Chapter 7
Integration of Fuzzy Logic Techniques into DSS for Profitability Quantification in a Manufacturing Environment

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ABSTRACT

Production control, planning, and scheduling are forms of decision making, which play a crucial role in manufacturing industries. In the current competitive environment, effective decision-making has become a necessity for survival in the marketplace. This chapter provides insight into the issues relating to integration of fuzzy logic techniques into decision support systems for profitability quantification in a manufacturing environment. The chapter is divided into five sections with a general introduction of the topic, followed by a thorough literature review on the existing techniques. Thereafter, fuzzy logic algorithms using logistic membership functions and resource variables for decision making aiming at quality improvement are discussed. A case study involving a textile firm is then described with the computational results and findings, and finally, future research directions are presented.

INTRODUCTION

Decision making has become very important in several areas of human endeavor and in real-world situations, it involves information which is fuzzy in nature (Metaxiotis *et al*, 2003 and Monfared & Yan, 2004). However, most of our traditional tools for formal modeling, reasoning and computing are crisp, deterministic and precise in character. By crisp we mean dichotomous, which is, yes-or-no type rather than more-or-less type. In conventional dual logic, for instance, a statement can be true or false and nothing in between. In set theory, an element can either belong to a set or

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not, and optimizing a solution is either feasible or not. Precision assumes the parameters of a model represent exactly either our perception of phenomenon modeled or the features of the real system that has been modeled (Sakawa & Yana, 1985).

A practical decision making problem is best tackled by mathematically modeling it. Often, a reasonable amount of mathematical models with incorporation of fuzziness are used in order to assist decision makers for making rational decisions. A discussion on fuzzy linear programming (FLP) with imprecision and uncertainty for decision making problems is provided. FLP handles fuzziness in the parameters where the model is parameterized to find a satisfactory solution in the form of function of membership values. This ensures easy computation (Delgado *et* al, 1989).

The continuous linear-programming involves decision variables that are fractional. However, when all decision variables are integers, it is known as integer-programming (Beasley, 2011 and Harvey, 2011),. A number of methods have been developed for integer programming such as enumeration, cutting-plane and group-theoretic techniques and they have been applied to various applications such as capital budgeting, warehouse location, scheduling, etc. (Bertsimas *et al*, 1999 and Ghanizadeh & Fakhri, 2009) However, often real-world problem, the realistic assumption is that does not always involve integers. That is the rational for this work where FLP method is used effectively for solving linear programs which involves non-integers. In this chapter, a methodology using logistic membership function to solve the FLP problem is presented.

BACKGROUND

The mathematical formalization of fuzziness was originally pioneered by (Zadeh, 1965). This paved the way for more research in the application of fuzzy in real-world problems (Orlovsky, 1980). Some earlier work on fuzzy decision making can be found in (Tamiz, 1996, Zimmermann, 1987, Kickert, 1978, Zimmermann, 1991). In the last decade, manufacturing companies decided to adopt intelligent solutions, since the traditional manufacturing decision-making mechanisms were found to be insufficiently flexible to respond to changing production styles and highly dynamic variations in product requirements (Kusiak, 1990 and Metaxiotis *et al*, 2002). (Custodio *et al,* 1994) discussed the issue of production planning and scheduling using a fuzzy decision system, whilst, several outlines concerning the development of a rule-base for the specification of manufacturing planning and control systems were made by (Howard *et al*, 2000). (Watada, 1997) has proposed one form of logistic membership function to overcome difficulties in using linear membership function in solving fuzzy decision making problem. Non linear logistic membership function was presented by (Vasant & Bhattacharya, 2007 and Bhattacharya & Vasant, 2007). Some representative publications can also be found in (Zimmermman, 1985, Yager *et al*, 1987, Dubois & Prade, 1980 Klir, & Yuan, 1995 and Ross, 1995)

The approach proposed here is based on interaction with the decision maker, the implementer and the analyst in order to find a compromised satisfactory solution for the fuzzy linear programming (FLP) problem. In a decision process using an FLP model, source resource variables may be fuzzy, instead of precisely given numbers in crisp linear programming (CLP) model. For example: machine hour, labor force, material needed and so on in a manufacturing center, are always imprecise, because of incomplete information and uncertainty in various potential suppliers and environments. Therefore, they should be considered as fuzzy resources, and FLP problem should be solved by using fuzzy set theory. In this chapter, a methodology to solve fuzzy linear programming problem with logistic membership is considered.