Pooling of logistics flows within a Territory Hospital Group

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1 Motivation and problem description

In recent years, several logistical pooling strategies and models have been developed in the literature to solve the supply chain network design problem and achieve economies of scale [2][3]. Therefore, in order to develop the health care system in France, the hospitals have met, since 2016, to form a Territorial Hospital Groups (THG) that aim at increasing cooperation between public hospitals and pooling the different services between institutions.

Our work consists in designing a new shared logistics network within various establishments of the THG. This collaboration is designed to regroup product flows to a single destination in order to reduce the overall costs, enable the different establishments to rationalize, share and optimize the storage of products in warehouses and pharmacies and, optimize their distribution to care units.

Initially, we applied our resolution approach to the "pre-pooling" model where each product is delivered by several suppliers to all stores (each store has its own supplier). Then, a second model is developed for the "pooling" scenario where each product is delivered by a single (the most economical) supplier to all stores. The objective is to find an optimal allocation of product flows and to set up a pooling scenario that groups one or more sub-families (materials, food, etc.) of products in the suitable warehouses of the THG establishment. Thus, in the hospital logistics network that we consider in our case study, there are warehouses that hold the stock of one or more sub-families of products, and cross-dock stores that represent a point of material handling and distribution, where products are not stored for an extended period of time.

The pooling scenario is carried out in two stages [4], (1) the placement of certain sub-families of products on one or more warehouses and (2) their distribution from these warehouses to one or more cross-docks. The objective is to minimize the total economics costs (full-time equivalent cost (FTE), distribution cost, procurement cost, ordering cost, holding cost).

2 Problem modeling

In order to display clearly the flows of materials (incoming and outgoing) between the actors and to indicate the warehouses in which the products are stored, our supply chain is modeled as a minimum-cost flow graph generalized to several sub-families of products (multi-graph), therefore, it can be efficiently solved in polynomial time [1]. There are three kinds of nodes, representing suppliers, warehouses, and cross-dock stores. Each supplier provides a certain quantity of product, which must be shipped first to a warehouse, and then from a warehouse to a cross-dock store. The proposed model allows to specify for each sub-family, its source (which supplier), its storage locations (warehouse) and its distribution to cross-docks stores. Different constraints should be respected:

- Each facility's demand for a product must be satisfied.
- The maximum storage capacity of warehouses should not be exceeded.

As it appears in Figure 1, the problem consists in determining the amount of the flow (quantity of products) not exceeding the capacity in each node (warehouses) to satisfy the demand, while minimizing the total cost.

Among the hypotheses considered, we assume that suppliers have unlimited delivery capacity and that we adopt the on-going supply strategy used in the warehouses.

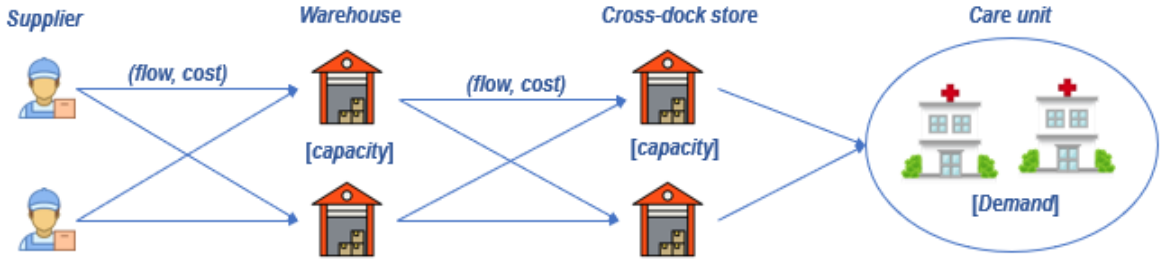

FIG. 1: Minimum-cost flow graph

3 Conclusion and future work

The two linear models (pre-pooled and pooled) are solved using the ILOG OPL-CPLEX solver. The experiments are carried out on two stages. The first was to show the effectiveness of pooling strategy on 3 instances built from a fictitious test base with a huge cost differential. All instances have the same number of suppliers, stores and product sub-families that belong to three main product categories (drinks and food, hotels, office equipment and computers). For the first instance, the unit price of each product varies from 60% to 70% between the different suppliers, as well as for FTE costs. For the second, a price change of up to 20% was considered. The third proceeding shows a slight variation (2-3%) in both FTE and distribution costs with relatively close replenishment periods for all stores. A comparison between the costs of each scenario is carried out for all instances by measuring the percentage of gain realized. The second step of the experimentation was to make a sensitivity analysis on both procurement and distribution costs to demonstrate exactly when the pooling strategy is advantageous.

This work aims to design an optimization model to organize product pooling within a THG in order to minimize logistics costs. As a future work, we will propose a model that considers uncertainties related to the demand of care units by using the possibility theory and fuzzy numbers.

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