Optimize Short to Long Run Supply Chain Planning

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INTRODUCTION[1]

There are certain industries that have historically used optimization and related operations research techniques as key components of their standard business practice. The airline and oil industries represent two examples that for decades have heavily utilized Operations Research (OR) techniques to support operations. There are also a wide range of firms that utilize optimization and OR techniques on a much more sporadic or one-off basis. In this chapter, we describe how private industry practitioners can and should employ mathematical optimization models to improve their logistics and supply chain operations at the strategic, tactical and operational levels. Additionally, we recommend approaches that can further the use of optimization and related methods in firms that may not have a rich history of utilizing these valuable techniques. Finally, supply chain operations and planning encompasses an extremely broad array of functions and processes ranging from sourcing and procurement, to manufacturing and distribution, to customer service and delivery, as well as related activities such as information technology applications, collaboration and information sharing strategies, etc. Therefore, for illustrative purposes and to narrow our discussion, in this chapter we focus primarily on manufacturing and distribution planning and operations; two key logistics and supply chain activities.[2]

To facilitate this discussion, we first review a hierarchical framework for organizing logistics and supply chain operations from the strategic level to the daily operating level. This will provide context for the balance of the chapter. We next consider traditional opportunities to employ optimization and related methods across this framework of activities. The discussion will also address "barriers and impediments" that exist in many organizations which lead to an underutilization of optimization methods. Following this, we review an approach that the author has employed in industry practice to facilitate the use of optimization and related Decision Support System (DSS) methods as a standard business practice. This review will include citations from several implementations. The chapter finishes with some thoughts on potential future directions in the application of practical optimization DSS models, and then final conclusions.

In summary, the objectives of this chapter include the following:

1. To illustrate how optimization DSS methods can enhance logistics and supply chain operations planning and scheduling,
2. To describe a hierarchical planning framework which firms can employ to organize planning and scheduling activities at the strategic, tactical and operational levels, and
3. To recommend a strategy for implementing optimization and related logistics and supply chain planning DSS methods in a firm.

BACKGROUND

There are major organizational issues, systems and infrastructure considerations, methodology issues, and numerous other problem dimensions to evaluate in formulating a firm's logistics and supply chain network planning approach. From all perspectives, effective supply chain planning

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over multiple time horizons requires that a firm establish appropriate linkages across horizons and establish points of intersections between these horizons. To facilitate a planning system that possesses the appropriate linkages, a firm must have an overall framework that guides how different planning horizons and planning components fit together.

A framework for supply chain and logistics planning should be hierarchical (i.e., should have multiple, linked planning horizons), and should define three planning levels, namely the strategic, tactical, and operational levels. The reader interested in an extended review of hierarchical supply chain planning systems is referred to Liberatore and Miller (2012), and Miller (2002). Briefly however, strategic planning activities focus on a horizon of approximately two or more years into the future, while tactical and operational activities focus on plans and schedules for 12 to 24 months, and one to 18 months in advance, respectively. At the corporate strategic level, a firm must address such key issues as overall firm objectives, market share and profitability goals, business and product mix targets, and so on. Planning decisions on overall corporate objectives drive strategic logistics and supply chain decisions. For example, market share and business or product mix objectives will strongly influence manufacturing capacity strategies.

At the strategic manufacturing planning level, the firm must address such issues as planned production capacity levels for the next three years and beyond, the number of facilities it plans to operate, their locations, the resources the firm will assign to its manufacturing operations, and numerous other important long term decisions. Decisions made at the strategic level place constraints on the tactical planning level. At the tactical level, typical planning activities include the allocation of capacity and resources to product lines for the next 12 to 18 months, aggregate planning of workforce levels, the development or fine-tuning of distribution plans, and numerous other activities. Within the constraints of the firm's manufacturing and distribution infrastructure (an infrastructure determined by previous strategic decisions), managers make tactical (annual)[3] planning decisions designed to optimize the use of the existing infrastructure. Planning decisions carried out at the tactical level impose constraints upon operational planning and scheduling decisions. At this level, activities such as distribution resource planning, rough cut capacity planning, master production scheduling, warehouse, transportation and shop floor control scheduling decisions all occur.

Feedback loops from the operational level to the tactical level and from the tactical level to the strategic level represent one of the most important characteristics of hierarchical logistics and supply chain planning systems. To assure appropriate linkages and alignment between levels, a closed-loop system which employs a "top down" planning approach complemented by "bottom up" feedback loops is required. For example, production and distribution plans which appear feasible at an aggregate level can often contain hidden infeasibilities that only manifest themselves at lower, more disaggregated levels. Without proper feedback loops imbedded into its planning system, the danger that a firm will attempt to move forward with infeasible plans always exists. These infeasibilities often do not surface until a firm is in the midst of executing its operational plans and schedules. For additional detail on the importance of feedback loops, the reader is referred to hierarchical production planning literature (see e.g., Hax & Meal, 1975; Miller, 2002; Miller, 2009; and Liberatore & Miller, 2012).

MAIN FOCUS

One can support a hierarchical framework with a wide variety of optimization and simulation models at all three supply chain planning levels. To illustrate these potential opportunities, consider Figure 1 which presents a generic tactical, operational (and strategic) manufacturing and distribution planning system. For purposes of this paper,

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