

“Mixed-Integer Nonlinear Programming Models and Algorithms for Large-Scale Supply Chain Design with Stochastic Inventory Management”

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Problem Statement

In the joint supply chain network design and inventory management problem, we are given a supply chain consisting of one or more suppliers, a number of retailers i , $i \in I$, together with some candidate sites j , $j \in J$ for distribution centers (the network structure is given in Figure 1). The replenishment lead time of each distribution center is assumed to be the same for all the candidate distribution centers, denoted as L . This in turn means that the suppliers can be treated implicitly and lumped into one supplier. There is a fixed annual setup cost f_j when each distribution center j is installed, and we consider that there are χ days in one year. The daily demand in retailer i is normally distributed with mean μ_i and standard deviation σ_i . The demand of each retailer is assumed to be independent of the other retailer’s demand. Each distribution center can serve more than one retailer, but each retailer should be only assigned to one distribution center to satisfy the demand. Transportation costs for shipments from supplier to distribution center j are expressed by a cost function with fixed cost g_j and variable cost a_j . Linear transportation costs d_{ij} are considered for shipments from distribution center j to retailer i . Most of the inventory in the network is held in the distribution centers where the inventory is managed with an order quantity/reorder point (Q, r) policy with *type I service level* (probability of “no stockout”). Inventory at each distribution centers includes working inventory and safety stock, with unit inventory holding cost h . There is a fixed ordering cost F_j each time when DC j order a

replenishment from the supplier. The retailers only maintain a very small amount inventory whose costs are ignored. To balance the fixed facility location cost, transportation costs and inventory costs, there is a weighted factor β for transportation costs, and a weighted factor θ for inventory costs.

The objective is to determine how many distribution centers to locate, where to locate them, which retailers to assign to each distribution center (DC), how often to reorder for replenishment at each DC, and what level of safety stock to maintain so as to minimize the total location, transportation, and inventory costs, while ensuring a specified service level α .

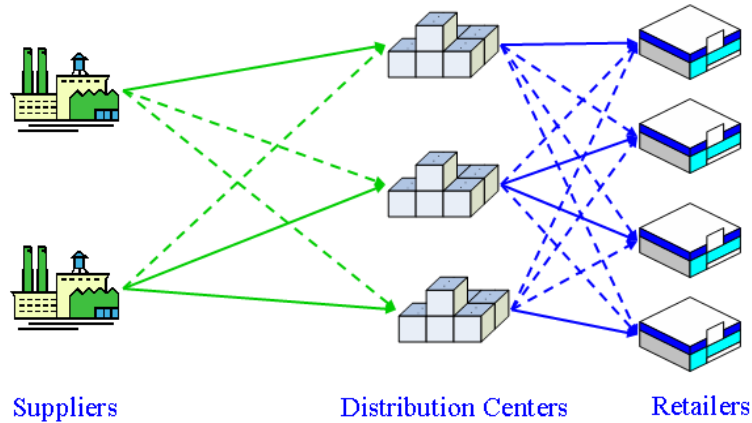


Figure 1 Supply chain network structure (three echelons)