Chapter 11
Combining Fix and Relax Heuristic and LP-Metric Method to Solve the Multi-Objective Integrated Production-Routing Problem

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ABSTRACT

Production routing problem is one of the problems of the integrated planning that interests in optimizing simultaneously production, inventory, and distribution planning. This chapter has the purpose of developing two mono-objective models for the production-routing problem: one of them minimizes the total costs which is the classical objective while the other one minimizes the energy consumed by the production system. A bi-objective model is then proposed to combine the two objectives mentioned previously using LP-metric method. To solve big instances of the problem in reasonable time, an approximate approach is proposed using the rolling horizon-based fix and relax heuristic. Finally, computational results are presented to compare the solutions obtained by both approaches.

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INTRODUCTION

Presently, in the economic context, the relationship between the customer and the supplier has strongly progressed, establishing the need for products and services customization, minimizing the delivery delays, delivery channels multiplication, and satisfaction rates. This led industrial companies to search for new methods to improve their performances and answer the greater degree for customers' expectations. Facing these goals, those companies need to set new planning all along the supply chain network to optimize their processes.

Supply chain management is a huge field that aims to better organize the companies' operations throughout the chain (from the initial suppliers until the distribution of the final product to the final customers) where there are so many issues to deal with. More recently, the focus on the integrated supply chain has become bigger. In fact, its benefits have been proven through the literature, optimizing many activities in a single problem, where its results are better than those of the optimization of each activity independently. For that reason, the operational research community pays more attention and gives more importance to this kind of integrated problem.

The Production Routing Problem (PRP), addressed in this chapter, makes part of the above-mentioned integration problems. In such a problem, the aim is to simultaneously optimize the production decision, the inventory, and the distribution. The PRP is an NP-hard problem because it jointly optimizes many decisions that are: setup, production, inventory, delivery amounts and routing decisions, which makes the problem hard to be solved, seeing that the various decisions may be conflicting, and finding the compromised solution with multiple decision variables under various categories of constraints presents the complexity of the problem. The PRP combines two famous classic problems: the Lot-Sizing Problem (LSP) and the Vehicle Routing Problem (VRP), which was presented by Adulyasak et al. (2015), and both of them have been widely studied. The LSP is the problem of determining the optimal production schedule with the optimal decisions of the amounts to produce and store according to customers' demands. At the same time, the VRP is the problem of determining the optimal vehicle routes either in a term of cost or distance.

The PRP may arise within a supply chain composed of a manufacturing factory that has the role of producing goods and delivering them to a set of customers or warehouses. According to the literature, the PRP aims to find the optimal production and distribution schedule in a multi-period planning horizon to minimize the whole system costs.

Most of the papers dealing with the PRP consider only the total costs minimization (setup, production, inventory and transportation costs) while energy, which is a very important aspect, has not yet been considered. To this fact, and through this work, we propose to include the concept of energy into the PRP definition, and we make a call, in our study, to a multi-objective method. To deal with such a problem, we provide a MILP approach that considers both classical and energy-minimizing PRP versions.

Nowadays, energy consumption has a strong relationship with the worldwide economic development, and because of the limited natural resources, energy has become a critical factor that affects the sustainable development of the industrial and transportation sector. We analyze, in this chapter, the relationship between the cost and the power in the integrated Production-Routing Problem that may be important for production and distribution companies in order to optimally manage their organizations. This chapter contributes to a better understanding of the conflict between the cost and the power consumption, as well as the impact of the power notion on the whole system decisions.