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Integrating the Kano model into a robust design approach to enhance customer satisfaction with product design

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ABSTRACT

The aesthetic qualities of products are critical factors in achieving higher customer satisfaction. This study presents a robust design approach incorporating the Kano model to obtain the optimal combination of design form elements. This can effectively enhance customer satisfaction and aesthetic product qualities with multiple-criteria characteristics. The Kano model is used to better understand the relationship between performance criteria and customer satisfaction, and to resolve trade-off dilemma in multiple-criteria optimization by identifying the key criteria in customer satisfaction. The robust design approach combines grey relational analysis with the Taguchi method to optimize subjective quality with multiple-criteria characteristics. This simultaneously yields the optimal aesthetic performance and reduces the variations in customer evaluations. Based on Kano model analysis, a weight adjustment process determines the weight of each product criterion for achieving the desired customer satisfaction performance. This process guides the prioritizing of multiple criteria, leading to higher customer satisfaction. A mobile phone design experiment was conducted to verify the benefits of using the proposed integrative approach. Results show that the generated optimal mobile phone design can effectively enhance overall aesthetic performance and customer satisfaction. Although mobile phone designs are the examples of this study, the proposed method may be further used as a universal robust design approach for enhancing customer satisfaction and product quality with multiple-criteria characteristics.

1. Introduction

Customer satisfaction is the major concern and prerequisite for competitiveness in today's global market. Because of market equivalence in product quality, the subjective quality of aesthetics is a critical determinant of customer satisfaction. For example, Apple's iMac was heralded as an "aesthetic revolution in computing". This indicates that the visual aesthetics of computers have become a factor in customer purchase decisions (Postrel, 2001). Related studies also concluded that the aesthetic quality of a design has a positive effect on customer satisfaction (Fynes and Búrca, 2005; Yamamoto and Lambert, 1994). Aesthetic design can enhance the desirability of a product and greatly influence customer satisfaction in terms of perceived product quality (Bloch, 1995). However, the relationship between subjective quality and customer satisfaction is seldom discussed (You et al., 2006; Yun et al., 2003). This study regards aesthetics as an aspect of quality and explores the impact of aesthetics on customer satisfaction.

Scientifically and efficiently enhancing the aesthetic quality of product design can be achieved by gauging customer responses to product aesthetics and correlating these perceptions to form elements. This enables researchers to modify designs and closer align them with

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customer needs (Coates, 2003). The customer-oriented Kansei engineering (Nagamachi, 2002) method is a tool for translating customer perceptions and feelings (Kansei in Japanese) into concrete form elements. This method has been successfully used to infer optimal product design (Chuang and Ma, 2001; Lai et al., 2006; Schütte and Eklund, 2005; You et al., 2006). Previous studies on Kansei engineering and aesthetics used questionnaire-collected data to examine customer subjective evaluations based on a mean scale rating. However, the evaluation of aesthetics is subjective and highly individualistic. Aesthetics evaluation based solely on mean scale ratings, without considering variation in customer evaluations, is not appropriate. Lai et al. (2005) presented a robust design approach to enhance quality perception by reducing the discrepancy between the actual customer feeling and the desired feeling and reducing ambiguity created by the highly individualized characteristics of the customers. The robust design approach focuses on bringing the mean closer to the desired target and simultaneously reducing quality variation. This design may be successfully used in subjective quality management.

Aesthetic experience has a multidimensional nature. Previous studies (Lavie and Tractinsky, 2004; Liu, 2003, Rashid et al., 2004; Schenkman and Jonsson, 2000) that used a one-dimensional construct (e.g., a semantic index "beautiful verse ugly" or a single aesthetic measure with Likert scale rating) to explain how users perceived subject quality are not appropriate. Optimizing aesthetic quality should be considered a multiple-criteria problem. Thus, multiple-criteria decision making is required. Usually these criteria are not equivalent, i.e., they make different contributions to the integral quality assessment. Some criteria are even competitive, i.e., an improvement in one criterion will inevitably lead to deterioration in another (Dimova et al., 2006; Chen et al., 2006). However, most studies (Bottani and Rizzi, 2008; Partovi, 2007; Wang et al., 2007) on multiple-criteria optimization employed weight determination methods to reflect how customers prioritize their wants without considering these features. The relationship between product criteria and customer satisfaction has mostly been assumed to be linear—the higher the perceived criteria quality, the higher the customer's satisfaction and vice versa. However, from the viewpoint of current theory, this relationship may be non-linear. Continuous improvement in some criteria, without considering what customers actually desire, may not be sufficient to enhance satisfaction. Conventional weight determination methods may not be able to completely illustrate the relationship between quality criteria and customer satisfaction levels. Understanding the relationship between certain quality criteria and customer satisfaction is necessary to decide which criteria to offer. Kano et al. (1984) developed a two-dimensional (linear and non-linear) quality model to address linear quality model shortcomings. This two-dimensional model divides quality criteria into must-be quality, one-dimensional quality and attractive quality. These terms describe a product's effect on customer satisfaction with or without a specific quality. The Kano model is an effective tool for categorizing product criteria and product requirements. Based on the Kano classification, the criterion with the greatest influence on customer satisfaction, i.e., the attractive quality, should be offered if two criteria cannot be promoted simultaneously due to technical or financial reasons. This method provides valuable guidance in trade-off situations during the product development stage (Conklin et al., 2004; Huiskonen and Pirttilä, 1998; Matzler and Hinterhuber, 1998). Accordingly, a design team can determine which areas should be targeted to produce maximum benefits in customer satisfaction. This study investigates the possible integration between a robust design approach and the Kano model for achieving higher customer satisfaction and the effectively optimizing multiple criteria.

Another purpose of this study is to explore aesthetic criteria characteristics and apply the Kano model to investigate the different impacts of criteria quality on customer satisfaction. An integrative method combining the Kano model with the robust design approach is proposed to enhance the subjective quality of aesthetics and customer satisfaction. The robust design approach combines grey relational analysis (GRA) and the Taguchi method (TM) into a grey-based TM (Lin and Lin, 2002; Tarng et al., 2002; Wang and Tong, 2004). We adopted this method to explore the relationship between design parameters and quality performance with multiple-criteria considerations. It also determines the optimal combination of design parameters to maximize quality performance and minimize quality variation. We adopted the Kano model to explore the relationship between multiple aesthetic criteria and customer satisfaction, and to identify the key factors that enhance satisfaction. The Kano classification results determined which aesthetic criteria should be emphasized to achieve higher satisfaction and optimize trade-offs between multiple criteria. Each criterion's effect on customer satisfaction was considered in the grey-based TM to effectively optimize aesthetic quality and customer satisfaction. We conducted an experimental study on mobile phone design to illustrate how the Kano model can be integrated into the robust design approach and to verify the effectiveness of the proposed method.

2. Theoretical background

2.1. Robust design approach for multiple-criteria optimization

Robust design is a quality improvement engineering method that seeks the lowest cost solution to product design specifications based on customer requirements. The TM is the conventional approach to achieve robustness (Cabrera-Rios et al., 2002). The primary tools of the TM are orthogonal arrays (OAs) and the signal-to-noise (S/N) ratio. The former substantially reduces the number of required experiments and the latter simultaneously finds the most robust combination and the best possible performance (Taguchi and Clausing, 1990). The TM defines a loss function to calculate the deviation between the experimental value and the desired value. The value of the loss function is further transformed into a S/N ratio. S/N