Consumer acceptance of Wood-Polymer Composites: a conjoint analytical approach with a focus on innovative and environmentally concerned consumers

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Abstract

Wood-Polymer Composites (WPCs) can contribute towards resource efficiency as they mainly consist of wood by-products and/or waste materials. The eco-innovative materials represent a hybrid solution on the 'two-evils' continuum' constituted by the competing materials of wood and plastics; the former being too expensive and resource consuming in mass consumption, the latter cheap but environmentally hazardous. However, consumer acceptance of WPCs is questioned due to the merger of components consumers perceive as being contradictory (wood and plastics). Additionally, it is discussed whether consumers' innovativeness enhances WPC acceptance, while eco-friendly consumers may reject WPCs because of environmental concerns related with the synthetic components.
To determine the potential market for products made of eco-innovative materials, two German-language online studies (n ¼ 198, n ¼ 357) were created to examine consumer acceptance of WPCs in relation to the competing materials. Study 1 introduced a 3 (material: wood, WPC, plastics) x 2 (appearance: wooden or synthetic) within-subject design. Consistent with the expectations, study 1 showed a clear preference for wood over plastics based on a convenient sample. WPCs remained in the centre position, even for environmentally concerned consumers. Study 2 was conducted to replicate the findings with a representative sample. It additionally considered consumer innovativeness and included further product categories. WPCs only slightly deviated from the centre position in study 2. Mostly important, study 2 proved that the higher the environmental concern and the innovativeness of consumers, the more WPCs were accepted. When taken together, the results point to a greater WPC market than previous research had indicated. In general, premature concerns about innovative materials can be prevented by consumer acceptance studies examining the new materials' position in a surrounding 'multi evils' continuum'.

Introduction

As raw materials and energy resources become scarce, innovative strategies realising efficient raw material use are required (Crabbe' et al., 2013). Within the past few years, suppliers and re-tailers have significantly invested in the development of green products[1] (Crabbe' et al., 2013; Gleim et al., 2013; Lin et al., 2013). These products are commonly referred to as eco-innovations, meaning innovative products which are more eco-friendly than conventional alternatives (Jansson, 2011). Eco-innovations carry various potentials: Besides a diverse range of environmental ben-efits and cost-savings because of less resources being used, eco-innovations can function as a differentiation strategy and are linked to competitive advantage (Crabb'e et al., 2013; Lin et al., 2013; Medeiros et al., 2014). This implies that the identification of target groups that are interested in eco-innovations and the stra-tegies for how to address these segments become important for the marketing of eco-innovative products.

[1] The terms 'green' and 'eco-friendly' are used interchangeably throughout the article.

An important precondition of eco-innovations' market success seems to be consumer awareness of eco-friendly purchase behaviour as a means of (ensuring or contributing towards) environmental protection, human health, and the responsible allocation of resources (Chao et al., 2012; Crabbe et al., 2013; Gleim et al., 2013; Grimmer and Bingham, 2013; Kanchanapibul et al., 2014). However, green products still represent a comparatively lower market share than optimists had suggested (Gleim et al., 2013; Lin and Huang, 2012; Rex and Baumann, 2007; Tseng and Hung, 2013). Given that attitudes do not necessarily translate into behaviour, it is essential to empirically examine consumers' purchase intention for eco-innovations (Ozaki, 2011).

Wood-Polymer Composites (WPCs) are such a group of eco-innovative materials, showing the potential to contribute towards more efficient resource utilisation (Teuber et al., 2015). WPCs exhibited a worldwide market growth in the last decade, which is predicted to further increase within the next few years (Carus et al., 2008; Eder and Carus, 2013). When investigating eco-innovations such as WPCs, the pro-environmental attitudes and the innovativeness of consumers can be the most important moderators of acceptance (e.g. Jansson, 2011; Lin and Huang, 2012). Nonetheless, this group of materials is unknown to many customers and the consumer acceptance is nearly unexplored (Haider and Eder, 2010; Weinfurter and Eder, 2009). The present article analyses consumer acceptance of WPCs in relation to two traditional materials. On the one hand, WPC acceptance is compared with solid wood, which is more expensive than WPCs for several applications and also resource consuming in mass consumption. Many by-products emerge during the production of goods consisting of solid wood which also require a material utilisation to improve resource efficiency, however, these by-products are still often directly used for energy (Carus et al., 2008). On the other hand, traditional full plastics are perceived as a cheap material but environmentally hazardous if they are based on fossil fuels.

2. Literature review

2.1. Consumers' green purchasing behaviour

A considerable amount of literature has been published on green consumer behaviour, primarily investigating consumer acceptance of fast-moving consumer goods (FMCG). Numerous studies in this domain refer to consumers' intention to buy organic food (e.g. Marette et al., 2012; Onozaka and McFadden, 2011; Vermeir and Verbeke, 2008; Yue et al., 2009). The acceptance of detergents and cosmetics (e.g. Lin and Huang, 2012; Luchs et al., 2010), green energy (e.g. Diaz-Rainey and Ashton, 2011; Hartmann and Apaolaza-Ibàrrez, 2012; Ozaki, 2011; Scarpa and Willis, 2010), and recycled and remanufactured products (e.g. Essoussi and Linton, 2010; Michaud and Llerena, 2011) has been explored. Most of the studies suggest an overall consumer acceptance of green FMCG. Thereby, various drivers of eco-friendly consumer behaviour are analysed with (environmental) attitude (e.g. Diaz-Rainey and Ashton, 2011; Hartmann and Apaolaza-Ibàrrez, 2012; Leonidou et al., 2010; Ozaki, 2011; Vermeir and Verbeke, 2008), values (e.g. Lin and Huang, 2012; Urien and Kilbourne, 2011; Vermeir and Verbeke, 2008) and socio-demographic characteristics (e.g. do Paço and Raposo, 2009; Park et al., 2012) as the most often considered determinants. Attitude and values turn out to be better predictors than socio-demographic characteristics, with the latter showing contradictory findings (Diamantopoulos et al., 2003; Diaz-Rainey and Ashton, 2011; Rex and Baumann, 2007; Zhao et al., 2014). The value that consumers attribute to eco-friendly products is often assessed by the additional willingness to pay (WTP), i.e. the surcharge consumers would spend for a green product compared to a conventional alternative. While some studies reveal the existence of a marginal or even non-existent WTP (Michaud and Llerena, 2011; Scarpa and Willis, 2010), others suggest a substantial surcharge for green products (Krystallis and Chryssohoidis, 2005; Marette et al., 2012).

Nonetheless, the drivers of green consumer behaviour and the WTP can vary between different product categories and even within a category (Essoussi and Linton, 2010; Krystallis and Chryssohoidis, 2005; Luchs et al., 2010; Yue et al., 2009). While many studies investigate consumer acceptance of everyday products, only a few consider durable goods characterised by high purchase involvements (Achabou and Dekhili, 2013; Davies et al., 2012) such as wood-based products. The few existing consumer studies about wood-based products mainly examine the effects of sustainable forest management certification and suggest that consumers prefer buying certified wood products and show an additional WTP for them (e.g. Aguilar and Vlosky, 2007; Anderson and Hansen, 2004; Cai and Aguilar, 2013b; Husted et al., 2014; Thompson et al., 2010; Vlosky et al., 1999). Also for certified wood products, attitudes are identified as important drivers of the purchase decision, whereas socio-demographic characteristics have low predictive power (e.g. Husted et al., 2014; Kalafatis et al., 1999; Thompson et al., 2010). Overall, studies about green consumer behaviour suggest that empirical investigations are not superfluous as consumer acceptance of green products is dependent on product category and the investigated materials. Additional studies are therefore required to assess consumer acceptance of new, eco-friendly materials and products. For identifying the predictors of consumer acceptance, the focus should be on attitudes and personality characteristics.

2.2. Consumer acceptance of WPC products

Research about consumer acceptance of wood-based products primarily concerns solid wood. Innovative composite materials such as WPCs must be examined as well, because they become increasingly important for efficient resource utilisation. The concept of WPCs shows the timber industry a new way for a production with almost no waste: WPCs allow for new fields of application for the material utilisation of by-products and waste materials from the wood processing and agricultural industry (Carus et al., 2008; Teuber et al., 2015). These fields of applications which, for example, rely on the material's three-dimensional formability, cannot be covered by traditional materials relying on wood by-products such as particle boards and pulp and paper. As wood is mostly the main component of WPCs (up to more than 80%) (Carus et al., 2008; Klyosov, 2007), WPCs have a potential to minimize wood waste and prevent a direct energetic utilisation of by-products. Additionally, the wood components of a WPC could also be part of a later stage of cascading utilisation. For example, wood-based products (solid wood products, flake boards, fibre boards etc.) can be recycled and used for WPC production (Krause et al., 2013). The wood component not only influences the physical and mechanical properties of the material, but also the visual properties (Carus et al., 2008): Products consisting of WPCs could exhibit a surface similar to wood or to plastic products.

In addition to the potential of fostering resource efficiency, evaluating the eco-friendliness of WPCs primarily depends on WPC composition and on a comparison with the material(s) replaced by WPCs. WPC composition highly impacts the eco-friendliness so that WPCs may be considered as fully environmentally sound materials if all WPC components show a high eco-friendliness (Teuber et al., 2015). Based on the review of life cycle assessments (LCA), Teuber et al. (2015) conclude that for most applications, WPCs have a higher environmental impact compared with

solid wood, but a lower compared with fossil fuel-based neat plastics. Amongst others, material characteristics such as durability are important. For example, it is discussed that WPCs provide an opportunity to extend the durability of solid wood for some applications without requiring additional maintenance on the part of the consumer (Caufield et al., 2005). In this context, WPC recycling is another issue that must be considered in the future and might further enhance WPC eco-friendliness (Teuber et al., 2015).

As stated above, central to these eco-innovative materials is a merger of wood, plastics and additives (Caufield et al., 2005), i.e. components consumers perceive as being contradictory. Therefore, the discussion of consumer acceptance of WPC products can be controversial. Despite numerous studies in the material sciences that aimed to improve the material quality (e.g. Ashrafi et al., 2011; Kuo et al., 2009), only a few consumer studies were conducted. An interview study by Jonsson et al. (2008) with 15 respondents suggested a low WPC acceptance in comparison to solid wood. Weinfurter and Eder (2009) found a minor importance of environmental issues in the consumer segment of 'do-it-yourselfers'. Nevertheless, profound examinations of WPC acceptance and the identification of relevant target segments are still missing.

As WPCs can substitute the two materials they consist of, the first comprehensive investigations of WPC acceptance should rely on a comparison with both pure constituents, i.e. solid wood and full plastics. When consumers must decide between these two established materials, an avoidance‐avoidance competition (Miller, 1944) may result. Consumers are confronted with 'two evils' representing the endpoints of a continuum: On the one hand, solid wood, formerly an eco-friendly material, is realized as expensive and too resource consuming in mass consumption. On the other hand, full plastics are perceived as cheap but are noted to be environmentally hazardous. Consumers are expected to prefer wood when having to decide between solid wood and full plastics for themselves. Within the category of wood-based products, consumers typically prefer solid wood to composite materials (Anderson and Hansen, 2004; Cai and Aguilar, 2013a; Jonsson et al., 2008). Beyond that, WPCs have natural and synthetic components, so that the eco-innovations serve as a hybrid solution. Therefore, WPCs will be located in the centre of the 'two evils' continuum', lessening the pollution from plastic waste as well as by forestalling exploitation.

Hypothesis 1. (H_1). The product choice varies with the product's material. Consumers prefer solid wood over full plastics, while WPCs are positioned in the centre of both (i.e. given an effect coding of the three materials, the a priori contrast of the two established materials (linear material effect code) should be strong whereas the contrast code for the central position will remain insignificant).

Previous research also indicated that consumers place emphasis on the products' appearance. Even for WPC products comprising a synthetic and a natural component, consumers seem to prefer a wood-like surface (Jonsson et al., 2008; Weinfurter and Eder, 2009). Hence, the natural appearance is expected to be the favoured one.

Hypothesis 2. (H_2). The product choice varies with the product's appearance. Appearance will have a main effect: A wooden surface will be preferred over a synthetic surface.

On the one hand, some research points to a WTP for green versus environmentally hazardous FMCG (Krystallis and Chryssohoidis, 2005; Marette et al., 2012). On the other hand, the price premium of eco-friendly products turns out to be a main barrier of green consumer behaviour (Gleim et al., 2013; Young et al., 2010). Consumers seem to be especially price sensitive for high-priced and infrequently bought wood products (Cai and Aguilar, 2013b; Thompson et al., 2010). Similarly, Anderson and

Hansen (2004) identify price as the most important factor for the purchase of wood products. Hence, price is expected to be an important additional driver of consumers' choices.

Hypothesis 3. (H_3). The product choice varies with a product's price. Price will have a negative main effect on consumers' preferences. The higher the price, the less likely the product is chosen.

2.3. Important consumer segments for WPC products

When determining the acceptance of WPCs, two consumer segments are of special interest. The first refers to those with a high environmental concern (EC). Environmental concern is defined as an individual's general attitude towards the environmental protection (Schultz, 2001). Environmentally concerned consumers typically trust the quality of green products more and purchase those products having a lower environmental impact (Gleim et al., 2013; Grimmer and Bingham, 2013; Kanchanapibul et al., 2014; Lin and Huang, 2012; Tseng and Hung, 2013; Zhao et al., 2014). Additionally, recent evidence suggests that environmentally concerned consumers value eco-friendly products by showing a WTP for a diverse range of green products compared to conventional ones (e.g. Diaz-Rainey and Ashton, 2011; Tseng and Hung, 2013; Vlosky et al., 1999; Yue et al., 2009). Therefore, this consumer segment should emphasise the preference for solid wood over full plastics. However, while environmentally concerned consumers accept eco-innovations sometimes, this does not have to apply to WPCs. Environmentally concerned consumers might overvalue the synthetic components they typically reject due to pollution and health concerns, or the perception of it as a cheap and baneful material (Eyerer et al., 2010; Petrescu et al., 2010).

Hypothesis 4. (H_4). Environmental concern (EC) interacts with the product's material: The higher the EC of an individual, the stronger her/his preference is for solid wood over full plastics, while WPCs are assimilated to full plastics (i.e. interactions of EC will occur with the linear effect code and the effect code for the central position).

Besides environmental concern, Lin and Huang (2012) determine novelty seeking as another predictor of green consumption. Similarly, Jansson (2011) identifies consumer innovativeness as an important driver for the acceptance of eco-innovations. This personality trait is conceptualized as an individual's predisposition to purchase a higher amount of new products and to adopt them earlier than the mainstream (Roehrich, 2004). The value that consumers with a high innovativeness ascribe to new products is further proved by their price insensitivity when purchasing innovative products (e.g. Goldsmith et al., 2005; Munnukka, 2008; Ramirez and Goldsmith, 2009). Based on this, the innovative segment should choose WPC more often than the average consumer.

Hypothesis 5. (H_5). Consumer innovativeness also interacts with the product's material: The higher an individual's innovativeness, the more their WPC choices approach those for solid wood, while the preference for solid wood over full plastics remains unaffected (i.e. an interaction of innovativeness will only occur with the effect code for the central position).

As supposed throughout the last paragraphs, environmentally concerned and innovative consumers represent different market segments. The proposed distinction can be illustrated by the value model comprising ten universal values which are organized in a circumplex structure (Schwartz, 1992, Fig. 1) and constitute segments as well as attitudes (e.g., Boer and Fischer, 2013). The ten values are positioned based on two dimensions. The first refers to an individual's degree of being open to change versus preferring conservative values. The second (self-transcendence vs. self-
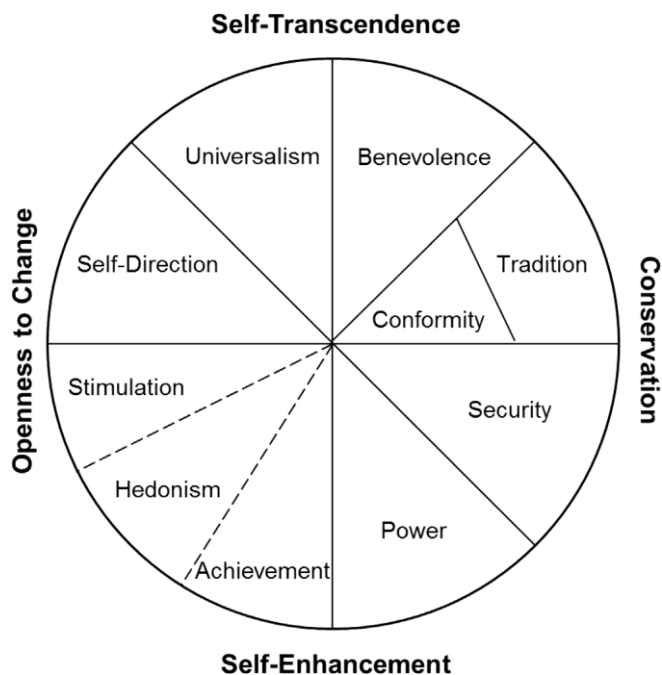
Fig. 1. Universal value structure (Schwartz, 1992).

enhancement) differs between pursuing one's own interests or transcending these by considering welfare and nature. Hence, the high innovativeness segment locates on the left hand side of the circle (openness to change), while the environmentally concerned segment is positioned at the upper quarter (self transcendence, see Fig. 1). By assessing environmental concern and innovativeness, four value segments can be effectively distinguished.

The assumptions are assessed by online surveys. However, the generalisability of online surveys evaluating consumers' product acceptance could be questioned by claiming that these studies lack some characteristics of real purchase situations, such as the opportunity to receive haptic product information. As an indirect test of generalizability, the Need for Touch (NFT) scale (Peck and Childers, 2003) is included, which assesses an individual's disposition for haptic product information processing in a purchase situation. If a haptic product examination is important, participants of the online survey who show a high NFT should choose fewer products compared to consumers with a low NFT and they are also expected to differ less between product variants.

Hypothesis 6. (H_6). If concerns regarding online surveys apply to this context, a negative main effect and a lower discrimination between the different values of the independent variables of material and appearance can be expected for consumers with high NFT.

In the next chapters, two studies are presented, assessing the consumer acceptance position of WPCs on the 'two evils' continuum'. Study 1 considers WPC acceptance with a particular focus on the environmentally concerned consumer segment and includes an investigation of the suitability of online surveys, while study 2 examines the segments of environmentally concerned and of innovative consumers compared to their respective counterparts.

3. Study 1

The primary objective of study 1 is to investigate WPC acceptance in relation to the competing materials of wood and plastics by using a convenience sample of younger German respondents. In addition to determining the WPC acceptance for the whole sample, we particularly examine the moderation impact of the environmental concern of the consumers and the suitability of online surveys.

3.1. Methods

3.1.1. Procedure and participants

Study 1 was an online survey using a 3 (material: solid wood, WPC, plastics) x 2 (appearance: wooden, synthetic surface) within-subjects design. 250 German respondents participated, 198 of whom have fully completed. The mean age was 25.47 years (SD ¼ 3.41, range from 18 to 40). 38% of the respondents were male and 69% were university students. WPCs were unknown materials for half of the respondents, 42% knew the term from hearsay, while only 8% reported good knowledge of WPC. In order to assess the purchase intention, participants were instructed to imagine buying a chair. Furniture was selected as it became an interesting WPC market in recent years since traditional applications (e.g. decking) reached the maturity stage in the European market (Eder and Carus, 2013). Specifically, the purchase of small furniture was chosen with the purpose of matching the expected younger age of the convenience sample.

In the beginning of the survey, all respondents received the following material information: a) wood: 'solid wood', b) WPC: 'Wood-Plastic-Composite: 70% wood (mainly wood by-products e.g., sawdust), 30% plastics, additives', c) polymers: 'synthetically produced material ('plastics'): mineral oil, coal, natural gas'. Additionally, two pictures were shown differing only with respect to the product's appearance (brown synthetic vs. brown wooden chair). Participants were recruited through mailed letters and announcements in online platforms. As motivation for participation each respondent was entered in a prize draw for three vouchers, worth 10 to 20 Euros.

3.1.2. Measures

The online survey consisted of several parts, whereupon the present paper refers to the measurements of EC, NFT, socio-demographic information and the purchase intention, the latter being determined by a choice-based conjoint analysis.

3.1.2.1. EC. EC was assessed with the 12-item scale from Schultz (2001, German according to Homburg and Wagner, 2007). Respondents answered on 7-point scales ranging from 1 (not concerned) to 7 (extremely concerned). All items were presented in random order. The EC mean score was 4.74 (SD ¼ 1.04) and internal consistency was high (Cronbach's a ¼ 0.89).

3.1.2.2. NFT. NFT was measured with a German version (Nuszbaum et al., 2010) of the 12-item scale from Peck and Childers (2003). Respondents answered on 7-point scales ranging from -3 (not at all true) to þ3 (exactly true). Cronbach's a was 0.91 for the 12-item scale.

3.1.2.3. Choice-based conjoint analysis (CBCA). The purchase intention was measured with a CBCA (Green and Rao, 1971), allowing to investigate the trade-offs between different product attributes consumers make during purchase decisions. Table 1 presents the three attributes of the CBCA and their levels (for study 1, only the 'chair' cells of Table 1 were realised). The verbal description of the attribute 'appearance' was supplemented with the two pictures introduced in the beginning of the survey. Only specific combinations of material and price were allowed which best reflected current market offers.

Table 1
Attributes and levels of the CBCA (Study 1 and 2).

Attributes		Levels		
Material		solid wood	WPC	plastics
Appearance		wooden surface	synthetic surface	
Price	(solid wood)	60 V[a]/120 V[b]/120 V[c]	70 V[a]/140 V[b]/150 V[c]	80 V[a]/160 V[b]/180 V[c]
	(WPC)	50 V[a]/100 V[b]/150 V[c]	60 V[a]/120 V[b]/180 V[c]	70 V[a]/140 V[b]/210 V[c]
	(plastics)	40 V[a]/80 V[b]/180 V[c]	50 V[a]/100 V[b]/210 V[c]	60 V[a]/120 V[b]/240 V[c]

Note: Price levels vary as a function of product category.
[a] Chair (Study 1 and Study 2).
[b] Window frame (Study 2).
[c] Fence (Study 2).

A fractional factorial design reduced the number of choices per participant. Each participant received 14 choice sets, 2 of them fixed and 12 randomly selected by Sawtooth Software, Inc. SSI Web (version 8.2). Every choice set consisted of two alternative chairs, supplemented with a 'none of these' option as the latter represents a possible choice in reality. Respondents were asked to make choices according to actual purchase situations for each choice set. Hence, a CBCA requires hypothetical choices and builds on the assumption that respondents choose those products they would also select in reality.

A balanced overlap design was employed due to its advantages for estimating main effects and interactions (Chrzan and Orme, 2000). Examining the multicollinearity of predictors, including their interactions, we found all pairwise effect correlations remaining $rrr < .44$. The largest one was the negative correlation of material (linear) and price, resulting from the two fixed cases causing this correlation. Apart from that, the low intercorrelations allowed for the inclusion of interactions without multicollinearity problems.

3.1.3. Data analysis
Data management and analysis was performed using SPSS 21. A nominal logistic regression was applied to analyse the CBCA. The categorical dependent variable 'choice' was a dichotomous dummy, taking the values of 1 (selected) and 0 (not selected). Appearance (effect coding: 1 ¼ wooden, -1 ¼ synthetic surface), material linear (1 ¼ solid wood, 0 ¼ WPC, -1 ¼ full plastics), material quadratic (-1 ¼ solid wood, 2 ¼ WPC, -1 ¼ plastics), price (1 ¼ base price e 15%, 0 ¼ base price, -1 ¼ base price þ 15%) and their interactions were included as predictors. While the material linear effect code distinguished between solid wood and full plastics, the material quadratic effect code estimated WPC in relation to the competing materials.[2] Price and EC scores were standardized before inclusion.

3.2. Results
The estimated overall probability to choose WPC (0.33) lay in the centre between solid wood (0.48) and full plastics (0.21). Table 2 shows the estimated coefficients of the logistic regression. Confirming H_1, participants preferred solid wood over full plastics (effect size Odds Ratio 2.27, 95% Confidence Interval (CI) 2.08e2.47), while WPC remained in the centre position (quadratic material Odds Ratio .97, n.s.). Fig. 2 illustrates that the higher the EC, the stronger the preference for solid wood over full plastics (Odds Ratio 1.20). As EC and the material quadratic effect code did not interact, WPC remained in the centre position also for

environmentally concerned respondents (Odds Ratio 1.01, n.s.). Therefore, H_4 is only partially supported; WPC was neither assimilated to the plastics nor to the wooden material.

Appearance and price were additional significant predictors of an individual's choice, with a wooden over a synthetic surface (Odds Ratio 1.60, as predicted by H_2) and a lower over a higher price being preferred (Odds Ratio 1.57, in support of H_3). Furthermore, appearance interacted with the linear material effect code (Odds Ratio 1.68), while the interaction did not appear with the material quadratic effect code (Odds Ratio 1.01, n.s.): Respondents especially favoured a wooden surface when the product consisted of solid wood. As indicated by Fig. 2, this preference was accentuated for environmentally concerned respondents (material linear x appearance x EC: Odds Ratio 1.11).

Finally, the results show that respondents with a high NFT did not choose fewer products compared with other participants (OR .98, n.s.). No interaction including NFT was significant. Hence, H_6 is not supported.

3.3. Discussion
This is the first consumer study demonstrating that the choices for WPCs are located in the perfect centre of the 'two evils' continuum'. While most of the hypothesised effects were proven, one result referring to the environmentally concerned consumer segment was unexpected. Although the preference for solid wood over full plastics was accentuated for environmentally concerned

Table 2
Results of the logistic regression (Study 1).

	Parameter estimates	
	B (SE)	Odds ratio (95% CI)
Intercept	-.71 (.03)***	
Material linear	.82 (.04)***	2.27 (2.08e2.47)
Material quadratic	-.03 (.02)	.97 (.93e1.01)
Appearance	.47 (.03)***	1.60 (1.50e1.70)
Price	.45 (.04)***	1.57 (1.44e1.70)
NFT	-.02 (.03)	.98 (.93e1.05)
Material linear x appearance	.52 (.04)***	1.68 (1.55e1.81)
Material linear x EC	.18 (.04)***	1.20 (1.11e1.30)
Material linear x appearance x EC	.10 (.04)**	1.11 (1.02e1.20)
Material linear x NFT	-.01 (.04)	.99 (.91e1.07)
Material linear x appearance x NFT	.06 (.04)	1.06 (.98e1.15)
Material quadratic x appearance	.00 (.02)	1.00 (.96e1.05)
Material quadratic x EC	.01 (.02)	1.01 (.97e1.06)
Material quadratic x appearance x EC	.01 (.02)	1.01 (.97e1.06)
Material quadratic x NFT	.01 (.02)	1.01 (.97e1.06)
Material quadratic x appearance x NFT	-.02 (.02)	.98 (.94e1.02)
Appearance x EC	.02 (.03)	1.02 (.95e1.08)
Appearance x NFT	.03 (.03)	1.03 (.97e1.10)
	$c^2(15)$ ¼ 938.17***	

Note: *p < .05, **p < .01, ***p < .001.

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[2] A significant linear material effect code indicates that consumers show a preference for one of the established materials, while a significant quadratic material effect code suggests that WPC deviates from the centre position of the 'two-evils' continuum'.
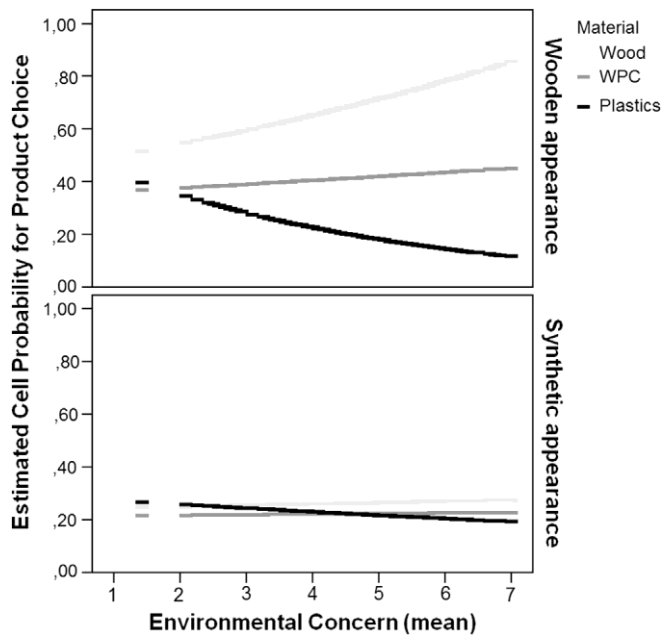
Fig. 2. Predicted probability for product choice depending on Environmental Concern in the 3 (material) x 2 (appearance) design (Study 1).

consumers, as predicted by the first part of H₄, they did not devalue WPCs simultaneously due to the synthetic components they typically reject (Eyerer et al., 2010; Petrescu et al., 2010). Hence, there seems to be a greater market for WPC products than it has been previously assumed. Nevertheless, this finding should be interpreted cautiously because of the sample's low mean age. Younger consumers take environmental issues into special consideration when making a purchase decision, resulting in greener consumer behaviour than shown on average (Kanchanapibul et al., 2014; Tseng and Hung, 2013). Therefore, several reasons are discussed. Amongst others, this generation grew up in an era where environmental issues were emphasised more and education was more important than ever before (Tseng and Hung, 2013). Kanchanapibul et al. (2014) argue that younger consumers particularly consider the future effects of their own behaviour. Because of this, study 1 shows that WPC products seem to be interesting for young consumers, so WPCs may be promising materials for products which are typically bought by the younger generation such as ready-to-assemble furniture. Nevertheless, the mentioned considerations require a follow-up study to analyse whether the obtained results are also confirmed when accessing a representative sample. A follow-up study can also rely on an online survey. Study 1 encounters concerns regarding the necessity for a haptic product evaluation as the results were independent of an individual's disposition to touch a product prior to a purchase.

4. Study 2

The main objectives of study 2 are to replicate the findings of the first study with a sample being representative for the German population and to investigate the innovativeness of consumers moderating their WPC acceptance. Study 2 also explores the possibility that the findings are generalisable to products other than furniture, as research indicates that the acceptance of green products may vary highly between different product categories (Essoussi and Linton, 2010). Thus, pricier WPC products belonging to other application areas are considered as well.

4.1. Methods

4.1.1. Procedure and participants

Study 2 used a 3 (material: solid wood, WPC, plastics) x 2 (appearance: wooden, synthetic surface) x 3 (product category: chair, window frame, fence) mixed-factorial design with product category as a between-subject factor. 513 German members of a commercial online panel (Global Market Insite, Inc.) participated in an online survey using Sawtooth Software, whereof 156 had to be excluded from the analysis due to doubtful data. Data of 357 participants were analysed. The mean age was 48.45 years (SD ¼ 15.91, range from 18 to 87) and gender was distributed nearly equally (46% male respondents). The mean duration of education was 14.29 years (SD ¼ 3.33) and the mean household size was 2.38 (SD ¼ 1.19). For the majority of the respondents (60%), WPCs were unknown prior to their participation, while 37% knew these materials from hearsay and only 3% indicated good knowledge.

All respondents received the same text as in study 1, except that corresponding pictures varied with product category. Photographs, which were provided according to the assigned condition, illustrated the two appearances (brown synthetic vs. brown wooden chair; white synthetic vs. brown wooden window frame; white synthetic vs. brown wooden fence).

4.1.2. Measures

This study consisted of several parts. In the following, we will focus solely on the measurement of EC, innovativeness, value importance, socio-demographic information and the purchase intention (CBCA).

4.1.2.1. EC and innovativeness.
EC was measured with the 12-item scale from Schultz (2001), and innovativeness with Roehrich's 6-item Innovativeness Scale (RIS; 1995, as cited in Roehrich, 2004; translated by the first author). Respondents answered on 7-point scales ranging from 1 (not concerned/does not apply at all) to 7 (extremely concerned/fully applies). The mean scores were 4.97 (SD ¼ 1.18) for EC and 3.54 (SD ¼ 1.34) for RIS. Internal consistency was high (EC: Cronbach's а ¼ 0.93, RIC: Cronbach's а ¼ 0.93).

4.1.2.2. Value circumplex.
The 10-item scale of the World Values Survey (2006) assessed the value circumplex. Respondents evaluated their similarity to fictitious personal descriptions on 6-point scales ranging from 1 (not at all similar) to 6 (perfectly similar). The ratings were combined to form the two axes of the value circle of Fig. 1 (Dobewall and Strack, 2014).

4.1.2.3. CBCA.
Again, the dependent variable was measured with a CBCA (for attributes and levels see Table 1). The only difference compared to study 1 was the variation of the product category (chair, window frame, fence) according to the experimental condition. All pairwise effect correlations were rrr < .18.

4.1.3. Data analysis

Data analysis was similar to study 1. Additionally, the standardised RIS scores and the corresponding interactions were included as further predictors. To ensure generalisability, the variable 'product' only defines three subsamples in the design of the model. This should support generalising its main effect over more products because possible interactions add to the error variance. However, interactions of material and product are not within the scope of this research.

4.2. Results

Before the CBCA was analysed, we checked the expected orthogonality of the environmental concern and the innovativeness in the representative sample. The value circumplex positioning showed that EC was mainly related to the self-transcendence vs. self-enhancement value dimension (r ¼ .19 and r ¼ -.06 for the second dimension), while RIS primarily corresponded with the openness to change vs. conservation dimension (r ¼ -.24 and r ¼ -.08 for the first dimension). Fig. 3 illustrates that EC and RIS were nearly orthogonally arranged and therefore can affect purchase intentions independently.

Fig. 4 illustrates the positioning of WPC in relation to solid wood and full plastics depending on the product's surface. Similar to study 1, the overall predicted choice probability was higher for solid wood (0.45) than for full plastics (0.26). Table 3 provides the results of the logistic regression, thereby confirming the significant main effect of the linear material effect code (Odds Ratio 1.55, CI 1.46e1.64). In contrast to study 1, the predicted overall probability to choose WPC (0.33) deviated slightly from the centre. The low effect size reveals that WPC was chosen marginally less than the mean (Odds Ratio .97). Hence, H_1 is only partially supported.

Appearance emerged as another predictor of the choice: As shown in Fig. 4, respondents clearly preferred a wooden over a synthetic surface (Odds Ratio 1.79, in support of H_2). The interaction of appearance and material was again only significant for the linear (Odds Ratio 1.39), but not for the material quadratic effect code (Odds Ratio 1.02, n.s.). In line with H_3, price was another important driver of the choice (Odds Ratio 1.37).

An individual's EC interacted with the linear material effect code, therefore proving an accentuated preference for solid wood over full plastics (Odds Ratio 1.11). The interaction was also significant for the material quadratic effect code but, contrary to the expectations, the WPC position deviated upwards from the centre (Odds Ratio 1.04) for environmentally concerned consumers. The left panels of Fig. 5 underline: the higher the EC, the higher the
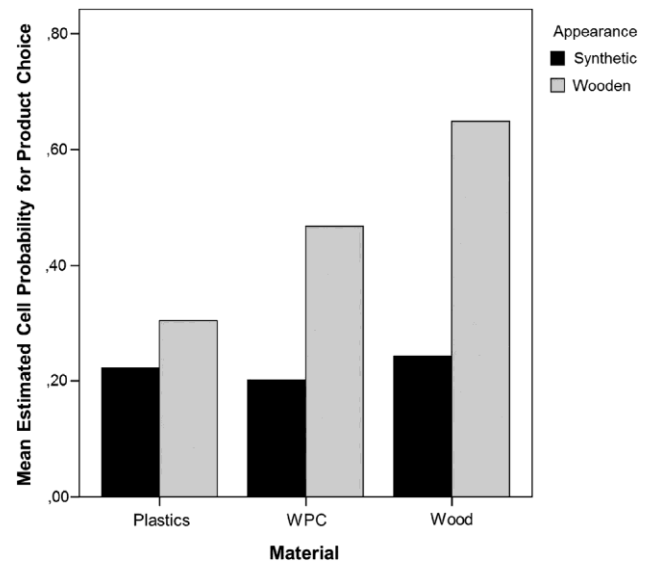

Fig. 4. Predicted probability for product choice in the 3 (material) x 2 (appearance) design (Study 2).

probability to choose WPC. Hence, H_4 is only partially confirmed, as EC consumers tended to assimilate WPC to wood. Comparing Tables 2 and 3, appearance interacted with EC only in study 2 (Odds Ratio 1.07), while the three-way interaction of appearance, EC and the linear material effect code was no longer significant (Odds Ratio .99, n.s.).

Additionally and in line with H_5, RIS interacted with the quadratic (Odds Ratio 1.03), but not with the linear material effect code (Odds Ratio 1.00, n.s.). Hence, high consumer innovativeness also led to increased WPC choices, as visualized in the right panels of Fig. 5.

4.3. Discussion

Study 2 investigates consumer acceptance of WPCs across different product categories with a sample representative for the
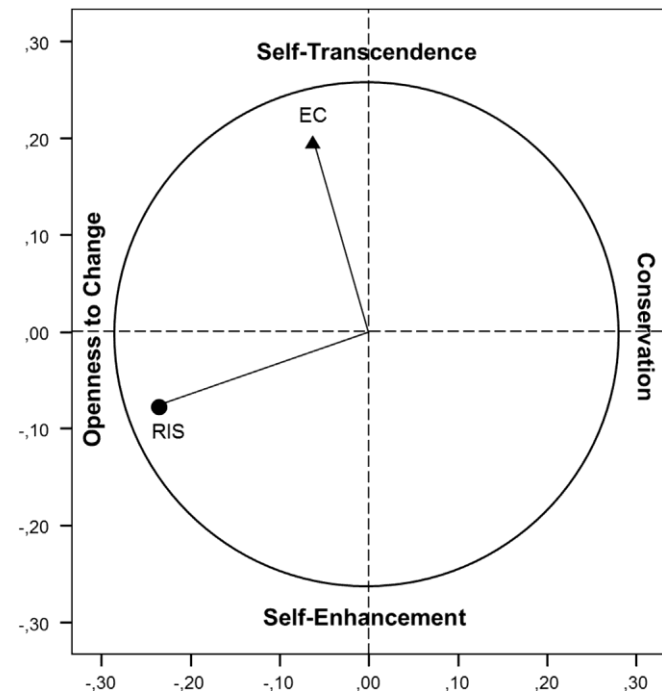
Table 3
Results of the logistic regression (Study 2).

	Parameter estimates	
	B (SE)	Odds ratio (95% CI)
Intercept	-.70 (.02)***	
Material linear	.44 (.03)***	1.55 (1.46e1.64)
Material quadratic	-.03 (.02)*	.97 (.94e1.00)
Appearance	.58 (.02)***	1.79 (1.71e1.87)
Price	.31 (.03)***	1.37 (1.30e1.44)
Material linear x appearance	.33 (.03)***	1.39 (1.32e1.47)
Material linear x EC	.10 (.03)**	1.11 (1.04e1.17)
Material linear x appearance x EC	-.02 (.03)	.99 (.93e1.05)
Material linear x RIS	.00 (.03)	1.00 (.94e1.06)
Material linear x appearance x RIS	-.04 (.03)	.96 (.91e1.02)
Material quadratic x appearance	.02 (.02)	1.02 (.99e1.06)
Material quadratic x EC	.04 (.02)*	1.04 (1.00e1.07)
Material quadratic x appearance x EC	.00 (.02)	1.00 (.97e1.03)
Material quadratic x RIS	.03 (.02)*	1.03 (1.00e1.07)
Material quadratic x appearance x RIS	-.00 (.02)	1.00 (.96e1.03)
Appearance x EC	.07 (.03)**	1.07 (1.02e1.12)
Appearance x RIS	.00 (.02)	1.00 (.95e1.05)
$c^2(16)$ ¼ 1364.08***		

Fig. 3. Positioning of EC and RIS in the value circumplex (Study 2).
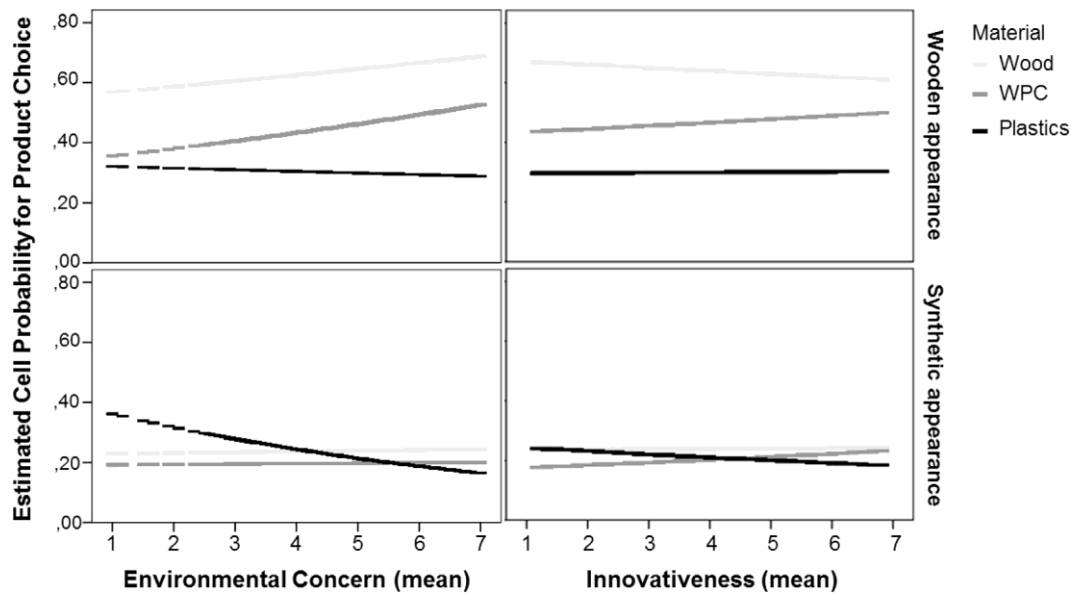
Note: *p < .05, **p < .01, ***p < .001.

Fig. 5. Predicted probability for product choice depending on Environmental Concern and Innovativeness in the 3 (material) x 2 (appearance) design (Study 2).

German population. Two important and distinctive target groups for WPCs were identified, as the choice probabilities of both segments deviated upwards from the centre of the 'two evils' continuum': According to the predictions, consumers expressing high innovativeness favoured the eco-innovations. Contrary to the assumptions, environmentally concerned consumers did not downgrade, but even upgraded WPC. The synthetic components of WPCs did not lead to a rejection as expected based on previous research (Eyerer et al., 2010; Petrescu et al., 2010). Although WPCs were positioned slightly below the centre for the overall sample, these results suggest positive sales prospects in environmental and in innovative consumer segments.

5. General discussion

By-products of the wood-processing industry are still primarily used for energy purposes. However, a material usage of these by-products has the potential to foster resource efficiency and cascading utilisation. WPCs are new materials consisting of wood by-products, therefore being promising eco-innovations. Nevertheless, consumer acceptance was controversial for a long time, as WPCs consist of materials that consumers perceive as being conflictive (wood and plastics).

We conducted two consumer studies to determine WPC acceptance in relation to the two competing materials making up the eco-innovations. The assessment was based on a 'two evils' continuum', as consumers usually must decide between materials either being perceived as eco-friendly but expensive and resource consuming in mass consumption (i.e. solid wood) or cheap but environmentally hazardous (i.e. full plastics). The present studies found that consumers perceived WPC as a hybrid solution so that the eco-innovative materials were positioned around the centre of the 'two evils' continuum'. While WPC took the exact centre position in study 1, which analysed a younger sample, the eco-innovations only slightly deviated in study 2 which provided a more representative sample of consumers. Kanchanapibul et al. (2014) already argued that green products do no longer represent a niche market, but become rather attractive for the mainstream market; based on the present studies the same conclusion can be drawn for eco-innovative materials. Furthermore, study 2 presents

evidence that WPCs are attractive materials for various product categories. This is an important finding as it is crucial to replace a wide range of environmentally hazardous products by eco-friendly alternatives in the mainstream market in order to realise green consumption behaviours comprehensively (Rex and Baumann, 2007).

Beyond that, the studies considered WPC acceptance for two consumer segments which should be analysed in conjunction with eco-innovative materials: innovative and environmentally concerned consumers. The different value circumplex positioning of consumers with high environmental concern and high innovativeness proved that the segments are distinctive. While the innovative consumer segment was expected to choose WPC more frequently than the average consumer, previous research had suggested that the environmentally concerned segment maybe would reject WPC (Eyerer et al., 2010; Petrescu et al., 2010; Weinfurter and Eder, 2009). Nevertheless, in our data, WPC deviated upwards on the 'two evils' continuum' for both segments indicating that even environmentally concerned consumers are open to eco-innovative composite materials containing synthetic components.

There is another reason why the WPC positioning around the centre is already a promising result. Although most investigations about green consumption refer to FMCG, only a few consider pricier products. Recent studies about the introduction of sustainability in the luxury sector demonstrated that consumers reject these efforts and especially devalue luxury products consisting of recycled materials (Achabou and Dekhili, 2013; Davies et al., 2012). Achabou and Dekhili (2013) stress that recycling and luxury products are psychologically incompatible. Based on these observations, a clear WPC rejection could have also been possible in our study, as all participants were informed that WPC mainly consist of by-products which could be perceived as being inferior. Furthermore, Luchs et al. (2010) show that sustainability claims can even have a negative effect on consumer acceptance of products where strength is an important factor. As strength is essential for the products considered in the present studies, the empirical positioning of WPC is quite encouraging.

In addition to the material, both studies reveal two further determinants of consumers' choices. On the one hand, appearance is

an important factor in study 1 and the most important predictor of consumers' choice behaviour in study 2. Consumers favour natural over synthetic appearances. For example, this might be due to the fact that they ascribe higher quality to the product and show more product trust given a wooden surface. A wooden surface is particularly important for solid wood products as they are even more preferred over synthetic materials when the natural material is visible. On the other hand, product price affected consumers' choices. The influence of price was somewhat higher in study 1, possibly due to respondents' younger mean age which might be associated with higher price sensitivity. Hence, it becomes important to offer the products at competitive prices.

5.1. Practical implications

The present studies provide further evidence that WPCs are still unknown by many consumers. Hence, potential customers should receive material information so that they consider these eco-innovations when reaching a purchase decision. Additional strategies should be pursued rather than just informing consumers about the mere WPC existence, because previous research had indicated that pricier goods are typically associated with more functional risks. Therefore, measures such as relying on established brand names, issuing warranties and providing consumers with more and detailed product information should be taken to reduce the perceived risks and further increase the purchase intention (Essoussi and Linton, 2010; Gleim et al., 2013).

Additional marketing implications reveal when considering the two consumer segments having a higher purchase intention than the average consumer. The consumer segment characterised by high innovativeness could be reached by foregrounding the newness of the materials and the innovative combination of two established materials. Material properties differing from conventional alternatives should also be highlighted (e.g. nearly free, three-dimensional formability). Referring to the environmentally concerned segment, it is recommended to direct the attention to the environmental compatibility of WPC. This could not only increase the purchase probability of environmentally concerned consumers, but also of the mainstream consumers, as green consumer behaviour is becoming increasingly conventional (Kanchanapibul et al., 2014).

From the results of the two studies, implications for WPC production arise as well. Firstly, it is suggested to further reduce the environmental impact of WPC. European WPC producers typically resort to new and fossil-fuel based plastics (Weinfurter and Eder, 2009). Replacing these by recycled plastics or bioplastics would lead to even more eco-friendly materials probably facilitating another market growth. Further studies conducted by the materials sciences are needed to thoroughly assess WPC eco-friendliness and its dependence on material composition. Reliable comparisons of the WPC eco-friendliness with competing materials are also required. Consumers must be provided with the results to allow for informed purchase decisions and to enable eco-friendly consumers to choose those WPCs with a low environmental impact. Secondly, consumers' preferences for a wooden surface must be considered. Products were highly favoured when the utilisation of natural resources was obvious. Hence, it is recommended to adapt the product's appearance to consumers' preferences.

5.2. Limitations and suggestions for future research

The major finding of the present studies is that the market for WPC products did not reveal a pessimistic point of view as much as previous research had indicated. Generally, such premature concerns about innovative materials can be prevented by consumer acceptance measurements examining the new material's position in a surrounding 'multi evils' continuum'. Therefore, this approach is recommended as a basis for future research.

Despite the promising results concerning consumer acceptance of WPCs, some limitations of the present studies must be considered. Due to the intention-to-behaviour gap reported in the literature (e.g. Sheeran, 2002; Webb and Sheeran, 2006), studies measuring consumers' purchase intention should be interpreted with caution. The purchase intention was assessed with a CBCA in both of the presented online surveys. This indirect measurement is more similar to actual purchase situations than a direct retrieval of the purchase intention mostly resulting in the mentioned gap. As participants could not touch materials and products during the survey, the NFT scale was included and encountered some concerns by showing that an individual's disposition for haptic product information processing did not influence the choices. Nonetheless, biases of a CBCA which result from the fact that participants only make hypothetical decisions must be acknowledged so that this research may be subject to some biases described by Mitchell and Carson (1989), such as incentives to misrepresent responses (participants do not state their actual WTP), amenity misspecification bias (wrong perception of the provided good) or sample nonresponse bias. Observing real purchase behaviour would therefore be more advantageous, though being difficult to realise (e.g. accessing real sales figures). Additionally, the CBCA only included a limited amount of attributes (material, appearance and price). Other product characteristics could influence the product choice as well (e.g. material composition (wood percentage, type of wood, wood origin), product availability, environmental certification) and should be investigated in future research. A methodological issue refers to the independency of attributes of the CBCA, which is not given as we selected price as an attribute. Price depended on material as we used mean market prices. Furthermore, the present studies compare consumer acceptance of WPCs with WPC's pure constituents, i.e., solid wood and full plastics. These are the most obvious and important materials WPCs could replace, however, future studies must also assess WPC in relation to other competing materials such as stone as a construction material or other biopolymers that are used for consumer goods. Further work also needs to be done to prove whether the results we obtained in this research could be generalised to the WPC market of other countries, as the participants of both studies were solely German consumers.

6. Conclusions

An efficient use of resources includes a material utilisation of by-products. While new materials based upon these by-products are in development, they will fail without achieving consumer acceptance. Two consumer studies examine the acceptance of WPCs which are eco-innovative materials containing a high amount of wood by-products and/or wood waste, but consumer acceptance is controversially discussed. However, both consumer studies suggest that the purchase intention for WPC is located around the middle of solid wood and full plastics. Consumer segments with high environmental concern and innovativeness are important target groups as they evaluate WPCs better than the average consumer. Hence, the market for eco-innovative materials such as WPC may be greater than it has been previously expected. This knowledge should help to encourage research about detailed drivers of consumer acceptance of WPCs and further eco-innovative materials. Marketing gains insights into how to better target consumers being interested in WPCs and how to assess consumer acceptance of innovative materials in relation to established ones. Additionally, it appears important that material sciences aim at improving WPC characteristics and eco-friendliness.

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