Close Loop Supply Chain Network Problem with Uncertainty in Demand and Returned Products: Genetic Artificial Bee Colony Algorithm Approach

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Abstract

In recent years, due to environmental concerns, remanufacturing of products is practiced in different companies and close loop supply chain network in these companies is significant to optimize. Therefore, current study is aimed to determine an optimal close loop supply chain network, which is composed of multiple producers, remanufacturers, intermediate centers and customer centers. Furthermore, uncertainty in the demand and uncertainty in the quantity of returned products is considered simultaneously in the network to make it significantly useful in the uncertain environment. A novel genetic artificial bee colony (GABC) algorithm is introduced with a new food source representation for the current problem. The proposed GABC algorithm considered neighbor food sources for local search and used crossover and mutation operations of genetic algorithm to enhance the exploration ability of the proposed algorithm. Taguchi method is employed to compute the optimal parameters of GABC for two different size test problems taken from literature and a Case problem which are modified according to the current research problem. The performance of presented GABC algorithm is tested by comparing the results of considered test problems with the results obtained from the original artificial bee colony (ABC) algorithm and genetic algorithm (GA). Moreover, to test the robustness of the proposed GABC algorithm, different scenarios of small and large size problems based on the quantity of demand and variations in demand are made to perform the experiments. Results indicate that proposed GABC outperforms standard ABC and GA in different scenarios to give smaller value of the total cost of network and gives more robust results to give smaller variations in the total cost of network due to uncertain variations in the demand, as compared to original ABC and GA.

Keywords: Close loop supply chain network; Remanufacturing; Demand Uncertainty; Genetic Artificial bee colony algorithm

1. Introduction

Close loop supply chain optimization problem is gaining popularity in recent years due to environmental concerns of different manufacturing industries. Close loop supply chain consists of forward and reverse loop of supply chain, which works simultaneously. In the forward loop, the newly manufactured products are moved to the customers in different areas. While in the reverse loop, used products are collected from customers and moved to intermediate centers for cleaning and disassembly operations. Later they are moved to the remanufacturing facilities for remanufacturing. Close loop of supply chain is significant to reduce environmental pollution due to reuse of scrap and used products from customers. Many companies nowadays are using reverse flow of their used products from customers to recovery centers (Fleischmann M et al, 2000). The recovery options of the used products includes reuse of the collected products, repairing of the returned items, remanufacturing or the combination of these options (Thierry MC, et al., 1993; Zhiqiang Lu and Nathalie Bostel, 2007). The reverse supply chain network system can be designed for direct reusable network, repairing network, recycling network and remanufacturing network (Fleischmann M et al., 1997; Thierry MC et al., 1993; Zhiqiang Lu and Nathalie Bostel, 2007). In reusable network, the products are directly reused, for example, soft drink bottles, pallets or containers etc. The repairing logistics network restores the failed products to their working conditions. For example, reconditioning of the domestic appliances including, washing machines, electric equipment, refrigerators etc, are involved in the repairing network. In recycling process, material is recovered without converting product structure, for example, steel scrap is used to manufacture different steel products, glass, papers etc. In remanufacturing, a product is reformed into its original shape by several operations which can include disassembly, overhauling cleaning and replacement.
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