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Customer satisfaction evaluation method for customized product development using Entropy weight and Analytic Hierarchy Process ☆

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ABSTRACT

Providing customized products with high customer satisfaction (CS) has become an inevitable trend for modern customized companies to remain competitive. This study proposes a CS evaluation method for customized product development using Entropy weight and Analytic Hierarchy Process (AHP). Firstly, customer requirements are identified based on Voice-of-Customer (VoC), and classified into four categories (*positive*, *negative*, *must-be* and *fuzzy* attributes) according to the characteristics of CS criteria. Then, CS evaluation model and its solution method are introduced in detail. This study especially focuses on the quantitative methods for each category of the evaluation criteria through formulating several mathematical models, and criteria weights are obtained through integrating Entropy weight and AHP method. Finally, a case study of applying the proposed methodology to customized portrait-based product industry demonstrates the functionality of the proposed methodology.

1. Introduction

In order to gain a competitive advantage in the buyer's market, the product production mode is shifting from production-centralized to customer-driven (Kwong, Wong, & Chan, 2009). The change in production mode induces a shift from mass production to mass or small-batch personalized customization (Pine, 1993). With the rapid development of the internet and other information technologies, customer's participation in a personalized product is no longer subjected to geographical restrictions. Therefore, a significant increase is seen in customer participation of personalized products. Manufacturing production companies can out-compete its peers if they provide high quality products and service with high customer satisfaction (CS) for customers and provide flexible response to market demand. Meanwhile, it becomes more acceptable that customers are willing to pay more for products that cater to their individual preferences, styles, needs, or expressions (Du, Jiao, & Tseng, 2006).

Customer satisfaction level is one of the most important factors in the evaluation of the quality and service during development of a new product, especially for customized product development. That's because customized products generally belong to small batch production. Once a customer places an order to customize a personalized product, the company will place expenses for the customer due to service for him. Therefore, most companies tend to take measures to prevent customers from canceling the order during product development phase. One such measure requires the customer to pay a certain percentage of deposit depending on a fixed schedule after an order has been placed. If the customer is dissatisfied with the final product then the company will experience a loss of sale. When this occurs, not only the customer will lose his deposit to the company, the company will have also wasted the material allocated for the manufacturing of the product. Thus, such a loss will greatly affect the company's future production of the product.

Therefore, the reduction of transaction risks associated with customer dissatisfaction and the maintenance of mutual interest of both parties are crucial issues facing personalized product customization companies. Implementing CS evaluation to the customized product is the best solution to this problem. CS evaluation offers immediate and objective feedback about customer's preferences and expectations (Li, Liu, Peng, & Gao, 2013). This way, company's performance could be evaluated using multiple criteria which will indicate the strength and weakness of the company. Meanwhile, implementing CS evaluation can also help decision-makers and designers of companies to make the right decisions, and help them to identify which products are competitive for

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future production. However, there is still no study on the suitable evaluation model, reasonable criteria and quantitative methods for customized product development. This paper attempts to fill this gap in the literature through proposing a methodology of CS evaluation for customized product development, which focuses on the quantitative methods for each category of the evaluation criteria through formulating several mathematical models, and criteria weights are obtained through integrating Entropy weight and Analytic Hierarchy Process (AHP) method. Our approach for calculating the CS value and criteria weights has considered both the subjective and objective attributes when customers perform CS evaluation. Through the case study, the proposed methodology is appropriate for applications in the customized portrait-based product industry. This methodology can reduce the risk of economic loss for customers and companies.

The remainder of the paper is organized as follows: Section 2 briefly discusses the existing relevant literature. Section 3 introduces the proposed methodology. Section 4 describes a case study: application to customized portrait-based product industry. Conclusions are given in Section 5.

2. Literature review

Since the late 1980s, a number of countries have established the national customer satisfaction index (CSI) model. The establishment of a national CSI typically requires 4–5 years (Preliminary survey conduction, evaluation of results and correlation with general financial indices, development of database, etc.). Johnson, Gustafsson, Andreassen, et al. (2001) and Kenett and Salini (2011) presented the latest surveys. The first model was the Swedish Customer Satisfaction Barometer (SCSB) built by Swedish researchers in 1989 (Fornell & Johnson, 1992). A derivative model of the SCSB was the American Customer Satisfaction Index (ACSI) which was developed with complete data in 1994 and reported results for approximately 200 companies from 34 industries (Fornell, Johnson, Anderson, et al., 1996). The ACSI defined the satisfaction as a weighted average of three survey ratings: perceived quality, perceived value, and customer expectations. ACSI has been used to measure CS for manufacturing, transportation, communications industry and other areas such as utilities, finance, insurance, retails, services, public administration, and government. Another well-known CSI model was the European Customer Satisfaction Index (ECSI) across 4 industries and 11 countries in the European Union in 1999 (e.g. Martensen, Kristensen, & Grønholdt, 2000; Westlund & Eklof, 2002). Although these models and their derivatives (Hsu, 2008) are an accepted satisfaction evaluation methodology, they are not suitable for the customized product industry, and the ACSI model criteria cannot be used for this kind of industries.

In recent years, the theoretical models of CS and CSI have found numerous applications in various industries. Yadav and Goel (2008) proposed a comprehensive framework of target planning for CS driven quality improvement efforts in the automotive product development process. The proposed framework facilitated a link between corporate and engineering decision making process, and the potential vehicles for the facilitation were classified and prioritized for further improvement using Kano model and Quality Function Development (QFD). The mathematical models were formulated as optimization problems in order to cascade down top-level targets to lower-level elements within given constraints. Chen and Aritejo (2008) and Kuo, Wu, and Deng (2009) successively focused on the CS and service quality measurements in Mobile industry. Deng, Lu, Wei, and Zhang (2010) presented the determinants of CS and loyalty to mobile instant message (MIM) services in China. Their findings confirmed that trust, perceived service quality, perceived customer value (including functional value and emotional value), contributed to generating CS with MIM, and the results showed that trust, CS and switching cost directly related to customer loyalty. Additionally, they found age, gender, and usage time had indirect effects. Yang and Peng (2008) developed a novel CS evaluation model for construction project management using a questionnaire-based survey and statistical analysis, which included two stages. One stage was In-service, which included cost, quality, time, communication and technique/tool, and another stage was Post-service, which included cost, quality, time and scope. They used descriptive statistical method to analyze important characteristics and summarized survey results. Yang and Zhu (2006) developed a housing satisfaction index (HIS) model based on the ACSI model, which was a set of causal equations that linked customer expectations, perceived quality, and perceived value to customer satisfaction. In turn, customer satisfaction was linked to consequences as defined by complaints and customer loyalty. In additional, CS evaluation or measurement models were proposed for various other service industries, such as e-commerce (Liu, Zeng, Xu, & Koehl, 2008) or e-service (e.g. Udo, Bagchi, & Kirs, 2010; Liu, Zhou, & Chen, 2010; Finn, 2011), financial service (e.g. Arbore & Busacca, 2009; Pyon, Woo, & Park, 2011), EMS (Liu, Li, & Ge, 2006), and hotel (e.g. Gu & Ryan, 2008; Wu & Liang, 2009; Han, Kim, & Hyun 2010; Hsieh & Lin, 2010), and Tourism (Pyon, Lee, & Park, 2009).

These CS models may be suitable for their specific areas of industries, but are generally not suitable for customized product development due to the characteristics of the products and service. Du et al. (2006) analyzed diverse elements of product quality in relation to customization and introduced utility functions to quantify the customer-perceived value in terms of the quality utility per unit cost and the ratio of marginal utility to marginal cost. However, there is still no study on the suitable evaluation model, reasonable criteria and quantitative methods for customized product development. This study attempts to fill this gap in the literature through proposing a methodology of CS evaluation for customized product development, including identifying customer requirements, classifying CS criteria, establishing CS model, as well as the quantitative methods for each category of the criteria and their weights.

3. The proposed methodology

The aim of this study is to propose a CS evaluation model for customized product development in the buyer's perspective. The major steps of the proposed methodology involve (a) identifying and classifying customer requirements based on Voice-of-Customer (VoC), (b) modeling, (c) model solution, including quantitative method for each criterion, and the corresponding weights by integration of Entropy weight and Analytic Hierarchy Process (AHP). Details of each step are presented in the following subsections.

3.1. Identifying and classifying customer requirements based on VoC

It is important to identify the most vital and representative criteria to evaluate the CS value for new product development. Note that there are various tools and techniques available to capture customer requirements and preferences. These are customer questionnaire, individual inquiring, intensive expert interviews or surveys via internet, paper and pencil, etc (e.g. Du et al., 2006; Martensen et al., 2000). Regardless of which approach, our aim here is to highlight that identification of the CS criteria should be based on VoC. This process can be achieved by thorough discussions between the analyst and the decision maker of the company