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Customer service based design of the supply chain

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Abstract

The purpose of this study is to propose a framework by which service elements and a company's own strategies can be included in the "traditional", cost-based design of the supply chain. The framework is demonstrated with a numerical example and it is based on integrating the analytic hierarchy process (AHP) and mixed integer programming (MIP). The target is to optimise a company's supply chain based on customer service requirements within the constraints of the supply chain.

Keywords: Supply chain management; Logistics management; AHP

1. Introduction

Supply chain design has been an important part of the logistics decision-making process in companies. The importance of supply chain design has increased when more and more companies have realised the possibilities of gaining additional value for their customers by restructuring the supply chain. In fact, the growing awareness of the critical impact of supply chain management on an organisation's competitiveness, profitability and strategic advantage has made supply chain a truly strategic issue and it has received increased emphasis everywhere [1,2]. In addition, transportation as a part of logistics operations can be seen as a value-adding process that directly supports the primary goal of the organisation, which is to be competitive in terms of high-level customer service, competitive price and quality, and flexibility in responding to market demands [3]. The focus of logistics is increasingly turning towards providing better services for customers instead of minimising the total transportation or logistics costs or maximising the total profits of the supplier. Furthermore, logistics managers put more emphasis on controlling the whole logistics chain than concentrating on the problems of one echelon in the logistics process. One result of this is that there has been a growing interest on partnership and customer satisfaction issues. Firms are moving from a decoupled decision making process towards a more coordinated and integrated design and control of their supply chain to provide goods and services to the customer at low cost and high service levels [4]. Companies must also be able to efficiently respond to changes and reconfigure their resources to be able to

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compete and create profit by taking advantage of the opportunities occurring in the market place [5].

Historically, the three fundamental stages of the supply chain, procurement, production and distribution, have been managed independently and buffered by large inventories [4]. This policy has changed, especially manufacturers have increasingly given their attention to the management of logistics issues, in the pursuit of strategies that will give them competitive advantage [6]. It is a well-known fact, that it is possible to gain even more advantage by improving the logistics chain instead of improving the performance of one player in the chain. Therefore, the area of logistics research is nowadays not solely restricted to the production process itself but has spread into a wide range of subjects relating to the entire material flow into, within, and out of the organization [7].

Section 2 discusses the different approaches to the distribution network design problem. In Section 3, we present an approach to customer service-based design of the supply chain which is based on the integrated utilisation of the analytic hierarchy process and mixed integer linear programming.

2. Logistics network design problem

The design of logistics network structure is an essential part of the location problem, which also is a well-known mathematical problem. One of the first theoretically oriented and widely quoted location problem papers was written by Hakimi [8]. After him, according to Hakimi and Kuo [9] it was Geoffrion and Grawes, who first included production in the facility location models. These models are called capacited production location problems. The first location–production–allocation problem with price-sensitive demands was given by Wagner and Falkson [10] (see also [11]). Since then several topics have been added to this base locating theory. The basic case is that facilities are to be established to meet fixed market demand by minimising the total cost of location, operation and transportation [9,11].

There are also many papers that deal with the plant location theory (see e.g. Verter and Dincer [12]). This paper presents the standard division of the plant location models:

- simple plant location problem (SPLP)
- plant location under uncertainty (SPLPU)
- international plant location problem (IPLP)

SPLP provides two types of decisions simultaneously [12] locational and allocations decisions. The SPLP model simply satisfies the market demands with minimal costs. According to Sridharan [13] the SPLP problem can also be called uncapacited plant location problem when each potential plant does not have an upper bound capacity on the amount of demand that it can serve. The SPLPU problem has a profit maximization objective, and the IPLP problem is stochastic in nature due to randomness in price and exchange range movements.

The most traditional quantitative framework for distribution network design is the cost minimisation approach, see for example, [11,14,15]. According to Lee [11] these models simultaneously locate a set of facilities and satisfy the demands of a given set of customers to minimise the total cost of location, operation and transportation. However, the problem of the cost minimisation framework is that it focuses the problem on the deliverer's point of view, and excludes the profitability to the customers. The focus of a more advanced distribution network design framework is on profit maximisation, see for example, Hakimi and Kuo [9]. In the profit maximisation framework the costs of the distribution network are deducted from the customer's profits. No attention is paid to the customer's wishes, however, and therefore, they are not satisfied. In several papers, for example, Meshkat and Ballou [16] and Canel and Khumawala [17], customer service elements have been included in the distribution design problem, in addition to cost and profit information. Typically this, the so-called service-sensitive framework, includes elements like product availability, delivery time requirements and delivery frequencies.

In this paper, we propose a customer service-based approach to distribution logistics network design. The more widely used approaches for logistics network design are the minimisation of costs and maximisation of profits whereas the proposed