Available online at www.sciencedirect.com
ScienceDirect
Computers & Industrial Engineering 51 (2006) 715–725
computers & industrial engineering
www.elsevier.com/locate/dsw

Fuzzy decision making of profit function in production planning using S-curve membership function

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Received 4 October 2002; received in revised form 3 June 2005; accepted 16 August 2006
Available online 28 September 2006

Abstract

Any modern industrial manufacturing unit inevitably faces problems of vagueness in various aspects such as raw material availability, human resource availability, processing capability and constraints and limitations imposed by marketing department. Such a complex problem of vagueness and uncertainty can be handled by the theory of fuzzy linear programming. In this paper, a new fuzzy linear programming based methodology using a modified S-curve membership function is used to solve fuzzy mix product selection problem in Industrial Engineering. Profits and satisfactory level have been computed using fuzzy programming approach. Since there are several decisions to be taken, a performance measure has been defined to identify the decision for high level of profit with high degree of satisfaction.

Keywords: Vagueness; Fuzzy programming; Membership function; Degree of satisfaction; Performance measure

1. Introduction

In this paper, we used the S-curve membership function methodology in a real life problem of mix product selection. This is referred here to as the product mix selection problem (Tabucanon, 1996). This problem occurs in production planning management where a decision maker plays very important role in making a decision in a fuzzy environment. As an analyst, we try to find the best solution for the decision maker to identify a final decision in order to implement it. We have considered this problem because it is very important to decision maker to make a decision when all parameters, such as objective coefficients, technical coefficients and resource variables are uncertain. Therefore, it is inevitable to solve this problem by using fuzzy linear programming approach. A real life industrial problem is selected and a solution is achieved.

As stated by Rubin and Narasimhan (1984) that the heart of the methodology for the FLP problems lies in the construction of membership function for the objection coefficients, technical coefficients, resource variables and decision variables. In this regards many researches used FLP approach in solving its applications

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doi:10.1016/j.cie.2006.08.017

problems in their work (Buckley & Feuring, 2000; Chou & Chen, 1996; Guu & Wu, 1999; Inuiguchi & Ramik, 2000; Maleki, Tata, & Mashinchi, 2000; Nishizaki & Sakawa, 2001; Parra, Terol, & Una, 1999a, Parra, Terol, & Una, 1999b; Rommelfanger, 1996; Sengupta, Pal, & Chakraborty, 2001; Wang & Wang, 1999).

The transitional step towards fuzzy linear programming models is models that consider some fuzzy values. Some of these models are linear mathematical of objective decision making presented by mainly crisp and some fuzzy values. Many authors studied such models (Cheng, 1999; Chuang, 1986; Lai & Hwang, 1993, 1994; Lai, 1995; Zimmermann, 1978). Zimmermann offered the solution for the formulation by fuzzy linear programming (Zimmermann, 1978). Lai's interactive technique contributed to the improvement of flexibility and robustness of objective decision making methodology (Lai, 1995). Bellman and Zadeh (1970) has proposed one of the most powerful tools to deal with problem in fuzzy environment. Fuzzy linear programming has been making tremendous progress after they were given life by Bellman and Zadeh (1970).

Various types of membership functions were used in fuzzy linear programming problem and its application such as a linear membership function (Gasimov & Yenilmez, 2002; Zimmermann, 1976; Zimmermann, 1978), the linear fuzzy constraints (Dubois & Prade, 1980), a tangent type of a membership function (Leberling, 1981), an interval linear membership function (Hannan, 1981), an exponential membership function (Carlsson & Korhonen, 1986), inverse tangent membership function (Sakawa, 1983), logistic type of membership function (Watada, 1997), concave piecewise linear membership function (Inuiguchi, Ichihashi, & Kume, 1990), piecewise linear membership function (Hu & Fang, 1998, 1999), flexible membership function (Bells, 1999) and dynamics membership function (Buller, 2002). As a tangent type, of a membership function, an exponential membership function, and hyperbolic membership function are non-linear function; a fuzzy mathematical programming defined with a non-linear membership function results in a non-linear programming. Usually a linear membership function is employed in order to avoid non-linearity. Nevertheless, there are some difficulties in selecting the solution of a problem written in a linear membership function (Watada, 1997). Therefore, in this paper a modified S-curve membership function is employed to overcome such deficits, which a linear membership function has. Furthermore, S-curve membership function is more flexible enough to describe the vagueness in the fuzzy parameters for the production planning problems.

Ramik (2002) solved the investment problem using fuzzy linear programming approach and linear membership function. In this research work the S-curve (Kuz'min, 1981) membership function is adopted in a real life industrial production planning of a chocolate manufacturing unit. The unit produces 8 products using 8 raw materials; mixed in various proportions by 9 different processes under 29 constraints. This complex problem has 8 inherent sub-problems. A set of solutions to all these sub-problems are achieved thus establishing the usefulness of the S-curve membership function for decision making in industrial production planning. The paper is organized as follows: next section is about statement of chocolate manufacturing problem with various cases. Section 3 deals with construction of modified S-curve membership function. Section 4 provides the computational result for the fuzzy mix product selection problem. The results of seven cases are presented in the performance measure in table form. The paper ends with conclusion and future research work.

2. Problem of chocolate manufacturing

The fuzzy mix product selection problem (FPSP) is stated as: there are n products to be manufactured by mixing m raw materials with different proportion and by using k varieties of processing. There are limitations in resources of raw materials. There are also some constraints imposed by marketing department such as product mix requirement, main product line requirement and lower and upper limit of demand for each product. All the above requirements and conditions are fuzzy. It is necessary to obtain maximum profit with certain degree of satisfaction. This is called here as fuzzy optimization under vague environment (Negoita, 1981). We use the interactive fuzzy linear programming with a modified S-curve membership function in solving FPSP.

2.1. FPSP with fuzzy objective coefficients

In the case of the fuzzy objective coefficients, the coefficients of objective function are represented in fuzzy intervals where, as available resources and technical coefficients are precise parameters. This problem is one of