Chapter 7

A Hybrid Approach using the Bees Algorithm and Fuzzy–AHP for Supplier Selection

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ABSTRACT

In this chapter, a new hybrid approach combining the Fuzzy Analytic Hierarchy Process (AHP) and the Bees Algorithm is proposed in order to solve the supplier selection problem. The Fuzzy Analytic Hierarchy Process is used to determine the importance weight of each criterion and sub-criterion considered for the supplier selection, which are quality, cost, service level, supplier profile and risk. These weights are utilized in a mathematical model to determine the optimum order level of each row material from each supplier. The model considers capacity, demand, on-time delivery, quality and bill of materials. To determine the optimum order levels, the Bees Algorithm is applied to optimize this NP-hard type model under the constraints. The results showed that the Bees Algorithm performed better than Genetic Algorithm during the optimization stage.

INTRODUCTION

Suppliers are one of the most important elements in a supply chain. A supply chain will be more robust and sustainable with stronger suppliers. In order to have robust suppliers in the chain, a strong evaluation process needs to be considered, as the supplier is the provider of raw materials/parts for main manufacturer, which needs to be supplied on time with right amount (Choi and Hartley, 1996). Thus the selection of appropriate suppliers directly/indirectly affects the performance of the entire supply chain. Supplier selections process has been widely modelled in literature (Lambiase et al, 2013). Several qualitative factors such as quality, cost, service level, supplier profile, risk, and quantitative factors such as capacity and demand should be considered during the supplier selection process (Ghodsypour and O’brien, 1998).

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The process requires an intense and strong decision making stage to determine the right suppliers and order quantities. To determine the correct decision under these multi criteria, a decision making process has to be utilized. In literature, several Multi Criteria Decision-Making (MCDM) methods have been proposed (Ho et al, 2010). Analytical Hierarchy Process (AHP) is one of the most common methods used for supplier selection since allows to make a decision through a pair-wise comparison of the criteria involved in the decision process (Saaty, 1988). However, in order to better support the uncertainty in the human judgment, fuzzy sets theory (Zadeh, 1965) has been added to the conventional AHP by replacing fixed value judgment with fuzzy intervals. In other words, in the Fuzzy-AHP (Kahraman et al, 2003) the pair-wise comparison of each criterion over another is not performed by crisp numbers, but by means of membership functions. Furthermore, in order to consider quantitative parameters and constraints, an optimization algorithm has to be utilized in order to allocate the optimum amount of purchases from different suppliers. In literature, several optimization algorithms have been applied to solve the supplier selection problem. Among these, a recent promising swarm-based meta-heuristic optimization algorithm is the Bees Algorithm (BA) (Yuce et al, 2013). The BA has been proposed by Pham et al. in 2005 (Pham et al, 2005) and since then has been used to solve different types of optimization problems as supply chain design (Mastrocinque et al, 2013), job shop scheduling (Packianather et al, 2014). The algorithm has a strong ability to perform better in most cases compare to other well-known optimization algorithms (Pham and Castellani, 2009). The algorithm can utilize both global search and local search during the search process, which are the main advantages compare to other global search based algorithms such as Genetic Algorithm (Davis, 1991). The algorithm utilizes the fitness evaluation operation to find the global optimum solutions, which provides another advantage to the algorithm compared to other bee based algorithms such as Artificial Bee Colony (ABC) (Karaboga, 2005). In this chapter, the Bees Algorithm has been used to determine the optimum amount of raw material units from each supplier under several constraints.

The main objectives of this chapter are firstly to give an overview of the supplier selection problem, then to utilize a hybrid approach using the Bees Algorithm and Fuzzy-AHP to determine the optimum purchase quantity. The authors want to provide an alternative methodology to decision makers for supplier selection problem.

The chapter is organized as follows: the background presents an overview on the supplier selection problem and solving methods. Section 1 presents the Fuzzy-AHP. Section 2 presents the Bees Algorithm and its applications. In section 3, the hybrid approach is presented. In section 4, the Fuzzy-AHP and BA (FAHPBA) approach is applied on a case study and results are discussed in details. Section 5 presents some future research directions. Finally, conclusions are given in section 6.

BACKGROUND

Supplier selection is a complex and multi-dimensional problem which involves the determination of optima suppliers considering several factors such as cost, deliver time, response time and etc. In literature, Verma and Pullman (1998) analyzed the difference between managers’ rating of the perceived importance of different supplier attributes and their actual choice of suppliers in an experimental setting. It has been noted that cost and delivery performance are the most important two key elements for the supplier selection process. Moreover, Ghodsypour and O’Brien (1998) proposed an integration of
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