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. © 2001 Elsevier Science B.V. All rights reserved.

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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
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 distri-
bution, have been managed independently and buf-
fered by large inventories [4]. This policy has
changed, especially manufacturers have increas-
ingly 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 ser-
vice-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 loca-
tion problem papers was written by Hakimi [8].
After him, according to Hakimi and Kuo [9] it was
Geoffrion and Graves, who first included produc-
tion in the facility location models. These models
are called capacitated 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 models:
- simple plant location problem (SPLP)
- plant location under uncertainty (SPLPU)
- international plant location problem (IPLP)

SPLP provides two types of decisions simulta-
neously [12] locational and allocations decisions.
The SPLP model simply satisfies the market
demands with minimal costs. According to Srid-
haran [13] the SPLP problem can also be called
uncapacited plant location problem when each po-
tential plant does not have an upper bound capac-
ity on the amount of demand that it can serve. The
SPLPU problem has a profit maximization objec-
tive, 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 minimisa-
tion approach, see for example, [11,14,15]. Accord-
ing 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 loca-
tion, 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 cus-
tomers. The focus of a more advanced distribution
network design framework is on profit maximisa-
tion, see for example, Hakimi and Kuo [9]. In the
profit maximisation framework the costs of the
distribution network are deducted from the cus-
tomer’s profits. No attention is paid to the cus-
tomer’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 logis-
tics network design are the minimisation of costs
and maximisation of profits whereas the proposed
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