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ORIGINAL ARTICLE

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Increasing the competitiveness of wood in material substitution: a method for assessing and prioritizing customer needs

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Abstract To increase the competitiveness of wood as a building material requires knowledge of which customer needs require attention in terms of quality improvement and/or product development to best satisfy customers. Hence, information as to the impact on customer satisfaction of the fulfillment of different customer needs, as well as the performance of wood and substitutes in providing for these needs, is needed. This article suggests the use of customer satisfaction modeling (CSM) for assessing customer needs. The methodology is evaluated in the context of floorcovering. The results suggest that CSM is well suited for extracting the information necessary for prioritizing customer needs: importance/impact and performance data for attributes as well as for customer benefits. The study indicates the necessity of considering substitute materials not only for performance comparisons; substitutes may also reveal otherwise latent customer needs. Practical, functional, benefits exert the greatest impact on customer satisfaction for wooden flooring as well as its closest substitutes, laminate and carpet. Hygiene and a low cost over the life cycle are apparently the customer benefits that require attention from wooden flooring manufacturers, because importance is high and performance relatively low.

Key words Wood · Building material · Customer satisfaction · Floorcovering

Introduction

The end consumer, in the sense of the household, plays an essential role in the wood supply chain as the ultimate user and payer. The market for repair and remodeling is growing in importance.[1] In contrast to the construction of new houses, where the influence of architects and structural engineers in material selection is dominant,[2] household assessments are generally more crucial in repair and cemodeling, thus further highlighting the importance of the end consumer.

A number of empirical studies have focused on the attitudes of architects and/or building contractors toward wood and substitute materials.[1–3] The general attitude of end consumers toward wood as a building material has also been investigated,[3] as well as the visual impressions and attitudes toward wood.[4] Still, little is known about end consumer choice of building material for specific purposes, referred to as substitute competition by Ahlmark.[5] An exploratory study of substitute competition established important predictors of application material preferences: where (in what usage context), why (salient evaluative criteria), and by whom (household characteristics) different floorcovering materials are used.[6] However, besides this product positioning, a comprehensive picture of the competitive situation of wood requires information regarding the impact on customer satisfaction of the fulfillment of different customer requirements or needs, as well as the performance of wood and relative substitutes, in providing for these needs. This information is necessary to determine which customer needs require attention in quality improvement and/or product development to best satisfy customers.

In this article, a methodology for measuring and prioritizing customer needs is suggested. The influence and involvement of the end consumer seems to increase as one moves from the construction sector toward the design sector, i.e., in the visible parts of the building.[3] Floorcovering is a material application with a pronounced design profile, and the household typically makes the choice of floorcovering material. Thus, the methodology is evaluated in the context of floorcovering.

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Theoretical frame of reference and implementation

Resources in quality improvement and product development should be deployed where customer importance is

high and product performance is low. Performance comparisons should be between competitors, in this instance substitute materials. Consideration of substitute materials could also identify latent customer needs.[7] The consumption context prescribes benefits that the alternatives in question must meet.[8] Hence, the usage context, i.e., the situation in which a product will be used, is instrumental in defining the alternatives to be actively considered, because it acts as an environmental constraint defining consumers' needs or goals, thus limiting the nature of means (products) that can achieve those goals, i.e., supply the desired benefits.[9] Consequently, substitutes are material alternatives sharing the same usage context. Investigations of importance weights and performance as to customer needs thus need to relate to a specific building application and usage context, in this instance floorcovering and the type of room considered for reflooring. Thus, prior to measuring and prioritizing customer needs, it is necessary to establish where (in what usage context) and why (salient evaluative criteria) the application materials under study are used.

In across-category consideration, several product categories are effective substitutes.[7] A number of studies have demonstrated that across-category choices differ from brand-level choices. Research results indicate that comparisons occur at more abstract levels when the alternatives are less (physically) comparable (e.g., see Corfman,[10] Johnson[11]). Thus, there is more than one way to create a given benefit.[12] This is imperative to acknowledge when it comes to comparing different building application materials, with alternatives differing as to physical characteristics. The comparison level has another dimension, related to the customer category investigated. Applications of the quality improvement method "quality function deployment" (QFD), although referring to customer input, the "voice of the customer," as customer needs, are generally based on rather concrete product attributes.[13] This level of customer input is perhaps justified for industrial customers, but is less so in the case of end consumers, the primary drivers of customer satisfaction, i.e., the overall evaluation of the purchase and consumption experience,[14] in this instance is determined by the benefits.[15] Furthermore, firms focusing on root needs, i.e., benefits or consequences, can develop totally new markets.[16]

In all, when assessing customer needs in an end-consumer context, the paradigm of the means–end theory should apply: the attributes of a product provide customers with certain benefits or consequences, which, in turn, satisfy customer needs. Products perceived as substitutable are presumed to deliver similar benefits.[12] Hence, the approach for measuring and prioritizing customer needs should allow analysis on the benefit – as well as the attribute – level. The quality improvement method "customer satisfaction modeling" (CSM), in linking inherently abstract or latent variables (LVs) such as customer benefits and satisfaction with concrete measures or manifest variables (MVs), meets this demand.[17] The aim of CSM is to provide information on how to increase customer satisfaction effectively. In CSM, meaning is ascribed to the LVs, benefits, and satisfaction in two ways. The first is through the MVs, i.e., the LVs are measured indirectly using multiple concrete proxies:[15] customer ratings on attributes (A_1, A_2 and A_3 in Fig. 1) and, e.g., customer ratings of overall satisfaction and satisfaction relative to expectations (S_1 and S_2 in Fig. 1). Furthermore, through the relation between benefits and satisfaction as stipulated by substantiated theory,[18] i.e., as a benefit improves, satisfaction should improve.

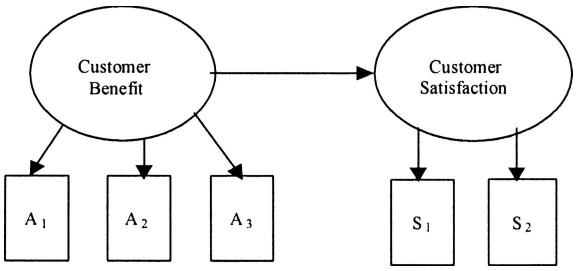

Fig. 1. Customer satisfaction model

Materials and methods

Phase 1. Where and why

The data as to where (in what usage context) and why (salient evaluative criteria) different floorcovering materials are used emanates from an exploratory study of the Dutch floorcovering market presented in Jonsson.[6] The description of the methodology in this respect is somewhat abridged here.

Data

Respondents were selected so as to comply with Ajzen and Fishbein's[19] "theory of reasoned action," which is based on an individual's intentions being more reliable determinants of behavior than attitudes, and with the requirement of phenomenology that questions should generate descriptions of lived experience (e.g., see Thompson et al.[20]). For the purpose at hand it was prudent to select households that were actively engaged in reflooring of their homes or had refloored in the near past. Consequently, customers at outlets for different types of floorcovering in the Netherlands were interviewed.

Evaluative criteria were obtained through open-ended interview questions concerning reasons for choosing the material(s) in question (planned refloorings and/or refloorings undertaken the last 5 years): "What made you choose this particular type of floorcovering material(s)?"/ "What makes you choose this type of floorcovering material(s)?" The motive for using this idiographic approach was that little is known about the phenomenon a priori.[21,22] The aspect of usage context of importance in this instance is the type of room(s) considered for reflooring. Again, open-ended interview questions were used. The interviews included a probing question to clarify what type of wooden flooring was intended, which was used whenever a

respondent answered "wood" when asked what material he, or she, had used/were planning to use. No specimens were presented, because explanation of floorcovering material preferences in general was the scope of the study. Presenting specimens would bias the investigation in favor of visual impressions and attitudes.[6]

Data analysis

Statistical processing of data from open-ended interview questions necessitates interpretative analysis to derive variables. Criteria applied (18 variables) and types of room considered for reflooring (11 variables) were retrieved directly from respondents (so-called in vivo categories). The variables were binary (1 for presence, 0 for absence of the variables in question). Extracting decisive predictors of material preferences in this instance calls for statistical methods of analysis capable of handling binary variables as well as collinear data resulting from contextual influences. Multivariate projection methods cope with many variables and few observations as well as highly collinear variables.[23] Furthermore, multivariate projection methods are able to handle binary variables. Partial least square discriminant analysis (PLS-DA) is a multivariate method of analysis that explicitly takes into account the class membership of observations, i.e., the preferred materials in this instance, in the problem formulation. By studying PLS-DA regression coefficients it is possible to determine why and where specific floorcovering materials are used. Hence, PLS-DA was conducted in order to extract the most decisive causal conditions for material preferences.

Phase 2. Attributes and benefits: importance and performance

Data

Respondents for this second phase of interviews were selected mianly for theoretical reasons[24]: questions should generate descriptions of lived experience.[20] For the purpose at hand, it is prudent to select respondents with experience of the floorcovering materials in question: only those customers who had installed the floorcoverings in question in the last 5 years were interviewed. Interviews took place at outlets for different types of floorcovering in the Netherlands. The total number of interviews was 100: 27 wood users (15 solid and 12 engineered wood users respectively), 47 laminated flooring (laminate) users, and 26 textile flooring (carpet) users.

Respondents were asked to rate the performance of the floorcoverings in question on attributes (using a 1 to 7 Likert-type scale, from 1= not at all to 7= to a high degree), and assess their satisfaction using ratings of overall satisfaction and satisfaction relative to expectations (again using a 1 to 7 Likert-type scale, from 1= not at all to 7= highly satisfied). For respondents with experience of wooden flooring, the questionnaire included a question as to the type of wooden flooring: solid or engineered wood.

Data analysis

CSM makes a distinction between observable and latent variables. Benefits, being LVs, need to be assigned MVs to acquire meaning.[15] The approach suggested here is deductive in that it takes benefits as the starting point and proposes or implies observable measures, i.e., attributes.[17] In contrast, when attributes are cited as evaluative criteria the benefits, which these attributes reflect, need to be derived. Factor analysis is useful in this instance. By looking at what variables have large loadings for a particular factor, assumptions regarding the relation of MVs and LVs can be evaluated. Principal components analysis (PCA), in coping with many variables and few observations as well as collinear variables,[23] is a favorable method of factor extraction in this instance.

The relationships illustrated in Fig. 1 are estimated statistically in CSM. There are two common methods for estimating this type of model: partial least squares (PLS) and covariance structure models like linear structural relationships (LISREL).[25] PLS is especially well suited to satisfaction modeling, because, being prediction oriented, it attempts to explain the ultimate dependent variable.[18] Furthermore, PLS copes with small samples, and does not impose distributional assumptions on the data,[26] which is an attractive feature with satisfaction data being typically skewed.[27] PLS estimation renders possible the simultaneous evaluation of the measurement and structural portions of the model.[17] The LVs are easily measured as weighted linear aggregates of their respective MVs.[15] Hence, CSM, using PLS, is conducted to extract the information necessary for prioritizing benefits and attributes: importance and performance data.

Performance information is provided for each level in the model. Performance information for the LVs, i.e., satisfaction and benefits, are calculated as weighted indices of their respective MV ratings.[17] Being directly observable, performance information for the attributes is provided by respective survey ratings. Importance is estimated as the impact of a given set of variables on variables at the next level in the customer satisfaction model.[17] Variation in performance on attributes across respondents allows estimation of the impact that an increase in a satisfaction driver has on customer satisfaction.[15] Importance information is provided at benefit level through the path coefficients, which, as in regression analysis, are interpreted as impact scores, and at attribute level using MV loadings and weights.[17] Loadings are the correlation of the individual MVs to the LV indices of which they are a part.[17] The weights, i.e., the values given to a collection of MVs when calculating an LV index, are the loadings after scaling to make the variance of LVs equal to one.[18] Attribute weights provide a more meaningful and diagnostic basis for priority setting than loadings.[17] When assessing the importance of attributes, one should consider both the attribute weights and the benefit impact scores by multiplying each attribute weight by the impact that its benefit has on satisfaction.[17] The reliability of the measurement part of the model is satisfactory if the MV loadings are high or if the MVs used

to measure a particular LV have relatively uniform weights. The theoretical or LV relationships are judged using two criteria: whether the estimated impact scores are significant and in the predicted directions, and the amount of variation explained in the endogenous construct (see Fornell and Cha[18] for a detailed description of the PLS methodology).

The reasons voiced for choosing a specific floorcovering material extracted in phase 1 are typically those benefits and attributes salient for the floorcovering alternative in question. However, one should not automatically assume that other customer needs, cited as a reason for choosing substitutes, are of no importance for those using wood. Rather, by considering these latent needs new market opportunities may develop. Hence, in acquiring importance and performance information, customer needs cited for choosing substitutes (floorcoverings frequently used in the same type of room(s) in this instance) ought to be included.

Table 1. Where: living room use for each material

Material	Living room use (%)
Wood	42
Laminate	30
Carpet	11
Ceramic tiles	8
Linoleum	7
Vinyl	2

Table 2. Why: salient evaluative criteria

Laminate	Carpet	Wood
Esthetics	Warmth	Esthetics
Good price	Softness	Natural material
DIY	Esthetics	Wood feeling
Hygiene	Sound-absorbing	

DIY, suitability for do-it-yourself projects

Results

Where and why

There was no discernible difference in consumer assessment between the different types of wooden flooring in the phase 1 interviews; therefore, these responses were treated as one class: wood. Furthermore, as respondents were unable to specify the kind of printed wood overlay in instances of laminated flooring preference (in all instances where laminate was the preferred floorcovering, it was of the printed wood overlay type), laminated flooring constitutes one class: laminate. No distinction was made between planned and undertaken refloorings. This is justified by the concern to attain as many instances of the phenomenon as possible. Besides, nothing in the results seems to indicate any systematic difference between the two categories.[6]

Wood has a comparative advantage as a floorcovering in living rooms.[6] Other floorcovering materials frequently used in living rooms are textile flooring (henceforth carpet) and laminate (see Table 1). Hence, carpet and laminate are apparently the main substitutes for wood.

Table 2 displays what was found to be decisive (salient) evaluative criteria for wood, laminate, and carpet preferences, respectively, in Jonsson.[6] The evaluative criteria include benefits/consequences: *Esthetics*, *Hygiene*, *DIY* (suitable for do-it-yourself), as well as more concrete attributes: *Good* (favorable) *price*, *Warmth*, *Softness*, *Sound-absorbing*, *Natural material*, *Wood feeling*.

The relation of attributes and benefits

The closest competitors of wooden flooring are apparently laminate and carpet. The materials analyzed were thus wooden flooring, laminate, and carpet. When the aim is to disclose which customer needs are the prime drivers of satisfaction, this rather aggregated level of analysis as to the types of floorcovering is justified.

The interview transcripts as to evaluative criteria in the phase 1 interviews suggest two aspects (MVs) of *Hygiene*: *Easy cleaning* and *Not getting filthy easily*. Hence, these MVs are assumed to reflect the benefit *Hygiene*. The benefit *DIY* is linked to perceived ease of installation, and is assumed to be reflected in the attributes (MVs) *Pieces fit together easily* and *Clear installation instructions*. Esthetic considerations voiced in connection with wood and laminate refer to the "wood properties"; the MV suggested a priori in this instance is *Authentic wood appearance*. For carpet, the attribute reflecting *Esthetics* is assumed to be *Nice color and pattern*. As for the attributes cited as evaluative criteria, *Good price* (initial cost) and *Durable* (an aspect of recurring costs) can be seen as providing a benefit suitably termed *Low life cycle cost* (henceforth *LLCC*). *Durable* was found to be a salient criterion for ceramic tiles preference only,[6] but is of such (potential) importance as to merit inclusion in the analysis here. *Sound-absorbing* is hypothesized to reflect the benefit *Nice atmosphere*, whereas *Softness*, *Warmth*, and *Wood feeling*, all being tactile phenomena, are assumed to provide the benefit *Nice underfoot*. *Natural material* could reflect either of *Nice underfoot*, *Nice atmosphere*, or *Esthetics*.

The initial PCA conducted on the data from respondents with experience of wooden flooring (solid and engineered flooring, 27 observations in all) included the attributes *Warmth*, *Wood feeling*, *Sound-absorbing*, *Natural material*, *Authentic wood appearance*, *Good price*, *Durable*, *Easy cleaning*, and *Not getting filthy easily*, as well as the average of overall satisfaction and satisfaction relative to expectations, termed *Satisfaction average*. *Pieces fit together easily* and *Clear installation instructions* had to be excluded in this instance, as there were only six respondents who had installed the wooden flooring themselves (only those who had installed the floorcovering in question themselves were asked to rate it on these two attributes). Furthermore, *Softness*, being closely connected with the intrinsic nature of

carpet, was not included. In the initial PCA, with five components (corresponding to the number of assumed benefits), each of the MVs associated with only one factor, i.e., had a single high loading, except *Authentic wood appearance* which did not load significantly on any of the components extracted (The two highest loadings for this variable were 0.52 and 0.57 respectively. A loading of at least 0.7 is required for accounting for at least 50% of the variable's total variance). Due to this circumstance, and the fact that *Authentic wood appearance* had the lowest communality, it was deleted from the final PCA (see Hair et al.[28] for a detailed account of how to interpret component matrices and respecify factor models). The final PCA was consequently conducted with four components, accounting for 83% of the variance.

Judging by the pattern of component loadings in Table 3, attributes *Good price* and *Durable*, having high loadings on the first component, plausibly constitute good reflections of *LLCC*. These attributes are also the ones most strongly associated with *Satisfaction average*. *Easy cleaning* and *Not getting filthy easily* indeed reflect the benefit *Hygiene*, because they both show high loadings on the second component. MVs *Sound-absorbing* and *Natural material*, both exhibiting high loadings on the third component, apparently reflect the same benefit, termed *Nice atmosphere*. *Warmth* and *Wood feeling* finally, loading high on the fourth component, are apparently proper reflections of the benefit *Nice underfoot* in this instance (*Wood feeling* is a borderline case with regard to significance).

Table 3. Principal component loadings: wood

Attribute	Component			
	1	2	3	4
Warmth	–0.001	0.294	–0.141	0.844
Wood feeling	–0.325	–0.414	0.197	0.655
Sound-absorbing	–0.159	–0.205	0.872	0.095
Natural material	0.040	–0.103	0.919	–0.107
Good price	0.859	0.146	–0.080	–0.186
Durable	0.869	0.032	–0.121	–0.148
Easy cleaning	0.149	0.919	–0.085	0.035
Not getting filthy easily	0.158	0.826	–0.269	0.085
Satisfaction average[a]	0.735	0.386	0.127	0.327

The number of observations for all variables included is 27
[a]The mean value of the ratings of overall satisfaction and satisfaction relative to expectations

The PCA conducted on the data from respondents with experience of laminated flooring (47 observations in all) included the following attributes: *Warmth*, *Sound-absorbing*, *Natural material*, *Authentic wood appearance*, *Good price*, *Durable*, *Easy cleaning*, *Not getting filthy easily*, *Pieces fit together easily*, *Clear installation instructions*. Unfortunately, the attribute *Wood feeling* was inadvertently overlooked in translating the questionnaire for laminate users. The six extracted components (corresponding to the number of assumed benefits) account for 85% of the variance.

The pattern from the PCA as to wooden flooring users is partly repeated in Table 4. Hence, *Easy cleaning* and *Not getting filthy easily*, exhibiting high loadings on the first component, once again seem to reflect the benefit *Hygiene* well, and *Good price* and *Durable*, with high loadings on the second component, plausibly constitute good reflections of *LLCC*. However, in the case of laminate users, *Natural material* is apparently associated with *Authentic wood appearance*, thus reflecting the benefit *Esthetics* in this instance. *Pieces fit together easily* and *Clear installation instructions*, both loading high on the fourth component, apparently reflect the benefit *DIY* well. Benefits *Nice atmosphere* and *Nice underfoot* are reflected in one attribute each in this instance: *Sound-absorbing* and *Warmth*, respectively.

The attributes included in the PCA conducted on the data from respondents with experience of carpet were: *Warmth*, *Softness*, *Sound-absorbing*, *Good price*, *Durable*, *Easy cleaning*, *Not getting filthy easily, Nice color and pattern*. *Pieces fit together easily* and *Clear installation instructions* were not included due to the limited number of observations (13 respondents who had installed the carpet-

Table 4. Principal component loadings: laminate

Attribute	Component					
	1	2	3	4	5	6
Warmth	0.104	0.036	0.224	–0.003	0.026	0.932
Sound-absorbing	–0.045	–0.009	0.281	0.015	0.927	0.018
Natural material	0.149	0.200	0.850	–0.093	0.109	0.077
Authentic wood appearance	–0.159	–0.007	0.825	–0.058	0.161	0.173
Good price	0.524	0.713	–0.079	0.009	0.043	0.230
Durable	0.021	0.849	0.223	0.048	–0.020	–0.134
Easy cleaning	0.863	0.289	–0.053	–0.027	0.139	0.151
Not getting filthy easily	0.912	0.031	0.041	0.116	–0.189	–0.057
Pieces fit together easily	0.129	0.114	0.017	0.896	–0.225	–0.084
Clear installation instructions	–0.010	0.016	–0.231	0.811	0.390	0.111
Satisfaction average[a]	0.537	0.630	0.031	0.228	0.033	0.253

The number of observations for all variables included is 47, except for *Pieces fit together easily* and *Clear installation instructions*. The number of observations for these two variables is 35
[a]The mean value of the ratings of overall satisfaction and satisfaction relative to expectations

Table 5. Principal component loadings: carpet

Attribute	Component				
	1	2	3	4	5
Softness	0.023	0.879	0.083	–0.002	0.250
Warmth	–0.316	0.787	0.049	0.337	0.156
Sound-absorbing	–0.024	0.372	0.071	0.139	0.901
Nice color and pattern	–0.038	0.159	0.127	0.961	0.117
Good price	–0.212	0.118	0.856	0.247	0.235
Durable	0.522	0.072	0.760	–0.088	–0.192
Easy cleaning	0.854	–0.387	–0.167	0.138	–0.127
Not getting filthy easily	0.907	0.017	0.085	–0.230	0.010
Satisfaction average[a]	0.619	0.570	0.279	0.158	0.217

The number of observations for all variables included is 26
[a]The mean value of the ratings of overall satisfaction and satisfaction relative to expectations

Table 6. Benefit and attribute importance: wood

Benefits and attributes	Impact score	Significance	Attribute weight	Impact × weight	Absolute weight
Hygiene	0.24	0.060			
Easy cleaning			0.32	0.08	11%
Not getting filthy easily			0.29	0.07	10%
Nice atmosphere	0.13	0.259			
Sound-absorbing			0.49	0.07	9%
Natural material			0.50	0.07	9%
LLCC	0.43	0.002			
Good price			0.29	0.12	17%
Durable			0.29	0.12	17%
Nice underfoot	0.20	0.100			
Warmth			0.47	0.09	13%
Wood feeling			0.49	0.10	14%

The latent variables, i.e., the benefit and satisfaction indices, were scaled to unit variance and centered
LLCC, Low life cycle cost

ing themselves out of 26 observations in all). The five extracted components (corresponding to the number of assumed benefits) account for 92% of the variance.

In conformity with the results for wood and laminate, *Easy cleaning* and *Not getting filthy easily* apparently reflect *Hygiene* well, judging by the pattern of component loadings in Table 5. *Warmth* and *Softness*, having high loadings on the second component, plausibly constitute good reflections of *Nice underfoot*. Again, *LLCC* is well reflected in *Good Price* and *Durable*. The benefits *Esthetics* and *Nice atmosphere* are reflected in one attribute each in this instance: *Nice color and pattern* and *Sound-absorbing*, respectively.

Attributes and benefits: importance and performance data

PLS was conducted to estimate the impact of benefits on satisfaction, the weight of each benefit's attributes, their product (i.e., the overall importance of each attribute), and the absolute weight (i.e., the importance in relation to the other attributes).

Table 6 presents PLS estimates of benefit and attribute importance for wooden flooring users. The impact scores are, except for *Nice atmosphere*, significant on at least the 10% level. *LLCC* is apparently the most crucial benefit for customer satisfaction in this instance, followed by *Hygiene* and *Nice underfoot*; the latter two benefits roughly of equal importance. The model explains 51% of the variation in satisfaction.

Table 7 reports PLS estimates for laminate users. Again, *LLCC* has the greatest impact on satisfaction. *Hygiene* is the second most important benefit, followed by *DIY*. *Esthetics*, *Nice Atmosphere*, and *Nice underfoot* all seem to have a negligible impact on satisfaction for laminate users. The model explains 59% of the variation in satisfaction.

PLS estimates for carpet users are presented in Table 8. *Hygiene* and *Nice underfoot*, roughly of equal importance, are the benefits that impact most on satisfaction in this instance, followed by *LLCC*. *Nice atmosphere*, and, particularly, *Esthetics* are less important benefits for carpet users. The model explains 66% of the variation in satisfaction.

Priority setting should consider both the performance and importance/impact information, according to the logic: improve the areas that are important to customers and in which the product performance is poor.[15] Table 9 displays performance levels for wood, laminate, and carpet on: satisfaction, what apparently are the most important benefits, and their respective manifest variables (MVs).

Table 7. Benefit and attribute importance: laminate

Benefits and attributes	Impact score	Significance	Attribute weight	Impact × weight	Absolute weight
Hygiene	0.24	0.036			
Easy cleaning			0.46	0.11	13%
Not getting filthy easily			0.45	0.11	13%
DIY	0.17	0.100			
Pieces fit together easily			0.53	0.09	10%
Clear installation instructions			0.50	0.08	10%
LLCC	0.38	0.001			
Good price			0.37	0.14	17%
Durable			0.47	0.18	21%
Esthetics	0.07	0.511			
Natural material			0.30	0.02	3%
Authentic wood appearance			0.32	0.02	3%
Nice atmosphere	0.07	0.471			
Sound-absorbing			0.65	0.05	6%
Nice underfoot	0.07	0.486			
Warmth			0.65	0.05	5%

The latent variables, i.e., the benefit and satisfaction indices, were scaled to unit variance and centered

Table 8. Benefit and attribute importance: carpet

Benefits and attributes	Impact score	Significance	Attribute weight	Impact × weight	Absolute weight
Hygiene	0.35	0.001			
Easy cleaning			0.39	0.14	17%
Not getting filthy easily			0.41	0.15	18%
Nice underfoot	0.32	0.008			
Softness			0.49	0.16	19%
Warmth			0.43	0.14	17%
LLCC	0.18	0.054			
Good price			0.45	0.08	10%
Durable			0.42	0.08	9%
Esthetics	0.03	0.750			
Nice color and pattern			0.66	0.02	2%
Nice atmosphere	0.12	0.256			
Sound-absorbing			0.65	0.08	9%

The latent variables, i.e., the benefit and satisfaction indices, were scaled to unit variance and centered

Table 9. Benefit and satisfaction performance

Benefit and attribute	Wood	Laminate	Carpet
LLCC	5.2	5.7	4.9
Good price	5.0	5.9	5.1
Durable	5.4	5.5	4.7
Hygiene	4.9	5.5	4.0
Easy cleaning	5.0	6.0	4.3
Not getting filthy easily	4.9	5.0	3.7
Nice underfoot	5.4	4.5	4.4
Warmth	5.7	4.5	4.8
Wood feeling	5.2	–	–
Softness	–	–	4.2
Satisfaction	6.3	5.9	5.2
Overall	6.2	5.9	5.3
Relative expectations	6.3	5.8	5.1

Performance values for benefits and satisfaction were calculated as weighted averages of their respective manifest variables. For laminate, the performance value for the benefit *Nice underfoot* was calculated using one attribute (*Warmth*) only

Wood users are apparently, on average, quite satisfied. The tactile qualities of wooden flooring (*Nice underfoot*) are rated highly. The surprising circumstance that carpet does not perform better on tactile qualities is probably a reflection of the generally bad image of this floorcovering, manifested in a relatively low rating in satisfaction. Wooden flooring fares less well, especially compared to laminate, on *LLCC* and *Hygiene*. As for *LLCC*, it is primarily the price of wooden flooring that is perceived as less favorable. For *Hygiene*, the attribute *Easy cleaning* is responsible for the low performance of wood compared to laminate. In this connection it should be mentioned that discriminant analysis revealed some differences in evaluations between solid and engineered wood users. Hence, the mean values of the ratings are significantly higher (at the 5% level) for engineered wood on the attributes *Good price*, *Durable*, and *Not getting filthy easily*, as well as for satisfaction relative to

expectations. Caution is warranted in interpreting the latter results, however, due to small sample size (15 solid and 12 engineered wood users).

Discussion

Methodology

A comprehensive picture of the competitive situation of wood as a building material is needed for successful quality improvement and product development. Substitutes are those material alternatives sharing the same usage context. Thus, it is necessary to establish why and where the building application materials under study are used. The methodology used in Jonsson,[6] combining qualitative data gathering and multivariate analysis (PLS-DA), is well adapted for extracting salient evaluative criteria and establishing in what usage contexts building application materials are used.

Comparisons occur at more abstract levels the less physically comparable the alternatives. This is imperative to acknowledge when it comes to material substitution, with alternatives differing as to physical characteristics. Customer satisfaction can be expressed as a function of current quality and past satisfaction,[29] or, as expressed by Bergman and Klefsjö:[30] "The quality of a product (article or service) is its ability to satisfy the needs and expectations of the customer." From the customer's perspective, the primary drivers of customer satisfaction are the benefits that a product or service provides.[15] Hence, firms focusing on root needs, i.e., benefits or consequences, can develop totally new markets.[16] In all, assessing customer needs in material substitution in an end-consumer context should allow analysis on the rather abstract level of customer benefits.

The results of this study suggest that CSM using PLS is well suited for extracting the information necessary for prioritizing customer needs: importance and performance data for attributes as well as customer benefits. Furthermore, the circumstance that importance is equivalent with impact in CSM allows parsimonious analysis, as there is no need for separate surveys to acquire importance and performance information.

Managerial implications

CSM, with its external focus on customers, constitutes a useful complement to quality function deployment (QFD). Importance and performance data extracted by CSM make the prioritizing of customer benefits and attributes possible, thus providing valuable input to QFD, where customer requirements, moving downstream through successively lower levels of abstraction, are systematically translated into measurable product and process parameters (for a comprehensive account of QFD, e.g., see Akao[31]).

The results of this study indicate that practical, functional, benefits exert the greatest impact on customer satisfaction for wooden flooring as well as its closest substitutes laminate and carpet. This is noteworthy, because the salient evaluative criteria for choosing wooden flooring found in Jonsson[6] were of a nonfunctional nature. This circumstance highlights the necessity of considering substitutes when assessing customer needs to identify latent needs.[7] Customer benefits *Low life cycle cost* (*LLCC*) and *Hygiene* are apparently the most important to improve for wooden flooring manufacturers, because importance is high and performance relatively low. As for *LLCC*, it has been shown that the life cycle cost of wooden floorings is significantly higher than for other types of floorcovering, and that recurring costs are much higher than the initial cost.[32] These circumstances, and the fact that it might be undesirable to lower the price, imply that manufacturers of wooden flooring should prioritize durability. For *Hygiene*, the attribute *Easy cleaning* is apparently the one that requires attention for quality improvement and/or product development.

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