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Defining perceived quality in the automotive industry: an engineering approach.

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Abstract

Perceived quality is one of the most important factors underlying success of car manufacturers today. There is a significant amount of literature regarding perceived quality from a marketing research perspective, applied psychology and consumer research. From an engineering viewpoint, perceived quality is represented in the literature mainly by the work that assesses different aspects of perceived quality in order to evaluate them in the early design stages. As a result of this no theoretical framework has yet been compiled that combines customer view on perceived quality and the engineering prospects of this broad term. Consequently, terms regarding perceived quality components and elements often have multiple meanings or meanings similar to each other. There is a need to standardize the terminology and definitions related to perceived quality more concretely. This paper presents the basis of a theoretical framework in an attempt to build a model, including different aspects of perceived quality regarding automotive industry needs. Based on the literature review and industry examples, the authors propose a common terminology and perceived quality definition in the field of the automotive industry.

1. Introduction

Car manufacturers in the modern global economic system need to develop products that meet their customer expectations. In the premium segment of the automotive industry such a challenge takes on a new scale. In this highly competitive area, delivering "zero defects" quality simply is not enough [1], [2], [3]. The greatest advantage can be reached by understanding the customer's perception of the quality. In other words, understanding the dimensions of perceived quality. Numerous authors in different areas of research have focused on the customer's perception. Identification of the influences on the customer during product evaluation is one of the important parts of the research. Measuring and assessing the importance of the product attributes that have an impact on the customer choice is the other. The influences arise from the product features (aesthetic, functional, emotional) that signal quality to the customer [2]. Furthermore, evaluation of the product

attributes remains highly subjective [4]. Since the nature of the research mentioned above is mainly theoretical two major problems have arisen: a) deficiency of a common terminology that explains and defines all aspects of perceived quality; b) implementation of these methods and tools is rather difficult. The difficulties are mainly based on the subjective evaluation of the product properties. Often designers and engineers involved in the evaluation process of the product attributes must rely on previous experience and intuition. Despite this, the decisions they make are crucial to the product success on the market [5]. There is a need to support them with a method regarding objective assessment and quantification of the subjective product attributes regarding different aspects of perceived quality. One of the important steps towards this goal will be the definition of perceived quality elements in the automotive industry. In this paper the authors propose their view on perceived quality as a set of *Value Based Perceived Quality* (VPQ) and *Technical Perceived Quality* (TPQ) attributes. The VPQ embodies the total customer experience

of the product attributes and external factors (e.g. brand heritage) through the senses and cognition. The TPQ represents the engineering approach, based on the level of individual technical aspects of the product, perceived with the purpose to fulfill customer requirements and competitiveness. TPQ is a subset of VPQ.

This paper is disposed as follows: section 2 is a literature review regarding existing definitions of perceived quality and section 3 presents the case of two automotive companies regarding discrepancies in the definition of perceived quality. Consequently, section 4 describes a framework that the authors propose regarding perceived quality in the automotive industry. Section 5 discusses the need of the proposed framework. Section 6 concludes and summarizes the most important findings.

2. Perceived quality in the Literature

This part presents a preliminary analysis of existing literature regarding perceived quality in two different dimensions: product quality and consumer perception.

2.1 What is quality?

It is recognized by many authors that product quality has a multidimensional structure. In 1984, Garvin introduced five approaches of quality definition: transcendent, product based, user based, manufacturing based and value based [6]. The transcendent approach has a philosophic nature and proposes: "quality cannot be defined precisely". The product-based approach sees quality as a measurable variable. The user-based approach represents an idiosyncratic and highly subjective view of quality. The manufacturing-based approach represents mainly engineering practices, where quality is identified as "fulfillment of the requirements". The value-based approach defines quality regarding cost and price. As a framework of product quality elements Garvin proposed eight basic dimensions, as follows:

- Performance (primary product characteristics)
- Features ("bells and whistles" / secondary attributes that improve product performance and quality)
- Reliability (frequency of failure)
- Conformance (match with specifications)
- Durability (product life)
- Serviceability (speed of repair)
- Aesthetics ("fits and finishes")
- Perceived quality (reputation and intangibles)

Garvin identifies aesthetics and perceived quality as the most subjective dimensions of quality [6]. According to Garvin, advertising has a similar impact on the customer impression as the aesthetics and perceived quality [7]. Mitra and Golder use the term "objective quality" defining it as 'performance combined with all product attributes'. Objective quality could be measured by mixed methods and expert ratings and exclude subjective attributes like aesthetics and external factors like brand image [8]. Regarding perceived quality, Mitra and Golder interpret this term as the "perception of the customer", deriving from Zeithaml's definition of perceived quality. Zeithaml (1988) describes perceived quality as the subjective consumer judgment regarding overall product superiority, different from objective quality [9]. Lieb et al.

presented a rich retrospective review regarding the evolution of the perceived quality definition and influences on purchase behavior. Therefore, Lieb et al. proposed to see perceived quality as "a scalable input factor for company's product development"[10]. Such an opinion is antagonistic to the common view that perceived quality is not comparable to objective quality or cannot be measured [9]. A marketing oriented view of perceived quality is supported by a number of researchers. Aaker [11] proposes a definition of perceived quality as "the customers perception of the overall quality or superiority of a product or service with respect to its intended purpose, relative to alternatives. Perceived quality is, first, a perception by customers. It thus differs from several related concepts, such as:

- Actual or objective quality: the extent to which the product or service delivers superior service
- Product-based quality: the nature and quantity of ingredients, features, or services included
- Manufacturing quality: conformance to specification, the "zero defect" goal".

Castleberry and McIntyre [12] discuss aspects of perceived quality as: "…a belief about the degree of excellence of a good or service that is derived by examining consciously and/or unconsciously, relevant cues that are appropriate and available, and made within the context of prior experience, relative alternatives, evaluative criteria and/or expectations".
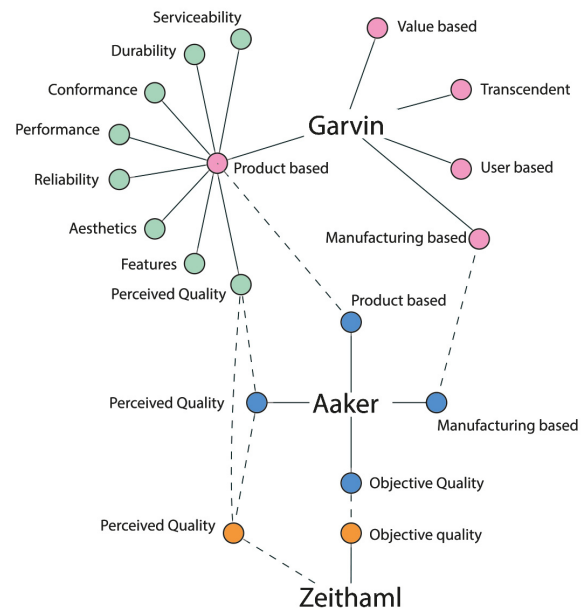

Fig. 1. Schematic illustration of the quality dimensions, approaches and the links within, derived from the Literature.

Through analyzing these views of perceived quality two major classes can be drawn: marketing oriented approach and engineering approach. Marketing point of view focuses on the user-oriented approach, engineers look for lack-of defects quality. According to Garvin [6] these two views are in potential conflict regarding the communication issues.

2.2 Perceived quality aspects and the automotive industry

In the automotive industry, research regarding perceived quality is established mainly by investigation of brand image and heritage, aesthetic quality and different technical aspects related to material quality, sound quality, etc. Homer [13] describes the relationship between brand image and quality, bringing attention to the cases with conflict between product quality and its perceived "image". The strategy portrayed by Aaker and Joachimsthaler [14], regarding brand architecture, presents the sub-brands as the co-drivers that increase the perceived quality of the brand. Stylidis et al. [15] highlighted this approach and the specific use of the sub-brands, in the case study of Volvo Car Group and Volvo Trucks. Law and Evans [16] summarized the importance of understanding what 'luxury' and 'premium' mean to the high-end automotive consumer. Understanding which factors establish a premium automotive brand in comparison to a luxury brand is very important, since these terms are widely used in the communication strategy of automotive companies. An extensive methodology regarding consumers' perception of heritage brands restricted to the automotive industry is presented by Wiedman et al.[17].

A number of major studies have been conducted exploring the area of aesthetics in the automotive industry. Ranscombe et al. [5] examined the influence of different aesthetic features on the consumers' brand perception. Proposed visual decomposition strategy, regarding vehicle images, can improve evaluation of the product appearance.

There has been visible controversy in the literature regarding the definition of the aesthetics as a part of visual evaluation of the vehicle. Maxfield et al. [18] interpret aesthetic quality as follows: "*Aesthetic quality* has no precise definition, since it is a qualitative attribute that is perceived by the customer through visual inspection and comparison. It may be loosely defined as the 'look' of the product." Juster et al. [19] discuss the term "cosmetic" quality and describe it as: "*Cosmetic quality* has no precise definition. It is a customer perceived product attribute. It may be loosely defined as the 'look' of the product". Such an approach complies with the "classic" view on aesthetics as one of the quality dimensions, while acknowledging that some confusion exists in terms of the exact definition. Therefore, a number of authors propose methods for quantification of the specific visual quality aspects. Hazra et al. [20] introduced an inspection method for determining cosmetic quality of automotive skin panels. Penzkofer et al. [21] presented a visual analysis method for non-ideal assemblies; supporting that tolerance values have an impact on aesthetic requirements. Forslund et al. [22], [23], [24] produced a number of noteworthy papers regarding visual sensitivity [25], effects of geometrical variation in perceived quality and optical quality, as one of the product attributes in the automotive industry. Dagman et al. [26], within the empirical study, investigated the relation of the car body split lines and *Visual Quality Appearance* (VQA) to the customers. Gap and flush are other factors that influence perception of the aesthetics by the customer. Stoll and Paetzold [27], Wickman and Söderberg [28] presented results of the gap and flush evaluation regarding visual quality in a virtual environment. Wickman and Söderberg [29] introduced *Quality Appearance Index* as a part of the evaluation of visual quality. Wagersten et al. [30] introduced a framework that

supports evaluation of the perceived quality at the early stages of product development. Assessment of the perceived quality concerning vehicle interior often refers to craftsmanship and material quality. Petiot et al. [3] illustrated users' perception of craftsmanship as a cross-cultural study. Ersal et al. [31] performed an analysis of vehicle interior characteristics and perceived attributes of craftsmanship. Referring to Turley et al.'s [32] definition of craftsmanship stated as "… perception of quality experienced by a customer; it is based on sensory interaction and emotional impact." The effort to develop a comprehensive methodology regarding measuring quality perception of interior materials is presented by Bhise et al. [33].
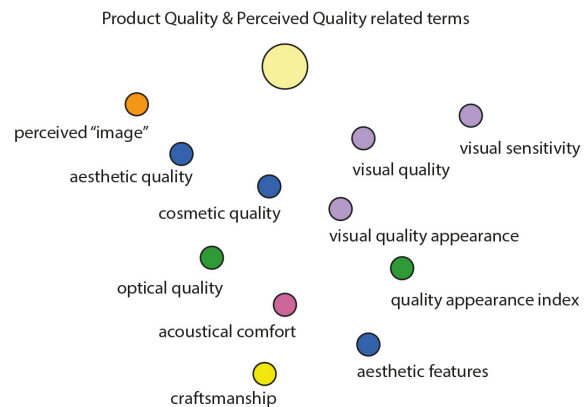

Fig. 2. Schematic illustration of the terms related to product quality and perceived quality in the automotive industry

Noise, vibration and harshness (NVH), along with sound perception is another important dimension of the vehicle quality. Evaluation methods of NVH, as well as sound perception by the customer are widely covered in the literature. Sköld [34] demonstrated analysis of perception and reaction to sounds in vehicles. Jung [35] highlighted factors influencing acoustic comfort in the vehicle. Genell [36] presented an analysis of the sound perception in heavy trucks.

2.3 Review outcome

The literature review shows that, although product quality related aspects have drawn much attention over the past decades, there are certain gaps and overlaps in the definition of perceived quality (see Fig. 1 and Fig. 2).

3. Perceived quality approach in the automotive industry

An example of the discrepancies concerning the perceived quality approach in the industry can be seen in the case of Volvo. In the 2011 Volvo Car Group (VCG) introduced the brand strategy "Designed around you", as part of the new communication plan, placing the human factor at the center of brand development. Since VCG is a premium car manufacturer, communication of the "zero defects" quality could be interpreted as lack of quality. At this point, perceived quality plays a significant role in the overall quality assessment. VCG distributes brand and quality attributes

under three major categories: *Contemporary luxury experience*, *Created around people* and *Strength in every sense*. Communicating quality attributes, VCG determines a "*Contemporary luxury experience*" as a description of attributes regarding interior/exterior design, aesthetic, craftsmanship. Volvo Group Truck Technology (GTT) shares the same company core values as VCG, but they have different approaches to perceived quality communication strategy. On the product level, quality in premium trucks is represented by durability and reliability. Perceived quality in this context is communicated by GTT as "quality impression". Quality impression is the umbrella term that includes such attributes as: robustness, gaps and flush, surface fit and finish, homogeneity among the parts, functionality and comfort impression [15]. It is evident there are significant differences in the positioning and naming of perceived quality attributes even in the case of these two companies that share the same core values.

4. Developing a conceptual terminology framework for perceived quality in the automotive industry

Traditional quality models interpret perceived quality either as a component of product quality [6], or as a subjective customer perception or judgment [9] in both cases different from "objective" quality. Such an argumentation is based on the assumption of the immeasurable nature of perceived quality. Indeed, the customer is the key element for successful product development. In research and industry, there are many methods that help in the translation of the subjective product properties into technical requirements. Among them: Kansei engineering methods [37], the Kano-method [38], the conjoint analysis [39], the combination of the semantic differential method with the maximum-difference scaling (MaxDiff) [40]. However, many of the methods have significant limitations and assessment of the subjective perceived quality attributes is a non-trivial task.

Developing comprehensive terminology is the first step towards objective justification of perceived quality attributes. In order to improve perceived quality in the early stages of product development, it is important to identify major components that would comply with specific tasks of the automotive industry.

Perceived quality in the automotive industry has a dualistic nature. The authors propose a definition as *Value Based Perceived Quality* (VPQ) and *Technical Perceived Quality* (TPQ). The VPQ embodies the total customer experience of the product attributes and external factors (e.g. brand heritage) through the senses and cognition. The TPQ represents the engineering approach, based on the level of individual technical aspects of the product, perceived with the purpose to fulfill customer requirements and competitiveness. TPQ is the subset of VPQ.

It is important to mention that competitiveness is one the critical dimensions of perceived quality. In the premium segment of the automotive industry, the number of players is limited. As a consequence, assessment and evaluation of perceived quality attributes is highly affected by the competitors. It is possible to say that the level of perceived quality in the premium segment is driven, to a great extent, by competition among the players.

The first stage of the framework presents that TPQ can be divided into four major components: *Visual Quality*, *Feel Quality*, *Sound Quality* and *Smell Quality* (see Fig.3). These elements have a complex structure and construct forms, including more specific perceived quality components.
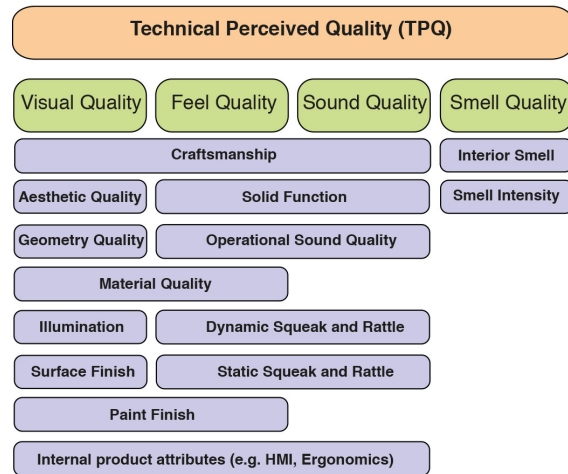

Fig. 3. Illustration of the proposed conceptual terminology framework of the technical perceived quality in the automotive industry

The next stage elements form major clusters of the TPQ. The components such as the *Aesthetic Quality* and *Geometry Quality* convey the *Visual Quality*, together with *Illumination* and *Surface Finish*. *Craftsmanship* and *Ergonomics* have an impact on *Visual Quality* along with *Feel Quality* and *Sound Quality*. The *Material Quality* is distributed over *Visual Quality* and *Feel Quality*, as well as *Paint Finish*. The *Solid Function*, *Operational Sound Quality*, *Static* and *Dynamic Squeak and Rattle* comprise elements such as *Feel Quality* and *Sound Quality*. VPQ, in addition to the existing components, operates with components such as *Customer Behavior*, *Branding* and *Core Values* (The final proposed framework is presented in Fig.4). The last stage of the framework is the sub-attributes of the second stage elements. It is necessary to mention that the importance of these ground level attributes can change over time. An example illustrating such a change could be passive safety. It is a highly important attribute, however, in order to communicate premium perceived quality it is necessary to make the shift towards an active safety system.

As an additional illustration, the *Visual Quality* is a complex component of the TPQ, therefore, there is a possibility to assess *Visual Quality* by performing an evaluation of its parts. *Craftsmanship* has a multidimensional nature and presents difficulties in evaluation. However, there is a possibility to convert qualitative measures into the quantitative score and assess craftsmanship objectively [41]. *Aesthetic Quality* as well as *Geometry Quality* (split lines)

assessment methods and techniques are widely presented in the literature. There are also methods for squeak and rattle evaluation, such as E-LINE™ method [42].
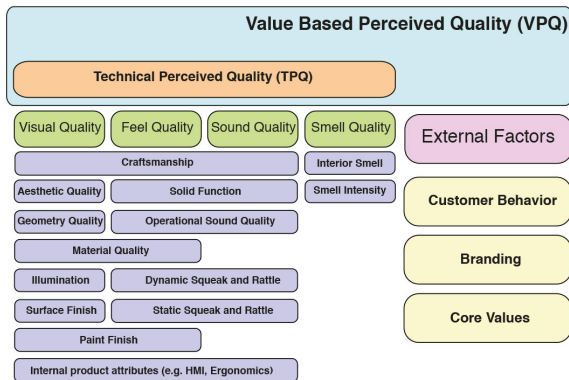

Fig. 4. Illustration of the proposed conceptual terminology framework of the value based perceived quality in the automotive industry

To be able to successfully develop and implement evaluation methods regarding every component of the TPQ, there is a need to define product ingredients on the engineering level, since every single TPQ component has a number of sub-attributes. It is the question for future research to determine all components from the ground level and find methods for objective evaluation. The terminology framework presented by the authors is the first step in the taxonomy of perceived quality.

5. Discussion

In the automotive industry implementing the strategy of applying a user-based approach to quality, through market research and identification of product requirements that represent quality, is hardly manageable in the stage of translation of these requirements into the product attributes. Primarily, because of the subjective origin of some product attributes and lack of information regarding importance of such attributes to the customer, it is difficult to perform an assessment in the early stage of product development.

For highly complex processes, like vehicle manufacturing, the correct definition of perceived quality attributes is essential. Dissemination of the perceived quality attributes to manageable areas is important in regards to objective evaluation and quantification of the subjectively assessed areas.

Although perceived quality is a relatively common term in many scientific publications, rather limited research has been conducted regarding an engineering approach. As the literature review shows, the definition of perceived quality in the automotive industry is dispersed, convergent and at some point even mutually exclusive. The precise and universal definition of the perceived quality elements is a step towards developing methods and tools for objective justification of the perceived quality attributes. There remains an open question as to which perceived quality attributes engineers have to focus on in order to achieve the highest level of customer appreciation. Close collaboration between researchers and the industry is essential to achieve such an ambition.

6. Conclusions and future work

The study shows that the definition of perceived quality and product quality does not yet encompass all elements, especially when it comes to the area of the automotive industry. There are certain confluences and disengagements in the definition and terminology use. This paper presents a comprehensive framework of terminology regarding perceived quality in the automotive industry. Authors have focused on the broad definition of perceived quality components in relation to the automotive industry. Therefore, the introduced framework is only an early stage for future research. The importance of the various aspects related to perceived quality will become evident over time. This is occurring mainly as a result of the extremely competitive premium automotive sector and the drawbacks resulting from the technocratic way of regarding communication of the quality. The automotive manufacturers have to develop and implement perceived quality evaluation methods and techniques as a holistic approach, in order to be successful and stay competitive in the market.

Further research is needed to completely understand the different dimensions of perceived quality. Nevertheless, the study does show that there are gaps in the definition of perceived quality, and there is a need for universal taxonomy of perceived quality elements.

Acknowledgements

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