

# OPERATIONS MANAGEMENT

Twelfth Edition

PROCESSES AND SUPPLY CHAINS

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 Pearson

# Operations Management

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# Operations Management

PROCESSES AND SUPPLY CHAINS

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Dedicated with love to our families.



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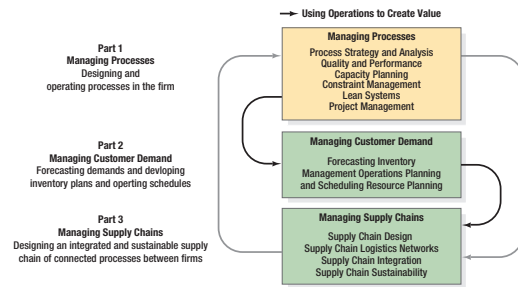
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# Preface

## New to This Edition

The profession of operations management is constantly evolving as new technologies, innovative ideas, and increasing competition enter the global picture. Since the *eleventh* edition we have monitored events and developments in operations management and made the *twelfth* edition the most relevant text to date for all business students regardless of their major. Here are the highlights of the new material for this edition:

**Unifying Central Figure** We have introduced a new figure to introduce each chapter that embodies our philosophy of operations management. We adhere to the “building block” approach to teaching operations management. In Part 1, we discuss how to design and manage processes, sometimes referred to as “journeys” in practice, at the firm level. These processes must effectively satisfy customer demands. In Part 2, we discuss how firms forecast their demands and satisfy them with appropriate inventory and scheduling practices. In Part 3, we show how the building blocks are connected into supply chains, linking the processes in one firm with those of another. All three levels of the diagram are linked with feedback loops.



**Chapter Opening Vignettes** Each chapter opens with a real-world example of a company addressing the topic of that chapter. In this edition we have introduced five new vignettes highlighting the operations of CVS Pharmacy, Airbus, Microsoft, Ford Motor Company, and the Burj Khalifa, the tallest building in the world.

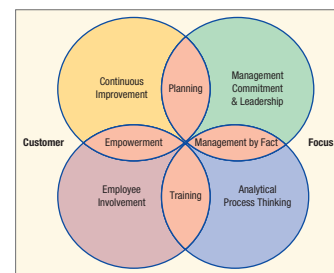
**Managerial Practices** It is important for the understanding of operations management to provide many examples of current practices. In this edition, we have added eleven new managerial practices, ranging from the scheduling of major league baseball umpires to the use of drones in a disaster-relief supply chain.



**Video Cases** Fourteen chapters have a video case showing actual managers dealing with an important operating problem. Each video has an associated case in the text, along with thought-provoking questions to generate discussion. In this edition we have two new video cases, one featuring TASER and its quality program, and the other featuring Choice Hotels and their major information technology project. Videos of all fourteen cases appear in MyLab Operations Management.



**New Topics** The field of operations management is typically at the vortex of the storm when disruptive technologies become available. To keep the *twelfth* edition at the cutting edge of operations management, we have added three new sections dealing with the latest in new technology and its effects on the operations of a firm. In Chapter 1, “Using Operations to Create Value,” we discuss the *Internet of Things* (IoT), which relates to the interconnectivity of objects that can collect and exchange data without human intervention. IoT has implications for product design and development, healthcare, inventory management, and logistics, to name a few. In Chapter 8, “Forecasting,” the use of *big data* for forecasting demand is shown to have great potential for operations management. Big data refers to the use of huge, complex databases, often generated by the IoT, for predicting the demand for products and services. Finally, Chapter 14, “Supply Chain Integration,” discusses how a disruptive technology such as *additive manufacturing* (AM) can reduce material inputs and make supply chains more flexible. AM, also called 3-D printing, creates products on demand by laying down successive layers of material to fabricate a 3-D object.



In addition to discussing the impact of new technologies on operations, we have added a new section in Chapter 3, “Quality and Performance,” that introduces a systems approach to total quality management and emphasizes its importance with an integrating diagram that explains the interactions between continuous improvement, employee involvement, management commitment, and analytical process thinking.

## Solving Teaching and Learning Challenges

Many students who take the introduction to operations management course have difficulty seeing the relevance of a process view of a business or the concepts of competitive priorities, throughput, and sustainability to their lives and their careers. Teaching can be a challenge when students are not motivated and get little reinforcement in what they have learned. We have found that students get motivated when they study concepts, techniques, and methods that are actually used in practice, and they get reinforcement when they can apply what they have learned. As for motivation, we have designed the *twelfth* edition on four pillars:

- **Practical.** This text is written from a managerial perspective. There are many examples of problems typically experienced in practice and the decision tools used to analyze them. The explanations are intuitive and provide a basis for students to apply the concepts and techniques in practice.
- **Current.** The chapter opening vignettes, managerial practices, videos, and photos connect the topics covered in the text to present-day practice and issues.
- **Comprehensive.** The *twelfth* edition covers all of the new and traditional topics managers need to know to make their processes competitive weapons in a dynamic environment. Regardless of the functional area, *processes* are the means to get work done.
- **Understandable.** The *twelfth* edition has numerous diagrams clearly showing the concepts or techniques being discussed. We took care to avoid unnecessary jargon. Key terms are defined in the margins of the paragraph where they are used, and key equations are listed at the end of the chapter. Further, each learning goal for a chapter is repeated at the end of the chapter with guidelines for review. All of these features are in the *twelfth* edition to enhance clarity and make the text much more accessible to students of all majors.

The following testimonials are exemplary of the value students are finding in the text.

The Krajewski, Malhotra, Ritzman text was instrumental in my success in my career preparation, university project work, and job-hunting process. As I had not been previously exposed to operations management, the text was an excellent introduction to the field and the vast variety of management related career opportunities. It also helped lay a strong conceptual foundation that positioned me for success throughout my advanced supply chain management courses. I found it most useful during my work as student consultant as the text's in-depth explanation of inventory management helped my group and I design an inventory replenishment tool for the Sonoco Company.

Further, the work's clear and concise explanations of operations management concepts prepared me to ace technical questions during both internship and job interviews. Its powerful descriptions have positioned me for success in my future career by instilling a deep understanding of core management principles. After working with this text, I am confident that I will be able to implement lean techniques in my position after graduation.

Jessica Thiergartner

Global Supply Chain and Operations Management | International Business  
University of South Carolina Honors College (2017)

The Krajewski, Malhotra, Ritzman text laid an amazing foundation for me as I started my Global Supply Chain and Operations Management journey as I earned my International MBA. The text was laid out in a logical way that enabled students to start with the basics and build upon that knowledge as we worked through each chapter. I was able to easily follow along as the professor taught, and I found the text to be an excellent source to refer to when something the professor taught was not perfectly clear to me by the end of class. The videos and stories were especially helpful in understanding how each of the concepts could be applied to real-world situations. I am an individual who learns by example, so having specific examples that I could learn about and understand truly helped me to know how I would use the concepts in my future career.

I also used this text extensively during my internship with a logistics company. As I worked on challenging projects that incorporated many of the concepts discussed in the book, I referred to the text to refresh my memory and to make sure I was implementing practices and processes in the correct way. The material was presented in a way that made it easy to translate into real-world use.

Jean McDowell

International MBA Candidate (2017)  
Darla Moore School of Business

As for reinforcement by applying what they have learned, the *twelfth* edition provides ample opportunity for students to engage with the content.

- **Examples and Solved Problems.** Many students struggle with quantitative problem solving. To help students who have difficulty, in the *twelfth* edition each technique or interim calculation has an associated example problem in the chapter where it is discussed and a solved problem showing the entire technique for another problem at the end. In each case the problem and all the steps toward solution are clearly demonstrated. Similar solved problems appear in MyLab Operations Management.

<b>EXAMPLE 9.9</b>	<b>Calculating <i>P</i> and <i>T</i></b>	<p>Again, let us return to the bird feeder example. Recall that demand for the bird feeder is normally distributed with a mean of 18 units per week and a standard deviation in weekly demand of 5 units. The lead time is 2 weeks, and the business operates 52 weeks per year. The <i>Q</i> system developed in Example 9.6 called for an EOQ of 75 units and a safety stock of 9 units for a cycle-service level of 90 percent. What is the equivalent <i>P</i> system? Answers are to be rounded to the nearest integer.</p>	<p><b>MyLab Operations Management</b> Tutor 9.5 in MyLab Operations Management provides a new example to determine the review interval and the target inventory for a <i>P</i> system.</p>
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### Solved Problem 5

Suppose that a periodic review (*P*) system is used at the distributor in Solved Problem 4, but otherwise the data are the same.

- Calculate the *P* (in workdays, rounded to the nearest day) that gives approximately the same number of orders per year as the EOQ.
- What is the target inventory level, *T*? Compare the *P* system to the *Q* system in Solved Problem 4.
- What is the total annual cost of the *P* system?
- It is time to review the item. On-hand inventory is 40 mixers; receipt of 440 mixers is scheduled, and no backorders exist. How much should be reordered?

**SOLUTION**

- The time between orders is
 
$$P = \frac{\text{EOQ}}{D} (260 \text{ days/year}) = \frac{440}{26,000} (260) = 4.4, \text{ or } 4 \text{ days}$$
- Figure 9.15 shows that  $T = 812$  and safety stock =  $(1.41)(79.37) = 111.91$ , or about 112 mixers. The corresponding *Q* system for the countertop mixer requires less safety stock.

- **Discussion Questions and Problems.** Instructors can use the discussion questions in class to spark dialog of various issues and managerial situations. The problems are grouped under learning goals to make it easier for instructors assign problems that cover all goals, both in the text and in MyLab Operations Management. Students can complete assignments on MyLab Operations Management and receive instant feedback. Tutorials are available to assist students in learning the techniques and methods for solving common operating problems.

## Discussion Questions

- What are the economies of scale in college class size? As class size increases, what symptoms of diseconomies of scale appear? How are these symptoms related to customer contact?
- A young boy sets up a lemonade stand on the corner of College Street and Air Park Boulevard. Temperatures in the area climb to 100°F during the summer. The intersection is near a major university and a large construction site. Explain to this young entrepreneur how his business might benefit from economies of scale. Explain also some conditions that might lead to diseconomies of scale.
- Identify an industry in which expansionist strategy has generally been followed by most firms in the past. Under which conditions will it be better for a firm to follow the wait-and-see strategy rather than the expansionist strategy? Then identify a firm or an industry that has done so successfully.

## Problems

The OM Explorer and POM for Windows software is available to all students using the 12th edition of this textbook. Go to <http://www.pearsonhighered.com/krajewski> to download these computer packages. If you purchased MyLab Operations Management, you also have access to Active Models software and significant help in doing the following problems. Check with your instructor on how best to use these resources. In many cases, the instructor wants you to understand how to do the calculations by hand. At the least, the software provides a check on your calculations. When calculations are particularly complex and the goal is interpreting the results in making decisions, the software replaces entirely the manual calculations. Problems 20, 21, 22, 23, 24, and 25 require reading of Supplement A, "Decision Making." Problems 15, 16, 17, 24, and 25 require reading of MyLab Operations Management Supplement F, "Financial Analysis."

- **Cases.** Students can test their understanding of the content using cases in two ways. First, the *twelfth* edition has 14 video cases. Each video case has two parts, a written case describing a problem experienced by a real company along with several questions asking how the student might resolve the issue at hand, and a video on MyLab Operations Management showing the actual setting for the case and discussions with managers regarding the problem. Each format provides a rich environment to discuss the topic of the chapter. The second way instructors can engage students is to use any of the thirteen written cases in the text. These cases often provide data that students can use with techniques in the text to resolve an issue.

## CASE

## Yankee Fork and Hoe Company

The Yankee Fork and Hoe Company is a leading producer of garden tools ranging from wheelbarrows, mortar pans, and hand trucks to shovels, rakes, and trowels. The tools are sold in four different product lines ranging from the top-of-the-line Hercules products, which are rugged tools for the toughest jobs, to the Garden Helper products, which are economy tools for the occasional user. The market for garden tools is extremely competitive because of the simple design of the products and the large number of competing producers. In addition, more people are using power tools, such as lawn edgers, hedge trimmers, and thatchers, reducing demand for their manual counterparts. These factors compel Yankee to maintain low prices while retaining high quality and dependable delivery.

Garden tools represent a mature industry. Unless new manual products can be developed or a sudden resurgence occurs in home gardening, the

prospects for large increases in sales are not bright. Keeping ahead of the competition is a constant battle. No one knows this better than Alan Roberts, president of Yankee.

The types of tools sold today are, by and large, the same ones sold 30 years ago. The only way to generate new sales and retain old customers is to provide superior customer service and produce a product with high customer value. This approach puts pressure on the manufacturing system, which has been having difficulties lately. Recently, Roberts has been receiving calls from long-time customers, such as Sears and True Value Hardware Stores, complaining about late shipments. These customers advertise promotions for garden tools and require on-time delivery.

Roberts knows that losing customers like Sears and True Value would be disastrous. He decides to ask consultant Sharon Place to look into the matter

## VIDEO CASE

## Project Management at Choice Hotels International

Choice Hotels International is the company behind well-known hotel brands that range from budget-friendly EconoLodge and Rodeway Inns to Quality, Comfort Inns and its luxury brands, Ascend and Cambria. Over 6,400 properties are part of the franchisor's offerings in both domestically and abroad. This translates to over 500,000 rooms around the globe.

To help hotel guests find and book those rooms, Choice Hotels maintains a robust central reservation system, or CRS, that must connect travel agents, online reservation websites such as Trivago and Kayak, and mobile app users to the company's daily available inventory. On the back end, the system also must connect to each property's front check-in desk system and the organization's revenue management systems. For Choice, the CRS is the heart of their hotel operations and it could not operate without it.

The company first developed its CRS back in the 1980s using the latest project management techniques and information technology (IT) available. But the company's growth, coupled with dramatic changes in information technology and the cost of maintaining inflexible systems built for last century business that couldn't scale with growth, have compelled the organization in 2014 to embark on a multi-million dollar, multi-year project, called choiceEDGE, to replace this mission-critical system by 2017. To replace such a vital system, Todd Davis, Choice's Chief Information Officer (CIO), knew they couldn't just remove the old software and hardware systems and then plug in brand-new ones. The risk was too high. Nor could they rely on a linear systems development approach that would require the company to deliver a finished solution



Choice Hotels International, Inc.

Cambria Hotels and Suites, such as this one on Times Square in New York, is a luxury product of Choice Hotels. With over 6,400 properties across all of its brands, and more than 500,000 rooms to fill, Choice must have a flexible and reliable reservation system to remain competitive.

- **Experiential Learning and Active Model Exercises.** Perhaps the most engaging, and fun, activities in the *twelfth* edition are the experiential learning and active model exercises. There are five time-tested experiential learning exercises that require students to form teams for work both in and out of class on exercises that involve them in team-based discussion questions and decisions. Two of these experiences are competitive decision simulations that often generate intense interest in the students. In addition, there are 29 active model spreadsheets that require students to evaluate different situations based on problem scenarios. These models are perfect for asking “what if” questions and learning from the results.

All told, the *twelfth* edition has the elements to support student motivation and reinforcement and, along with a host of Instructor Resources, it solves most of the teaching and learning challenges involved in the introduction to operations management course.

## MyLab Operations Management

**Reach every student with MyLab Operations Management**—MyLab Operations Management is the teaching and learning platform that empowers you to reach *every* student. By combining trusted author content with digital tools and a flexible platform, MyLab Operations Management personalizes the learning experience and improves results for each student. Learn more about MyLab Operations Management.

**Deliver trusted content**—You deserve teaching materials that meet your own high standards for your course. That’s why we partner with highly respected authors to develop interactive content and course-specific resources that you can trust—and that keep your students engaged.

**Empower each learner**—Each student learns at a different pace. Personalized learning pinpoints the precise areas where each student needs practice, giving all students the support they need—when and where they need it—to be successful.

**Teach your course your way**—Your course is unique. So whether you’d like to build your own assignments, teach multiple sections, or set prerequisites, MyLab Operations Management gives you the flexibility to easily create *your* course to fit *your* needs.

**Improve student results**—When you teach with MyLab Operations Management, student performance improves. That’s why instructors have chosen MyLab Operations Management for over 15 years, touching the lives of over 50 million students.

## Developing Employability Skills

For students to succeed in a rapidly changing job market, they need to develop a variety of skills. We have identified seven critical skills that recruiters look for in students seeking a career in business. The matrix shows how major elements of the *twelfth* edition map into those essential skills.

### Employability Skills in KMR 12e

Text Elements	Communication	Critical Thinking	Collaboration	Knowledge Application and Analysis	Business Ethics and Social Responsibility	Information Technology Application and Computing Skills	Data Literacy
Active Model Exercises				✓		✓	✓
Cases	✓	✓	✓	✓			✓
Chapter Opening Vignettes				✓	✓		
Discussion Questions	✓				✓		
Experiential Learning	✓	✓	✓	✓			
Managerial Practices				✓	✓		
Numerical Examples		✓					✓
OM Explorer and POM for Windows						✓	
Photo Illustrations				✓			
Problems		✓		✓		✓	✓
Solved Problems and MyLab Operations Management Problem Videos		✓					✓

## Instructor Teaching Resources

This text comes with the following teaching resources.

Supplements available to instructors <a href="http://www.pearsonhighered.com/krajewski">www.pearsonhighered.com/krajewski</a>	Features of the Supplement
<b>Instructor's Manual</b>	<ul style="list-style-type: none"> <li>• Chapter-by-chapter summaries</li> <li>• Examples and activities not in the main book</li> <li>• Teaching outlines</li> <li>• Teaching tips</li> <li>• Solutions to all questions and problems in the book</li> </ul>
<b>Solutions Manual</b>	Solutions to the end-of-chapter content and video cases
<b>Test Bank</b>	<p>More than 1,500 multiple-choice, true/false, short-answer, and graphing questions with these annotations:</p> <ul style="list-style-type: none"> <li>• Difficulty level (Easy for straight recall, Moderate for some analysis, Difficult for complex analysis)</li> <li>• Type (Multiple-choice, true/false, short-answer, essay)</li> <li>• Topic (The term or concept the question supports)</li> <li>• Learning outcome</li> <li>• AACSB learning standard (Written and Oral Communication; Ethical Understanding and Reasoning; Analytical Thinking; Information Technology; Interpersonal Relations and Teamwork; Diverse and Multicultural Work; Reflective Thinking; Application of Knowledge)</li> </ul>
<b>Computerized TestGen</b>	<p>TestGen allows instructors to:</p> <ul style="list-style-type: none"> <li>• Customize, save, and generate classroom tests</li> <li>• Edit, add, or delete questions from the Test Item Files</li> <li>• Analyze test results</li> <li>• Organize a database of tests and student results</li> </ul>
<b>PowerPoints</b>	<p>Slides include all the graphs, tables, and equations in the textbook. PowerPoints meet accessibility standards for students with disabilities. Features include, but not limited to,</p> <ul style="list-style-type: none"> <li>• Keyboard and Screen Reader access</li> <li>• Alternative text for images</li> <li>• High color contrast between background and foreground colors</li> </ul>

## Acknowledgements

No book is just the work of the authors. We greatly appreciate the assistance and valuable contributions by several people who made this edition possible. Thanks to Beverly Amer of Aspenleaf Productions for her efforts in filming and producing the new video segments for this edition. Special thanks are due to Howard Weiss of Temple University whose expertise in upgrading the software for this book is greatly appreciated.

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Finally, we thank our families for supporting us during this project involving multiple emails, teleconference calls and long periods of seclusion. Our wives, Judie, Maya, and Barb, have provided the love, stability, and encouragement that sustained us while we transformed the eleventh edition into the twelfth.

# Operations Management



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# USING OPERATIONS TO CREATE VALUE

# 1

## DISNEY



Atlantide Phototravel/Getty Images

Characters perform at Cinderella's Castle in Magic Kingdom, Orlando, Florida, USA.

**D**isney Corporation is an internationally diversified entertainment and media enterprise comprising five business segments of media networks (e.g., ABC, ESPN networks), parks and resorts (e.g., Disneyland and Disneyworld), studio entertainment (e.g., Pixar and Marvel studios), consumer products (e.g., toys, apparel, and books), and interactive media (e.g., Disney.com). It is

one of the 30 companies that has been a part of the Dow Jones Industrial Average since 1991. With annual revenues of over \$55 billion in 2016, Disney is particularly well known for the 14 theme parks that it owns and licenses, and which are located around the world in Hong Kong, Paris, Shanghai, Tokyo, and the United States. Its largest park, Walt Disney World Resort, opened in Orlando, Florida, in 1971 and includes the Magic Kingdom, Epcot Center, Disney Studios, and Animal Kingdom.

Disney constantly evaluates and improves its processes to enhance customer experience. One of its recent innovations is a \$1 billion comprehensive reservation and ride-planning system that can allow guests to book rides months in advance through a website or a smartphone app. Dubbed as MyMagic+, it works through a radio-frequency identification (RFID) chip embedded inside electronic wristbands or bracelets that guests wear once they check into a Disney theme park. Called MagicBands, they link electronically to centralized databases and can be used as admission tickets, credit or debit cards, or hotel room keys. Just by tapping them against electronic sensors, these MagicBands also become a form of payment for food, entertainment, and merchandise. Data from these wristbands can help Disney determine when to add more staff to which rides, decide how many employees in costumes should roam around at which locations in the park, determine restaurant menus and which souvenirs should be stocked based on customer preferences, and even send email or text message alerts to guests when space opens up in an expedited queue at that guest's favorite ride such as Space Mountain or Pirates of the Caribbean. Apart from facilitating crowd control and data collection, this wearable technology helps Disney seamlessly personalize each guest's experience and change how they play and spend at the oft-advertised "Most Magical Place on Earth."

Despite some privacy concerns surrounding the use of RFID chips that can track a guest's identity and location within the theme parks, the new MyMagic+ system has multiple advantages. First, when visitors have well-planned schedules and forward visibility on what they are going to do on a given day on an hourly basis, they are less likely to jump ship to other theme parks in the area such as Sea World or the popular Wizarding World of Harry Potter by Universal Studios. Second, when the logistics of moving from one attraction to another are simplified, guests have additional opportunities to spend more time and money in Disney restaurants and shops. Finally, by using this new RFID-enabled technology, Disney can effectively increase its capacity when it is needed the most. For instance, this new system allowed Disney to handle 3,000 additional visitors to the Magic Kingdom in Orlando during the Christmas rush. With other costs more or less fixed, the incremental revenues from additional guests flow directly to the bottom line. Increased profitability through technological and operational innovations help Disney provide more value to its guests as well as maintain its leadership position in the entertainment industry on multiple dimensions. It is also one among many other reasons why despite the price of entrance tickets crossing an average of \$100 per day inclusive of taxes, an increase of 45 percent since 2005, there is no end in sight to the large crowds flooding Disney's theme parks.

*Sources:* Christopher Palmeri, "Disney Bets \$1 Billion on Technology to Track Theme Park Visitors," *Bloomberg Business Week* (March 7, 2014); Justin Bachman, "Disney's Magic Kingdom Nears \$100 Tickets, and the Crowds Keep Coming," *Bloomberg Business Week* (February 25, 2014); <http://thewaltdisneycompany.com/about-disney/company-overview>; <http://en.wikipedia.org/wiki/Disney> (April 22, 2017).

## LEARNING GOALS *After reading this chapter, you should be able to:*

- 1 Describe the role of operations in an organization and its historical evolution over time.
- 2 Describe the process view of operations in terms of inputs, processes, outputs, information flows, suppliers, and customers.
- 3 Describe the supply chain view of operations in terms of linkages between core and support processes.
- 4 Define an operations strategy and its linkage to corporate strategy and market analysis.
- 5 Identify nine competitive priorities used in operations strategy, and explain how a consistent pattern of decisions can develop organizational capabilities.
- 6 Identify the latest trends in operations management and understand how, given these trends, firms can address the challenges facing operations and supply chain managers in a firm.
- 7 Understand how to develop skills for your career using this textbook.

**Operations management** refers to the systematic design, direction, and control of processes that transform inputs into services and products for both internal and external customers. As exemplified by Disney, it can be a source of competitive advantage for firms in both service and manufacturing sectors.

This book deals with managing those fundamental activities and processes that organizations use to produce goods and services that people use every day. A **process** is any activity or group of activities that takes one or more inputs, transforms them, and provides one or more outputs for its customers. For organizational purposes, processes tend to be clustered together into operations. An **operation** is a group of resources performing all or part of one or more processes. Processes can be linked together to form a **supply chain**, which is the interrelated series of processes within a firm and across different firms that produce a service or product to the satisfaction of customers.<sup>1</sup> A firm can have multiple supply chains, which vary by the product or service provided. **Supply chain management** is the synchronization of a firm's processes with those of its suppliers and customers to match the flow of materials, services, and information with customer demand. As we will learn throughout this book, all firms have processes and supply chains. Sound operational planning and design of these processes, along with internal and external coordination within its supply chain, can create wealth and value for a firm's diverse stakeholders.

## Role of Operations in an Organization

Broadly speaking, operations and supply chain management underlie all departments and functions in a business. Whether you aspire to manage a department or a particular process within it, or you just want to understand how the process you are a part of fits into the overall fabric of the business, you need to understand the principles of operations and supply chain management.

Operations serve as an excellent career path to upper management positions in many organizations. The reason is that operations managers are responsible for key decisions that affect the success of the organization. In manufacturing firms, the head of operations usually holds the title chief operations officer (COO) or vice president of manufacturing (or of production or operations). The corresponding title in a service organization might be COO or vice president (or director) of operations. Reporting to the head of operations are the managers of departments such as customer service, production and inventory control, and quality assurance.

Figure 1.1 shows operations as one of the key functions within an organization. The circular relationships that are shown highlight the importance of the coordination among the three mainline functions of any business: (1) operations, (2) marketing, and (3) finance. Each function is unique and has its own knowledge and skill areas, primary responsibilities, processes, and decision domains. From an external perspective, finance generates resources, capital, and funds from investors and sales of its goods and services in the marketplace. Based on business strategy, the finance and operations functions then decide how to invest these resources and convert them into physical assets and material inputs. Operations subsequently transforms these material and service inputs into product and service outputs. These outputs must match the characteristics that can be sold in the selected markets by marketing. Marketing is responsible for producing sales revenue of the outputs, which become returns to investors and capital for supporting operations. Functions such as accounting, information systems, human resources, and engineering make the firm complete by providing essential information, services, and other managerial support.

### operations management

The systematic design, direction, and control of processes that transform inputs into services and products for internal, as well as external, customers.

### process

Any activity or group of activities that takes one or more inputs, transforms them, and provides one or more outputs for its customers.

### operation

A group of resources performing all or part of one or more processes.

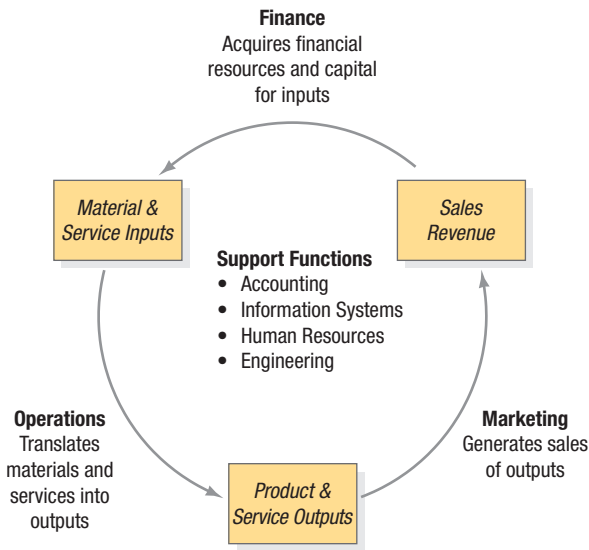
### supply chain

An interrelated series of processes within and across firms that produces a service or product to the satisfaction of customers.

### supply chain management

The synchronization of a firm's processes with those of its suppliers and customers to match the flow of materials, services, and information with customer demand.

<sup>1</sup>The terms *supply chain* and *value chain* are sometimes used interchangeably.



▲ **FIGURE 1.1**  
Integration between Different Functional Areas of a Business

and eventually even in distant colonies such as India. With the invention of the cotton gin in 1794, Eli Whitney introduced the concept of interchangeable parts. It revolutionized the art of machine-based manufacturing, and coupled with the invention of the steam engine, led to the great industrial revolution in England and the rest of Europe. The textile industry was



Martyr Goddard/Getty Images

The Ford Motor Company, founded in 1903, produced about 1 million Model T's in 1921 alone.

one of the earliest industries to be mechanized. The industrial revolution gradually spread to the United States and the rest of the world in the 19th century and was accompanied by such great innovations as the internal combustion engine, steam-powered ships, metallurgy of iron making, large-scale production of chemicals, and invention of machine tools, among others. The foundations of modern manufacturing and technological breakthroughs were also inspired by the creation of a mechanical computer by Charles Babbage in the early part of the 19th century. He also pioneered the concept of division of labor, which laid the foundation for scientific management of operations and supply chain management that was further improved upon by Frederick Taylor in 1911.

Three other landmark events from the 20th century define the history of operations and supply chain management. First is the invention of the assembly line for the Model T car by Henry Ford in 1909. The era of mass production was born, where complex products like automobiles could be manufactured in large numbers at affordable prices through repetitive manufacturing. Second, Alfred Sloan in the 1930s introduced the idea of strategic planning for achieving product proliferation and variety, with the newly founded General Motors Corporation offering “a car for every purse and purpose.” Finally, with the publication of the Toyota Production System book in Japanese in 1978, Taiichi Ohno laid the groundwork for removing wasteful activities from an organization, a concept that we explore further in this book while learning about lean systems.

The recent history of operations and supply chains over the past three decades has been steeped in technological advances. The 1980s were characterized by wide availability of computer-aided design (CAD), computer-aided manufacturing (CAM), and automation. Information technology applications started playing an increasingly important role in the 1990s and started connecting the firm with its extended enterprise through Enterprise Resource Planning Systems and outsourced technology hosting for supply chain solutions. Service organizations like Federal Express, United Parcel Service (UPS), and Walmart also became sophisticated users of information technology in operations, logistics, and management of supply chains. The new millennium has seen an acceleration of this trend, along with an increased focus on sustainability and the natural environment. We cover all these ideas and topical areas in greater detail throughout this book.

These relationships provide direction for the business as a whole and are aligned to the same strategic intent. It is important to understand the entire circle, and not just the individual functional areas. How well these functions work together determines the effectiveness of the organization. Functions should be integrated and should pursue a common strategy. Success depends on how well they are able to do so. No part of this circle can be dismissed or minimized without loss of effectiveness, and regardless of how departments and functions are individually managed; they are always linked together through processes. Thus, a firm competes not only by offering new services and products, creative marketing, and skillful finance but also through its unique competencies in operations and sound management of core processes.

## Historical Evolution and Perspectives

The history of modern operations and supply chain management is rich and over 200 years old, even though its practice has been around in one form or another for centuries. James Watt invented the steam engine in 1785. The subsequent establishment of railroads facilitated efficient movement of goods throughout Europe, and eventually even in distant colonies such as India. With the invention of the cotton gin in 1794, Eli Whitney introduced the concept of interchangeable parts. It revolutionized the art of machine-based manufacturing, and coupled with the invention of the steam engine, led to the great industrial revolution in England and the rest of Europe. The textile industry was one of the earliest industries to be mechanized. The industrial revolution gradually spread to the United States and the rest of the world in the 19th century and was accompanied by such great innovations as the internal combustion engine, steam-powered ships, metallurgy of iron making, large-scale production of chemicals, and invention of machine tools, among others. The foundations of modern manufacturing and technological breakthroughs were also inspired by the creation of a mechanical computer by Charles Babbage in the early part of the 19th century. He also pioneered the concept of division of labor, which laid the foundation for scientific management of operations and supply chain management that was further improved upon by Frederick Taylor in 1911.

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## A Process View

You might wonder why we begin by looking at processes rather than at departments or even the firm. The reason is that a process view of the firm provides a much more relevant picture of the way firms actually work. Departments typically have their own set of objectives, a set of resources with capabilities to achieve those objectives, and managers and employees responsible for performance. Some processes, such as billing, may be so specific that they are contained wholly within a single department, such as accounting.

The concept of a process, however, can be much broader. A process can have its own set of objectives, involve a work flow that cuts across departmental boundaries, and require resources from several departments. You will see examples throughout this text of companies that discovered how to use their processes to gain a competitive advantage. You will notice that the key to success in many organizations is a keen understanding of how their processes work, since an organization is only as effective as its processes. Therefore, operations management is relevant and important for all students, regardless of major, because all departments have processes that must be managed effectively to gain a competitive advantage.

## How Processes Work

Figure 1.2 shows how processes work in an organization. Any process has inputs and outputs. Inputs can include a combination of human resources (workers and managers), capital (equipment and facilities), purchased materials and services, land, and energy. The numbered circles represent operations through which services, products, or customers pass and where processes are performed. The arrows represent flows and can cross because one job or customer can have different requirements (and thus a different flow pattern) than the next job or customer.

Processes provide outputs to customers. These outputs may often be services (that can take the form of information) or tangible products. Every process and every person in an organization has customers. Some are **external customers**, who may be end users or intermediaries (e.g., manufacturers, financial institutions, or retailers) buying the firm's finished services or products. Others are **internal customers**, who may be employees in the firm whose process inputs are actually the outputs of earlier processes managed within the firm. Either way, processes must be managed with the customer in mind.

In a similar fashion, every process and every person in an organization relies on suppliers. **External suppliers** may be other businesses or individuals who provide the resources, services, products, and materials for the firm's short-term and long-term needs. Processes also have **internal suppliers**, who may be employees or processes that supply important information or materials.

Inputs and outputs vary depending on the service or product provided. For example, inputs at a jewelry store include merchandise, the store building, registers, the jeweler, and customers; outputs to external customers are services and sold merchandise. Inputs to a factory manufacturing blue jeans include denim, machines, the plant, workers, managers, and services provided by outside consultants; outputs are clothing and supporting services. The fundamental role of inputs, processes, and customer outputs holds true for processes at all organizations.

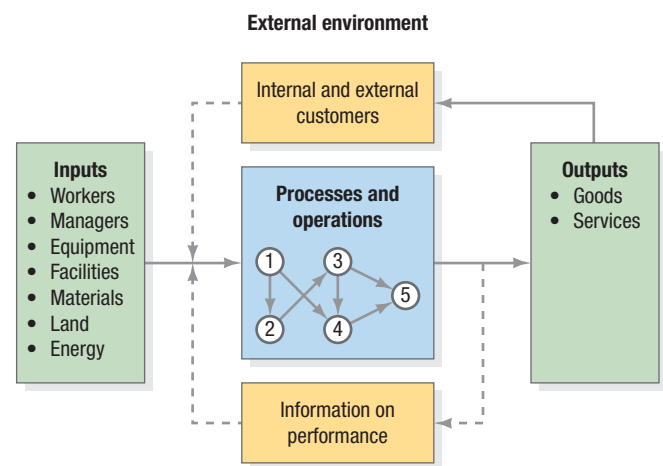
Figure 1.2 can represent a whole firm, a department, a small group, or even a single individual. Each one has inputs and uses processes at various operations to provide outputs. The dashed lines represent two special types of input: participation by customers and information on performance from both internal and external sources. Participation by customers occurs not only when they receive outputs but also when they take an active part in the processes, such as when students participate in a class discussion. Information on performance includes internal reports on customer service or inventory levels and external information from market research, government reports, or telephone calls from suppliers. Managers need all types of information to manage processes most effectively.

## Nested Processes

Processes can be broken down into subprocesses, which in turn can be broken down further into still more subprocesses. We refer to this concept of a process within a process as a **nested process**. It may be helpful to separate one part of a process from another for several reasons. One person or one department may be unable to perform all parts of the process, or different parts of the process may require different skills. Some parts of the process may be designed for routine work while other parts may be geared for customized work. The concept of nested processes is

▼ FIGURE 1.2

Processes and Operations



### external customers

A customer who is either an end user or an intermediary (e.g., manufacturers, financial institutions, or retailers) buying the firm's finished services or products.

### internal customers

One or more employees or processes that rely on inputs from other employees or processes to perform their work.

### external suppliers

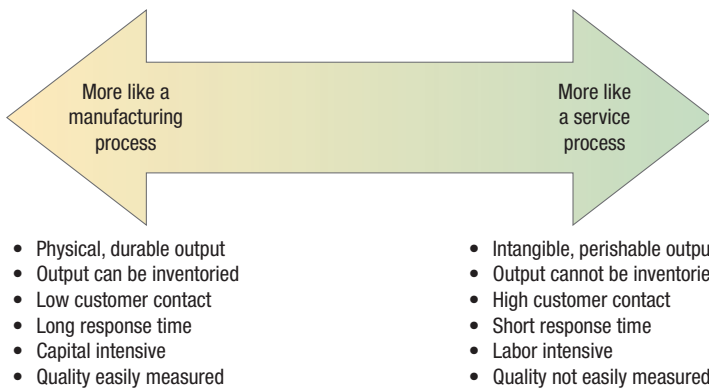
The businesses or individuals who provide the resources, services, products, and materials for the firm's short-term and long-term needs.

### internal suppliers

The employees or processes that supply important information or materials to a firm's processes.

### nested process

The concept of a process within a process.



▲ **FIGURE 1.3**  
Continuum of Characteristics  
of Manufacturing and Service  
Processes

manufacturing processes? The answer lies at the heart of the design of competitive processes. While Figure 1.3 shows several distinctions between service and manufacturing processes along a continuum, the two key differences that we discuss in detail are (1) the nature of their output and (2) the degree of customer contact. In general, manufacturing processes also have longer response times, are more capital intensive, and their quality can be measured more easily than those of service processes.

Manufacturing processes convert materials into goods that have a physical form we call products. For example, an assembly line produces a 370 Z sports car, and a tailor produces an outfit for the rack of an upscale clothing store. The transformation processes change the materials on one or more of the following dimensions:

1. Physical properties
2. Shape
3. Size (e.g., length, breadth, and height of a rectangular block of wood)
4. Surface finish
5. Joining parts and materials

The outputs from manufacturing processes can be produced, stored, and transported in anticipation of future demand.

If a process does not change the properties of materials on at least one of these five dimensions, it is considered a service (or nonmanufacturing) process. Service processes tend to produce intangible, perishable outputs. For example, the output from the auto loan process of a bank would be a car loan, and an output of the order fulfillment process of the U.S. Postal Service is the delivery of your letter. The outputs of service processes typically cannot be held in a finished goods inventory to insulate the process from erratic customer demands.

A second key difference between service processes and manufacturing processes is degree of customer contact. Service processes tend to have a higher degree of customer contact. Customers may take an active role in the process itself, as in the case of shopping in a supermarket, or they may be in close contact with the service provider to communicate specific needs, as in the case of a medical clinic. Manufacturing processes tend to have less customer contact. For example, washing machines are ultimately produced to meet retail forecasts. The process requires little information from the ultimate consumers (you and me), except indirectly through market surveys and market focus groups. Even though the distinction between service and manufacturing processes on the basis of customer contact is not perfect, the important point is that managers must recognize the degree of customer contact required when designing processes.

**Similarities** At the level of the firm, service providers do not just offer services and manufacturers do not just offer products. Patrons of a restaurant expect good service and good food. A customer purchasing a new computer expects a good product as well as a good warranty, maintenance, replacement, and financial services.

Further, even though service processes do not keep finished goods inventories, they do inventory their inputs. For example, hospitals keep inventories of medical supplies and materials needed for day-to-day operations. Some manufacturing processes, on the other hand, do not inventory their outputs because they are too costly. Such would be the case with low-volume customized products (e.g., tailored suits) or products with short shelf lives (e.g., daily newspapers).

When you look at what is being done at the process level, it is much easier to see whether the *process* is providing a service or manufacturing a product. However, this clarity is lost when the whole company is classified as either a manufacturer or a service provider because it often performs both types of processes. For example, the process of cooking a hamburger at a McDonald's is a manufacturing process because it changes the material's physical properties (dimension 1), as is the process of assembling the hamburger with the bun (dimension 5). However, most of the

illustrated in greater detail in Chapter 2, "Process Strategy and Analysis," where we reinforce the need to understand and improve activities within a business and each process's inputs and outputs.

## Service and Manufacturing Processes

Two major types of processes are (1) service and (2) manufacturing. Service processes pervade the business world and have a prominent place in our discussion of operations management. Manufacturing processes are also important; without them the products we enjoy as part of our daily lives would not exist. In addition, manufacturing gives rise to service opportunities.

### Differences

Why do we distinguish between service and manufacturing processes? The answer lies at the heart of the design of competitive processes. While Figure 1.3 shows several distinctions between service and manufacturing processes along a continuum, the two key differences that we discuss in detail are (1) the nature of their output and (2) the degree of customer contact. In general, manufacturing processes also have longer response times, are more capital intensive, and their quality can be measured more easily than those of service processes.

other processes visible or invisible to McDonald's customers are service processes. You can debate whether to call the whole McDonald's organization a service provider or a manufacturer, whereas classifications at the process level are much less ambiguous.

## A Supply Chain View

Most services or products are produced through a series of interrelated business activities. Each activity in a process should add value to the preceding activities; waste and unnecessary cost should be eliminated. Our process view of a firm is helpful for understanding how services or products are produced and why cross-functional coordination is important, but it does not shed any light on the strategic benefits of the processes. The missing strategic insight is that processes must add value for customers throughout the supply chain. The concept of supply chains reinforces the link between processes and performance, which includes a firm's internal processes as well as those of its external customers and suppliers. It also focuses attention on the two main types of processes in the supply chain, namely (1) core processes and (2) support processes. Figure 1.4 shows the links between the core and support processes in a firm and a firm's external customers and suppliers within its supply chain.

### Core Processes

A **core process** is a set of activities that delivers value to external customers. Managers of these processes and their employees interact with external customers and build relationships with them, develop new services and products, interact with external suppliers, and produce the service or product for the external customer. Examples include a hotel's reservation handling, a new car design for an auto manufacturer, or Web-based purchasing for an online retailer like Amazon.com. Of course, each of the core processes has nested processes within it.

In this text we focus on four core processes:

1. **Supplier Relationship Process.** Employees in the **supplier relationship process** select the suppliers of services, materials, and information and facilitate the timely and efficient flow of these items into the firm. Working effectively with suppliers can add significant value to the services or products of the firm. For example, negotiating fair prices, scheduling on-time deliveries, and gaining ideas and insights from critical suppliers are just a few of the ways to create value.
2. **New Service/Product Development Process.** Employees in the **new service/product development process** design and develop new services or products. The services or products may be developed to external customer specifications or conceived from inputs received from the market in general.
3. **Order Fulfillment Process.** The **order fulfillment process** includes the activities required to produce and deliver the service or product to the external customer.
4. **Customer Relationship Process,** sometimes referred to as *customer relationship management*. Employees involved in the **customer relationship process** identify, attract, and build relationships with external customers and facilitate the placement of orders by customers. Traditional functions, such as marketing and sales, may be a part of this process.

### Support Processes

A **support process** provides vital resources and inputs to the core processes and is essential to the management of the business. Processes as such are not just in operations but are found in

#### core process

A set of activities that delivers value to external customers.

#### supplier relationship process

A process that selects the suppliers of services, materials, and information and facilitates the timely and efficient flow of these items into the firm.

#### new service/product development process

A process that designs and develops new services or products from inputs received from external customer specifications or from the market in general through the customer relationship process.

#### order fulfillment process

A process that includes the activities required to produce and deliver the service or product to the external customer.

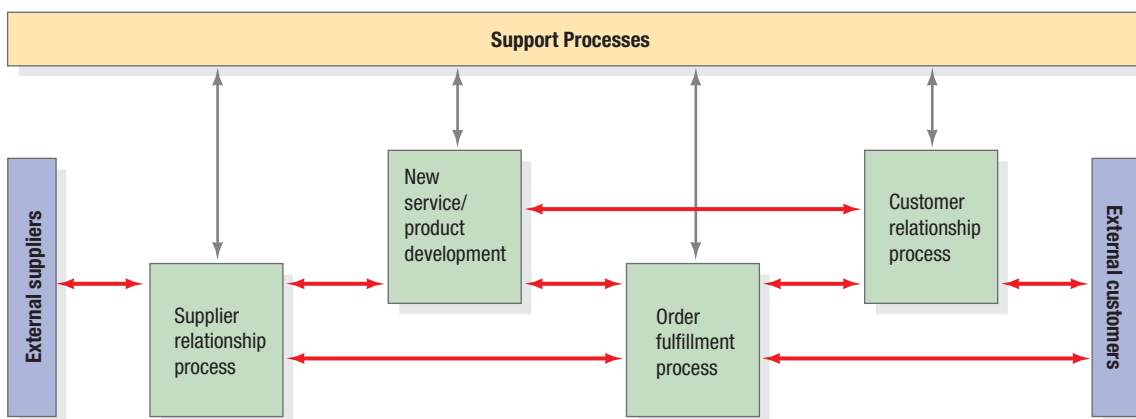
#### customer relationship process

A process that identifies, attracts, and builds relationships with external customers and facilitates the placement of orders by customers, sometimes referred to as *customer relationship management*.

#### support process

A process that provides vital resources and inputs to the core processes and therefore is essential to the management of the business.

**MyLab Operations Management** [Animation](#)



◀ **FIGURE 1.4**  
Supply Chain Linkages  
Showing Work and  
Information Flows



accounting, finance, human resources, management information systems, and marketing. The human resources function in an organization provides many support processes such as recruiting and hiring workers who are needed at different levels of the organization, training the workers for skills and knowledge needed to properly execute their assigned responsibilities, and establishing incentive and compensation plans that reward employees for their performance. The legal department puts in place support processes that ensure that the firm is in compliance with the rules and regulations under which the business operates. The accounting function supports processes that track how the firm's financial resources are being created and allocated over time, while the information systems function is responsible for the movement and processing of data and information needed to make business decisions. Organizational structure throughout the many diverse industries varies, but for the most part, all organizations perform similar business processes. Table 1.1 lists a sample of them that are outside the operations area.

**TABLE 1.1 | ILLUSTRATIVE BUSINESS PROCESSES OUTSIDE OF OPERATIONS**

Activity-based costing	Employee benefits	Help desks
Asset management	Employee compensation	IT networks
Billing budget	Employee development	Payroll
Complaint handling	Employee recruiting	Records management
Credit management	Employee training	Research and development
Customer satisfaction	Engineering	Sales
Data warehousing	Environment	Security management
Data mining	External communications	Waste management
Disaster recovery	Finance	Warranty

All of these support processes must be managed to create as much value for the firm and its customers as possible, and are therefore vital to the execution of core processes highlighted in Figure 1.4. Managers of these processes must understand that they cut across the organization, regardless of whether the firm is organized along functional, product, regional, or process lines.

## Supply Chain Processes

### supply chain processes

Business processes that have external customers or suppliers.

**Supply chain processes** are business processes that have external customers or suppliers. Table 1.2 illustrates some common supply chain processes.

These supply chain processes should be documented and analyzed for improvement, examined for quality improvement and control, and assessed in terms of capacity and bottlenecks. Supply chain processes will be only as good as the processes within the organization that have only internal suppliers and customers. Each process in the chain, from suppliers to customers, must be designed and managed to add value to the work performed.

**TABLE 1.2 | SUPPLY CHAIN PROCESS EXAMPLES**

Process	Description	Process	Description
<b>Outsourcing</b>	Exploring available suppliers for the best options to perform processes in terms of price, quality, delivery time, environmental issues	<b>Customer Service</b>	Providing information to answer questions or resolve problems using automated information services as well as voice-to-voice contact with customers
<b>Warehousing</b>	Receiving shipments from suppliers, verifying quality, placing in inventory, and reporting receipt for inventory records	<b>Logistics</b>	Selecting transportation mode (train, ship, truck, airplane, or pipeline) scheduling both inbound and outbound shipments, and providing intermediate inventory storage
<b>Sourcing</b>	Selecting, certifying, and evaluating suppliers and managing supplier contracts	<b>Cross-docking</b>	Packing of products of incoming shipments so they can be easily sorted more economically at intermediate warehouses for outgoing shipments to their final destination

# Operations Strategy

**Operations strategy** specifies the means by which operations implements corporate strategy and helps to build a customer-driven firm. It links long-term and short-term operations decisions to corporate strategy and develops the capabilities the firm needs to be competitive. It is at the heart of managing processes and supply chains. A firm’s internal processes are only building blocks: They need to be organized to ultimately be effective in a competitive environment. Operations strategy is the linchpin that brings these processes together to form supply chains that extend beyond the walls of the firm, encompassing suppliers as well as customers. Since customers constantly desire change, the firm’s operations strategy must be driven by the needs of its customers.

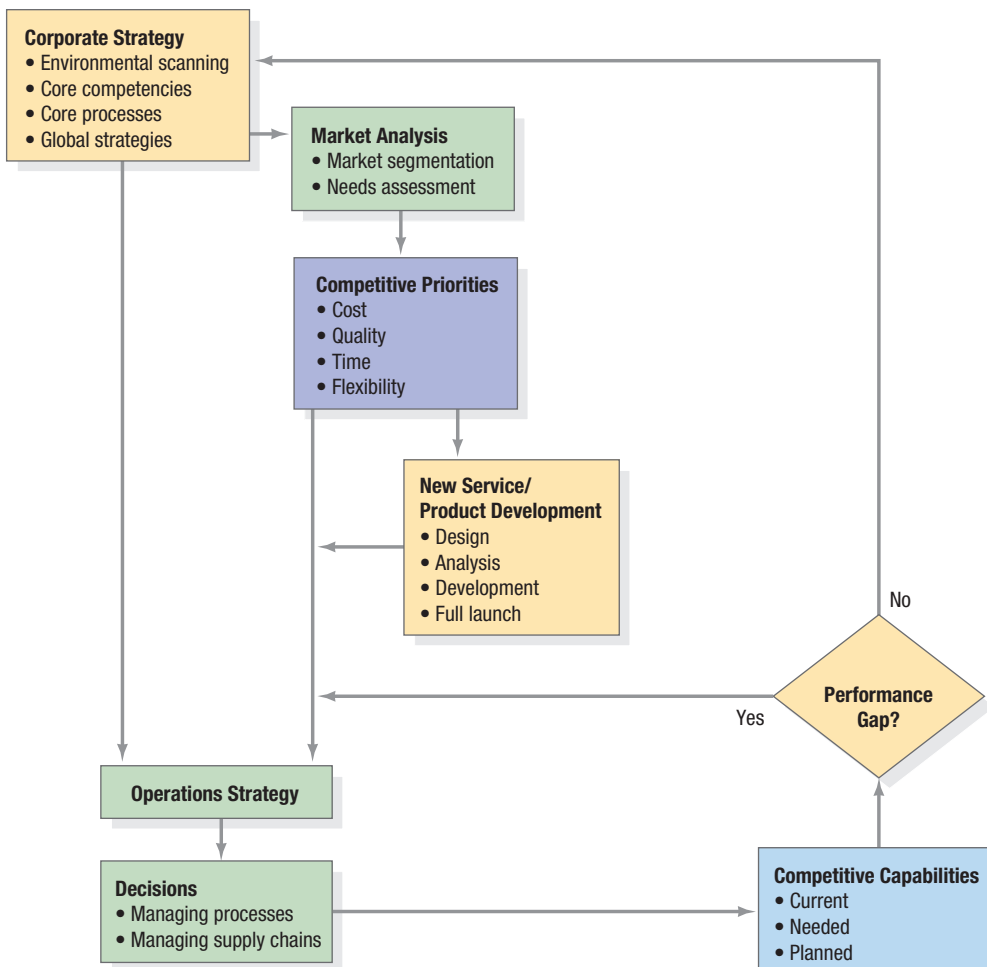
Developing a customer-driven operations strategy is a process that begins with *corporate strategy*, which, as shown in Figure 1.5, coordinates the firm’s overall goals with its core processes. It determines the markets the firm will serve and the responses the firm will make to changes in the environment. It provides the resources to develop the firm’s core competencies and core processes, and it identifies the strategy the firm will employ in international markets. Based on corporate strategy, a *market analysis* categorizes the firm’s customers, identifies their needs, and assesses competitors’ strengths. This information is used to develop *competitive priorities*. These priorities help managers develop the services or products and the processes needed to be competitive in the marketplace. Competitive priorities are important to the design of existing as well as new services or products, the processes that will deliver them, and the operations strategy that will develop the firm’s capabilities to fulfill them. Developing a firm’s operations strategy is a continuous process because the firm’s capabilities to meet the competitive priorities must be periodically checked, and any gaps in performance must be addressed in the operations strategy.

## operations strategy

The means by which operations implements the firm’s corporate strategy and helps to build a customer-driven firm.

# Corporate Strategy

Corporate strategy provides an overall direction that serves as the framework for carrying out all the organization’s functions. It specifies the business or businesses the company will pursue, isolates new opportunities and threats in the environment, and identifies growth objectives.



◀ **FIGURE 1.5**  
Connection Between Corporate Strategy and Key Operations Management Decisions

MyLab Operations Management Animation