IDENTIFYING PRODUCT ATTRIBUTES FOR QUALITY FUNCTION DEPLOYMENT: CONSUMER PERCEPTIONS IN THE CASE OF WOODEN MULTI-STOREY HOUSES

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Abstract:
In order to bridge the gap between external consumer value and internal production quality, an understanding of consumers' needs is vital. Consumers' needs have to be translated through a firms' internal value chain to improve production quality. The Means-End Chain approach elicits consumers' needs in terms of product attributes, which further can be translated into engineering characteristics by using the House of Quality concept as the first step in Quality Function Deployment. Here, the relative importance of the attributes plays an important role for further processing. This paper' aims at identifying product attributes and their relative importance, as an input into the House of Quality within Quality Function Deployment. This is done in the case of wooden multi-storey houses in Sweden, since there is a documented gap between the external consumer value and the internal production quality. Based on the Means-End Chain approach, the Extended Association Pattern Technique was used for a two stage study to elicit product attributes. Results from 34 interviews and 503 returned questionnaires revealed ten product attributes ranked by importance, to be further translated into engineering characteristics within Quality Function Deployment.

Key words: Means-End Chain; Extended Association Pattern Technique; Quality Function Deployment; House of Quality; wooden multi-storey houses.

INTRODUCTION

During the last 30 years, working on quality issues has moved focus from internal production processes to a more consumer oriented external focus. Now, internal quality improvements need to be achieved based on the creation of value for the consumer (Ljungberg and Larsson 2007). This is in line with current approaches in product development, where consumer needs have to be communicated within the firm so that product planning and design, engineering and manufacturing are performed accordingly (Chen and Ko 2010). This means that improving a firm's internal processes necessitates an identification and understanding of its consumers (Ljungberg and Larsson 2007), and requires that the gap between internal quality and external consumer value is getting closed, which is a complex translation process (Gustafsson 1996).

Closing that gap means translating quality aspects through the value chain and is traditionally being studied from two different scientific starting points. The external part from market researchers (Kotler *et al.* 2010) and the internal part by means of manufacturing and engineering-based methods (Harrington 1991). Fig. 1 suggests different process steps to close the gap between external customer values and internal production requirements, called the Extended Means-End Chain.
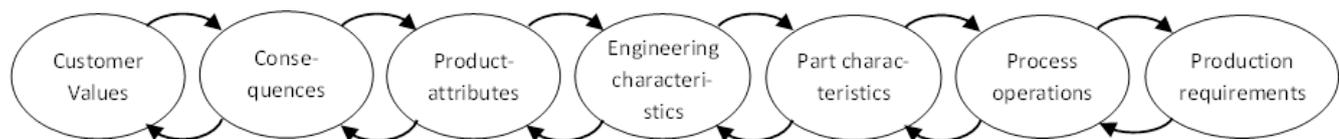

Fig. 1
The Extended Means-End Chain to close the gap between internal quality and external consumer values, based on Gustafsson (1996).

The Swedish forest and wood industry represents an industry where the gap between external consumer values and internal production requirements exists, and is documented, e.g. in the case of the wooden housing industry. The production and product planning and development in that industry is on a low level, compared to other industries (Eliasson 2011). Current methods and materials used in that industry are often not sufficiently effective, e.g. when it comes to prefabrication, and the industry has yet to seize the benefits of moving its production into factories. Eliasson (2011) argues that a mutual quality perception within the value chain, including the consumer, is important to ensure and improve the quality of the houses being produced. Concerning quality aspects of wood, the natural characteristics of the material are very complex to describe. Therefore, the translation of the often visual perception of the material by the consumer, to a written and eventually measurable form, becomes difficult. To analyse where and why quality deviances occur in the value chain becomes complex (Johansson 2011).

Stendahl (2009) concludes that the product development process in the wood industry is described as relatively un-structured and performed in a more trial-and-error fashion than is recommended by literature. He shows that resource constraints, involvement in daily operative work, and the ensuing difficulty in prioritising development work are the most important barriers to product development in that industry. A challenge for managers is to make it possible for the staff to work with more long term development instead of only focussing on the short term operative work.

For long term product planning, quality improvement efforts should focus on closing the gap between internal production quality and external consumer value (Setijono 2008). This seems to be even more critical in the case of wooden multi-storey houses in Sweden, since their market share increased from about 1% in 2000 to 10% in 2005, further to about 15% in 2010 (Schauerte 2010), and is expected to continuously take market share from competing materials up to around 30% in 2020 (Widman 2012). Whilst more and more construction companies discover the advantages of prefabricated wooden houses, e.g. when it comes to time, efficiency and costs, several technical challenges still have to be mastered to successfully counteract disadvantages of the building material wood (Widman 2012).

Such improvements of technical details are important, but nonetheless not sufficient. They probably imply a better engineering-based internal production quality, but are most often not based upon the creation of benefit and value for the consumer. This means that the external, consumer oriented work on quality is missing (Schauerte 2009a). According to Kotler *et al.* (2009), focussing mainly on continuous product improvements easily can lead to marketing myopia, i.e. focussing on the product itself with a technology fixation that is based upon the belief that technical supremacy leads to business success (Olsen *et al.* 2011). In other words: building bigger, higher and faster is no guaranty for matching the values from consumers and their demands on housing quality. Understanding consumers' values plays a crucial role in the early stages in the product development process (Sorensen and Henchion 2011). Thus, in order to close the gap between internal production quality and external consumer value, as described above, the external part needs to be worked on in the case of wooden multi-storey houses in Sweden.

Connecting Means-End Chain theory and Quality Function Deployment

Consumer value can be defined as the consumer's assessment of the product's overall capacity to satisfy existing needs (Kotler *et al.* 2010). This means that consumers evaluate why a certain product would be relevant to choose (Olson and Reynolds 2001), which is a perception of the benefits that potential products deliver (Olsen *et al.* 2011). According to the Means-End Chain (MEC) theory on consumer behaviour, the cognitive process of perceiving a product includes product attributes, their consequences and consumers' values. These are called the elements of a MEC. An attribute is not important by itself but gets important by causing desired consequences that are perceived by the consumer to help to achieve a personal value (Walker and Olsson 1991). Accordingly, the consumer is assumed not to buy products for the products sake but for the desired consequences the product delivers through usage (Costa *et al.* 2004). This means that product attributes and their consequences have to be matched with consumer values (Vriens and Ter Hofstede 2000, Schauerte 2010). As an example of a MEC, a sports-shoe has "air support" (attribute), which can consequence in "feeling relaxed after running", which in turn can be related to the personal value "self-esteem" (Herman and Huber 2000).

Every completely linked chain between product attributes, consequences and values constitutes a MEC. MECs are hierarchical in nature and describe the consumers' knowledge about the product in question (Gengler and Reynolds 1995). Values are end states of MECs and to be seen as abstract goals that motivate action. They are translations of individual needs and desires, whilst product attributes and their consequences are the means to attend or fulfil these (Lagerkvist *et al.* 2012). Since values give meaning to consequences and attributes, they motivate consumers' decision making (Phillips and Reynolds 2009).

As products have several attributes, and each attribute has several consequences, their perceived relevance of contributing to the fulfilment of personal values most likely differs in importance (Schauerte 2009a). In order for values to be reached or get fulfilled, consumers try to maximize positive and minimize negative consequences, thereby learning the attributes being vital (Gutman 1997). Therefore, the exact mix of product attributes and their consequences, with which consumers perceive to fulfil their values with, should be identified (MacMillan and McGrath 2000).

These product attributes can further on serve as the input to be translated into the next step in the Extended Means-End Chain, i.e. engineering characteristics, as presented in Fig. 1. Translating product attributes into engineering characteristics, and further down the chain, can be performed by using the Quality Function Deployment (QFD) approach (a.o. Bergman and Klevsjö 2010, Johnson 2005, Setijono 2008). Even though general linguistic usage of terms within QFD refers to "customer requirements" (a.o. Li and Wang 2010, Chauda *et al.* 2011), these requirements could be expressed in terms of products attributes, according to the description of the MEC approach above. Thus, it could be stated that QFD comprises different translation steps from product attributes to production requirements. QFD sets targets for product characteristics in order to match consumers' requirements (Poel 2007).

The first translation within QFD, from product attributes to engineering characteristics, can be performed by applying the House of Quality (HoQ) concept, which can be regarded as the most crucial step deserving most attention (Chen 2009), as it links the consumer to the product development team (Li and Wang 2010). HoQ normally inherits a stage, where consumers judge the relative importance of each attribute for the purpose of further processing in the HoQ (Franceschini 2002). This, however, could be simplified by using the advocated MEC approach, since, according to among others Pieters *et al.* (1995) and de Ferran and Grunert (2007), the resulting MECs already are relative in their importance.

OBJECTIVES

Contributing to bridging the gap between external consumer value and internal production quality, this paper aims at identifying product attributes and their relative importance in the case of wooden multi-storey houses for consumers in Sweden, as an input into the House of Quality within Quality Function Deployment.

METHOD AND RESULTS

Many studies on MECs use the laddering technique, i.e. personal, qualitative interviews that due to complexity need to be carried out by skilled interviewers. Because of that, it is difficult to apply laddering for large-scale market studies, since time and monetary constraints constitute bottlenecks. As a result, Ter Hofstede *et al.* (1998) introduced a quantitative approach to gather MEC data, called the Association Pattern Technique.

This method implies two steps. At first, an explanatory step, where attributes, consequences and values are elicited by using laddering interviews. Here, about 30 laddering interviews are regarded as sufficient in order to elicit reliable elements of MECs. However, the perceived linkages between those elements, and thus the relative importance of specific elements, might not be sufficiently reliable, since personal interviews may violate the concepts of external validity in terms of generalisation. Hence, the MEC elements serve as the input into the association pattern matrices used in step 2, the descriptive part (Vriens and Ter Hofstede 2000). In that second step, an attribute-consequence matrix and a consequence-value

matrix were combined in a survey. In those matrices, respondents were asked to mark perceived linkages between attributes and consequences in matrix 1, and between consequences and consumers personal values in matrix 2. The perceived linkages between those elements were then used to establish MECs.

The authors could validate their method; yet, they disregarded potentially perceived linkages, and thus relationships, between consequences and consequences, even though several other MEC-studies could identify such consequence-consequence linkages (a.o. Leppard *et al.* 2004, Skytte and Bove 2004, Henneberg *et al.* 2009). As consequences are determining the connection between the product and the consumer, this negligence potentially might lead to results that leave crucial parts of consumer's product knowledge aside. Therefore, an additional consequence-consequence matrix was suggested and validated by Schauerte (2009b), called the Extended Association Pattern Technique.

Respondents in MEC studies have to fulfil one requirement: they have to use a product within the product category being investigated. That usage context plays an important role, since it helps respondents to more easily recall personally relevant information of and knowledge about the product to be investigated (Schauerte 2009b). This means for the present study that respondents had to live in multi-storey houses at the time; yet, not necessarily houses build of wood.

Stage 1: personal laddering interviews
In this explanatory stage, 34 laddering interviews were made. Despite of the requirement of usage context stated above, and for representative geographical reasons, respondents were selected randomly. The interviews were performed and analysed acting on Reynolds and Gutmans' (1988) advices. Fig. 2 shows the resulting ten product attributes, ten consequences and six values from the resulting MECs, ordered without any specific relative position.

Attributes	Consequences	Values
1. Modern & esthethic	1. Healthy living	1. Good health
2. Typical Swedish housing	2. Worth the money	2. Feeling comfortable
3. Positive for the environment	3. Active environmentalism	3. High quality of life
4. High construction and material risk	4. Good image & reputation	4. Self-realization
5. Warm interior atmosphere	5. Pleasant & comfortable housing	5. Need of security
6. Natural material	6. Financial disadvantages	6. Concern about the environment
7. Healthy interior	7. Individual housing	
8. More expensive to run	8. Limited freedom of action	
9. Higher construction costs	9. Financial advantages	
10. Lower construction costs	10. Insecure housing	

Fig. 2
Result of the laddering study of Swedish respondents for wooden multi-storey houses.

The displayed attributes could already be used as an input into the Quality Function Deployment, however, due to reasons of external validity, as mentioned above, the relative importance of the attributes should be found by applying the survey study.

Stage 2: matrix-survey study
In this descriptive stage, respondents were selected randomly, except of the requirement of usage context and for geographical reasons. 3900 surveys were handed out in Sweden of which 503 were returned. This gives a response rate of 13.2%. All responses were entered into SPSS 16.0 for Windows and the data analysis was accomplished according to the advices made by various authors (a.o. Pieters *et al.* 1995, Reynolds and Gutman 2001). A Hierarchical Value Map (HVM) was generated to present the results. In a HVM, the perceived linkages are shown in a tree diagram of structural, hierarchical nature, from consumer values on the top, to consequences and attributes on lower hierarchical levels (Reynolds and Gutman 2001). Every chain with linkages from attributes to values within a HVM represents a perceptual orientation, i.e. a Means-End Chain. As a HVM contains several perceptual orientations, these most likely differ in their magnitude. The order of dominance can be identified by looking for the strongest relations between elements on different levels of abstraction (de Ferran and Grunert 2007).

Since the complete HVM for the present study is rather complex and would require too much scope and explanation than is appropriate to be presented in this paper, the top three MECs within that HVM are shown below. To show the complexity of HVMs, Fig. 3 furthermore reveals how those top three MECs are interrelated with each other. For a more detailed methodological description of all mentioned stages of data collection and analysis read Schauerte (2009b).

Going back to the origin of MEC theory reveals that the conceptualisation of consumers' perceptions of objects should be approached from a motivational view. Higher level elements, like values, give meaning to lower level elements, like consequences and attributes, and therefore stimulate consumers' decision making on different levels of abstraction (Phillips and Reynolds 2009). Thus, the most dominant MECs should be identified by first determining the strongest relationships between consequences and values, followed by the strongest incoming linkage to the respective consequence from another consequence or from an attribute. The resulting MEC is then to be read beginning at the attribute level moving upwards the hierarchy.

The three most important MECs in the present study are depicted in Fig. 3 and should be read as follows. To start with, Swedish respondents regard 'higher construction costs' as causing 'financial disadvantages' (51%), which in turn leads to 'insecure housing'. The latter consequence is an undesired consequence, whilst 'secure housing' is associated with 'need of security' by 74% instead. Second, 57% perceive 'healthy interior' resulting in 'healthy living', which 65% in turn perceive as fulfilling their personal value 'good health'. Third, 'warm interior atmosphere' is by 53% seen as leading to 'pleasant & comfortable housing', which is further linked to 'feeling comfortable' (54%).
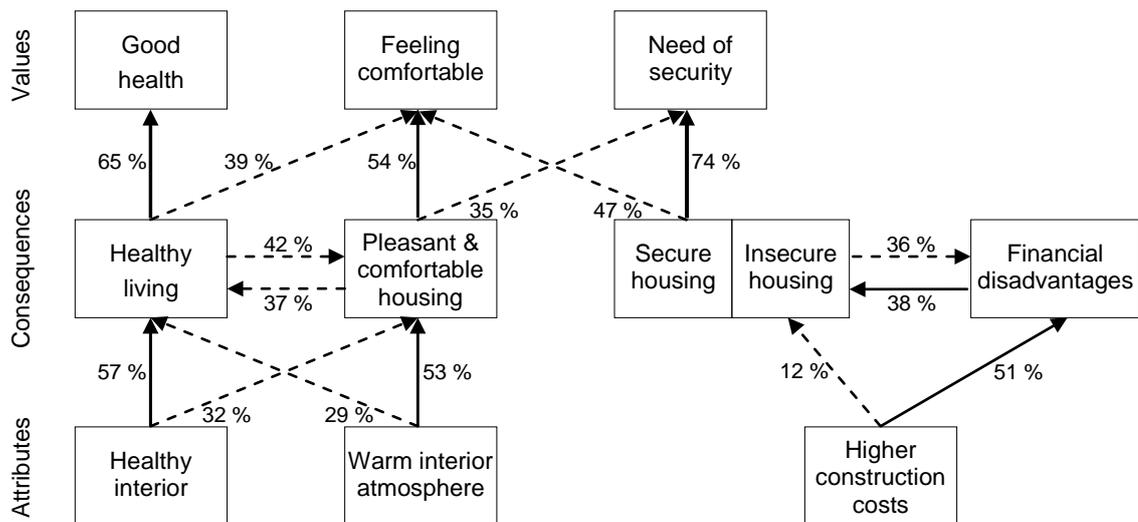

Fig. 3
Hierarchical Value Map: Top 3 Means-End Chains of Swedish respondents for wooden multi-storey houses and interrelations between those chains.

As mentioned before, higher level values and consequences give meaning to attributes and determine their importance. In addition to the three most important attributes in Fig. 3, seven other attributes were found. All ten identified attributes are ordered by importance in Fig. 4. At this stage, a methodological problem might occur. The listed attributes in Fig. 4 are ranked by importance, yet, their relative degree of difference remains unknown. The relative distance between number 1 and 2 might be larger as the relative distance between number 4 and 5. In the present data, the attributes are ranked on an ordinal scale, which means that their order can be expressed by numbers in a meaningful way; yet, they should not be used for arithmetic operations like division or multiplication, as sometimes performed in the HoQ (van de Poel 2007). Therefore, the ranking in Fig. 4 has to be regarded with respect to that, in order to avoid unreliable results from the HoQ concept.

Product attributes:

1. Higher construction costs	6. Lower construction costs
2. Healthy interior	7. High construction and material risk
3. Warm interior atmosphere	8. Positive for the environment
4. Natural material	9. Modern & esthetic
5. More expensive to run	10. Typical Swedish housing

Fig. 4
Product attributes ordered by importance for Swedish respondents for wooden multi-storey houses.

CONCLUSIONS

The purpose of this paper was to identify product attributes and their relative importance in the case of wooden multi-storey houses for consumers in Sweden, as an input into Quality Function Deployment. This, in order to bridge the gap between external consumer value and internal production requirements.

In a study with 34 personal interviews and 503 answered surveys, 10 product attributes of wooden multi-storey houses could be detected being relevant for Swedes, see Fig. 4. Even the relative importance of the attributes could be shown, however, when further processing them in the House of Quality concept, their ordinal scaling and the determining limitations of arithmetic operations have to be taken into consideration.

REFERENCES

Chauda A, Jain R, Singh AR (2011) Integration of Kano's Model into quality function deployment (QFD). International Journal of Advanced Manufacturing Technology 53:689-698

Chen CC (2009) Integration of quality function deployment and process management in the semiconductor industry. International Journal of Production Research 47(6):1469-1484

Chen LH, Ko WC (2010) Fuzzy linear programming models for NPD using a four-phase QFD activity process based on the means-end chain concept. European Journal of Operational Research 201:619-632

Costa AIA, Dekker M, Jongen WMF (2004) An overview of means-end theory: potential application in consumer oriented food product design. Trends in Food Science & Technology 15:403-415

De Ferran F, Grunert KG (2007) French fair trade coffee buyers' purchasing motives: An explanatory studt using means-end chain analysis. Food Quality and Preference 18:218-229

Eliasson L (2011) Ställ krav på virket – rätt virke för produktionen I framtidens trähusfabrik. Licentiate thesis ISBN 978-91-86491-89-5. Department of Forest and Wood Technology, Institution of Technology, Linnaeus University

Widman P (2012) Ny har byggarna fått träsmak. Fastighetstidningen, online at: http://www.fastighetstidningen.se/trahus/

Franceschini F (2002) Advanced Quality Function Deployment. St. Lucie Press, Boca Raton, Florida

Gengler CE, Reynolds TJ (1995) Consumer understanding and advertising strategy: analysis and strategic translation of laddering data. Journal of Advertising Research July/August:19-32

Gustafsson A (1996) Customer Focused Product Development by Conjoint Analysis and QFD. PhD thesis no. 418, Division of Quality Technology, Department of Mechanical engineering, Linköping University

Harrington JH (1991) Business process improvement. McGraw-Hill, New York

Herrmann A, Huber F (2000) Value-oriented brand positioning. International Review of Retail, Distribution and Consumer Research 10(1):95-112

Johansson J (2011) Aspects on automatic grading of wood for improved material utilization in the Swedish hardwood Sawmill Industry. Proc of the International Scientific Conference on Hardwood Processing, Virginia Tech, Blacksburg, VA (USA)

Kotler P, Keller KL, Brady M, Goodman M, Hansen T (2009) Marketing Management. Pearson Education Limited, Harlow

Kotler P, Armstrong G, Wong V, Saunders J, Burk Wood M (2010) Principles of Marketing, 5th European Edition. Prentice Hall, Harlow

Lagerkvist CJ, Ngigi M, Okello JJ, Karenja N (2012) Means-End Chain approach to understanding farmers' motivations for pesticide use in leafy vegetables: The case of kale in peri-urban Nairobi, Kenya. Crop Protection 39:72-80

Li JR, Wang QH (2010) A rough set based mining approach for house of quality analysis. International Journal of Production Research 48(7):2095-2107

Ljungberg A, Larsson E (2007) Processbaserad verksamhetsutveckling. Studentlitteratur, Lund

Olsen JC, Reynolds TJ (2001) The Means-End Approach to Understanding Consumer Decision Making. 77-90 in Reynolds T J, Olson J C (eds.) Understanding consumer decision making: the means-end approach to marketing and advertising strategy. Erlbaum, Mahwah, NJ

Olsen NV, Menichelli E, Grunert KG, Sonne AM, Szabó E, Bánáti D, Naes T (2011) Choice probability for apple juice based on novel processing techniques: Investigating the choice relevance of menas-end-chains. Foot Quality and Preference 22:48-59

Phillips JP, Reynolds TJ (2009) A hard look at hard laddering – A comparison of studies examining the hierarchical structure of means-end theory. Qualitative Market Research: An International Journal 12(1):83-99

Pieters R, Baumgartner H, Allen D (1995) Ameans-end chain approach to consumer goal structures. International Journal of Research in Marketing 12:227-244

Schauerte T (2009a) Desired and Perceived Customer Value – are the Limnologen end-users satisfied? 61-66 in: Serrano E (2009) (ed.) Documentation of the Limnologen Project – Overview and Summaries of Sub Projects Results. Report no. 56, ISBN: 978-91-7636-672-1

Schauerte T (2009b) Investigating Consumer Perceptions by applying the Extended Association Pattern Technique – A Study on Wooden Multistory Houses. PhD thesis no.194/2009, Department of Forest and Wood Technology, Institution of Technology, Växjö University

Schauerte T (2010) Consumer Perceptions on Wooden Multistory Houses: Segmenting International Markets. Proc of the 2010 Society of Wood Science and Technology SWST/UNECE-TC Annual Convention, Geneva, (Switzerland)

Setijono D (2008) The Development of Quality Management toward Customer Value Creation. PhD thesis no. 135/2008, Department of Forest and Wood Technology, Institution of Technology, Växjö University

Sorensen D, Henchion M (2011) Understanding consumers' cognitive structures with regard to high pressure processing: A means-end chain application to the chilled ready meals category. Food Quality and Preference 22:271-280

Stendahl M (2009) Product Development in the Wood Industry – Breaking Gresham's Law. PhD thesis no. 2009:3, Department of Forest Products, Faculty of Forestry, Swedish University of Agricultural Sciences

Vriens M, Ter Hofstede (2000) Linking Attributes, Benefits and Consumer Values. Market Research Fall:5-10

Walker BA, Olsson (1991) Means-End chains: connecting people with self. Journal of Business Research 22:111-119