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EDITION



Introduction to Operations and Supply Chain Management

FOURTH EDITION

Cecil C. Bozarth • Robert B. Handfield

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INTRODUCTION TO OPERATIONS AND SUPPLY CHAIN MANAGEMENT

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PEARSON

To Andrea, James, and Philip

C.B.

To the Memory of My Brother, Carl Handfield

R.H.

ABOUT THE AUTHORS



Cecil Bozarth is Professor of Operations and Supply Chain Management at the Poole College of Management at N.C. State University, where he has received awards for teaching excellence at both the undergraduate and graduate levels. He is a former chair of the Operations Management Division of the Academy of Management, and in 1999 was recognized by APICS as a subject matter expert (SME) in the area of supply chain management. His particular areas of interest are operations and supply chain strategy and supply chain information systems. Cecil's consulting experience cuts across a wide range of industries, including such companies as BlueCross BlueShield of North Carolina, Daimler-Benz, John Deere, Duke Energy, Eisai, Ford Motor Company, GKN, IBM, GlaxoSmithKline, Milliken, Patheon, Sonoco, and others. For thirteen years, Cecil was an associate editor for the *Journal of Operations Management*; he now serves on the journal's editorial advisory board. Cecil has also served as a guest editor for the *Academy of Management Journal*, as well as the *Journal of Operations Management*.



Robert Handfield is the Bank of America Professor and a Distinguished University Professor at N.C. State University. Handfield has consulted with over 25 Fortune 500 companies, including Biogen Idec, Caterpillar, John Deere, GlaxoSmithKline, Boston Scientific, Delphi, Chevron, British Petroleum, Chevron Phillips, Bank of America, Sensata, Honda of America, KPMG, Conoco Phillips, Federal Express, SAP, and others, and is a world-renowned expert in the areas of purchasing and logistics. Rob is the former editor-in-chief of the *Journal of Operations Management* and has written several books on SCM topics, including *Introduction to Supply Chain Management* (Prentice Hall, with Ernest L. Nichols; translated into Japanese, Korean, Chinese, and Indonesian), *Supply Chain Redesign* (Prentice Hall Financial Times), and *Purchasing and Supply Chain Management*, 5th edition (South-Western College Publishing, with Robert M. Monczka, Larry C. Giunipero, and James L. Patterson).

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P R E F A C E

When we set out to write the first edition of this book, we wanted to create an introductory text that provides an integrated and comprehensive treatment of both operations *and* supply chain management. That goal has remained the same through this, our fourth, edition.

NEW TO THE FOURTH EDITION

With this fourth edition, we have continued our strategy of providing detailed coverage of important operations and supply chain topics while still maintaining a trim, integrated book. Here are some of the highlights:

- **MyOMLab**, brand new to this edition, is a powerful tool that ties together all elements in this book into a strategic and innovative learning tool, an exam tool, a homework tool, and an assessment center. By using MyOMLab, instructors can assign hundreds of problems from the text and/or problems and questions from the test bank for students to take online at any time, as determined by the instructor. Visit www.myomlab.com for more information.
- An **Enhanced eText**, available in MyOMLab, gives instructors and students the ability to highlight the text, bookmark, search the glossary, and take notes. More importantly, the eText provides a new way of learning that is particularly useful to today's students. Students are able to review animations of figures, indicated by **MyOMLab Animation**, and videos, indicated by **MyOMLab Video** with a simple click of an icon. Visit www.myomlab.com for more information.
- **Chapter 1, "Introduction to Operations and Supply Chain Management,"** now includes a link to the Institute for Supply Management's (ISM) annual salary survey, which breaks down salaries by job position, work experience, and education level.
- **Chapter 2, "Operations and Supply Chain Strategies,"** begins with a description of Tesla Motor's operations and supply chain strategy that addresses everything from battery manufacturing to supercharging stations and ends with a case study that examines Netflix's strategic shift from a supply chain strategy dominated by *physical* activities to one dominated by *information* flows. The experience of Netflix reinforces the idea that supply chains can link together players through physical flows, information flows, or monetary flows. The idea of using information flows to replace physical flows is one we return to throughout the book.
- **Chapter 4, "Business Processes,"** leads off with a discussion of the challenges Intermountain Healthcare, a Utah-based healthcare provider with 22 hospitals and more than 185 clinics, faces in providing care that is as cost-effective as possible, yet still state-of-the-art and responsive to individual patient's needs. Intermountain's unique solution—developing computerized "protocols" for common ailments while simultaneously preserving the flexibility needed to deal with complex cases—illustrates how critical effective business process management is to meeting today's organizational challenges.
- **Chapter 7, "Supply Management,"** now contains an expanded discussion of social responsibility and how it extends to a firm's sourcing partners. Specifically, the chapter includes a detailed discussion of the challenges facing the apparel industry, which has been rocked by unsafe practices at some of its suppliers.
- **Chapter 12, "Managing Production across the Supply Chain,"** now includes a two-part case study, "BigDawg Customs." The chapter begins by outlining some of the problems BigDawg is facing matching actual customer orders to production and managing inventories. The chapter ends by showing how master scheduling and material requirements planning (MRP) can help BigDawg management deal with these challenges.

COVERAGE OF ANALYTICAL TOOLS AND TECHNIQUES

Even with the extended focus on SCM, this book does not overlook the important role of analytical tools and techniques. In fact, these subjects are covered in a way that is both comprehensive and integrated throughout the text. The key tools developed in the text are the ones most frequently mentioned by professors and represent a fundamental “tool kit” that can be applied in any manufacturing or service environment. Highlights of the coverage are as follows:

- The book contains **comprehensive coverage** of the tools and techniques in the traditional OM areas (quality, capacity, queuing, forecasting, inventory, planning and control, and project management), as well as the purchasing and logistics areas.
- Tools and techniques are always introduced **within the context** of the OM and SCM issues at hand. For example, a capacity analysis tool kit is woven into a discussion of sales and operations planning across the supply chain rather than being treated separately.
- Throughout the book, students are shown how tools and techniques can be applied using **Microsoft Excel spreadsheets**. Learning is reinforced through homework problems that provide the students with a template and hints for checking their answers.
- **Optimization modeling** is discussed and illustrated at two points in the book. Specifically, students are shown in a step-by-step fashion how to develop and solve the assignment problem in Chapter 8 and the sales and operations problem in Chapter 10 using Excel’s Solver function. Learning is reinforced through homework problems that provide the students with a template and hints for checking their logic.

Tools and Techniques Integrated Throughout

TOOLS AND TECHNIQUES	SOLVED EXAMPLES	HOMEWORK PROBLEMS	EXCEL EXAMPLES/ PROBLEMS
Chapter 2: Operations and Supply Chain Strategies			
Value index	X	X	X
Chapter 3: Process Choice and Layout Decisions in Manufacturing and Services			
Service blueprinting	X		
Line balancing	X	X	
Assigning department locations	X	X	
Chapter 4: Business Processes			
Performance measures (productivity, efficiency, cycle time, percent value-added time)	X	X	
Process mapping	X	X	
Six Sigma methodology and DMAIC process	X		
Continuous improvement tools (root cause analysis, scatter plots, check sheets, Pareto charts)	X	X	
Cause-and-effect diagrams	X		
Chapter 5: Managing Quality			
Process capability ratio	X	X	
Process capability index	X	X	
Six Sigma quality	X	X	
\bar{X} and R charts	X	X	X
p charts	X	X	X
Acceptance sampling	X		
Chapter 6: Managing Capacity			
Expected value analysis	X	X	X
Decision trees	X	X	
Break-even analysis	X	X	X
Indifference point	X	X	X
Learning curves	X	X	
Theory of constraints	X		
Waiting lines (queuing analysis)	X	X	

(continued)

TOOLS AND TECHNIQUES	SOLVED EXAMPLES	HOMEWORK PROBLEMS	EXCEL EXAMPLES/ PROBLEMS
Little's Law	X	X	
Simulation analysis	X		X
Chapter 7: Supply Management			
Total cost analysis	X	X	
Weighted-point evaluation system	X	X	X
Profit leverage	X	X	
Spend analysis	X	X	
Chapter 8: Logistics			
Shipment consolidation	X	X	X
Perfect order calculation	X	X	
Landed costs	X	X	
Weighted center of gravity model	X	X	X
Optimization modeling (assignment problem using Excel Solver function)	X	X	X
Chapter 9: Forecasting			
Moving average model	X	X	X
Exponential smoothing model	X	X	X
Adjusted exponential smoothing model	X	X	X
Linear regression	X	X	X
Seasonal adjustments	X	X	X
Multiple regression	X	X	X
MAPE, MAD, MFE, and tracking signal	X	X	X
Chapter 10: Sales and Operations Planning (Aggregate Planning)			
Top-down sales and operations planning	X	X	X
Bottom-up sales and operations planning	X	X	
Cash flow analysis	X	X	
Load profiles	X	X	
Optimization modeling (top-down sales and operations planning using Excel Solver function)	X	X	X
Chapter 11: Managing Inventory throughout the Supply Chain			
Periodic review systems	X	X	
Economic order quantity	X	X	X
Reorder points and safety stock	X	X	X
Quantity discounts	X	X	
Single-period inventory systems (newsboy problem)	X	X	
Pooling safety stock	X	X	X
Chapter 12: Managing Production across the Supply Chain			
Master scheduling	X	X	
Material requirements planning (MRP)	X	X	
Job sequencing rules	X	X	
Distribution requirements planning (DRP)	X	X	
Chapter 13: JIT/Lean Production			
Kanban sizing	X	X	
Linking MRP and Kanban	X	X	
Chapter 14: Managing Projects			
Gantt charts	X	X	
Activity on node (AON) diagrams and critical path method (CPM)	X	X	Microsoft Project example
Project crashing	X	X	
Chapter 15: Developing Products and Services			
Quality function deployment (QFD)	X		

INSTRUCTOR RESOURCES

At the Instructor Resource Center, www.pearsonglobaleditions.com/Bozarth, instructors can easily register to gain access to a variety of instructor resources available with this text in downloadable format. If assistance is needed, our dedicated technical support team is ready to help with the media supplements that accompany this text. Visit <http://247.pearsoned.com> for answers to frequently asked questions and toll-free user support phone numbers.

The following supplements are available with this text.

Instructor's Solutions Manual

The Instructor's Solutions Manual, updated by Cecil Bozarth, contains detailed solutions for all end-of-chapter Discussion Questions, Problems, and Case Study questions. Each solution has been reviewed for accuracy. The Instructor's Solutions Manual is available for download by visiting www.pearsonglobaleditions.com/Bozarth.

Test Bank

The Test Bank, updated by Professor Geoff Willis at the University of Central Oklahoma, contains hundreds of questions, including a variety of true/false, multiple-choice, fill-in-the-blank, and essay questions for each chapter. Each question is followed by the correct answer, the main headings, difficulty rating, and keywords. The Test Bank has been reviewed for accuracy. It is available for download by visiting www.pearsonglobaleditions.com/Bozarth.

TestGen

Pearson Education's test-generating software is available from www.pearsonglobaleditions.com/Bozarth. The software is PC and Mac compatible and preloaded with all of the Test Bank Questions. You can manually or randomly view test questions and drag and drop to create a test. You can add or modify test bank questions as needed.

PowerPoint Presentations

PowerPoint presentations, updated by Professor Kathryn Marley at Duquesne University, are available for every chapter to enhance lectures. They feature figures, tables, Excel, and main points from the text. They are available for download by visiting www.pearsonglobaleditions.com/Bozarth.

Excel Problems

Instructors can create different homework problems for different class sections and even different students. This feature is ideal for instructors teaching large sections of an introductory operations/supply chain course. With these homework problems, professors have an extra measure to guard against plagiarism in homework assignments. Here's how it works:

1. Students go to the Multimedia Library in MyOMLab or to the Data Download Page at www.pearsonglobaleditions.com/Bozarth and open an Excel spreadsheet listed under the chapter of interest.
2. Students type their name and a four-digit number chosen by the instructor into the spreadsheet. The four-digit number creates new parameters for the problem.
3. Students print out their customized homework sets and solve the problems.
4. The instructor uses an **Excel-based key** that uses the same four-digit number to generate the correct answers.

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CHAPTER **one**

CHAPTER OUTLINE

Introduction

1.1 Why Study Operations and Supply Chain Management?

1.2 Important Trends

1.3 Operations and Supply Chain Management and You

1.4 Purpose and Organization of This Book

Chapter Summary

Introduction to Operations and Supply Chain Management

CHAPTER OBJECTIVES

By the end of this chapter, you will be able to:

- Describe what is meant by operations and supply chain management, and explain why activities in these are critical to an organization's survival.
- Describe how electronic commerce, increased competition and globalization, and relationship management have brought operations and supply chain management to the forefront of managers' attention.
- Identify the major professional organizations and career opportunities in operations and supply chain management.

INTRODUCTION

Let's start with a question: What do the following organizations have in common?

- **Walmart**, which not only is a leading retailer in the United States but also has built a network of world-class suppliers, such as GlaxoSmithKline, Sony, and Mattel;
- **FedEx**, a service firm that provides supply chain solutions and transportation services;
- **Flextronics**, a contract manufacturer that assembles everything from plug-in electric motorcycles to LCD and touch displays; and
- **SAP**, the world's largest provider of enterprise resource planning (ERP) software.

While these firms may appear to be very different from one another, they have at least one thing in common: a strong commitment to superior operations and supply chain management.

In this chapter, we kick off our study of operations and supply chain management. We begin by examining what operations is all about and how the operations of an individual organization fits within a larger supply chain. We then talk about what it means to *manage* operations and supply chains. As part of this discussion, we will introduce you to the Supply Chain Operations Reference (SCOR) model, which many businesses use to understand and structure their supply chains.

In the second half of the chapter, we discuss several trends in business that have brought operations and supply chain management to the forefront of managerial thinking. We also devote a section to what this all means to you. We discuss career opportunities in the field, highlight some of the major professional organizations that serve operations and supply chain professionals, and look at some of the major activities that operations and supply chain professionals are involved in on a regular basis. We end the chapter by providing a roadmap of this book.



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Operations management and supply chain management cover a wide range of activities, including transportation services, manufacturing operations, retailing, and consulting.

1.1 WHY STUDY OPERATIONS AND SUPPLY CHAIN MANAGEMENT?

So why should you be interested in operations and supply chain management? There are three simple reasons.

1. **Every organization must make a product or provide a service that someone values.** Otherwise, why would the organization exist? Think about it. Manufacturers produce physical goods that are used directly by consumers or other businesses. Transportation companies provide valuable services by moving and storing these goods. Design firms use their expertise to create products or even corporate images for customers. The need to provide a valuable product or service holds true for not-for-profit organizations as well. Consider the variety of needs met by government agencies, charities, and religious groups, for example.

The common thread is that each organization has an operations function, or *operations*, for short. The **operations function** is the collection of people, technology, and systems within an organization that has primary responsibility for providing the organization's products or services. Regardless of what career path you might choose, you will need to know something about your organization's operations function.

As important as the operations function is to a firm, few organizations can—or even want to—do everything themselves. This leads to our second reason for studying operations and supply chain management.

2. **Most organizations function as part of larger supply chains.** A **supply chain** is a network of manufacturers and service providers that work together to create products or services needed by end users. These manufacturers and service providers are linked together through physical flows, information flows, and monetary flows. When the primary focus is on physical goods, much of the supply chain activity will revolve around the conversion, storage, and movement of materials and products. In other cases, the focus might be on providing an intangible service. For example, “Progressive Insurance uses satellites, camera phones, software, and the Internet to issue final settlement checks on the spot within minutes of being called to an accident scene.”¹

Supply chains link together the operations functions of many different organizations to provide real value to customers. Consider a sporting goods store that sells athletic shoes. Although the store doesn't actually make the shoes, it provides valuable services for its customers—a convenient location and a wide selection of products. Yet, the store is only one link in a much larger supply chain that includes:

- Plastic and rubber producers that provide raw materials for the shoes;
- Manufacturers that mold and assemble the shoes;
- Wholesalers that decide what shoes to buy and when;
- Transportation firms that move the materials and finished shoes to all parts of the world;
- Software firms and Internet service providers (ISPs) that support the information systems that coordinate these physical flows; and
- Financial firms that help distribute funds throughout the supply chain, ensuring that the manufacturers and service firms are rewarded for their efforts.

So where does this lead us? To our third reason for studying operations and supply chain management—and the premise for this book.

3. **Organizations must carefully manage their operations and supply chains in order to prosper and, indeed, survive.** Returning to our example, think about the types of decisions facing a shoe manufacturer. Some fundamental operations decisions that it must make include the following: “How many shoes should we make, and in what styles and sizes?” “What kind of people skills and equipment do we need?” “Should we locate our

Operations function

Also called *operations*. The collection of people, technology, and systems within an organization that has primary responsibility for providing the organization's products or services.

Supply chain

A network of manufacturers and service providers that work together to create products or services needed by end users. These manufacturers and service providers are linked together through physical flows, information flows, and monetary flows.

¹Federal Reserve Bank of Dallas, *Supply Chain Management: The Science of Better, Faster, Cheaper*, 2005, www.dallasfed.org/assets/documents/research/swe/2005/swe0502b.pdf.



Roman Sigaev/Fotolia

Athletic shoes at a retailer represent the last stage in a supply chain that crosses the globe and involves many different companies.

plants to take advantage of low-cost labor or to minimize shipping cost and time for the finished shoes?”

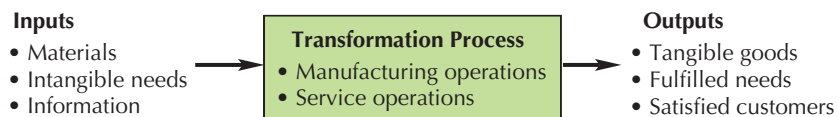
In addition to these operations issues, the shoe manufacturer faces many decisions with regard to its role in the supply chain: “From whom should we buy our materials—the lower-cost supplier or the higher-quality one?” “Which transportation carriers will we use to ship our shoes?” The right choices can lead to higher profitability and increased market share, while the wrong choices can cost the company dearly—or even put it out of business.

Operations Management

Let’s begin our detailed discussion of operations and supply chain management by describing operations a little more fully and explaining what we mean by operations management. As we noted earlier, all organizations must make products or provide services that someone values, and the operations function has the primary responsibility for making sure this happens.

The traditional way to think about operations is as a *transformation process* that takes a set of inputs and transforms them in some way to create outputs—either goods or services—that a customer values (Figure 1.1). Consider a plant that makes wood furniture. Even for a product as simple as a chair, the range of activities that must occur to transform raw lumber into a finished

FIGURE 1.1
Viewing Operations as a Transformation Process





Health care services use highly skilled individuals as well as specialized equipment to provide physiological transformation processes for their patients.

chair can be overwhelming at first. Raw lumber arrives as an input to the plant, perhaps by truck or even train car. The wood is then unloaded and moved onto the plant floor. Planing machines cut the lumber to the right thickness. Lathes shape pieces of wood into legs and back spindles for the chairs. Other machines fabricate wood blanks, shaping them into seats and boring holes for the legs and back spindles.

In addition to the equipment, there are people who run and load the machines, conveyors, and forklifts that move materials around the plant, and there are other people who assemble the chairs. Once the chairs are finished, still more people pack and move the chairs into a finished goods warehouse or onto trucks to be delivered to customers. In the background, supervisors and managers use information systems to plan what activities will take place next.

The operations function can also provide intangible services, as in the case of a law firm. A major input, for example, might be the need for legal advice—hardly something you can put your hands around. The law firm, through the skill and knowledge of its lawyers and other personnel, transforms this input into valuable legal advice, thereby fulfilling the customer's needs. How well the law firm accomplishes this transformation goes a long way in determining its success.

Figure 1.1 makes several other points. First, inputs to operations can come from many places and take many different forms. They can include raw materials, intangible needs, and even information, such as demand forecasts. Also, operations are often highly dependent on the quality and availability of inputs. Consider our furniture plant again. If the lumber delivered to it is of poor quality or arrives late, management might have to shut down production. In contrast, a steady stream of good-quality lumber can ensure high production levels and superior products. Second, nearly all operations activities require coordination with other business functions, including engineering, marketing, and human resources. We will revisit the importance of cross-functional decision making in operations throughout the book. Third, operations management activities are information and decision intensive. You do not have to be able to assemble a product or treat a patient yourself to be a successful operations manager—but you *do* have to make sure the right people and equipment are available to do the job, the right materials arrive when needed, and the product or service is completed on time, at cost, and to specifications!

Operations management

“The planning, scheduling, and control of the activities that transform inputs into finished goods and services.”

Operations management, then, is “the planning, scheduling, and control of the activities that transform inputs into finished goods and services.”² Operations management decisions can range from long-term, fundamental decisions about what products or services will be offered and what the transformation process will look like to more immediate issues, such as determining the best way to fill a current customer request. Through sound operations management, organizations hope to provide the best value to their customers while making the best use of resources.

Supply Chain Management

The traditional view of operations management illustrated in Figure 1.1 still puts most of the emphasis on the activities a particular organization must perform when managing its own operations. But, as important as a company’s operations function is, it is not enough for a company to focus on doing the right things within its own four walls. Managers must also understand how the company is linked in with the operations of its suppliers, distributors, and customers—what we refer to as the supply chain.

Upstream

A term used to describe activities or firms that are positioned *earlier* in the supply chain relative to some other activity or firm of interest. For example, corn harvesting takes place upstream of cereal processing, and cereal processing takes place upstream of cereal packaging.

Downstream

A term used to describe activities or firms that are positioned *later* in the supply chain relative to some other activity or firm of interest. For example, sewing a shirt takes place downstream of weaving the fabric, and weaving the fabric takes place downstream of harvesting the cotton.

First-tier supplier

A supplier that provides products or services directly to a firm.

Second-tier supplier

A supplier that provides products or services to a firm’s first-tier supplier.

As we noted earlier, organizations in the supply chain are linked together through physical flows, information flows, and monetary flows. These flows go both up and down the chain. Let’s extend our discussion and vocabulary using a product many people are familiar with: a six-pack of beer. Figure 1.2 shows a simplified supply chain for Anheuser-Busch. From Anheuser-Busch’s perspective, the firms whose inputs feed into its operations are positioned **upstream**, while those firms who take Anheuser-Busch’s products and move them along to the final consumer are positioned **downstream**.

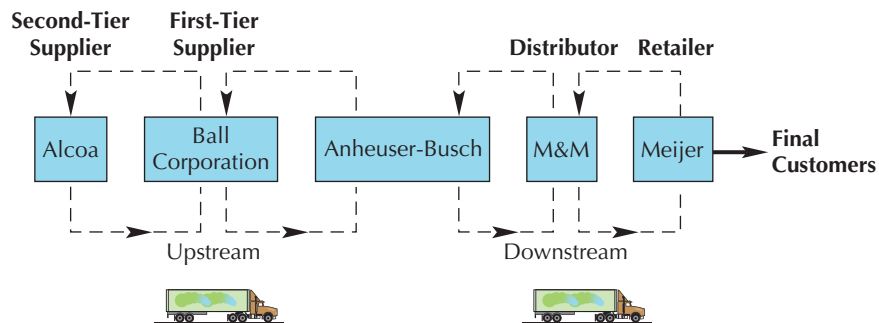
When the typical customer goes to the store to buy a six-pack, he probably does not consider all of the steps that must occur beforehand. Take cans, for example. Alcoa extracts the aluminum from the ground and ships it to Ball Corporation, which converts the aluminum into cans for Anheuser-Busch. In the supply chain lexicon, Ball Corporation is a **first-tier supplier** to Anheuser-Busch because it supplies materials directly to the brewer. By the same logic, Alcoa is a **second-tier supplier**; it provides goods to the first-tier supplier.

The cans from Ball Corporation are combined with other raw materials, such as cartons, grain, hops, yeast, and water, to produce the packaged beverage. Anheuser-Busch then sells the packaged beverage to M&M, a wholesaler which, in turn, distributes the finished good to Meijer, the retailer. Of course, we cannot forget the role of transportation carriers, which carry the inputs and outputs from one place to the next along the supply chain.

As Figure 1.2 suggests, the flow of goods and information goes both ways. For instance, Ball Corporation might place an order (information) with Alcoa, which, in turn, ships aluminum (product) to Ball. Anheuser-Busch might even return empty pallets or containers to its first-tier suppliers, resulting in a flow of physical goods back *up* the supply chain.

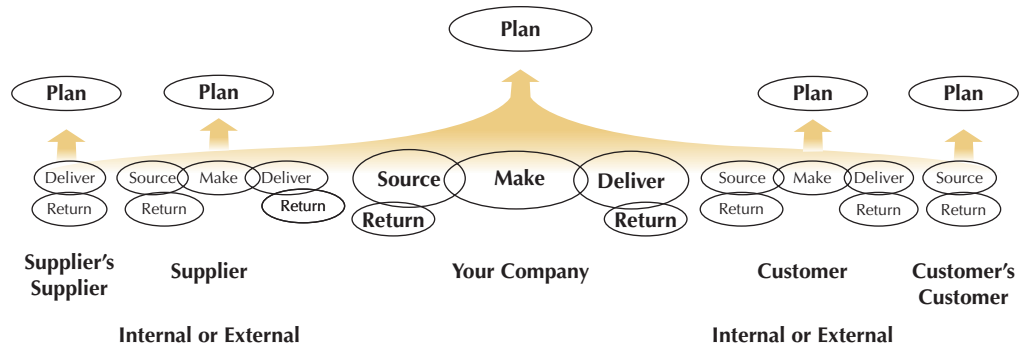
Of course, there are many more participants in the supply chain than the ones shown here; Anheuser-Busch has hundreds of suppliers, and the number of retailers is even higher. We could also diagram the supply chain from the perspective of Alcoa, M&M, or any of the

FIGURE 1.2
A Simplified View of Anheuser-Busch’s Supply Chain



²Definition of Operations Management in J. H. Blackstone, ed., *APICS Dictionary*, 14th ed. (Chicago, IL: APICS, 2013). Reprinted by permission.

FIGURE 1.3
The Supply Chain Operations Reference (SCOR) Model



other participants. The point is that most of the participants in a supply chain are both customers and suppliers. Finally, the supply chain must be very efficient, as the final price of the good must cover all of the costs involved plus a profit for each participant in the chain.

While you were reading through the above example, you might have thought to yourself, “Supply chains aren’t new”—and you’d be right. Yet most organizations historically performed their activities independently of other firms in the chain, which made for disjointed and often inefficient supply chains. In contrast, **supply chain management** is the *active* management of supply chain activities and relationships in order to maximize customer value and achieve a sustainable competitive advantage. It represents a conscious effort by a firm or group of firms to develop and run supply chains in the most effective and efficient ways possible.

But what exactly *are* these supply chain activities? To answer this, we turn to the **Supply Chain Operations Reference (SCOR) model**. The SCOR model is a framework, developed and supported by the Supply Chain Council, that seeks to provide standard descriptions of the processes, relationships, and metrics that define supply chain management.³ We will explore the SCOR model in more detail in Chapter 4, but for now, Figure 1.3 provides a high-level view of the framework. According to the SCOR model, supply chain management covers five broad areas:

1. *Planning activities*, which seek to balance demand requirements against resources and communicate these plans to the various participants;
2. *Sourcing activities*, which include identifying, developing, and contracting with suppliers and scheduling the delivery of incoming goods and services;
3. *“Make,” or production, activities*, which cover the actual production of a good or service;
4. *Delivery activities*, which include everything from entering customer orders and determining delivery dates to storing and moving goods to their final destination; and
5. *Return activities*, which include the activities necessary to return and process defective or excess products or materials.

Finally, notice that Figure 1.3 shows the supply chain management task extending from the company’s suppliers’ suppliers, all the way to the customers’ customers. As you can imagine, coordinating the activities of all these parties is challenging.

To illustrate, let’s consider Walmart, one of the earliest proponents of supply chain management.⁴ What Walmart was doing in the late 1980s and early 1990s was nothing short of revolutionary. Individual stores sent daily sales information to Walmart’s suppliers via satellite. These suppliers then used the information to plan production and ship orders to Walmart’s warehouses. Walmart used a dedicated fleet of trucks to ship goods from warehouses to stores in less than 48 hours and to replenish store inventories about twice a week.

Supply chain management
The *active* management of supply chain activities and relationships in order to maximize customer value and achieve a sustainable competitive advantage. It represents a conscious effort by a firm or group of firms to develop and run supply chains in the most effective and efficient ways possible.

Supply Chain Operations Reference (SCOR) model
A framework developed and supported by the Supply Chain Council that seeks to provide standard descriptions of the processes, relationships, and metrics that define supply chain management.

³Supply-Chain Council. www.supply-chain.org.

⁴G. Stalk, P. Evans, and L. E. Shulman, “Competing on Capabilities: The New Rules of Corporate Strategy,” *Harvard Business Review* 70, no. 2 (March–April 1992): 57–69.



JG Photography/Alamy

Walmart was an early proponent of superior supply chain performance. Other companies have now adopted many of the practices Walmart pioneered in the 1980s.

The result was better customer service (because products were nearly always available), lower production and transportation costs (because suppliers made and shipped only what was needed), and better use of retail store space (because stores did not have to hold an excessive amount of inventory).

Walmart has continued to succeed through superior sourcing and delivery, and many of the practices it helped pioneer have taken root throughout the business world. In fact, many retailers now make *multiple* shipments to stores each day, based on *continuous* sales updates. To illustrate how widespread supply chain management thinking has become, consider the example of Panera Bread in the *Supply Chain Connections* feature.

Supply chain management efforts can range from an individual firm taking steps to improve the flow of information between itself and its supply chain partners to a large trade organization looking for ways to standardize transportation and billing practices. In the case of Walmart, a single, very powerful firm took primary responsibility for improving performance across its own supply chain. As an alternative, companies within an industry often form councils or groups to identify and adopt supply chain practices that will benefit all firms in the industry. One such group is the Automotive Industry Action Group (AIAG, www.aiag.org), whose members “work collaboratively to streamline industry processes via global standards development & harmonized business practices.”⁵ The Grocery Manufacturers of America (GMA, www.gmaonline.org/) serves a similar function. Other organizations, such as the Supply Chain Council (SCC, www.supply-chain.org), seek to improve supply chain performance across many industries.

⁵www.aiag.org/StaticContent/about/index.cfm.

SUPPLY CHAIN CONNECTIONS

PANERA BREAD: “A LOAF OF BREAD IN EVERY ARM”

There is a good chance that you have either heard of or visited a Panera Bread bakery-cafe. Panera Bread is a specialty food retailer that has built its business on providing consumers with fresh artisan bread products served at strategically located, distinctive bakery-cafes. Between December 2003 and September 2013, the number of Panera locations grew from 602 to 1,736. Financial results were equally impressive: 2013 revenues and profits were up over 2005 by 223% and 232%, respectively.⁶

But have you ever thought about the upstream supply chain activities that must be accomplished in order to support the company’s mission statement, “A loaf in every arm”? In the case of Panera Bread, keeping up with the growth in the number of bakery-cafes—while still maintaining a high-quality, consistent product—presents a special challenge. The company has responded by investing heavily in its supply chain. As one article put it:⁷

During the past 10 years, Panera Bread’s manufacturing and supply chain team has built a fresh dough manufacturing system that consists of 17 facilities with more than 800 employees. In excess of 200 million pounds of dough are delivered by 110 trucks that travel 9.7 million miles annually. Oh, and the team also manages vendor contracts, controls the distribution system for the retail bakery-cafes and supports the company’s baking activities. The team is responsible for everything that comes through the back doors of Panera Bread bakery-cafes.

Even in this short description, we can see how Panera Bread’s supply chain activities cover everything from sourcing to production to delivery. It’s a safe bet that Panera Bread’s interest in effective supply chain management will continue to “rise” along with its products.



Judith Collins/Alamy

⁶Panera Bread, *Investor Relations*, www.panerabread.com/en-us/company/investor-relations.html.

⁷L. Gorton, “Fresh Ideas,” *Baking and Snack*, December 1, 2004.

1.2 IMPORTANT TRENDS

As we shall see, operations management and supply chain management are as much philosophical approaches to business as they are bodies of tools and techniques, and thus they require a great deal of interaction and trust between companies. For right now, however, let’s talk about

three major developments that have brought operations and supply chain management to the forefront of managers' attention:

- Electronic commerce;
- Increasing competition and globalization; and
- Relationship management.

Electronic Commerce

Electronic commerce

Also called *e-commerce*.
 "The use of computer and telecommunications technologies to conduct business via electronic transfer of data and documents."

Over the past 25 years, no single trend has done more to change the nature of business than the Internet and the resulting breakthroughs in electronic commerce. **Electronic commerce**, or e-commerce for short, refers to "the use of computer and telecommunications technologies to conduct business via electronic transfer of data and documents."⁸ Progressive Insurance, a company we mentioned earlier, is just one example of a company that has built its business around e-commerce. Another is Netflix, which first used the Internet and advanced software applications to help subscribers order DVDs but now uses the Internet to stream movies through subscribers' game consoles and other wireless devices. From a supply chain perspective, breakthroughs in information technology (IT) have made instantaneous communications across supply chain partners a reality. IT can link together suppliers, manufacturers, distributors, retail outlets, and, ultimately, customers, regardless of location. Such systems can also provide visibility into incoming shipments and delays and can even tell planners how many units of product are on any given store shelf location in the world.

Increasing Competition and Globalization

The second major trend is the increasing level of competition and globalization in the world economy. The rate of change in markets, products, and technology continues to escalate, leading to situations where managers must make decisions on shorter notice, with less information, and with higher penalty costs if they make mistakes. Customers are demanding quicker delivery, state-of-the-art technology, and products and services better suited to their individual needs. At the same time, companies in mature economies are finding new competitors are entering into markets that have traditionally been dominated by "domestic" firms.

Despite these challenges, many organizations are thriving. In later chapters, for example, you will read how many companies embraced the changes they were facing and put renewed emphasis on improving their operations and supply chain performance. In some ways, the increased competition and globalization of businesses have given many firms opportunities to break away from the pack.

Relationship Management

E-commerce breakthroughs have given companies a wide range of options for better managing their operations and supply chains. Furthermore, increasing customer demands and global competition have given firms the incentive to improve in these areas. But this is not enough. Any efforts to improve operations and supply chain performance are likely to be inconsequential without the cooperation of other firms. As a result, more companies are putting an emphasis on relationship management.

Of all the activities operations and supply chain personnel perform, relationship management is perhaps the most difficult and therefore the most susceptible to breakdown. Poor relationships within any link of the supply chain can have disastrous consequences for all other supply chain members. For example, an unreliable supplier can "starve" a plant, leading to inflated lead times and resulting in problems across the chain, all the way to the final customer.

To avoid such problems, organizations must manage the relationships with their upstream suppliers as well as their downstream customers. This can be quite difficult when supply chain

⁸Definition of Electronic Commerce in J. H. Blackstone, ed., *APICS Dictionary*, 14th ed. (Chicago, IL: APICS, 2013). Reprinted by permission.

partners are geographically distant or when there are cultural differences. In the case of high-tech firms, many components can be purchased only from foreign suppliers who are proprietary owners of the required technology. In such environments, it becomes more important to choose a few, select suppliers, thereby paving the way for informal interaction and information sharing. We will discuss the challenges of relationship management more in Chapter 7.

1.3 OPERATIONS AND SUPPLY CHAIN MANAGEMENT AND YOU

At this point, you might be asking yourself, “If I choose to work in operations or supply chain management, where am I likely to end up?” The answer: Anywhere you like! Operations and supply chain personnel are needed in virtually every business sector. Salaries and placement opportunities for operations and supply chain personnel also tend to be highly competitive, reflecting the important and challenging nature of the work, as well as the relative scarcity of qualified individuals. In fact, each year the Institute for Supply Management (ISM) publishes a salary survey broken down by job position, work experience, and education level.⁹

You also might be asking yourself, “What would my career path look like?” Many operations and supply chain managers find that over their career, they work in many different areas. Table 1.1 lists just a few of the possibilities.

Professional Organizations

If you decide to pursue a career in operations or supply chain management, you will find a number of professional organizations willing to help you. These organizations have professional certification programs that establish an individual as a professional within his or her particular area. Most organizations also have regular meetings at the local level, as well as national and international meetings once or twice a year. We highlight some of these organizations here.

APICS—APICS (www.apics.org) describes itself as “The Association for Operations Management.” It is a widely recognized professional society for persons interested in operations and supply chain management. APICS currently has more than 67,000 members and 250 chapters throughout the United States and its territories.

TABLE 1.1
Potential Career Paths in
Operations and Supply Chain
Management

Analyst	Uses analytical and quantitative methods to understand, predict, and improve processes within the supply chain.
Production manager	Plans and controls production in a manufacturing setting. Responsible for a wide range of personnel.
Service manager	Plans and directs customer service teams to meet the needs of customers and support company operations.
Sourcing manager	Identifies global sources of materials, selects suppliers, arranges contracts, and manages ongoing relationships.
Commodity manager	Acquires knowledge in a specific market in which the organization purchases significant quantities of materials and services. Helps formulate long-term commodity strategies and manage long-term relationships with selected suppliers.
Supplier development manager	Measures supplier performance, identifies suppliers requiring improvement, and facilitates efforts to improve suppliers' processes.
International logistics manager	Works closely with manufacturing, marketing, and purchasing to create timely, cost-effective import/export supply chains.
Transportation manager	Manages private, third-party, and contract carriage systems to ensure timely and cost-efficient transportation of all incoming and outgoing shipments.

⁹ISM's 2014 Salary Survey. www.ism.ws/files/Tools/2014ISMSalarySurveyBrief.pdf.

ISM—The Institute for Supply Management (ISM, www.ism.ws) provides national and international leadership in purchasing and materials management, particularly in the areas of education, research, and standards of excellence. Established in 1915, ISM has grown to more than 40,000 members.

CSCMP—The Council of Supply Chain Management Professionals (CSCMP, www.cscmp.org) seeks to be the preeminent professional association providing worldwide leadership for the evolving logistics profession through the development, dissemination, and advancement of logistics knowledge.

ASQ—The American Society for Quality (ASQ, www.asq.org) is a leader in education and all aspects of quality improvement, including the Baldrige Award, ISO 9000, and continuous improvement activities.

If you are a student, it is not too early to start thinking of joining one of these organizations. In fact, many of them provide scholarships for college education and can help defray education costs.

Cross-Functional and Interorganizational Linkages

Even if you decide that a career in operations and supply chain management is not for you, chances are you will still find yourself working with people in these areas. This is because *none* of the major operations and supply chain activities takes place in a vacuum. Rather, these activities require the input and feedback of other functions within a firm, as well as suppliers and customers. Table 1.2 lists some major operations and supply chain activities, as well as some of the key outside participants. Look, for example, at process selection. Engineering and IT personnel help identify and develop the technologies needed, while human resources personnel identify the people skills and training programs necessary to make the system work. Involving marketing personnel and customers will ensure that the process meets the customers’ needs. Finally, finance personnel will need to be involved if the process requires a substantial investment in resources.

TABLE 1.2 Major Operations and Supply Chain Activities

OPERATIONS AND SUPPLY CHAIN ACTIVITY	PURPOSE	KEY INTERFUNCTIONAL PARTICIPANTS	KEY INTERORGANIZATIONAL PARTICIPANTS
Process selection	Design and implement the transformation processes that best meet the needs of the customer and the firm.	Engineering Marketing Finance Human resources IT	Customers
Forecasting	Develop the planning numbers needed for effective decision making.	Marketing Finance Accounting	Suppliers Customers
Capacity planning	Establish strategic capacity levels (“bricks and mortar”) and tactical capacity levels (workforce, inventory).	Finance Accounting Marketing Human resources	Suppliers Customers
Inventory management	Manage the amount and placement of inventory within the company and the supply chain.	IT Finance	Suppliers Customers
Planning and control	Schedule and manage the flow of work through an organization and the supply chain; match customer demand to supply chain activities.	Marketing IT	Suppliers Customers
Purchasing	Identify and qualify suppliers of goods and services; manage the ongoing buyer–supplier relationships.	Engineering Finance Marketing	Suppliers
Logistics	Manage the movement of physical goods throughout the supply chain.	Marketing Engineering	Suppliers Customers

1.4 PURPOSE AND ORGANIZATION OF THIS BOOK

Now that we have defined operations and supply chain management, it's time to discuss the purpose and organization of this book. Simply put, the purpose of this book is to give you a solid foundation in the topics and tools of *both* operations management and supply chain management. This is a significant departure from most other operations management textbooks, which are dominated by internal operations issues and treat supply chain management as a subdiscipline. Our decision to emphasize both areas is based on two observations. First, organizations are demanding students who have been exposed to traditional supply chain areas such as purchasing and logistics, as well as more traditional operations topics. Students who have had a course only in operations management are seen as not fully prepared. Second, our years of experience in industry, education, and consulting tell us that supply chain management is here to stay. While a strong internal operations function is vital to a firm's survival, it is not sufficient. Firms must also understand how they link in with their supply chain partners. With this in mind, we have organized the book into five main parts (Table 1.3).

Part I, *Creating Value through Operations and Supply Chains*, introduces some basic concepts and definitions that lay the groundwork for future chapters. Chapter 2 deals with the topic of operations and supply chain strategies, including what they are, how they support the organization's overall strategy, and how they help a firm provide value to the customer.

Part II, *Establishing the Operations Environment*, deals with fundamental choices that define an organization's internal operations environment. Chapter 3 deals with the manufacturing and service processes that firms put in place to provide products or services. Chapter 4 is devoted to the topic of business processes, which can be thought of as the "molecules" that make up all operations and supply chain flows. Chapter 4 will also introduce you to some of the approaches companies use to design and improve their business processes, including the Six Sigma methodology. Quality control is a particularly important part of process management, and so we devote Chapter 5 to the topic. In Chapter 6, we discuss the concept of capacity: How much and what types of capacity will an organization need? In the supplement to Chapter 6, we also offer a more advanced discussion of capacity from a process perspective. The topics covered here—including queuing theory and simulation modeling—are particularly relevant in service environments where capacity decisions can have a direct impact on customer waiting and processing times. Chapters 3 through 6 together set clear boundaries on what an organization can do and how the operations function will be managed. As such, we address them early in the book.

TABLE 1.3
Organization of the Book

I. Creating Value through Operations and Supply Chains

Chapter 1: Introduction to Operations and Supply Chain Management

Chapter 2: Operations and Supply Chain Strategies

II. Establishing the Operations Environment

Chapter 3: Process Choice and Layout Decisions in Manufacturing and Services

Chapter 4: Business Processes

Chapter 5: Managing Quality

Chapter 6: Managing Capacity

III. Establishing Supply Chain Linkages

Chapter 7: Supply Management

Chapter 8: Logistics

IV. Planning and Controlling Operations and Supply Chains

Chapter 9: Forecasting

Chapter 10: Sales and Operations Planning (Aggregate Planning)

Chapter 11: Managing Inventory throughout the Supply Chain

Chapter 12: Managing Production across the Supply Chain

Chapter 13: JIT/Lean Production

V. Project Management and Product/Service Development

Chapter 14: Managing Projects

Chapter 15: Developing Products and Services

Part III, *Establishing Supply Chain Linkages*, turns the spotlight away from the internal operations function to how organizations link up with their supply chain partners. Through sourcing decisions and purchasing activities, organizations establish supply chain relationships with other firms. In fact, nearly all firms play the role of upstream supplier or downstream customer at one time or another. Chapter 7 describes the broad set of activities carried out by organizations to analyze sourcing opportunities, develop sourcing strategies, select suppliers, and carry out all the activities required to procure goods and services, while Chapter 8 deals with the physical flow of goods throughout the supply chain and covers such areas as transportation, warehousing, and logistics decision models.

Part IV, *Planning and Controlling Operations and Supply Chains*, focuses on core topics in planning and control. These topics can be found in any basic operations management book. But in contrast to more traditional books, we have deliberately extended the focus of each chapter to address the implications for supply chain management. Forecasting, covered in Chapter 9, is a prime example. By forecasting downstream customer demand and sharing it with upstream suppliers, organizations can do a better job of planning for and controlling the flow of goods and services through the supply chain. In Chapter 10, we discuss not only how firms can develop tactical sales and operations plans, but also how they can link these plans with supply chain partners. In Chapter 11, we don't just cover basic inventory models; we discuss *where* inventory should be located in the supply chain; *how* transportation, packaging, and material-handling issues affect inventory decisions; and *how* inventory decisions by one firm affect its supply chain partners. Similarly, in Chapters 12 and 13, we don't just cover basic production planning topics; we show how such techniques as distribution requirements planning (DRP) and kanban can be used to synchronize the flow of goods between supply chain partners.

The last part of the book, Part V, *Project Management and Product/Service Development*, covers two topics that, while not generally considered part of the day-to-day operational activity of a firm, are nevertheless important to operations and supply chain managers. Chapter 14 describes how organizations manage projects, such as new product development efforts or capacity expansions. Chapter 15 addresses the product and service development process, with an emphasis on how these decisions directly affect choices in operations and supply chain management.

The chapters in Part I provide the foundation knowledge, while Part II deals with fundamental choices that serve to define the capabilities of a firm's operations area. Sourcing and logistics—the topics of Part III—establish linkages between a firm and its supply chain partners. Finally, through the planning and control activities described in Part IV, firms and their partners manage the flows of goods and information across the supply chain.

CHAPTER SUMMARY

Operations and supply chains are pervasive in business. *Every* organization must provide a product or service that someone values. This is the primary responsibility of the operations function. Furthermore, most organizations do not function independently but find that their activities are linked with those of other organizations through supply chains. Careful management of operations and supply chains is, therefore, vital to the long-term health of nearly every organization.

Because operations and supply chain activities cover everything from planning and control activities to sourcing and

logistics, there are numerous career opportunities for students interested in the area. Trends in e-commerce and global competition, as well as the growing importance of maintaining good relationships with other supply chain partners, will only increase these opportunities. Fortunately, there are many professional organizations, including APICS, CSCMP, and ISM, that cater to the career development of professionals in operations and supply chain management.

KEY TERMS

Downstream	22	Operations management	22	Supply Chain Operations Reference (SCOR) model	23
Electronic commerce	26	Second-tier supplier	22	Upstream	22
First-tier supplier	22	Supply chain	19		
Operations function	19	Supply chain management	23		