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The Assessment of Floorcovering Materials by End-Consumers and Sales Representatives: *A Comparative Study of Substitute Competition*

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ABSTRACT

The knowledge of factors affecting the end-consumers choice of building material for specific purposes, i.e., the mechanisms of *substitute competition*, necessary to understand the competitive situation of wood, is limited.

In this paper interviews of floorcovering customers and sales representatives are analysed. The results suggest that by using a multivariate projection method, PLS-DA (*Partial Least Square Discriminant Analysis*), it is possible to extract the most important predictors of material preferences from answers to open-ended questions and make comparisons between the two groups, thus allowing parsimony, as there is no need for a follow-up study with pre-structured response alternatives to quantify variables (e.g., using Likert scales).

End-consumers and sales representatives show agreement in their assessment of determinant attributes and appraisal of the different materials. Unlike the other materials, the decisive reasons for choosing wood appear to be exclusively non-functional.

Keywords end-consumer, building material, substitute competition, PLS-DA

INTRODUCTION

The end-consumer of building materials, i.e., the household, plays an essential role in the supply chain, as the ultimate user and payer of the products and / or services in question. The market for reconstruction and conversion is expected to grow markedly in Europe. In this type of building activity the house or flat residents', i.e., the household's, assessments are generally more crucial than in the construction of new houses. This further highlights the importance of the end-consumer.

A number of studies concern the attitude of architects and building contractors towards wood and substitute materials, e.g., Eastin et al. (1999) and Anon. (1992). The general attitude of end-consumers towards wood as a building material, e.g., Anon. (1998), as well as the visual impressions and attitudes toward wood (Broman 1996) have also been investigated. The knowledge of attributes affecting the latter group's choice of material for specific purposes/ applications, i.e., the mechanisms of *substitute competition* (see Ahlmark 1977, p. 1), seems to be limited, though. Consequently, a methodology allowing estimation of decisive predictors of material preferences is called for. Further, it is of interest to investigate whether or not sales representatives and end-consumers differ as to assessing decisive attributes / criteria and appraising different building application materials

In this study a qualitative approach as to data gathering is combined with a multivariate

method of analysis, *Partial Least Square Discriminant Analysis* (PLS-DA). The objective is to evaluate the potential of the methodology in extracting decisive attributes / criteria and in making comparisons between end-consumers and sales representatives.

The influence, and involvement, of the end-consumer seems to increase as one moves from the construction- towards the design-sector, i.e., visible parts of the building (Anon 1998). Floorcovering is a material application with a pronounced design profile, and the household typically makes the choice of floorcovering material. This makes floorcovering a good illustrative example.

MATERIALS AND METHODS

The interview data

In Social Sciences there are two main methodological approaches, nomothetic and idiographic. The nomothetic approach emphasises quantitative analysis of a few aspects to test hypotheses and make statistical generalisations. The idiographic approach, in contrast, relies on a case study approach to achieve in-depth understanding of complex phenomena, and is the preferred strategy when little is known about a phenomenon (Eisenhardt 1989; Yin 1984). Consequently, an idiographic approach was used in this instance. *Observational units* (see Ragin 1987) were selected for theoretical reasons rather than for representativity (see Glaser and Strauss 1967). For the purpose at hand it was prudent to select households who were actively engaged in re-flooring of their homes and/or had re-floored in the near past. A convenient method is to interview customers at outlets for different types of floorcovering, in order to include as many materials as possible. Interviews of end-consumers were thus conducted in five different shops in the Greater Manchester area and North Wales. The number of interviews is sixty-seven.

To get an idea about mechanisms affecting household material preferences, open-ended questions concerning the choice of floorcovering material (planned re-floorings and / or re-floorings undertaken the last five years) were used: Type of room(s) considered, type of material(s), and reasons for choosing the material(s) in question ("What made you choose this particular type of flooring material?"/"What makes you choose this type(s) of flooring material(s)?"). The interviews included a probing question to clarify what type of wooden flooring was intended, used whenever a respondent answered "wood" when asked what material he, or she, had used / were planning to use. The alternatives were softwood parquet, hardwood parquet, solid softwood floorboards, solid hardwood floorboards, and laminated flooring (hardwood or softwood printed wood overlay. Laminated flooring is of course not real wooden flooring, but is often mistaken for one). In addition, to get further input, questions concerning the general attitude toward different floorcovering materials ("How would you describe the following types of floorcovering materials?") were used. The materials were vinyl, linoleum, ceramic tiles (henceforth tiles), textile flooring (henceforth carpet), laminated flooring (henceforth laminate), softwood parquet, hardwood parquet, solid softwood floorboards, and solid hardwood floorboards (henceforth wood).

Sales representatives (eleven interviews in all) were interviewed at ten different shops in North Wales, NW England and SW England. The sales representatives where asked what features of floorcovering materials they considered important and what materials to choose in different types of rooms, from the customer's point of view.

The interviews resulted in two types of variables potentially explaining floorcovering

material preferences: reasons for preferring a particular floorcovering material, and type of room considered for reflooring. The variables were retrieved directly from respondents (so-called in vivo categories), that is; respondents expressed them. Related words and expressions then formed instances of the same category / variable (e.g., "durable" is an instance of *hardwearing*, as is "sitting room" an instance of *Living room*). All the variables are binary (1 for presence, 0 for absence of the variables in question).

Multivariate projection methods

Multivariate projection methods like *Principal Component Analysis* (PCA) and *Partial Least Square Discriminant Analysis* (PLS-DA) are able to handle binary variables. This is a necessity when analysing answers from open-ended questions. Further, these analytic tools cope with many variables and few observations as well as collinear variables (Wold et al. 1987).

A fundamental assumption in PCA is that directions in multivariate space with maximum variation are more or less coupled to so-called latent variables, or principal components. The first principal component captures the largest variation structure in the data. The second component, fitted orthogonally to the first, describes as much of the remaining variation as possible, and so forth. Though PCA finds the directions in multivariate space with maximum variation, it is not necessarily so that these maximum variation directions coincide with maximum separation directions among classes. In these instances PLS-DA is more apt (Eriksson et al. 1999). PLS-DA takes already in the problem formulation explicitly into account the class membership of observations, an attractive feature in the present context as the classes, i.e., the preferred floorcovering materials, are initially known. The objective of PLS-DA is to find a model that separates classes of observations on the basis of their *X*-variables (predictors).

When deciding the appropriate number of components in a PLS-DA model, it is desirable to find a model with an optimal balance between fit, R^2 (= explained variation), and prediction ability, Q^2 (= predicted variation). R^2 is inflationary and approaches unity as model complexity (number of terms, number of components, etc.) increases, whereas Q^2 is not, as at a certain degree of complexity Q^2 will not improve any more. When using SIMCA with cross validation, the tested dimension is considered significant if Q^2 for the whole data set (Rule 1) or for at least one Y-variable (Q^2_{Y}) is larger than a significance limit (Rule 2). In evaluating the overall performance of a PLS model it is to be noted that without a high R^2 it is impossible to get a high Q^2. Generally, an accumulated (over all PLS dimensions) predicted variation share, $Q^2_{(cum)}$, larger than 0.5 indicates a rather strong model.

In interpreting the influence on *Y* (the matrix of responses) of every term (x_k) in the model, the interpretation tool VIP (*variable influence on projection*) is of good use. VIP is the weighted sum of squares of the PLS weights over all model dimensions. The attractive feature of VIP is the parsimony, as one VIP–vector summarises all components and *Y*-variables. Terms with a VIP value larger than 1 are the most relevant for explaining *Y*. For discriminating between important and unimportant predictors a cut-off around 0.7 to 0.8 works well in most cases[11].

To evaluate which conditions/ variables are decisive for each outcome (chosen material); studying PLS regression coefficients is useful. These regression coefficients are directly related to the weights, W*, describing the correlation between *X* and *Y*. An advantage of PLS regression coefficients are that they provide one vector of concise model information per response, not several vectors of weights.

RESULTS AND DISCUSSION

Methodological implications

The importance of the context and situation in *substitute competition* is apparent in the interviews of end-consumers. The *usage context* seems to be the most important contextual factor; a given household often chooses different materials depending on type of room. Ownership and the style of the dwelling are other aspects of *usage context* sometimes referred to, as the following remarks on wooden flooring indicate: "*Very beautiful, but expensive, more applicable for house owners*" - "*Our house is to modern for that*". This confirms Ajzen and Fishbein's (1980) proposition: It is more fruitful to consider attitudes toward the act of using a product, rather than attitudes toward the product itself. Another contextual factor, the life situation, e.g., child(ren) living at home, asthma in the household, the presence of pets, apparently affects material preferences through perspectives produced, as proposed by phenomenological consumer research (see, e.g., Thompson et al. 1989): "*Because of kids, easy maintenance and no dust*" - "*Because of large dog and parquet has thin grooves, laminate is better*". In *substitute competition*, then, benefit importance weights do not, as Howard (1989) suggests in the case of brand competition, appear to be the main source of individual differences in choice behaviour. Rather, these differences can be explained by differences as to criteria applied, i.e., materials are chosen or rejected on the grounds of desired attributes being perceived as present or not. This state of affairs makes the use of scales irrelevant. Instead open-ended questions, resulting in dichotomous variables, is both sufficient and appropriate.

Multivariate projection methods have potential for examining causally complex data, as they cope with many variables and few observations as well as collinear variables (Wold et al. 1987). In addition, multivariate projection methods, like *Partial Least Square Discriminant Analysis* (PLS-DA), are able to handle binary variables, a necessity when analysing answers from open-ended questions. Thus, PLS-DA was conducted in order to extract the most important attributes/ criteria, and to make comparisons between end-consumers and sales representatives.

Empirical

The interviews of end-consumers resulted in nineteen binary variables regarding reasons for preferring a particular floorcovering material, i.e., there are nineteen attributes/ criteria cited. The type of room considered for reflooring is represented by nine binary variables.

Initially a PLS-DA with five classes was conducted: carpet, laminate, tiles, vinyl and linoleum, and wood. Few observations and the fact that there is no discernible difference in consumer assessment between the different types of wooden flooring (henceforth wood) motivate treating these responses as one class. In this connection it should be noted that knowledge of wooden flooring was poor amongst the consumers. Respondents were not (with one exception) able to specify the kind of wood in instances of real wood preference, nor were they able 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). Hence laminate constitute one class only. Vinyl and linoleum is likewise treated as one class, due to few observations and the fact that the consumers make no distinction between these materials. A model with four significant components, according to the more stringent Rule 1 used in this study to avoid modelling noise, resulted. The $R^2_{Y(cum)}$ of 0.64 and $Q^2_{(cum)}$ of 0.59 indicate a rather good overall model. However, class no. four, vinyl and linoleum

preference, is poorly accounted for: $R^2_{VY(cum)} = 0.017$ and $Q^2_{V(cum)} = 0.008$, probably because there are only four instances of vinyl/ linoleum preference. Excluding these observations, i.e., conducting a PLS-DA with the four remaining classes, resulted in a model with three significant components, $R^2_{Y(cum)} = 0.81$ and $Q^2_{(cum)} = 0.77$. The model can be considered strong, as the $Q^2_{(cum)} > 0.5$.

Table 1. VIP values end-consumers: Attributes.

Variable	VIP	Variable	VIP
aesthetic2	1,99	"Wood feeling"	0,62
warmth	1,80	good price	0,61
aesthetic3	1,62	fashion	0,59
hygienic	1,41	softness	0,50
waterproof	1,23	aesthetic1	0,50
natural	1,10	DIY	0,50
aesthetic	1,09	acoustics	0,50
hardwearing	0,77	foothold	0,41
"a change"	0,74	tradition	0,41
health	0,74		

VIP values are displayed in Table 1. Predictors with large VIP values are the most relevant for explaining material preferences. Aesthetic considerations apparently play an important role, as do more objective criteria / attributes related to the nature and function of the different floorcovering materials (*warmth*, h*ygienic*, *waterproof,* and *natural*).

Regression coefficients are, in this instance, useful for evaluating which variables are decisive for the choice of a particular material. As the type of room apparently affects the choice of floorcovering, it is appropriate to include these variables in the analysis. Consequently, a PLS-DA with the more important attributes, i.e., with a VIP value ≥ 0.75 (= the cut-off value adopted in this study), and variables for the type of room considered, was conducted: Three significant components, $R^2_{Y(cum)} = 0.77$ and $Q^2_{(cum)} = 0.72$. Hence, a strong model.

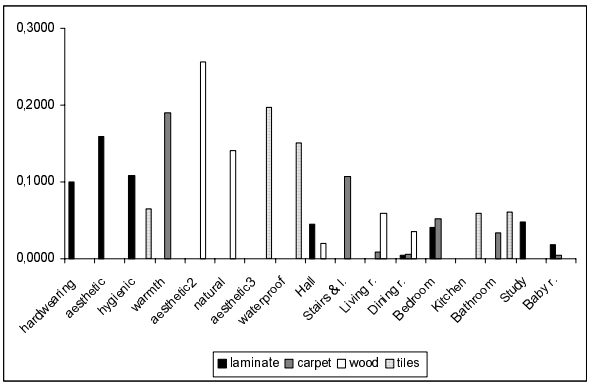

Figure 1. Regression coefficients end-consumers: Attributes and type of room.

Figure 1 displays the PLS regression coefficients for the four responses (classes). The coefficient profile suggests that:

· Laminate, apart from aesthetic considerations (*aesthetic*) is the preferred floorcovering when hygiene and durability (*hardwearing*) are present as important criteria. Laminate has a comparative strength in halls, bedrooms, studies, and, to a lesser degree, in children's bedrooms (*Baby room*). It should be mentioned that the aesthetic property of laminate appreciated by consumers favouring this material is the "wood effect", as is apparent from this representative quotation: "*Because I like the look of wooden floors*".

· Carpet is chosen if: (tactile) warmth is at hand as an important criterion. Carpet is mainly used in stairs & landings, bedrooms and bathrooms.

· Those who find it aesthetic appealing (*aesthetic2*) and who appreciates it being a natural material favour wood. It is used in living rooms and dining rooms mainly. Unlike the other materials, the decisive reasons for choosing wood are apparently exclusively subjective and non-functional.

· Tiles are chosen for kitchens and bathrooms on hygienic grounds, because it is regarded as waterproof and has aesthetic value (*aesthetic3*).

The interviews of sales representatives resulted in twelve binary variables regarding reasons for preferring a particular floorcovering material. The type of room considered for reflooring is represented by seven binary variables.

Initially a PLS-DA with five classes was conducted: carpet, laminate, tiles, vinyl, and wood. A model with three significant components, according to the more stringent Rule 1 used in this study to avoid modelling noise, resulted. However, class no. five, tiles, is poorly accounted for: an $R^2_{VY(cum)}$ of 0.17 and a $Q^2_{V(cum)}$ of 0.09 only. Excluding these observations, i.e., conducting a PLS-DA with the four remaining classes, resulted in a model with three significant components, $R^2_{Y(cum)} = 0.77$ and $Q^2_{(cum)} = 0.60$. The model appears to be rather strong as the $Q^2(cum) > 0.5$, but the small number of observations calls for caution in interpreting the modelling power.

Table 2. VIP values sales representatives: Attributes.

Variable	VIP	Variable	VIP
aesthetic2	1,63	natural	0,91
waterproof	1,45	hardwearing	0,88
warmth	1,28	acoustics	0,56
aesthetic	1,18	good price	0,47
softness	0,95	aesthetic 1	0,39
hygienic	0,94	DIY	0,39

VIP values are displayed in Table 2. Comparing Table 1 and Table 2, important criteria / attributes, i.e., predictors with VIP values ≥ 0.75, are apparently almost identical in the two samples. Hence, end-consumers and sales representatives seem to agree in their assessment of determinant attributes. However, the total number of attributes listed by end-consumers is higher, they include more subjective, non-functional, attributes: "*a change*", "*Wood felling*", *fashion*, and *tradition*.

As was the case for the end-consumers, a PLS-DA with the more important attributes,

i.e., with a VIP value ≥ 0.75, and variables for the type of room, was conducted: Three significant components, $R^2_{Y(cum)} = 0.84$ and $Q^2_{(cum)} = 0.72$.

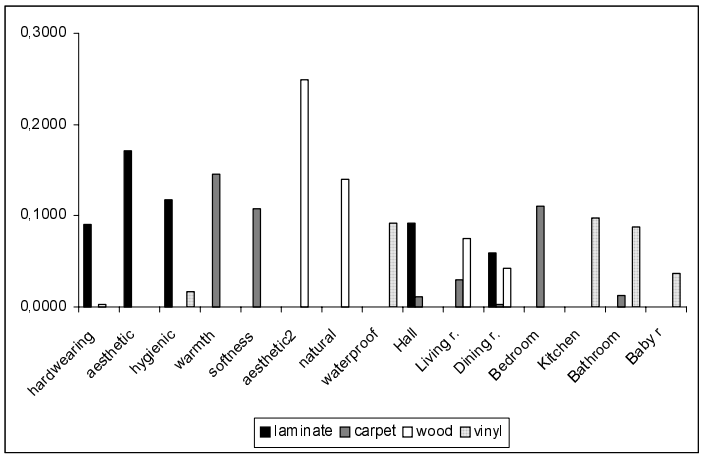

Figure 2. Regression coefficients sales representatives: Attributes and type of room.

Figure 2 displays the PLS regression coefficients for the four responses (classes). The coefficient profile of Figure 2 is quite similar to the one of Figure 1. End-consumers and sales representatives thus show agreement in their appraisal of the different materials (vinyl replaced tiles in the sales representatives case). There are some small divergences though, e.g., sales representatives do not consider laminate a popular floorcovering in bedrooms.

CONCLUSIONS

The results suggest that by using PLS-DA it is possible to simplify complexity, by extracting the most important causal conditions for each outcome (preferred material), the models used were quite strong. The conducted PLS-DA depicts as decisive the same attributes/ criteria emerging with salience in the interviews. PLS-DA makes it possible to detect both between and within sample differences as to the choice of application material from the answers to open-ended questions, thus allowing parsimony in the analysis, as there is no need for a follow-up study with pre-structured response alternatives to quantify variables (e.g., using Likert scales).

The fact that end-consumers and sales representatives on the whole show agreement in their assessment of determinant attributes and appraisal of the different materials could be taken to imply that it would suffice to interview sales representatives only. However, end-consumers list more subjective, non-functional criteria, and further, obtaining in-depth understanding of underlying motives / perspectives necessitates interviews of end-consumers. To grasp this contextual influence calls for an analysis including variables capturing the life situation of the households (see the section *Methodological implications*).

The results of this study imply that, unlike the other materials, the decisive reasons for choosing wood are exclusively subjective and non-functional. One of the apparently decisive reasons for choosing wood is its natural material property, natural. Broman (1996), in studying

people's visual impressions and attitudes toward Scots pine wood surfaces, likewise noted the importance of this attribute. This quality of wood, being part of its intrinsic nature / character, could provide an edge on laminate and should be stressed in marketing efforts.

REFERENCES

AHLMARK, D. 1977. Substitute and competition – a study of product differentiation based on material properties (Swedish). Research report 6069. Ekonomiska forskningsinstitutet vid Handelshögskolan i Stockholm, EFI, Stockholm.

AJZEN, I. AND FISHBEIN, M. 1980. Understanding Attitudes and Predicting Social Behavior. Prentice-Hall, Englewood Cliffs, NJ. 278pp.

ANON. 1992. Saw Milling at the Turn of the Century (Swedish). R 1992:40. Närings och Utvecklingsverket, Stockholm. 188 pp.

ANON. 1998. Wood as a building material. A qualitative study-Denmark. Jobno.: 980901. Research International Norway, Oslo.

BROMAN, N. O. 1996. Two methods for measuring people's preferences for Scots pine wood surfaces: A comparative multivariate analysis. Mokuzai Gakkaishi 42(2): 130-139.

EASTIN I. L, SHOOK, S. R. AND SIMON, D. R. 1999. Softwood lumber substitution in the U.S. residential construction industry in 1994. Forest products Journal 49(5): 21-27.

EISENHARDT, K. 1989. Building theories for case study research. Academy of Management Review 14: 532-550.

ERIKSSON, L., JOHANSSON, E., KETTANEH-WOLD, N. AND WOLD, S. 1999. Introduction to Multi- and Megavariate Data Analysis using Projection Methods (PCA & PLS). Umetrics AB, Umeå. 490 pp.

GLASER, B. G. AND STRAUSS, A. L. 1967. The Discovery of Grounded Theory. Aldine De Gruyter, New York. 271 pp.

HOWARD, J. A. 1989. Consumer Behavior in Marketing Strategy. Prentice-Hall, Englewood Cliffs, NJ. 375 pp.

RAGIN, C. 1987. The Comparative Method: Moving Beyond Qualitative and Quantitative Strategies. University of California Press, Berkeley, Ca. 185 pp.

THOMPSON, C. J., LOCANDER, W. B. AND POLLIO, H. R. 1989. Putting consumer experience back into consumer research: The philosophy and method of existential-phenomenology. Journal of Consumer Research 16(2): 133-146.

WOLD, S., ESBENSEN, K. AND GELADI, P. 1987. Principal component analysis - A tutorial. Chemometrics and Intelligent Laboratory Systems 2: 37-52.

YIN K. (1984) Case Study Research. Sage, Beverly Hills, Ca. 160 pp.