

SOLVING A REAL-WORLD SUPPLY CHAIN PROBLEM BY MATHEURISTICS: CHALLENGES AND PRACTICAL SOLUTIONS

Alexandre Checoli Choueiri⁽¹⁾, Leandro Magalhães⁽²⁾

⁽¹⁾Federal University of Paraná (UFPR)

⁽²⁾Federal University of Technology - Paraná (UTFPR), Graduate Program in Electrical and Computer Engineering (CPGEI)

Keywords: Supply chain management; matheuristics; real-world case study; capacitated facility location; multi-period production-distribution inventory management; fleet composition and sizing.

Abstract

As a company expands, it may become necessary to establish strategic policies to improve service levels. When such services depend on industrial operations, this can lead to decisions about opening new facilities. The problem of determining facility locations, as with all strategic decisions, involves significant financial investments and long-term commitments. Typically, when such problems arise, a range of related decisions must also be considered, since site selection influences and often constrains other network design choices.

The production-distribution optimization problem captures several of these decisions. In this paper, we describe a case study based on real-world data from a food manufacturing company. The problem, at its core, involves determining the optimal locations for capacitated distribution centers (DCs), as well as quantities of (different) products transported from factories to these DCs and from the DCs to final customers. The main objective is to satisfy demands while minimizing total costs. Also, when customer demand and/or factory capacities are not constant, a time horizon must be incorporated to capture such variations, leading to a multi-period dimension. In addition to the above-discussed characteristics, the problem also involves tactical decisions, such as fleet composition and production, that share resources across different product families.

We propose an integer programming (IP) model to represent the problem, along with a math-heuristic solution approach. The heuristic, based on Variable Neighborhood Search (VNS), is used to determine the set of distribution centers (DCs) to be opened. Subsequently, the IP model is solved, fixing the selected DCs to determine product flows and inventory levels. As a second stage, for all determined flow arcs, we use a Variable Size Bin Packing (VSBP) model to determine the fleet-composition for each factory and warehouse.

Although this methodology may serve as a general solution framework, a variety of nuances must be addressed when solving a real-world case study. For example: (a)

the number of clients may become prohibitively large, even for a math-heuristic approach; (b) if some form of clustering is applied, this may affect the cost function, as it becomes an approximation; and (c) the classical inventory balance constraint enforces zero inventory in the final period, which may not reflect the company's desired operating conditions, among others.

In this paper, we briefly describe the matheuristic solution approach used to solve large real-world instances; however, we focus on exploiting the interface between application requirements and the mathematical and computational adaptations needed to apply the framework in practice. Each adaptation point is discussed in detail to provide insights for future researchers dealing with similar case studies.