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A novel approach to incorporate customer preference and perception into product configuration: A case study on smart pads

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ABSTRACT

This paper proposes a hybrid framework combining AHP (analytical hierarchy process), KM (Kano model), with DEMATEL (decision making trial and evaluation laboratory) to incorporate customer preference and perception into the process of product development. Initially, AHP is applied to respondents to form a basis of market segmentation. Thereafter, with respect to identified segments, AHP and KM are employed to extract customer preference for design attributes (DAs) and customer perception of marketing requirements (MRs), respectively. Finally, by means of DEMATEL, the causal relationships between MRs and DAs are systematically recognized to uncover new ideas of next-generation products.

1. Introduction

In a traditional "*supply-push*" driven era, manufacturing companies merely considered offering products with high quality, low cost, functioning performance and courteous after-sales service to satisfy market majorities [12]. Nowadays, owing to the concept of mass customization, customer satisfaction has become a growing concern to dominate the competing paradigm [2,6]. In order to survive in today's "*demand-pull*" environments, modern companies need to conceive attractive products/services to acquire different market segments and even for "customized" individuals [18]. Nevertheless, customers are too diverse, too heterogeneous, and too widely scattered in their preferences, perceptions, shopping behaviors, lifestyles, and their psychological demographics [27]. Thus, irrespective of the fact that high product variety does significantly stimulate product sales, most manufacturing companies are inevitably facing the trade-offs between increasing product variety and controlling manufacturing complexity [14,29]. In practice, to respond to dynamically changing customer desire, awareness of customer preference/perception is becoming much more imperative than ever before during the process of product development [21].

To tackle the aforementioned issues, one of the most famous schemes originated from the discipline of strategic marketing is a so-called "STP" approach (segmentation-targeting-positioning), which has been widely adopted among academic researchers and industrial practitioners [16]. Specifically, the step of "segmentation" allows marketers to divide the entire market into ad-hoc segments in which customers demonstrate similar patterns within a group but behave heterogeneously between groups. Secondly, the step of "targeting" helps a firm assess each segment's attractiveness, profitability, and then be able to select one or more segments to run their business. Finally, the step of "positioning" emphasizes differentiating a firm from competitors through offering attractive alternatives.

Apparently, market segmentation is the most critical step to achieve the success of the entire process of STP. According to Wang [28], there are several commonly used variables for market segmentation, including demographic variables (i.e. age, gender, race, and salary), psychographic variables (i.e. social class, lifestyle and personality) and behavioral variables (i.e. user preference, usage pattern, and loyalty status). Theoretically, market segmentation assumes that groups of customers with similar profiles or patterns are likely to demonstrate a homogeneous response to specific product promotion and marketing programs [9]. In this study, the purpose of market segmentation is to form a launch pad for generating and assessing potential product alternatives, particularly with respect to those identified niche segments. To effectively divide the whole market, customers' perceived importance degrees of design attributes are treated as input variables to carry out market segmentation.

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Furthermore, to help an enterprise better understand and capture dynamically changing customer desire, this paper attempts to incorporate customer preference as well as customer perception into the process of product development, especially to diminish the gap between customers' requirements and manufacturers' alternatives. Consequently, a market-oriented framework which integrates AHP, KM with DEMATEL is proposed and several key issues are addressed below:

- Learning which design attributes (DAs) are more representative to segment the entire market,
- Examining customer preference for multi-leveled DAs for generating concepts and assessing product alternatives in a customer-driven manner,
- Eliciting customer perception of marketing requirements (MRs) to form a launch pad for discovering new ideas of the next-generation products,
- Identifying the complicated interrelationships between DAs and MRs to help product managers better understand their inherent dynamics.

The rest of this paper is structured as follows. Section 2 briefly overviews classical techniques for eliciting customer preference and Section 3 introduces the proposed framework. An industrial example regarding configuring product varieties of smart pads is illustrated in Section 4. Finally, conclusions and future studies are drawn in Section 5.

2. Review of classical techniques to elicit customer preference

In an era of mass customization, companies need to deliberately understand what customers want and need in order to avoid fatal mistakes before implementing their product strategies [9,12]. New product development (NPD), defined as a process of transforming an identified market opportunity into profitable product(s) for sale, usually consists of a sequence of steps in which an enterprise employs to conceive, design, and commercialize product alternatives [3]. As a matter of fact, NPD is an interdisciplinary activity involving marketing, operation, manufacturing, and requires sustainable commitment from the top level of management. Therefore, various disciplines including marketing research, consumer behavior, and concurrent engineering, attempt to contribute to different stages of NPD [18]. Currently, recent publications have witnessed emerging growth of the front-end issues such as customer relationship management and customer requirement management [14].

In fact, the capability of concept generation and concept evaluation for different segments has been recognized as one of the key determinants for many firms to survive in an extremely uncertain business environment [3,4,9,19]. Nevertheless, without incorporating customer preference or customer perception into the process of concept generation/evaluation, the objective of customer satisfaction is difficult to be fulfilled [2,6,21]. To the best of our knowledge, several techniques which are widely applied to various industries like quality function deployment (QFD), conjoint analysis (CA), and Kano model (KM), are shortly overviewed later.

2.1. Quality function deployment (QFD)

Quality function deployment [1] is a well-known scheme that provides a structural framework to translate customers' voices into tangible product design. Typically, the conventional QFD consists of the following four phases: phase one translates marketing requirements into design attributes; phase two translates design attributes into part characteristics; phase three translates part characteristics into manufacturing operation, and phase four translates manufacturing operation into production requirements [17]. By considering the interdependences between MRs and DAs and the correlations among themselves, QFD is capable to derive the priorities of DAs in terms of the weights of MRs [29,30]:

$$R_{ij}{}' = \frac{\sum_{k=1}^{n} R_{ik} \times \gamma_{kj}}{\sum_{k=1}^{n}\sum_{k=1}^{n} R_{ik} \times \gamma_{kj}}, \tag{1}$$

$$Wt_{DAj} = \sum_{i=1}^{m} Wt_{MRi} \times R_{ij}{}', \tag{2}$$

where Wt_{MRi} and Wt_{DAj} represent the weight of MR_i and DA_j, respectively. Here, m marketing requirements and n design attributes are assumed to characterize the QFD, R_{ij}' is the normalized dependence between MR_i and DA_j, and λ_{ik} and γ_{kj} denote the correlations among MRs and DAs, respectively.

Nevertheless, QFD has been criticized by insufficient customer involvement (i.e. customer preference and customer satisfaction) when generating the weights of MRs or DAs. In addition, QFD is deficient in generating/assessing product concepts, especially when a product is functionally decomposed into various design attributes associated with multi-levels. To enhance its applicability, several researchers suggest to combine the QFD with conjoint analysis (CA) or Kano model (KM) [8,21,24,26].

2.2. Conjoint analysis (CA)

Conjoint analysis [20] is one of the most popular techniques to measure diverse customer preference among multi-attributed products or services. When a product is decomposed into independent attributes associated with their corresponding levels, a respondent's overall utility could be decomposed into his/her part-worth values [8,25]. For reference, a general mathematical form of CA can be modeled as follows [13]:

$$U_k = \beta_0 + \sum_{i=1}^{m}\sum_{j=1}^{n} u_{ijk}, \tag{3}$$

where U_k means alternative k's overall utility, β_0 denotes a regularized constant, u_{ijk} represents alternative k's part-worth utility corresponding to attribute i associated with level j, m is the number of attributes and n is the number of associated levels for attribute i. To derive the importance degree of various attributes, it is widely accepted that an attribute having a wider range of part-worth values should have greater impact on the overall utility of a product.

For convenience, let's illustrate a simple example. Suppose that a smart pad is characterized by six attributes (A1–A6) associated with multi-levels (e.g. A1(3), A2(2), A3(3), A4(2), A5(2), and A6(2)), intuitively, a maximal number of 144 ($3^2 * 2^4$) combinations might be possibly generated. To derive their part-worth utilities of six attributes, it is impossible to ask an evaluator to prioritize 144 alternatives at a time. Hopefully, by means of fractional factorial design, the entire process could be significantly simplified and reduced to rank only 16 orthogonal alternatives. Obviously, CA treats a multi-attributed product on a single layer and thus it cannot process a functional hierarchy structure.

2.3. Kano model (KM)

The basic idea of KM [15] is using a nonlinear way to measure customers' asymmetric perceptions of two sides: positive delight when an attribute is present and negative disgust when an attribute is