Available online at www.sciencedirect.com
ScienceDirect
Computers & Industrial Engineering 56 (2009) 616–630
computers & industrial engineering
www.elsevier.com/locate/caie

Fuzzy expert systems and challenge of new product pricing

Alireza Haji [a], Morteza Assadi [b,*]

[a] Industrial Engineering Department, Sharif University of Technology, P.O. Box 11365-8639, Tehran, Iran
[b] Industrial Engineering Department, Wichita State University, 1845 Fairmount, Wichita, KS 67260, USA

Available online 21 April 2007

Abstract

This paper is focused on the representation and treatment of knowledge and data uncertainty within the context of an important industrial challenge, i.e., new product pricing. The most well known participating factor in pricing process is cost meanwhile the other factors like customer value and firm's strategy should be considered in the pricing process, as well. Besides, there are other important factors like the risks that consumer bear in purchasing new product which must be carefully analyzed and considered. Nonetheless, many of these factors are blended with uncertainty. In recent decades, fuzzy logic was well developed and implemented in many applications to treat vagueness in complicated systems. Finding the pricing process a critical and complicated process which includes many vague parameters, we tried to design a fuzzy expert system to cope with this challenge. In this paper, after a brief introduction of fuzzy logic which has revealed a methodology to work with uncertainty and imitate humans reasoning, the pricing factors are introduced. Then a fuzzy expert system is designed to find the appropriate price of the new product considering the related parameters.

Keywords: New product; Pricing factors; Fuzzy logic; Fuzzy expert system

1. Introduction

Today's firms face a fickle environment characterized by frequent mortality and innovation and high priority on research and development to be located in the first place in the market. Market has been changed dramatically and popular strategies of the 1980s, such as cost saving and quality improvement, are insufficient to win today's competitive battles (Jobber, 1998; Ozer, 1999). In such a mercurial market, one of the most important elements to survive and being on the edge of customer's needs is New Product (Brethauer, 2002; Crawford & Di Benedetto, 2000). Those companies that can create and dominate new markets by introducing new products will withstand and gain large benefits. Successful new products are lifeblood of many companies. Based on some negative aspects like the long time that they require to reach a mass market, new products may bankrupt the firm if fail. On the other hand, the success of new products will lead the firm to a unique place in market and bring affluent benefit. During the development of new product (NPD process) many critical decisions are made. These decisions resemble links of a chain. The more wise the decisions, the more strong the

* Corresponding author.
E-mail addresses: ahaji@sharif.edu (A. Haji), mxassadi@wichita.edu (M. Assadi).

0360-8352/$ - see front matter
doi:10.1016/j.cie.2007.03.005

chain, and the more successful the new products. The most critical part of this chain that connects this chain to the customer is price. Therefore no decision is more vital than setting the true price to charge customer.

In literature, new products are categorized in different ways (Crawford & Di Benedetto, 2000; Jobber, 1998; Kahn, 2006). But similar to Lehmann and Winer (2001), we classify new products as *really new products* and *slightly new products*. Slightly new products (or lemon-scent products) are existing products that have minor variations in features. In contrast, really new products raise the need for special technology or infrastructure while broadening or creating new category in the market. In this paper, the main focus is on really new products. The main characteristic of really new products which induces vagueness into pricing process is the imprecise usage and competitive situations since the market is unknown and technology is not tested (Lehmann & Winer, 2001).

Three key elements which product manager considers for setting price are *marketing strategy*, *perceived value*, and *competition* (Jobber, 1998; Lehmann & Winer, 2001). As we will discuss later, all of these factors are blended with uncertainty and ambiguity. Since humans have the capability of understanding and analyzing obscure or imprecise data which are not easily incorporated into existing analytical methods, expert's judgments are vital in decisions involving uncertainty and ambiguity. When a situation is characterized by either a lack of evidence or inability of experts to make a significant measurement of the possibility of an event, the experts simply decree the score of a given event by means of linguistic terms like "low", "high", etc. (Lin & Chen, 2004; Zimmermann, 1996). In other words, it is difficult to assign a crisp (non-fuzzy) value to a subjective judgment since the data is imprecise and vague. The strength of fuzzy logic in capturing the ambiguity and exploiting imprecise data created a motivation for us to use fuzzy logic in new product pricing. Foundations and basic definitions of fuzzy sets are explained in the literature (Klir & Yuan, 1995; Zadeh, 1965, 1996, 1999; Zimmermann, 1996) and will not be repeated in this paper. However, a brief overview on fuzzy logic and fuzzy systems will be presented in the next section and then in the third section the factors that are important in new product pricing will be reviewed. Fourth section presents a review on the previous new product pricing practices and fifth section deals with the elucidation of proposed system and its features. Conclusions and recommendations for future works are provided in final section.

2. Fuzzy systems

2.1. Fuzzy logic and membership functions

In Zadeh words, who first introduced the concept of fuzzy logic in 1965 (Zadeh, 1965), fuzzy logic is equal to "Computing with Words". He has stated that the main role of fuzzy logic is to serve as a methodology for computing with words which no other methodology attains such this purpose (Zadeh, 1996, 1999).

Fuzzy logic enables us to emulate the human reasoning process and make decisions based on vague or imprecise data. Linguistic terms can better represent knowledge, experience, and subjective viewpoint of decision makers in more intuitive way and natural language format. Each linguistic term can be expressed by a fuzzy set. In fuzzy set theory, elements of a set are allowed to have membership values between zero and one. If we depict this membership value by α, α can be any value in $[0,1]$ interval. A fuzzy set is usually shown by membership functions which can be of any shape by which the membership values can be computed for any element. Trapezoidal membership functions are common (Pedrycz, 1994) but unrealistic in their representation of uncertainty because of their sharp transitions. For more gradual transitions, it seems that spline-based functions like S-shaped and Π-shaped membership functions are better. Definitions of these functions are as follow:

$$S(x;a,b,c)=\begin{cases}0 & x<a\\ 2[(x-a)/(c-a)]^2 & a<x\leqslant b\\ 1-2[(x-c)/(c-a)]^2 & b<x\leqslant c\\ 1 & c<x\end{cases} \tag{1}$$

$$\Pi(x,a,b)=\begin{cases}S(x;b-a,b-a/2,b) & x\leqslant b\\ 1-S(x;b,b+a/2,a+b) & x>b\end{cases} \tag{2}$$