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Location of distribution centers in a multi-period collaborative distribution network

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Abstract

This paper presents a research study which aims at determining optimal locations of regional distribution centers in a collaborative distribution network. We consider a multi-layered distribution system between a cluster of suppliers from a given region and several thousands customers spread over the whole country. The optimization problem consists of finding the locations of intermediate logistics facilities called regional distribution centers and assigning customers to these facilities according to one year of historical data. The distribution system combines full truckload (FTL) routes and less-than-truckload (LTL) shipments. The use of several rates for transportation, as well as the high impact of seasonality implies that, for each shipping date, the number of FTL routes and the cost of LTL shipments should be precisely evaluated. This problem is modeled as a mixed integer linear problem and used as a decision aiding tool on a real case study related to the distribution of horticultural products in France.

Keywords: Collaborative distribution network, location-allocation

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1 Introduction

Horizontal collaboration is defined as a business agreement between manufacturers at the same level in the supply chain in order to achieve a common objective. This may be realized by proper manipulation, utilization and sharing of appropriate resources [1]. However, companies which resort to horizontal collaboration are often competitors and they have to overcome many cultural, organizational and technical barriers. Competing companies are often reluctant to share strategic information or resources concerning their core business, while external operations such as the supply or distribution of goods are often natural candidates for collaboration.

The design of collaborative distribution networks belongs to the domain of supply chain network design. One key issue when designing a supply chain network is facility location, which has received considerable attention from academics and practitioners over the last several decades [3]. In general, facility location problems deal with the determination of the optimal number, capacity, type, and geographic location of facilities in such a way that the network cost is minimized while customer demand is satisfied. Facility location is often considered over a strategic planning horizon, generally at least several years.

In this paper, we focus on a cluster of competing companies in the same geographical area in Western France, which decide to establish horizontal collaboration for the delivery of their goods to a large set of customers spread over the whole country.

2 Problem formulation

2.1 Facilities

The distribution system uses a multi-layered distribution network, represented in Figure 1. It is composed of three types of facilities:

- Production Zone (PZ): composed of a set of suppliers and one Consolidation and Distribution Center (CDC). Suppliers are collaborating companies and they are the sources of all material flow in the network. The CDC acts as the main collaborative warehouse at the suppliers gate.
- A set of Regional Distribution Centers (RDCs) which are articulation points between FTL routes and LTL shipments in the collaborative network.
- A large set of customers that are the destinations of all product flows.