SEVENTH EDITION

Operations Management in the Supply Chain

DECISIONS AND CASES

Roger Schroeder | Susan Meyer Goldstein

Mc Graw Hill Education

Operations Management in the Supply Chain

Decisions and Cases

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Decisions and Cases

Seventh Edition

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Mc Graw Hill Education

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To our families, whose encouragement and love we appreciate
—Roger G. Schroeder
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Preface

FEATURES

Operations management is an exciting and vital field in today's complex business world. Therefore, students in both MBA and undergraduate courses have an urgent need to understand operations—an essential function in every business.

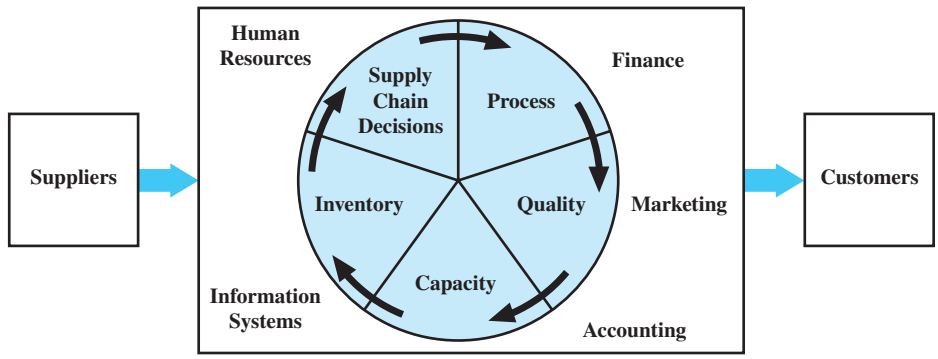
This textbook on operations management in the supply chain emphasizes decision making in operations with a supply chain orientation. The text provides materials of interest to general business students and operations and supply chain management majors. By stressing cross-functional decision making, the text provides a unique and current business perspective for all students. This is the first text to incorporate cross-functional decision making in every chapter.

A unique decision framework organizes the material by grouping decisions into five major categories: process, quality, capacity, inventory, and supply chain. This framework is intended to make it easy for students to understand the decision role and responsibilities of operations and supply chain management in relation to functions such as marketing and finance. See the illustration below. The text also provides a balanced treatment of both service and manufacturing firms. We continue to emphasize operations in the supply chain with new chapters on sourcing and logistics.

The most current knowledge is incorporated, including global operations, supply chain management, e-operations, service blueprinting, competency-based strategy, Six Sigma, lean systems, 3D printing, sustainability, supply chain risk, and mass customization. Complete coverage is also provided on traditional topics, including process design, service systems, quality management, ERP, inventory control, and scheduling.

While covering the concepts of operations and supply chain management in 18 chapters, the book also provides 18 case studies. The cases are intended to strengthen problem formulation skills and illustrate the concepts presented in the text. Long and short case studies are included. The cases are not just large problems or examples; rather, they are substantial management case studies, including some from the Northwestern, Sheffield, Cranfield, and The Case Centre collections.

The softcover edition with fewer pages than most introductory books covers all the essentials students need to know about operations management in the supply chain, leaving out only superfluous and tangential topics. By limiting the size of the book, we have condensed the material to the basics. The book is also available for the first time in digital formats in Connect and LearnSmart versions.



Decision-making framework for operations in the supply chain.

This book is ideal for regular operations management courses and also case courses and modular courses. It is particularly useful for those who desire a cross-functional and decision-making perspective that reaches across the supply chain. Instructors can easily supplement the text with their own cases, readings, or course materials as desired.

The Connect Library and Instructor Resources contain 20 Excel templates designed to assist in solving problems at the end of chapters and the case studies. These resources also contain technical chapters on linear programming, simulation, transportation method, and queuing, which can be assigned by the instructor, if desired. The resources have PowerPoint slides, solutions manual, the test bank, and web links to companies cited in the Student Internet Exercises in the text. Access to these web resources can be obtained from your McGraw-Hill sales representative or directly in the Connect Library.

A number of pedagogical features are contained in this book.

eXcel

- Operations Leader boxes are included in each chapter to illustrate current practices being implemented by leading firms.
- Each chapter contains at least three Student Internet Exercises. These exercises allow for extended learning about concepts discussed in the chapter.
- Points of cross-functional emphasis are noted in each chapter by a special symbol—a handshake. This highlights the locations of cross-functional aspects of operations decisions.
- Solved problems are included at the end of quantitative chapters to provide additional examples for students.
- Excel spreadsheets are keyed to specific problems at the end of chapters.

KEY CHANGES IN THE SEVENTH EDITION

This book is known for its decision orientation and case studies. We have strengthened the decision-making framework by addressing new decisions in sourcing, logistics, sustainability, and global supply chains. We also added new cases to address these decisions.

1. **Supply Chain Management.** This edition added a new section on Supply Chain. It contains two new chapters on Sourcing and Global Logistics. The Sourcing chapter contains material on sourcing goals, outsourcing, offshoring, reshoring, supply base optimization, the purchasing cycle, and scorecard weighting. The Global Logistics chapter contains material on the role of logistics, transportation modes, distribution centers, logistics networks, location, third-party logistics, and logistics strategy. In addition, the Supply Chain Management chapter was moved to this section and updated to add a new section on supply chain risk and another new section on supply chain sustainability. This edition now has the latest and best supply chain material available.

2. **Sustainability.** More emphasis is given to sustainability. It is now covered in the chapters on The Operations Function, Operations and Supply Chain Strategy, Process Selection, and Supply Chain Management. A new case study is added on Murphy Warehouse: Sustainable Logistics.

3. **Global.** More material is provided on global operations and supply chains. With the addition of the Sourcing and Global Logistics chapters, global emphasis now moves beyond operations to the entire supply chain. New material on outsourcing, offshoring, and managing global supply chains has been added. New cases on global sourcing, global plant location, and global logistics are added.

4. **Other Additions.** We have added materials on lean Six Sigma, 3D Printing, big data, analytics, ethics in sourcing, and disaster logistics.

5. **Digital Versions.** Digital versions of the text in McGraw-Hill's Connect and LearnSmart have been developed. The Connect version provides a complete course management system for the instructor and pdf content for students. It can be used to customize the course by selecting learning objectives for course coverage, using the test bank for multiple choice questions, automatic grading for selected quantitative problems, and access to all instructor support materials. The LearnSmart version provides feedback to students via multiple choice probes for each learning objective. The student is directed to return to readings where retention is weak.

6. **Cases.** Eighteen case studies are provided including cases from The Case Centre, and Northwestern, Sheffield, and Cranfield Universities. Existing cases have been revised to add current information. Ten new cases are added:

Altimus Brands: Managing Procurement Risk;
Murphy Warehouse Company: Sustainable Logistics;
Polaris Industries Inc.—Global Plant Location;
Shelter Box: A Decade of Disaster Relief;
The Westerfield Physician Practice: Value Stream Mapping;
Journey to Perfect: Mayo Clinic and the Path to Quality;
The Evolution to Lean Six Sigma in 3M, Inc.;
Sage Hill Above Onion Creek: Focusing on Service Process and Qualilty;
Toledo Custom Manufacturing: Quality Control;
Best Homes: Forecasting

INSTRUCTOR RESOURCES

Instructor Resource Center www.mhhe.com/schroeder7e

The Instructor Resource Center provides complete materials for study and review. At this book's website, instructors have access to teaching support such as electronic files of the ancillary materials: Solutions Manual, Technical Chapters, Excel Spreadsheets, PowerPoint Lecture Slides, Digital Image Library, and Test Bank.

Solutions Manual. Prepared by the authors, this manual contains solutions to all the end-of-chapter problems and cases.

Test Bank. The Test Bank includes true/false, multiple-choice, and discussion questions/problems at varying levels of difficulty.

EZ Test Online. All test bank questions are available in EZ Test Online, a flexible electronic testing program. The answers to all questions are given, along with a rating of the level of difficulty, chapter learning objective met, Bloom's taxonomy question type, and the AACSB knowledge category.

PowerPoint Lecture Slides. The PowerPoint slides draw on the highlights of each chapter and provide an opportunity for the instructor to emphasize the key concepts in class discussions.

Digital Image Library. All the figures in the book are included for insertion in PowerPoint slides or for class discussion.

Excel Spreadsheets. Twenty Excel Spreadsheets are provided for students to solve designated problems at the end of chapters.

Technical Chapters. Four technical chapters are provided for additional technical material on linear programming, transportation method, simulation and waiting lines.

Operations Management Video Series

The operations management video series, free to text adopters, includes professionally developed videos to help students fully understand the content and terminology within Operations and Supply Chain Management. These videos will be both relevant and up-to-date in order to be effectively utilized. Each video will come with a series of questions to assess the students' knowledge of the material.

TECHNOLOGY

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McGraw-Hill Connect® Operations Management is an online assignment and assessment solution that connects students with the tools and resources they'll need to achieve success through faster learning, higher retention, and more efficient studying. It provides instructors with tools to quickly pick content and assignments according to the topics they want to emphasize.

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- Access an instant view of student or class performance relative to learning objectives.
- Collect data and generate reports required by many accreditation organizations, such as AACSB.

Instructor Library. The *Connect Operations Management* Instructor Library is your repository for additional resources to improve student engagement in and out of class. You can select and use any asset that enhances your lecture. The *Connect Operations Management* Instructor Library includes:

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- PowerPoint presentations
- Test Bank
- Instructor's Solutions Manual
- Digital Image Library
- Excel Spreadsheets
- Technical Chapters

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Dynamic Links. Dynamic links between the problems or questions you assign to your students and the location in the eBook where that problem or question is covered.

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McGraw-Hill Global Education is a proud corporate member of AACSB International. Understanding the importance and value of AACSB accreditation, the authors of *Operations Management in the Supply Chain*, 7e have sought to recognize the curricula guidelines detailed in the AACSB standards for business accreditation. By connecting questions in the test bank and end-of-chapter material to the general knowledge and skill guidelines found in the AACSB standards.

It is important to note that the statements contained in *Operations Management in the Supply Chain*, 7e are provided only as a guide for the users of this textbook. The AACSB leaves content coverage and assessment within the purview of individual schools, the mission of the school, and the faculty. While *Operations Management in the Supply Chain*, 7e and the teaching package make no claim of any specific AACSB qualification or evaluation, we have within *Operations Management in the Supply Chain*, 7e labeled selected questions according to the general knowledge and skills areas.

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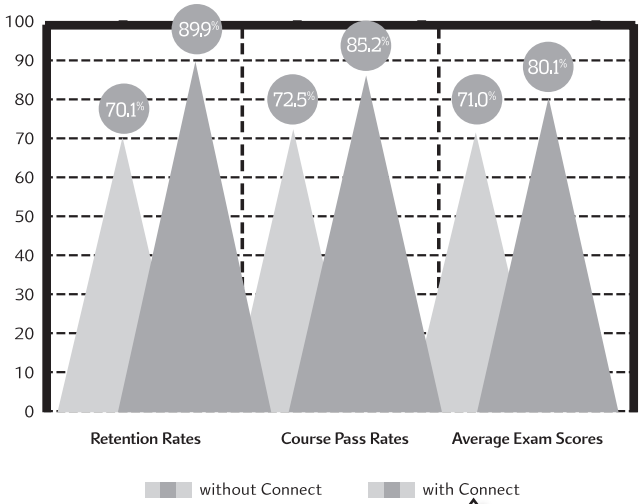

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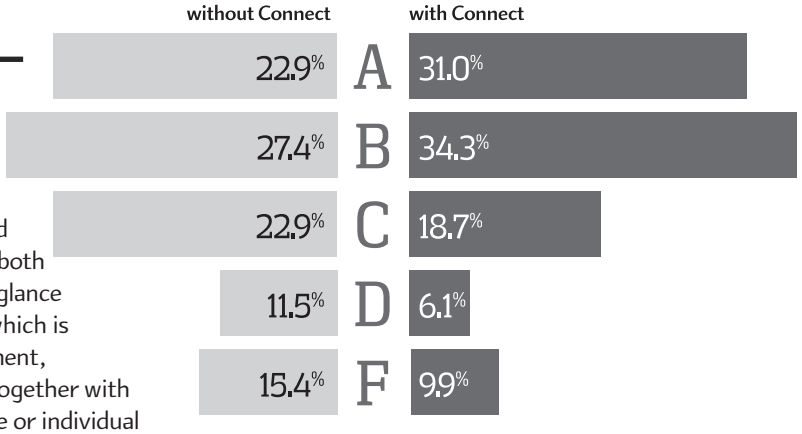

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Brief Table of Contents

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Introduction

1. The Operations Function
2. Operations and Supply Chain Strategy
3. Product Design

The introductory part of this text provides an overview of the operations function, operations and supply chain strategy, and product design. After reading this part, students should have an appreciation for the importance to the firm of decisions made in the operations function and its associated supply chain. Also, the need for strategy to guide all decision making is emphasized. New-product design is treated as a cross-functional decision responsibility that precedes the production and delivery of goods or services. ■

1
CHAPTER

The Operations Function

LEARNING OBJECTIVES

After reading this chapter, you should be able to:

LO1.1	Define operations management.
LO1.2	Describe the five main decisions made by operations and supply chain managers.
LO1.3	Explain the nature of cross-functional decision making with operations.
LO1.4	Define typical inputs and outputs of an operations transformation system.
LO1.5	Identify contemporary challenges facing operations and supply chain managers.

Operations management, as a field, deals with the production of goods and services. Every day we come in contact with an abundant array of goods or services, all of which are produced under the leadership of operations managers. Nonprofit and government services are also managed by operations managers. Without effective management of operations, a modern industrialized society cannot exist. The operations function is the engine that creates goods and services for the enterprise and underpins the global economy.

Operations managers have important positions in every organization. One example is the plant manager who is in charge of a factory. Other managers who work in the factory—including production and inventory control managers, quality managers, and line supervisors—are also operations managers. Collectively, this group of managers is responsible for producing the supply of goods in a manufacturing business. We should also include in the group of operations managers all manufacturing managers at the corporate or divisional level. These managers might include a corporate vice president of operations (or manufacturing) and a group of corporate staff operations managers concerned with quality, production and inventory control, facilities, and equipment.

Operations managers have important responsibilities in service industries as well. In the private sector, operations managers take leadership roles in hotels, restaurants, airlines,

Operations managers make important decisions in both manufacturing and service organizations.

banks, and retail stores. In each of these organizations, operations managers are responsible for producing and delivering the supply of services. In government offices, there are operations managers in the post office, police department, and housing department, to name only a few. Anyone who is responsible for producing or delivering the service is an operations manager.

At first glance, it may appear that service operations have little in common with manufacturing operations. However, the unifying feature of these operations is that both can be viewed as transformation processes inside organizations that are themselves embedded within supply chains. In manufacturing, inputs of raw materials, energy, labor, and capital are transformed into finished goods. In service operations, the same types of inputs are transformed into services. Managing the transformation process in an efficient and effective manner is the task of the operations manager in any type of organization.

Most Western economies have shifted dramatically from the production of goods to the production of services. It may come as a surprise that today more than 80 percent of the U.S. workforce is employed in service industries.[1] Even though the preponderance of employment is in the service sector, manufacturing remains important to provide the goods needed for export and internal consumption. Because of the importance of both service and manufacturing operations, they are treated on an equal basis in this text.

In the past when the field was related primarily to manufacturing, operations management was called production management. Later, the name was expanded to "production and operations management," or, more simply, "operations management," to include the service industries as well. The term "operations management" as used in this text refers to both manufacturing and service industries.

Today, individuals who work in operations and associated supply chains can belong to a number of professional societies. These societies provide opportunities to become certified, network with other professionals, and learn about and share best practices. See the Operations Leader box titled "Professional Societies Affiliated with Operations and Supply Chain Management." The Operations Leader boxes throughout this book highlight best practices and useful professional knowledge in a variety of industries.

1.1 WHY STUDY OPERATIONS MANAGEMENT?

All businesses want to hire bright people who can make the best decisions for the business as a whole, not the best marketing, finance, or operations decisions. They want employees who can see the big picture of how these functional areas interact. You will severely limit your career if you take a narrow functional perspective.

[1] U.S. Census Bureau, *Statistical Abstract of the United States,* Washington, DC, 2016 ed.

Operations Leader — Professional Societies Affiliated with Operations and Supply Chain Management

ASSOCIATION FOR OPERATIONS MANAGEMENT

The global leader and premier source of the body of knowledge in operations management, including production, inventory, the supply chain, materials management, sourcing and logistics (see www.apics.org for more information).

AMERICAN SOCIETY FOR QUALITY

The world's leading organization devoted to advancing learning, quality improvement, and knowledge exchange to improve business results and create better workplaces and communities worldwide (see www.asq.org for more information).

INSTITUTE FOR SUPPLY MANAGEMENT

The largest and one of the most respected supply management associations in the world, whose mission is to lead the supply management and sourcing profession through its standards of excellence, research, promotional activities, and education (see www.ism.ws for more information).

COUNCIL OF SUPPLY CHAIN MANAGEMENT PROFESSIONALS

The preeminent worldwide professional association for supply chain management professionals, whose vision is to lead the evolving supply chain management profession by developing, advancing, and disseminating supply chain knowledge and research (see http://cscmp.org for more information).

Every decision is cross-functional in nature.[2] You will be working with operations and need to understand operations no matter what career path you choose. Operations is a major function in every organization, and regardless of the function in which you work, you will interact with the operations function that produces goods or services (or both). The organization in which someone works only with people from his or her own function does not exist. That is why we take a cross-functional perspective in this text so that the content is useful to all majors.

As you study operations management, you will find that many of the ideas, techniques, and principles can be applied across the business, not just in operations. For example, all work is accomplished through a process (or sequence of steps). The principles of process thinking found in this text can be applied to all functions. After graduating, many students find that the ideas learned in operations management are among the most useful, regardless of the industry or career they enter.

Operations management is an exciting and challenging field of study. The material is both qualitative and quantitative, and both are essential to good management practices. You are embarking on a journey that is interesting and useful no matter what career you choose!

1.2 DEFINITION OF OPERATIONS MANAGEMENT AND SUPPLY CHAINS

LO1.1 Define operations management.

All organizations (for-profit and nonprofit) thrive by producing and delivering a good or a service deemed to be of **value** to customers. Value is the tangible and intangible benefits that customers derive from consuming a good or service at a price they are willing to pay.

[2] The "hand shake" symbol in the margin identifies a point of cross-functional emphasis and is designed to illustrate that the various functions must work together for an organization to be successful and thrive.

Operations Leader Dell Delivers Products and Value

In 1984 Michael Dell founded Dell Computer Corporation with $1000 in start-up capital and a business model to sell custom-configured personal computers directly to customers while passing along cost savings to customers by cutting out the middlemen. The company offers a range of products beyond personal desktop and mobile computing products; servers, storage, and networking products; printing and imaging products; electronics and accessories; enhanced business and consumer services; and business solutions. Nearly half of Dell's revenue comes from outside of the United States.

In 2013 Dell was taken private in a stock buyout by Michael Dell and investors. In 2015 Dell bought EDS services to expand its offerings to services, and the cloud.

A key to Dell's strategy is its customer-driven approach to innovation. This approach signals a commitment to delivering new products and services that are valued by customers and that address customer needs. This approach explains how Dell pioneered the direct-selling system to allow customer orders to be placed over the Internet or over the phone and, since 2007, through select retail outlets. Orders for products, once taken, are assembled in one of Dell's factories and often shipped to customers or retail stores within days, with the factories carrying very little finished goods inventory.

In addition to the importance of the operations function at Dell, sourcing and logistics activities are critical. Sourcing managers source the many components required to manufacture Dell products, and logistics managers handle the global movement of components and finished goods to satisfy customer demand. Managing Dell's fast and rapidly changing supply chain is a challenging task that they perform well.

Dell today is pursuing environmentally friendly best practices: Its global headquarters campus is now powered by 100 percent green energy; its desk computer systems have been designed to reduce carbon dioxide emissions; Dell was the first computer manufacturer to offer free computer recycling to customers worldwide; and its "Plant a Tree for Me" and "Plant a Forest for Me" programs have planted over 600,000 trees.

Source: Adapted from www.dell.com, 2015.

For example, value in a pair of shoes may be shoes that are good looking and comfortable and will last a long time at a price you can afford. What is of value to one customer (or set of customers) may not be of value to another. Flying in first class may be of value to business travelers, but for leisure travelers flying in first class may not be of value because of the price of first-class seats. Value, thus, is always defined in the eyes of the customer (or set of customers) relative to the price paid. See the Operations Leader box for Dell Computer Inc. for a company that creates value for its customers.

Organizations that are successful strive to identify the value inherent in the goods or services being offered to customers. They then deploy this understanding to guide the decisions that affect the production and delivery of those goods and services. These decisions have an impact on the design, execution, and performance of operations and should be coordinated with decisions made by managers of the sourcing and the logistics functions.

The **sourcing function** (also called purchasing or procurement) is responsible for finding other organizations to serve as sources and then buying the material and service inputs for the transformation process of the organization. The **logistics function,** in contrast, is typically responsible for the actual movement of goods and/or services across organizations. Collectively, the operations, sourcing, and logistics functions manage the production of the goods or services that are moved through the production process and delivered to customers.

Most organizations exist as part of a larger supply chain. The **supply chain** is the network of manufacturing and service operations (often multiple organizations) that supply one another from raw materials through production to the ultimate customer. The supply chain consists of the physical flow of materials, money, and information along the entire chain of sourcing production, and distribution. For example, the food supply chain reaches

from the farm to the food processor to the wholesaler and then the retailer. The supply chain links together the work and output of many different organizations.

In this book we discuss operations management in the supply chain. This means we deal with operations in the larger context of its supply chain, including external suppliers and customers. Before discussing the larger supply chain implications, we define operations management as follows:

> ***Operations management*** *focuses on decisions for the production and delivery of the firm's products and services.*

There are three aspects of operations management that require elaboration:

1. **Decisions.** The above definition refers to **decision making** as an important element of operations management. Since all managers make decisions, it is natural to focus on decision making as a central theme in operations. Within the broader context of supply chain, this decision focus provides a basis for identifying major decision types. In this text, we specify the five major decision responsibilities of operations and supply chain management as **process, quality, capacity, inventory,** and **supply chain.** These decisions provide the framework for organizing the text and describing what operations and supply chain managers do. We will discuss these decisions in greater detail in subsequent chapters.

2. **Function.** Operations is a major function in any organization, along with marketing and finance. In a manufacturing company, the operations function typically is called the manufacturing or production department. In service organizations, the operations function may be called the operations department or some name peculiar to the particular industry (e.g., the policy service department in insurance companies). In general, the generic term "operations" refers to the function that produces and delivers goods or services. While separating operations out in this manner is useful for analyzing decision making and assigning responsibilities, we must also integrate the business by considering the cross-functional nature of decision making in the firm.
3. **Process.** Operations managers plan and control the transformation process and its interfaces in organizations as well as across the supply chain. This **process view** provides common ground for defining service and manufacturing operations as transformation processes and is a powerful basis for the design and analysis of operations in an organization and across the supply chain. Using the process view, we consider operations managers as managers of the conversion process in the firm. But the process view also provides important insights for the management of productive processes in functional areas outside the operations function. For example, a sales office may be viewed as a production process with inputs, transformation, and outputs. The same is true for an accounts payable office and for a loan office in a bank. In terms of the process view, operations management concepts have applicability beyond the functional area of operations. Toyota, for example, uses lean thinking to improve processes throughout the firm, including processes in human resources, accounting, finance, information systems, and even the legal department. Process improvement is not restricted to operations.

Since the field of operations and supply chain management can be defined by decisions, function, and processes, we will expand on these three elements in detail in this chapter. But first we provide an example of the decisions that would be made by operations and supply chain management in a typical company that makes and markets pizzas.

1.3 DECISIONS AT PIZZA U.S.A.

LO1.2 Describe the five main decisions made by operations and supply chain managers.

Pizza U.S.A., Inc., produces and markets pizzas on a national basis. The firm consists of 85 company-owned and franchised outlets (each called a store) in the United States. The operations function in this company exists at two levels: the corporate level and the level of the individual store.

The major operations and supply chain decisions made by Pizza U.S.A. can be described as follows:

Process

Corporate staff makes some of the process decisions, since uniformity across different stores is desirable. They have developed a standard facility design that is sized to fit a particular location. Each store incorporates a limited menu with equipment that is designed to produce high volumes of pizza. As pizzas are made, customers can watch the process through a glass window; this provides entertainment for both children and adults as they wait for their orders to be filled. Because this is a service facility, special care is taken to make the layout attractive and convenient for the customers.

Within the design parameters established by the corporate operations staff, the store managers seek to improve the process continually over time. This is done both by additional investment in the process and by the use of better methods and procedures, which often are developed by the employees themselves. For example, a store might re-arrange its layout to speed up the process of producing pizzas.

Quality

Certain standards for quality that all stores must follow have been set by the corporate staff. The standards include procedures to maintain service quality and ensure the quality and food safety of the pizzas served. While perceptions of service quality may differ by customer, the quality of the pizzas can be specified more exactly by using criteria such as temperature at serving time and the amount of raw materials used in relation to standards, among others. Service-quality measures include courtesy, cleanliness, speed of service, and a friendly atmosphere. Service quality is monitored by store manager observation, comment cards, and occasional random surveys. Each Pizza U.S.A. store manager must carefully monitor quality internally and with suppliers to make sure that it meets company standards. All employees are responsible for the quality of their work to ensure that service quality and food quality are meeting the standards of the company.

Pizza U.S.A. satisfies its customers by carefully managing the four key decision areas in operations.

Capacity

Decisions about capacity determine the maximum level of output of pizzas. The capacity available at any point in time is determined by the availability of equipment and labor inputs for the pizza-making process at that time. First, when the initial location and process decisions are made, the corporate staff determines the physical capacity of each facility. Individual store managers then plan for annual, monthly, and daily fluctuations in capacity within the available physical facility. During peak periods, they may employ part-time help, and advertising is used in an