widely been identified as a significant factor influencing consumer preferences for materials. This is particularly evident in studies focusing on wood products (e.g., Cai and Aguilar, 2013), which have revealed a strong

[2] We examined the relationship between respondents' choice uncertainty and the latent classes (Table 4) to assess whether uncertainty could contribute to hypothetical bias (HB). When incorporated into the logit model (Table 5), choice certainty emerged as a significant and positive factor among individuals who either preferred reed fibre board or opted not to select any of the alternative products. This suggests a lower tendency towards HB within these groups.

preference for domestic origin. In a study on Finnish outdoor decking materials (Holopainen et al., 2017), origin was ranked as the third most important attribute overall, following material type and price. Furthermore, while excellent environmental friendliness was crucial for reed preferers, it was even more significant for the wood fibre and cellulose wool groups. This highlights a more balanced preference structure within this segment.

In interpreting the results, it is important to recognize that material labels may convey meanings beyond the explicitly defined attributes, such as perceived naturalness, familiarity or expected technical performance. To partially account for these unobserved associations, alternative-specific constants (ASCs) were included for each material, capturing systematic preference differences not explained by the observed attributes. Furthemore, in the CE design, attribute-level restrictions were unavoidable due to physical and technical constraints, resulting in a limited overlap between certain attributes and specific materials. While this introduces some correlation between labels and attribute ranges, the estimated preferences should be interpreted acknowledging that they probably reflect a combination of measured attribute effects and unobserved perceptions linked to the material labels.

Moreover, the study results suggest that consumer choices regarding insulation boards varied based on sociodemographic and psychographic backgrounds. Certain sociodemographic factors better explained the likelihood of belonging to specific groups. Female gender increased the likelihood of belonging to the RFB preferers, which aligns with earlier findings suggesting that women are more likely to support environmentally oriented consumption, such as a preference for certified wood products (Ozanne and Vlosky, 1997; Vlosky et al., 1999). Membership in the younger age group also increased the likelihood of preferring RFB. This finding is consistent with the broader observation that age significantly influences preferences for sustainable building materials (Gaffey et al., 2021; Friedrich, 2020; Dirx, 2024), although the specific material preferences linked to different age groups may vary between studies. In contrast to previous studies, such as Holopainen et al. (2017), which found educational level to influence preferences for sustainable wood products in outdoor applications, our study detected no significant association between education and the likelihood of preferring the sustainable alternative of reed fibre insulation. However, in our study, having a background in construction through education, studies, or work was significantly influential for all groups except the cellulose board preferers, albeit in different directions, either decreasing or increasing the likelihood. For RFB preferers, it increased the likelihood, which can partly be explained by awareness of the material or interest in experimenting with new materials.

Based on the latent class modelling results, the RFB-preferer segment represented 10.7% of all respondents. This figure should be interpreted strictly as a preference segment rather than an indicator of market size or expected demand, as it reflects stated preferences under hypothetical conditions. Consequently, this segment cannot be directly translated into actual market demand, particularly for a product that is not yet commercially available and for which consumers are not always the primary decision-makers. The segment is likely to mainly consist of low-volume buyers, such as cottage owners or small-scale renovators, meaning that their actual share of overall market volume is expected to be smaller than their numerical share in the sample.

Moreover, heterogeneity was evident across three factors, ecological and cultural sustainability, structural safety and durability, and practicality and economic considerations, as the importance of these factors in material selection varied among segments. Interestingly, eco-cultural sustainability emerged as a significant positive predictor of group membership for RFB preferers, whereas the broader psychographic measure of environmental orientation (NEP scale) did not. Although NEP was not a significant predictor, the preference for RFB was associated with a factor reflecting concrete eco-cultural values: the ecological footprint, carbon footprint, renewability, domestic origin and respect for tradition. The eco-cultural factor identified in this study thus reflects concrete, material-related attributes that are directly linked to the evaluation of the product itself, rather than general environmental worldviews. This suggests that material-specific eco-cultural values play a more decisive role than abstract pro-environmental worldviews when consumers assess unfamiliar or emerging materials. A possible explanation for this lies in the attitude–behaviour gap in green consumption, whereby general pro-environmental attitudes alone are not sufficient to explain concrete purchasing choices (Carrington et al., 2010), particularly in complex and infrequent decision contexts such as construction material selection. This interpretation is consistent with previous studies on bio-based materials, which have demonstrated that consumer choices are primarily driven by limited familiarity and by evaluations of specific product attributes rather than general sustainability attitudes (Sijtsema et al., 2016; Uehara et al., 2023). More broadly, research on green consumption indicates that purchasing decisions are often influenced more by product-related factors such as price, perceived quality and material attributes than by general pro-environmental attitudes (e.g., Sharma et al., 2023). Together, these findings suggest that the reed-preferring segment relies on a decision-making logic in which concrete, product-specific attributes play a central role in guiding choices. In the context of an unfamiliar material, such attributes may simplify decision-making, allowing consumers to form preferences despite limited prior experience. In this context, it is noteworthy that reed has traditionally been used as a roofing material in Finland, and although this practice has significantly declined and become rare (Suna, 2008), its cultural significance may still resonate with consumers today. Similarly, regarding other psychographic variables included in our analyses, marginal land utilisation was a significant explanatory factor for RFB preferers, probably because this group values the idea of using underutilised natural resources, which aligns with the sustainability principles associated with RFB. These findings suggest that, once introduced to the market, RFB should be marketed with an emphasis on its sustainability and renewability. However, to better understand how consumer preferences for RFB translate into actual adoption, further research could investigate how different dimensions of product acceptance influence the intention of consumers to use it, and how these attitudes compare across different countries.

Concerning WTP estimations, all evaluated insulation boards on the market exhibited higher WTP than their typical market prices. The particularly high estimated price for RFB prompted us to conduct an exploratory subclass analysis to estimate a separate model with three latent classes for the subgroup that preferred RFB. Within this group, only Class 1 exhibited clear price sensitivity, while Class 2 displayed indifference to cost. In contrast, Class 3 had a positive price coefficient, suggesting that higher prices may have been perceived as a signal of quality, indicating that RFB was viewed as a premium product by some consumers.

The subclass analysis provides an exploratory extension to examine the internal structure of the reed fibre preferer segment in greater depth. This approach was motivated by the unusually low and heterogeneous price sensitivity observed within this group in the primary latent class model. By focusing on this segment, the analysis revealed meaningful within-group heterogeneity that would not be identifiable in a conventional latent class model with a limited number of classes. At the same time, we acknowledge that the procedure relies on modal class assignment, and therefore, although posterior class probabilities were generally high, classification uncertainty from the first-stage model cannot be ruled out. The subclass approach was therefore adopted as a more parsimonious and targeted strategy. Nevertheless, alternative approaches, such as accounting explicitly for attribute non-attendance or three-step methods that correct for classification error, could provide valuable complementary insights and represent important avenues for future research.

The relative WTP values between insulation materials appeared broadly consistent with actual market price differences in Finland. In particular, the ranking and proportional differences between materials, such as the higher valuation of wood fibre compared to stone wool, aligned with actual cost structures, suggesting that the model captures meaningful preference patterns. Although absolute WTP levels exceeded retail prices, the relative comparisons appear more informative for interpreting perceived value. The initially high WTP estimate for RFB was moderated through subgroup analysis, resulting in price ratios between RFB, WFB, SWB and CWB that better reflect market conditions.

While our study offers valuable insights into interested segments and effective marketing arguments, it also has certain limitations. Since RFB is a novel and hypothetical product, unfamiliarity may have influenced respondents' choices. Previous research suggests that consumers often experience uncertainty and ambivalence toward bio-based products, especially when they are unfamiliar with the concept and the specific product (Sijtsema et al., 2016). However, in our case, post-choice uncertainty was lower among RFB preferers compared to those who favoured other products. This may reflect strong ideological motivations driving the selection of the reed-based option.

In addition, the simplified attribute combinations and the cognitive load of repeated choice tasks can influence respondents' decisions. Consequently, respondents may have focused on a few key attributes rather than evaluating all information thoroughly. This simplification could affect the consistency of preferences and, in particular, the accuracy of WTP estimations.

Moreover, prior studies have demonstrated that consumers do not always attend to price when making choices, which can lead to inflated WTP estimates (e.g., Tadesse et al., 2025). Similarly, attribute non-attendance, where respondents ignore certain attributes, can distort WTP calculations, as WTP is derived from trade-offs between attributes and price. Although our survey included a no-choice option, it was not explicitly emphasised in each choice task. As noted by Tadesse et al. (2025), repeated opt-out reminders can help mitigate hypothetical bias and improve the realism of stated preferences.

Another limitation relates to the bid range used in the choice experiment, which may influence the resulting WTP values. The placement and spacing of price levels can anchor respondents' expectations and affect their stated WTP. This issue has been recognised in earlier research and remains a methodological challenge in stated preference studies (Ahtiainen et al., 2023; Börger et al., 2025). Nevertheless, testing new approaches to develop the price range (Kilders and Caputo, 2023) and cheap talk and opt-out reminders (Börger et al., 2025) may have provided more reliable WTP estimates. Furthermore, a key challenge in designing the price range in this case is that insulation represents only one component within a broader construction process that entails multiple expense categories for the household.

A further limitation relates to the country-specific context of the study. The results are based on data collected in Finland, where housing structures, the prevalence of owner-occupied versus rental housing and decision-making roles in construction may differ from those in other countries. These institutional differences may influence how consumers engage in material choices and therefore limit the direct generalisability of the findings. Previous research has identified several barriers that hinder the adoption of sustainability aspects in material selection, such as high initial costs, limited knowledge and skills among professionals, a lack of trained builders, slow industry acceptance, inadequate policy support and incentives, complex and inconsistent certification and life cycle assessments, entrenched construction habits and vested interests in conventional materials (Akadiri, 2015; Markström et al., 2018; Dams et al., 2023; Zerari et al., 2024). According to Zerari et al. (2024), in the context of bio-based insulation materials, the main opportunities lie in progressive improvements supported by policies and incentives, growing environmental awareness and the thermal, acoustic and environmental performance of bio-based insulation materials, alongside long-term cost savings and value. Increased educational initiatives, advertising and awareness campaigns also play significant roles.

6. Conclusions

This study provides exploratory evidence on how consumers evaluate a hypothetical bio-based insulation material under stated preference conditions. The results indicate that interest in reed fibre board is concentrated in a specific consumer segment rather than broadly distributed across the population.

From the perspective of insulation board production, these findings suggest that reed fibre board is more likely to be positioned as a niche or potentially premium product rather than a direct substitute for conventional insulation materials. This implies that production and market-entry strategies may need to focus on targeted segments where sustainability-related product characteristics are valued.

Our findings suggest several implications for both market development and policy design. First, there is a clear need to improve access to information, not only for construction professionals but also for consumers, regarding the environmental and technical characteristics of emerging bio-based insulation materials. Second, their marketing strategies may benefit from emphasising ecological benefits, as sustainability-related attributes were highly valued across consumer segments. Notably, for the segment most interested in reed fibre insulation, even a price point twice that of conventional stone wool did not deter interest, suggesting that perceived quality and environmental performance may support a premium positioning, although this evidence remains based on stated preferences. Third, while domestic origin was appreciated, it was not a decisive factor for all consumers, suggesting that regional collaboration around raw material sourcing, such as within the Baltic Sea area, could be viable from a consumer perspective. Finally, although WTP was evident among certain groups, it may not be sufficient to drive widespread adoption on its own. Consumers are not always the primary decision-makers in the selection of insulation materials; instead, choices are shaped by professionals such as architects, contractors, builders, retailers and energy-efficiency advisors. This highlights the importance of engaging these stakeholders alongside consumers. Increasing awareness, building confidence in reed fibre insulation and fostering collaboration across the value chain could support its uptake. In this context, consumer interest provides an important foundation that can create favourable conditions for wider market adoption, if combined with informed professional recommendations and supportive policy measures.

Declaration of generative AI use

During the preparation of this work, the author used Microsoft Copilot to improve the clarity and readability of the text and to assist with language editing. After using this tool, the author reviewed and revised the content as necessary and takes full responsibility for the content of the publication.

CRediT authorship contribution statement

Liina Häyrinen: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing – original draft, Writing – review & editing. **Annika Tienhaara:** Formal analysis, Methodology, Validation. **Eija Pouta:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.clrc.2026.100461.

Appendix A.1. Factor analysis results for different material attributes (N = 2974). (Maximum likelihood, varimax rotation; responses indicating 'I can't say' were treated as missing values and excluded from the analysis)

	Factor 1: Ecological and cultural sustainability	Factor 2: Structural safety and durability	Factor 3: Practicality and economic considerations
Ecological footprint (impact on biodiversity)	**0.880**	0.170	0.046
Carbon footprint	**0.878**	0.159	0.003
Renewability (made from renewable natural resources)	**0.831**	0.140	0.115
Domestic origin	**0.584**	0.198	0.182
Respect for tradition	**0.513**	0.071	0.276
Health safety (e.g., safe fire retardant)	0,263	**0.721**	0.144
Moisture control, breathability	0.102	**0.712**	0.277
Fire safety	0.176	**0.704**	0.179
Durability over time (e.g., compression and settling)	0.167	**0.651**	0.305
Functionality in the intended application	0.045	**0.648**	0.326
Energy efficiency	0.188	**0.553**	0.305
Ease of installation	0.171	0.284	**0.619**
Availability	0.142	0.336	**0.614**
Price	0.020	0.212	**0.530**
Space requirement	0.294	0.320	**0.465**
Explained variance (%)	21.026	20.878	12.034
Cronbach's alpha	0.870	0.866	0.733

Appendix A.2. Factor analysis results for land use statements (N = 2974). (Maximum likelihood, varimax rotation; responses indicating 'I can't say' were treated as missing values and excluded from the analysis)

	Factor 1: Marginal land utilisation	Factor 2: Marginal land conservation
The production of reed fibre helps mitigate climate change by sequestering carbon and reducing greenhouse gas emissions.	**0.691**	0.212
The production of reed fibre promotes water protection by removing nutrients from water bodies.	**0.684**	0.149
Old/unused peat production areas should be utilized for common reed production.	**0.679**	0.066
Agricultural land that cannot be used for food production could be used for fibre production.	**0.656**	0.147
Previously drained peatlands can be converted into wetlands and used for fibre production.	**0.601**	0.245
Leaving unproductive areas in their natural state promotes biodiversity.	0.257	**0.732**
Unproductive areas should be left in their natural state, left unmanaged or restored.	0.078	**0.722**
Leaving unproductive areas in their natural state promotes water protection.	0.190	**0.708**
Not all land areas need to have a designated use.	0.121	**0.490**
Explained variance (%)	25.793	21.696
Cronbach's alpha	0.811	0.744

Data availability

Data will be made available on request.

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