Chapter 3
Supply Chain Network Design Using an Enhanced Hybrid Swarm-Based Optimization Algorithm

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ABSTRACT

Supply chain network design is one of the most important strategic issues in operations management. The main objective in designing a supply chain is to keep the cost as low as possible. However, the modelling of a supply chain requires more than single-objective such as lead-time minimization, service level maximization, and environmental impact maximization among others. Usually these objectives may cause conflicts such as increasing the service level usually causes a growth in costs. Therefore, the aim should be to find trade-off solutions to satisfy the conflicting objectives. The aim of this chapter is to propose a new method based on a hybrid version of the Bees Algorithm with Slope Angle Computation and Hill Climbing Algorithm to solve a multi-objective supply chain network design problem. A real case from the literature has been selected and solved in order to show the potentiality of the proposed method in solving a large scale combinatorial problem.

INTRODUCTION

The supply chain (SC) is a complex system (Mastrocinque et al., 2014) aiming to move products or services from suppliers to customers and involves people, technologies, information, materials among others. At the strategic level, supply chain network design is a crucial decision affecting the future success of the business (Lambiase et al., 2013). A supply network can have different configuration depending on the criteria used during the design stage.

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Optimization is a powerful tool employed by decision-makers to calculate the optimal value of decision variables in order to minimize/maximize certain objective functions. It has been widely used for solving production related problems (Vasant, 2010; Vasant & Barsoum, 2009; Vasant & Basoum, 2010). The most common supply chain optimization model is based on the evaluation of a single objective function, usually an economic index such as total cost of the supply chain or profit. However, reality can be more complex than reduce the modelling of a supply network to a single-objective In fact other objectives might be considered when it comes to design the configuration of a supply chain such as lead-time minimization, environmental impact minimization, service level maximization, among others (Voudouris, 1996). Typically, these objectives may be in contrast between them such as increasing the service level usually causes a growth in costs. Therefore, the aim of a multi-objective supply network design should be to find trade-off solutions in order to satisfy the conflicting objectives.

In multi-objective optimization there is no single optimum solution, but there are different solutions forming the so-called Pareto set. Pareto solutions are a set of trade-offs between different objectives and they are non-dominated solutions which means there is no other solution which would improve an objective without causing a worsening in at least one of the other objectives (Deb, 2001).

In literature, several methods have been proposed to solve supply chain design problems to get the Pareto optimal solutions. Especially, evolutionary and meta-heuristics algorithms such as genetic algorithms (Altiparmak et al., 2006), particle swarm optimization algorithm (Mahnam et al., 2009), ant colony algorithm (Moncayo-Martinez & Zhang, 2011), the Bees Algorithm (Mastrocinque et al., 2013) among others, have proven to be a valid tool in order to solve the multi-objective supply chain network design.

The Bees Algorithm has proven to be a powerful method for multi-objective supply network design (Yuce et al., 2015). Recently an enhanced version of the Bees Algorithm (BA) using Slope Angle Computation and Hill Climbing Algorithm (SACHCA) has been proposed (Yuce et al., 2015a) and successfully applied for single-objective problems such as continuous type functions and single-objective job shop scheduling.

In this chapter the authors apply the SACHCA-based Bees Algorithm to a multi-objective optimization problem such as supply chain design in order to test its performance on a large scale combinatorial problem and give to the decision maker an alternative tool. In order to explore the behavior of the SACHCA-based Bees Algorithm, it has been used to solve a real-world problem such as the notebook supply network design (Graves & Willems, 2005) considering two conflicting objectives such as minimizing the total cost and the total lead time of the network.

This chapter is organized as follows: the background section revises the literature on the multi-objective supply chain optimization and the Bees Algorithm. In section 1, the enhanced version of the Bees Algorithm with Slope Angle Computation and Hill Climbing Algorithm is presented. In section 3 the notebook supply chain case study from the literature is explained. In section 4 the optimization results are presented and discussed. Finally future research direction and conclusion are given.

BACKGROUND

In literature, several multi-objective supply chain design models have been proposed. In (Altiparmak et al., 2006) a facility location problem of a four echelons supply chain (suppliers, plants, distribution centers-DCs and customers) have been proposed, where the objectives are to minimize the total cost, maximize customer services and the capacity utilization balance for DCs using a genetic algorithm