

CHAPTER 1

INTRODUCTION

1.1 OVERVIEW OF SUPPLY CHAIN MANAGEMENT

The term **supply chain management** is difficult to define, and its definition has changed over time as the purposes and components of supply chains have evolved. Perhaps the most authoritative definition comes from the Council of Supply Chain Management Professionals (CSCMP), who define supply chain management as follows:

Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies. (Council of Supply Chain Management Professionals (CSCMP) 2011)

In the interest of keeping things a little simpler, we offer the following definitions:

A *supply chain* consists of the activities and infrastructure whose purpose is to move products from where they are produced to where they are consumed. *Supply chain management* is the set of practices required to perform the functions of a supply chain and to make them more efficient, less costly, and more profitable.

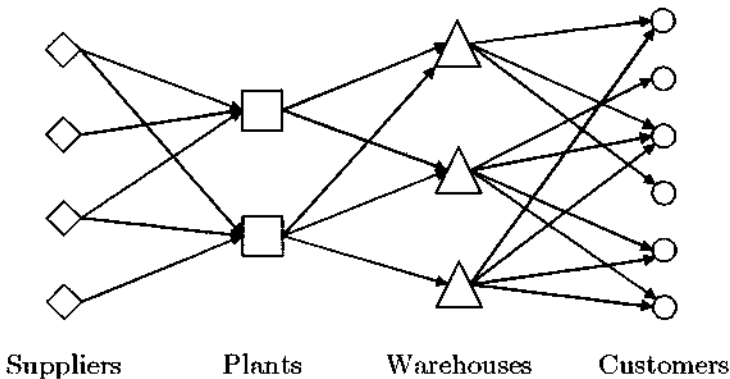


Figure 1.1 Schematic diagram of supply chain network.

Supply chain management costs firms over US\$1 trillion per year in the United States alone (Council of Supply Chain Management Professionals (CSCMP) 2010), representing nearly 10% of gross domestic product (GDP). These practices include a huge range of tasks, such as forecasting, production planning, inventory management, warehouse location, supplier selection, procurement, and shipping. Mathematical models have been developed to analyze and optimize each of these practices, and these models are the primary focus of this book.

The terms “logistics” or “logistics management” are closely related to “supply chain management.” In fact, we consider them to be roughly synonymous.

Supply chains are often represented graphically as a schematic *network* that illustrates the relationships between its elements. (See Figure 1.1.) Each vertical “level” of the supply chain (suppliers, plants, etc.) is called an *echelon*. A location in the network is referred to as a *stage* or *node*. The links between stages represent some type of flow—typically, the flow of goods, but sometimes the flow of information or money. The portion of the supply chain from which products originate (the left-hand portion in Figure 1.1) is referred to as *upstream*, while the demand end is referred to as *downstream*.

Actually, the phrase “supply chain” is a bit of a misnomer, since “chain” implies a linear system like the one pictured in Figure 1.2. In this system, sometimes referred to as a *serial system*, each echelon has only a single stage. But today’s supply chains more closely resemble the complex network in Figure 1.1; each echelon may have dozens, hundreds, or even thousands of nodes. (Nevertheless, we will often study serial systems of the type pictured in Figure 1.2. Even more frequently, we will study single-stage systems.)

The models we study generally try to find the least-cost or greatest-profit solution that satisfies some constraints. For example, a firm might want to choose warehouse locations to minimize transportation costs, subject to the constraint that every customer must be served. Or it might want to decide how much inventory should

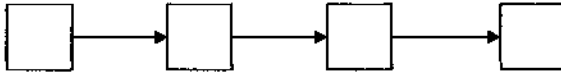


Figure 1.2 Supply “chain.”

be stored at a given warehouse in order to minimize the cost of holding inventory, subject to a “service level” constraint that requires a certain percentage of customer orders to be satisfied on time. Or it might want to design a contract with its supplier to maximize its own profit, or that of the supply chain as a whole.

The ideal supply chain management model would *globally* optimize every aspect of the supply chain, but such a model is impossible both because of the difficulties in modeling some aspects of the supply chain mathematically, and because the resulting model would be too large and complex to solve. Instead, supply chain models typically focus on *local* optimization of one element of the supply chain, or on the integration of two or more aspects of the supply chain, generally in less detail.

1.2 LEVELS OF DECISION MAKING IN SUPPLY CHAIN MANAGEMENT

It is convenient to think about three levels of supply chain management decisions: strategic, tactical, and operational.

- *Strategic* aspects of the supply chain involve decisions that take effect over a long time horizon, typically years or decades. These aspects have a major impact on all functions of the firm. Examples include locations and sizes of warehouses, locations and capabilities of factories, and contracts with suppliers.
- *Tactical* aspects of the supply chain involve decisions over a moderate time horizon like months. Tactical decisions can be changed periodically but generally with some difficulty. Examples include assignments of customers to warehouses and inventory replenishment policies at warehouses.
- *Operational* aspects of the supply chain occur over short planning horizons like days or weeks, during which policies must be executed but cannot be changed. Examples include filling customer orders and routing of delivery vehicles.

The models in this book are mostly concerned with strategic and tactical decisions.

1.3 APPLICATIONS OF SUPPLY CHAIN MANAGEMENT

Although the models and algorithms in this book are most commonly applied to traditional, private-sector supply chains, many can be applied to new kinds of supply

chains, and even to areas we might not think of as supply chains. Understanding the building blocks of traditional supply chains will prepare you to understand more recent applications of supply chain theory, a few of which are briefly discussed below.

“Green” Supply Chains: Companies, like individuals, are increasingly concerned about their environmental impacts, and many have begun to make their supply chains “greener.” Some companies have started to look at overall supply chain carbon emissions, from the burning of fuel in truck engines to the generation of power to maintain warehouse temperatures. However, early research on supply chain emissions has tended to focus narrowly on one aspect of the supply chain at a time, ignoring the internal dynamics of the supply chain. There is a need to develop integrated supply chain models that evaluate the environmental impacts of suppliers, manufacturers, and distributors in order to make environmentally sound decisions. Some of the topics covered in this book, especially the models that integrate multiple functions of the supply chain, may help lay the groundwork for such research.

Energy: Historically, electricity grids have functioned like the ultimate just-in-time supply chains, with no (or very little) inventory and almost instantaneous delivery of goods (i.e., energy). However, the modernization of electricity grids will provide new opportunities for optimizing their design and operation. Tomorrow’s grids are likely to look a lot like today’s supply chains, with inventories (in the form of large-scale batteries and other storage devices), supply uncertainty (from volatile renewable generation sources such as wind and solar), demanding customer service requirements (as electricity markets continue to become deregulated and new competitors enter the marketplace), and novel pricing schemes (enabled by new communication infrastructure that can communicate pricing information in real time). In addition, classical principles of facility location will play a role in designing these grids, as will newer models for robust and resilient network design, as it becomes increasingly important to protect the grid from accidental or intentional disruptions that can affect the lives and livelihoods of millions of people. By viewing the grid as a supply chain network, we can leverage existing tools to develop a new generation of electricity systems.

Health Care: The portion of the United States gross domestic product (GDP) that is devoted to health care is roughly equal to the entire GDP of China, and health care costs continue to grow. The health care system encompasses many complex supply chains, and there are many opportunities to improve the operations of these supply chains using the tools discussed in this book. Moreover, there are “virtual” supply chains within the health care system—flows of people, expertise, money, and other resources whose behavior can be modeled using many of the same techniques. In addition, the health care system consists of a huge number of individual parties—hospitals, doctors, insurers, pharmaceutical and device companies, patients—with often conflicting objectives. Coordination models of the type covered in this book will be useful tools for ensuring that the net result of the interactions among these parties is beneficial to patients and to society as a whole.