Expert Systems with Applications 38 (2011) 10631–10637

Contents lists available at ScienceDirect

Expert Systems with Applications

journal homepage: www.elsevier.com/locate/eswa

Feature fatigue analysis in product development using Bayesian networks

Ming Li, Liya Wang *

Department of Industrial Engineering and Logistics Management, Shanghai Jiao Tong University, No. 800 Dongchuan Road, 200240 Shanghai, China

ARTICLE INFO

Keywords:
Feature fatigue analysis
Bayesian networks
Customer preferences
Product development

ABSTRACT

The construct of "feature fatigue" represents the phenomenon of customer's inconsistent satisfaction: customers prefer to choose products with more features and capacities initially, but once actually worked with a product they will find the complex ones are too hard to use. Clearly, customer's dissatisfaction after use will have a negative effect on company's long-term revenue, and the inconsistence is a big challenge for firm's product development. Researchers have proposed some methods to "defeat" feature fatigue, however, most recent research just analyzes features one by one and ignore the relationships among them. Another problem is that the uncertain nature of customer preferences has not been paid enough attention. To solve these problems, a probability based methodology for feature fatigue analysis is proposed, in which Bayesian network techniques are used to represent the uncertain customer preferences for capacity and usability. And in this method, sensitivity analysis is implemented to identify the key features that affect feature fatigue most, and the relationships among features are analyzed using Bayesian network inference. An example is given to illustrate the usage of the proposed method in product development process.

1. Introduction

Intuition and past research suggest that customers usually buy products based on the number of provided features, and they are often seduced by extra features in the moment of purchasing (Kruger, Galak, & Burrus, 2007; Nowlis & Simonson, 1996; Venkatesh & Mahajan, 1993). In today's competitive environment, satisfying customer needs has become a great concern, and companies try their best to develop products with more features and capacities (Chen & Wang, 2007; Jiao, Zhang, & Helander, 2006). However, many studies show that people are poor predictors of their own enjoyment and happiness, especially when they are facing products with too many features (Mandel & Nowlis, 2008). That means satisfaction and dissatisfaction in the moment of purchasing is not necessarily equal to customers' experiences after using (Löfgren & Witell, 2008). Actually customers often overestimate the utility of extra features prior to purchasing, and after use, they will complain and even return products considering the problem of usability or mismatch with their expectations (Keijzers, den Ouden, & Lu, 2008). So just focusing on how to attract customers by high-feature products will not be helpful for seller's long-term revenue.

Many cases have been reported to show this problem. For example, a study points that 63% of mobile phone returns in UK has no hardware or software fault but the reported problems relate to usability like issues about the configuration of the handset (Keijzers et al., 2008). Another case is the BMW 7-Series cars, whose dashboard contains over 700 features. This kind of high capacity car is truly attractive in the first moment, but most of the owners are frustrated by the multi-function displays and multi-step options in the complicated system, and their dissatisfaction will affect BMW's sale in a long term (Rust, Thompson, & Hamilton, 2006).

To represent the phenomenon of customer's inconsistent satisfaction, Thompson, Hamilton, and Rust (2005) used the construct of "feature fatigue" (FF). Based on some case studies, they indicate that capability and usability are two important factors to affect customer's long-term satisfaction. When buying products such as a cell phone, even though customers know that too many features will lead to usability problem, they still tend to choose high-feature models because capability gets more attention in this moment. However, after working with a product actually, customers will find that usability becomes more important as products with more features are harder to use. So adding numerous features can increase the perceived capability of loaded product, but at the same time it will reduce the perceived usability. To examine how many features are suitable for a product, Thompson et al. (2005) propose an analytical model considering both before and after use, which can help manager to balance sales benefits and customer usability cost of adding features.

* Corresponding author. Address: Department of Industrial Engineering and Logistics Management, School of Mechanical Engineering, Shanghai Jiao Tong University, No. 800 Dongchuan Road, 200240 Shanghai, China. Tel.: +86 1381 849 1902.

E-mail addresses: imelm@sjtu.edu.cn (M. Li), wangliya@sjtu.edu.cn (L. Wang).

0957-4174/$ - see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.eswa.2011.02.126

To date, the problem of FF has been recognized as an important issue in many fields, and some research has been reported to explain or "defeat" FF. But there are still some limitation and shortcoming in previous research. Facing the problem as which feature should be added to a product considering FF, Thompson et al. (2005) just focus on the total number of features but ignore the difference between them. Some researchers have recognized that different feature has different impact on customer's perceived capability and usability. Typically they try to divide features into different classes like hedonic and utilitarian ones (Gill, 2008; Tsai & Liu, 2007), but the processes of evaluation and classification are usually one by one, ignoring the relationship analysis among features. In fact, as a product is combined with a set of functions and features, the same feature, no matter hedonic or utilitarian, will have different impact on FF in different combination. For example, if adding FM radio to a cell phone which contains MP3 player function, the perceived capacity may not increase significantly as adding the radio to a simple phone which has no entertainment function. As for usability, customers may not feel the product becomes harder to use if they have paid attention to learn how to use the MP3 player. But for simple phone users who have no related experiences, the FM radio will set the product to a higher complexity level. So when making feature adding decisions, the relationships among features contained in the product should be considered from both capacity and usability aspects.

Furthermore, the uncertainty nature of customer preferences is a big challenge for the research of FF. When asking questions like "How do you feel the capacity of product A", customers will give their answers depending on their own experience, feeling, context and even their mood at that time (Corney, 2000). As FF analysis is mainly based on customer preferences for capacity and usability (Rust et al., 2006), the uncertainties must be quantified and combined in the analysis process, to make sure that all decisions are taken on a rational basis. It is, of course, an extremely complex task because of the large number of features and their relationships to be considered and the large uncertainty associated with customer preferences for the whole product and each individual feature.

To overcome the existing problems, we propose a probability based methodology to deal with the task of FF analysis in product development. In this method Bayesian network is used to represent the structure of a product. And we will describe how to build and use Bayesian network based on customers' perceived capability and usability data. The proposed methodology will address the issues concerned with FF embedded with uncertainties of customer preferences and will help decision-makers to make intelligent decisions during the process of product development.

The remainder of this paper proceeds as follows. In the next section, we elaborate on the recent literature on FF. In Section 3, the proposed method is introduced. And an example is presented to illustrate the usage of this method in Section 4. Finally, in Section 5, conclusions are given.

2. Literature review

FF is used to represent the phenomenon that customers are overwhelmed by too many product features. Traditionally, market and economic research indicates that more features will make product more appealing to customers, and company's profit will increase at the same time (Ellison, 2005; Green & Krieger, 1991; Hauser & Rao, 2003). It is true that when a product concludes more features, its perceived capacity will increase, but the perceived usability will decrease considering the problem of complexity. Thompson et al. (2005) show that at the point of purchasing, customers prefer to choose high-feature products, that means they give more weight to the factor of capacity. But when using the product in practice, customers realize that the problem of usability is much more important than they ever thought, especially when too many features make the product too complex to use. The difference of customer's utility function for high-feature product before and after use will lead to dissatisfaction and the phenomenon of FF, which will have a negative effect on company's long-term revenue. To solve this problem Thompson et al. (2005) propose an analytical model to decide the suitable number of a product's features considering customers' reaction over a long period of time.

To explain the reason for FF, Hamilton and Thompson (2007) use construal level theory to compare the different effect of direct and indirect product experiences. Their studies show that direct experiences trigger more concrete mental construal and increases preferences of high feasibility/low desirability products, while customers who engage in an indirect experience prefer high desirability/low feasibility products which will lead to the situation of FF. As a shift in construal is the mechanism responsible for the change in preferences, firms are suggested to increase experiential contact with products before purchase by opportunities for product testing. Advertising and online shopping are also helpful to encourage customers thinking concretely about the product they want to purchase.

Researchers have recognized the problem of FF in many fields. Tep (2009) use the FF notion in the context of web site's affective quality and features quality in relation to customer online satisfaction. Tsai and Liu (2007) explore the phenomenon of FF in customer decision making under the scenarios of forfeiture and acquisition, and examine customer's inequality of weights on utilitarian and hedonic features in the process of buying a car. Keijzers et al. (2008) discuss the usability problem of smart phone which is a typical high-feature product.

In order to "defeat" FF, Thompson et al. (2005) focus on how to decide the suitable number of features, and suggest that firms should offer a wider assortment of simpler products instead of all-purpose and feature-rich products. Rahman and Rahman (2009) argue that reducing the number of feature is unhealthy considering the presence of competition, and product variety will impose customers' search cost. Keijzers et al. (2008) also point that just restrict new product to fewer functions and features will not helpful and a trade-off has to be made between marketing, design and internal quality costs. Another problem is different features will have different effect on FF. Recent research have shown that customers not only place importance on the amount of the total features, but also the amount of different group of features like utilitarian attributes and hedonic ones (Gill, 2008; Tsai & Liu, 2007).

In this paper, we propose a probability based methodology for feature fatigue analysis. Not like previous study, we consider features' relationships in combination rather than one by one, and Bayesian network techniques are used to reflect the uncertainty nature of customer preferences. The proposed method is introduced in the next section.

3. Bayesian network based FF analysis method

A Bayesian network is a kind of powerful knowledge representation and reasoning tools under conditions of uncertainty (Heckerman, 1996). Formally, a Bayesian network consists of three parts $B = \langle V, A, P \rangle$. The first part V is a set of discrete and stochastic variables. In a network, the variables are represented by nodes. The second part A is a set of arcs which connect the nods and indicate direct dependencies between the variables. V and A constitute a direct acyclic graph $G = \langle V, A \rangle$. The last part P represents a set of conditional probability distribution. Suppose V represents