

Chapter 1

Nature-Inspired Intelligence in Supply Chain Management: A Review of Selected Methods and Applications

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ABSTRACT

Supply chain management is a vital process for the competitiveness and profitability of companies. Supply chain consists of a large and complex network of components such as suppliers, warehouses, customers etc. which are connected in almost every possible way. Companies' main aim is to optimize the components of these complex networks to their benefit. This constitutes a challenging optimization problem and often, traditional mathematical approaches fail to overcome complexity and to converge to the optimum solution. More robust methods are required sometimes in order to yield to the optimal. The field of artificial intelligence offers a great variety of meta-heuristic techniques which specialize in solving such complex optimization problems, either accurately, or by obtaining a practically useful approximation, even if real time constraints are imposed. The aim of this chapter is to present a survey of the available literature, regarding the use of nature-inspired methodologies in supply chain management problems. Nature-inspired intelligence is a specific branch of artificial intelligence. Its unique characteristic is the algorithmic imitation of real life systems such as ant colonies, flock of birds etc. in order to solve complex problems.

INTRODUCTION

Nowadays, most firms face difficulties in obtaining a competitive advantage over other companies due to the fact that most of their underlying processes

have become complex. A remedy to this issue is to adopt the organizational scheme of supply-chains: an international network of external partners such as suppliers, warehouses, distribution centres. A starting point of this functional chain can be considered the collection of raw materials and an

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ending point the preparation of the final product and the delivery to its final destination (customer or any other terminal) (Silva et al. 2002). Logistics is a particular part of this process and deals with the planning, handling and control of the storage of goods between the manufacturing and the consumption point. One crucial challenge for decision makers is to satisfy all customers, using the available transportation fleet, while at the same time minimizing any intermediate costs (storage costs, transportation costs, delivery time etc.). The above problem can get very complex, especially in the case where various real life constraints regarding time, cost, availability etc. are imposed. A general term that characterizes these kinds of problems is the term “scheduling problems” (Silva et al. 2002).

A wide range of methodologies has been used to solve this optimization problem. However, traditional mathematical methods have proven insufficient in tackling the requirements rising from the development of market competition (Silva et al. 2003). Nature-inspired intelligent techniques are considered to be quite efficient in handling NP-hard problems (i.e. optimization problems in which the optimum cannot be found in polynomial time). The main characteristic of these methods is the imitation of the way natural systems function and evolve in order to deal with real-world situations (Vassiliadis and Dounias 2009). For example, natural ant colonies cooperate so as to find high-quality food source, a flock of birds implements a scheme of indirect communication with the aim of finding the optimal direction, etc. Some examples of nature-inspired algorithms are the following:

- *Ant Colony Optimization (ACO)*
- *Particle Swarm Optimization (PSO)*
- *Genetic Algorithms*
- *Genetic Programming*
- *Memetic Algorithms*
- *Artificial Immune Systems*
- *DNA Computing*

All of the above methods have been applied to hard optimization problems. However, literature indicates that only some of them have been applied to the optimization of logistic processes.

The main aim of this chapter is to present a literature review of the application of nature-inspired algorithms in supply chain management. Specifically, the focus is on certain parts of the supply chain, where certain processes need to be optimized such as finding the optimal route for a fleet. Academic research indicates that the use of NI methods is beneficial in dealing with this kind of problems. The contribution of this study is to collect the majority of academic work regarding the application of NI algorithms in logistic processes and to give a clear presentation of the usefulness and applicability of these techniques for future research projects.

The chapter is organized as follows. In section 1, an introduction of this chapter is given. In section 2, the main characteristics of the supply chain management problem are presented. In section 3, some NI algorithms as well as their natural principles are analyzed. In the next section, findings from the literature review are presented. Finally, in section 5, the main conclusions steaming from the review are summarized.

SUPPLY CHAIN MANAGEMENT OPTIMIZATION PROBLEM

Supply chain planning is adopted by more and more modern enterprises in order to upgrade performance. Their main aim is to organize and manage all different partners of this integral process in a coordinated manner so as to fulfil the customers’ expectation (Silva et al. 2005). What is more, these different partners operate under different sets of constraints and objectives. However, high interdependency of the various parts of the supply chain system implies that optimization of one part may influence considerably the performance of the remaining parts.

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