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The multi-objective label correcting algorithm for supply chain modeling

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ABSTRACT

Purpose—The purpose of this paper is to provide a multi-objective label correcting algorithm (MLC) to solve supply chain modeling problems. Design/methodology/approach—In the study, the proposed approach extends label correcting algorithm to apply to multi-objective problems where various conflicting objectives have to be considered simultaneously so as to make a trade-off between different criteria at the same time. The algorithm performs a forward search from a selected output point to all accessible points. It processes the stack of nodes based on the last-in-first-out (LIFO) rule. For the serial way, a node in the stack is pulled out for exploration and its subsequent node(s) is (are) pushed into the stack in each iteration. Then the MLC determines and updates the paths. The algorithm terminates when all nodes in the stack are pulled. Findings—The paper demonstrates that the MLC methodology can successfully resolve the supplier selection problem by taking into account the preference of the decision makers. Originality/value—many researches had proposed that many areas of the industry as, for example, telecommunications, transportation, aeronautics, chemistry, mechanical, and environment, deal with multi-objective, where various conflicting objectives have to be considered simultaneously. The method presented in the paper will help future studies in modeling of supply chain.

1. Introduction

Mithun et al. (2008) say that design of the chain should be able to integrate the various elements of the chain and should strive for the optimization of the chain rather than the entities or group of entities. In recent year, supply chain management is a holistic and strategic approach to demand, operations, procurement, and logistics process management (Mithun et al., 2008). Over the years, most firms have focused their attention on the effectiveness and efficiency of separate business functions. As new ways of doing business, however, a growing number of firms have begun to realize the strategic importance of planning, controlling, and designing a supply chain as a whole.

Modeling is crucial work in supply chain since this is done in an effort to help firms capture the synergy of inter-functional and inter-organizational integration and coordination across the supply chain and to subsequently make better supply chain decisions. Supply chain modeling can be characterized as a primary method- or algorithm-oriented approach towards SCM. Supply chain model is often represented as a resource network. The nodes in the network represent facilities, which are connected by links that represent direct transportation connections permitted by the company in managing its supply chain. Supply chain modeling has to configure this network and to program the flows within the configuration according to a specific objective function based on algorithms (Swaminathan and Tayur, 1999). Therefore, supply chain can be modeled as a configurable and flow-programmable resource network. The network employs a completely different and very selective view of what is going on in the supply chain. But as literature and practice prove, it is a quite powerful way of improving the chain (Kotzab and Otto, 2003). Supply chain modeling offers short-, medium- or long-term optimization potentials. Elements within the optimization scope may be plants, distribution centers, suppliers, customers, orders, products, or inventories. The standard problems for supply chain modeling are formulated in the following manner. A set of goals should be achieved by minimizing the costs of transfer and transformation. In partial solutions, particular goals are selected, such as securing a certain service level to minimize lead time and maximize capacity utilization, or to secure availability of resources (Kotzab and Otto, 2003). The standard solutions in supply chain modeling can be found in the establishment of certain algorithms, which identify the optimal solution for the problem.

The label correcting algorithm has been proven to be extremely efficient through solving a certain supply chain modeling problem—the shortest path problem (Angelica and Giovanni, 2001, 2002). In previous researches, many areas of the industry, for example, telecommunications, transportation, aeronautics, chemistry, mechanical, and environment, deal with multi-objective, where various conflicting objectives have to be considered simultaneously (Figueira et al., 2010). For example, the relationship between production and maintenance objectives has been considered as a conflict in management decision. If a decision maker uses single

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objective algorithm to optimize the production objective or the maintenance objective separately, the conflict may result in an unsatisfied demand or machine breakdowns. It is because the production services and maintenance services do not respect the requirement of each other (Berrichi et al., 2010).Due to these reasons, this paper develops a multi-objective label correcting algorithm to achieve a trade-off but consider different criteria at the same time.

2. Literature review

2.1. Supply chain management

One of the core problems in the dynamic supply chain is to implement supply chain formation, that is to say, the problem of selecting supply chain members to form supply chains to realize the goal of the whole supply chain. This problem refers to how to allocate orders to the multiple members in a supply chain environment (Cho and Kim, 2010). A supply chain (SC) is a network of retailers, distributors, manufacturers, and suppliers cooperating to satisfy customers' demands. In traditional business environments, each business tries to minimize its costs based on its own cost structure, regardless of other SC participants (Chaharsooghi and Heydari, 2010). Ito and Salleh (2000) define supply chain management as an integrated network of suppliers, factories, warehouses, distribution centers and retailers, through which the whole chain of logistic processes is managed so that aims to achieve a faster and more flexible co-ordination between a company and its customers and suppliers within the chain. Fredendall and Hill (2000), however, classify it into two categories: (1) The utilized processes from the initial raw materials to the ultimate consumption of the finished product linking across supplier-user companies; (2) The functions within and outside a company that enable the value chain to make products and provide services to the customer.

A variety of changes in the business environment including time-based competition, fast product cycle, just-in-time production, cost leadership, use of interorganizational systems, global competition, and knowledge management have fueled interest in supply chain management (Premkumar, 2000). The global supply chain has been divided into several stages. The number of stages has been determined so that each is large enough to minimize problem fragmentation, yet small enough to limit problem complexity so as to obtain an acceptable homogeneity of various variables, corresponding to qualitative performance measures and qualitative factors. The development and application of supply chain management has been conducted for years.

- Overview of supply chain management: Many relevant tactical/operational decisions in SCM, as it is the case with procurement, routing and the choice of transportation modes, are far from being integrated with location decisions (Melo et al., 2009). Thun and Hoenig (2011) study the empirical analysis of supply chain risk management practices. The results show that the group using reactive supply chain risk management has higher average value in terms of disruptions resilience or the reduction of the bullwhip effect, whereas the group pursuing preventive supply chain risk management has better values concerning flexibility or safety stocks.
- Logistics in SCM: A supply chain consists of all parties involved, directly or indirectly, in fulfilling a customer request. The supply chain not only includes the manufacturer and suppliers, but also transporters, warehouses, retailers, and customers themselves (Mithun et al., 2008). Logistics costs comprise a significant and relevant proportion of business costs, often exceeding 10 percent of company turnover (Engblom et al., 2012).
- Collaborative supply chain management: Diponegoro and Sarker (2009) propose an optimal policy to minimize the total cost of a manufacturer that procures raw materials from multiple suppliers, processes and delivers finished goods to multiple customers. Lai et al. (2009) think that a supply chain may operate under either preorder mode, consignment mode or the combination of these two modes.
- Coordination in supply chain management: Chen and Ding (2008) address supply chain coordination with flexible return policies; Plambeck and Taylor (2007) address the impact of repeatedly contracting on supply chain coordination; Choi et al. (2008) examine a supply contracting problem between parties who have mean-variance objectives. Seifert et al. (2012) study coordination in a three-echelon supply chain and examines the impact of sub-supply chain coordination.
- SCM models/tools/application cases: Melo et al. (2009) show that economic globalization has created new opportunities for companies to grow their businesses by marketing their products and offering their services all over the world. A good social system enables enterprises to enhance supply chain coherence, while a solid technical infrastructure helps a supply chain to gain competitive positions (Chow et al., 2008).

2.2. Supply chain modeling

Min and Melachrinoudis (1999) configure multi-echelon supply chain networks connecting material flows among suppliers, manufacturers, break-bulk terminals, and customers. Their analytic hierarchy process-based model also considers contingency planning associated with supply chain reconfiguration. McLaughlin et al. (2006) report on research to date concerning the creation of a hybrid model for managing performance and decision making with elements of an IBM supply chain. Coordination is a key concept in supply chains. In most definitions of supply chain management (SCM), coordination has an important role. Coordination models introduced in the literature include quantity discount models, return policies, revenue sharing contracts, credit option (delay in payments contracts), and quantity flexibility (Chaharsooghi and Heydari, 2010). Swaminathan and Tayur (1999) solved a so-called vanilla box problem where the inventories of semi-finished products were stored in vanilla boxed and then were assembled into final products after a customer actually ordered them further into the supply chain. Khan and Pillania (2008) explore the dimensions of strategic sourcing and determine its relationship with organizational supply chain agility and performance. It classifies manufacturing firms based on their level of supply chain agility and tests the differences in firms' performance across the clusters so obtained. In an effort to integrate inventory, transportation and location functions of a supply chain, Nozick and Turnquist (2001) proposed and approximate inventory cost function and then embedded it into a fixed-charge facility location model.

Recently, the efficient design and operation of supply chains with return flows have, in particular, become a major challenge for many companies, given the high number of factors involved and their intricate interactions (Salema et al., 2010). Although most supply chain issues are strategic by nature, there are also some tactical problems. These include inventory control, production/distribution coordination, order/freight consolidation, material handling, equipment selection, and layout design. The problems encountered when dealing with operational routines include vehicle routing/scheduling, workforce scheduling, record keeping, and packaging. It should be noted that the aforementioned distinctions are not always clear, because some supply chain problems may involve hierarchical, multi-echelon planning that at overlap different decision levels. Supply chain models can also be classified into various frameworks