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A strategic approach to improve sustainability in transportation service procurement

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ABSTRACT

This paper focuses on the procurement of full truck-load transportation service with the view to ensuring sustainability in transport logistics. The carrier assignment problem (CAP) involved in truck load contract auction is studied using a complete enumeration method and heuristic approach. Performance of both methods is compared in terms of solution quality and computational time based on the results of sample problems considered. Also, the impact of combinatorial bidding on reducing empty haul in real world case is analyzed and environmental sustainability is achieved through reduction in carbon foot print.

1. Introduction

The importance and the need for sustainable business development in logistics (e.g. green logistics) has been widely recognized in recent years. Sustainability has become one of the greatest challenges of the 21st century because of the rapid growth of world population, globalization, outsourcing operations and intensity of customer demands. Sustainable business development is a holistic strategic management that includes the entire value delivery chain from the origins of raw materials to production processes, customer applications and the end-of-life solutions (Rainey, 2006). Each and every product manufactured in the industry reaches the end customer through various stages of a supply chain. The role of logistics in the distribution of goods along the supply chain is inevitable. In the era of globalization and e-commerce, the role of logistics has become more and more demanding due to needs for cross continental movement of freights. Efficient logistics service networks are required so that the goods can be delivered to customers at right time in right quality.

Nowadays, most manufacturing companies have factories and facilities at different parts of the globe and a market that spans the entire globe. In these circumstances, multi-modal transportation is essential for servicing various transportation demands in their global supply chains (Barnhart and Laporte, 2007). In multi-modal transportation, a product is transported from the manufacturing facility to the end users through various channels of supply chain by using different transportation modes such as air, road, rail and sea routes. It should be noted that most domestic freight is transported by roads and trains. Trucks are normally used for moving the goods from one part of a country to the other either as a truckload or less-than truckload (consolidated package). From the sustainable perspective, Life Cycle Assessment (LCA) is a very important tool

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to identify the scope for improvement in each and every activity of all the LCA phases, including the transportation phase. In this scenario, it is vital to eliminate unnecessary movement in the distribution channel. According to Blaeser and Whiting (2012), among the current green technologies used by the logistics industries, route optimization is the most prominent one especially with the large sized truckload industries. Studying the interaction between sustainability and technological innovation in the field of logistics is essential (Klumpp et al., 2009). To leap forward in this direction, an attempt is made in this paper to reduce transportation costs (and emissions) by reducing empty haul of the carriers in the full truckload industry.

Truckload transportation service can be either full truckload or less-than truckload. In full truckload transport, a dedicated truck is deployed for moving a shipment from its origin to the destination; whereas in the less-than truckload transport, many smaller shipments are consolidated and moved by using a single truck. Full truckload is very common in industry because of dedicated fleet movements along the supply chain without intermediate stops. This ensures on time delivery of goods at the destinations which can be difficult to achieve in the case of transfer oriented less-than truckload services.

Manufacturing industries nowadays tend to outsource transport logistics activity to improve efficiency and reduce cost. For this purpose, a contract will be established by a manufacturer with the freight service companies for the period of two or three years. Auction procedure is generally followed for allocating the lanes to the different trucking companies. Here a lane refers to a source–destination pair, between which freight has to be moved. This research work studies the problem of assigning lanes to various carriers who participate in the auction, formally called as carrier assignment problem (CAP) (Sheffi, 2004). It is also known as the Winner Determination Problem (WDP). CAP is a complex problem faced in a transportation service procurement auction for establishing contracts with carriers. So far the research in this area (particularly with the combinatorial bidding) is limited and hence requires more attention.

In recent times, combinatorial bidding has become very important in transportation service auctions because of the associated benefits of utilizing economy of scope. Economy of scope is nothing but an opportunity available for the carrier to utilize the empty movement in their existing network in the future bidding. If the lane offered in a particular call for bidding matches with the lanes of empty movement in their current network, then there is an opportunity to aggressively bid for these lanes since it adds no significant cost to the carrier. Also in combinatorial bidding, carriers can submit bids in the form of lane bundles that enable the carrier to bid for combinations of lanes of their own choice with less empty movements. According to Lee et al. (2007), repositioning of empty trucks constitutes a substantial portion of operating expenses. Here, there is no risk of getting an incomplete set in the bundle and hence carriers can bid without fear of exposure problems. This way, shippers will benefit as the transportation cost will be reduced, leading to a win–win situation for both carriers and shippers. This will also lead to logistics sustainability because of the scope for elimination or reduction of empty truck movement.

From the summary of survey shown in Table 1, it is evident that various authors have addressed the sustainability aspect in different areas of research in logistics such as 3PL, reverse logistics, logistics operations and customized logistics. Issues related to social sustainability (Presley et al., 2007; Sarkis et al., 2010) as well as environmental sustainability (Lieb and Lieb, 2010; Dey et al., 2011) are discussed. All these works are confined to the above mentioned topics in logistics and no article is found in transportation service procurement. In this regard, an attempt is made in this work in such a way that sustainability is achieved through route optimization. Route optimization achieved by reducing empty movement of trucks, which is the main advantage of using combinatorial bidding. To solve CAP with combinatorial bids, a heuristic method is proposed and explained in detail in Section 6.

In this study, combinatorial bids are considered in order to exploit the associated cost related benefits and also to minimize the carbon footprint because of the elimination of unwanted empty movement of trucks. This will enhance the chances of achieving the environmental sustainability in logistics management. Even though various authors (Song and Regan, 2003; Sheffi, 2004; Ma et al., 2010) have discussed the advantages of combinatorial bidding in truckload procurement auction in detail, our approach is more holistic, as environmental sustainability benefits derived through combinatorial bidding is also accounted for along with cost reduction. But in practice, the use of combinatorial bidding in truckload procurement auction is very limited and in this regard, this research work addresses the real world bidding case. The carrier assignment model is solved for the problem considered by using both a complete enumeration method and a heuristic approach. Cost savings and sustainability related benefits are achieved through adoption of combinatorial bidding hence it is considered in this study. In formulating the carrier assignment model, demands for each lane are taken from the estimated data available in the call-for-bidding offered by the shipper, but it is assumed as unity in most of the literature (Song and Regan, 2003; Sheffi, 2004; Guo et al., 2006). In the real world transportation service procurement process, load to be moved in each lane is not unity and it varies across different lanes. This study considers such a varying demand pattern so that the model is closer to the reality.

The rest of the paper is organized as follows. Section 2 describes the procedures and terminologies involved in truckload procurement auction for establishing a contract. In Section 3, literature related to logistics sustainability and carrier assignment problem is discussed separately in detail. Section 4 presents the formulation of the carrier assignment problem. Section 5 describes a complete enumeration method for the proposed carrier assignment problem of different sizes. Section 6 details a heuristic approach for solving the above mentioned problem. In Section 7, results obtained by the proposed methods are compared and their performance is elaborated. Section 8 summarizes the concluding remarks and scope for future research.