

GLOBAL
EDITION



Operations Management

Processes and Supply Chains

THIRTEENTH EDITION

Lee J. Krajewski • Manoj K. Malhotra



Operations Management

PROCESSES AND SUPPLY CHAINS

Thirteenth Edition

Global Edition

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Dedicated with love to our families.



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Preface

It does not take a genius to know that the world, in particular the business world, is changing. Although the Twelfth Edition was successful at bringing current practice in operations management, in an easy-to-understand format, to a broad brush of business students, it became clear that much has happened since it was published. We began the Thirteenth Edition by obtaining feedback from instructors, reviewers, practicing managers, and students and diligently wove these inputs into the fabric of each chapter. However, before we could actually start the revision, the COVID-19 coronavirus pandemic struck the world. While it brought economic ruin to hundreds of millions of people worldwide, and death to many across the globe, it afforded an extraordinary opportunity to demonstrate how business operations can respond when an unexpected disaster presents itself. In the Thirteenth Edition you will see many examples of the effects of the coronavirus on business operations and how they were handled. We offer one final thought: If you are a business major taking operations management as a required course but you are not an operations major, we have made a special effort to show you how the principles of operations management *will* be useful to you regardless of your chosen career path.


New to This Edition

Video Cases—Cleveland Clinic In addition to the existing selection of real-world video cases throughout the text, this edition features the world-renowned Cleveland Clinic, headquartered in Cleveland, Ohio. Cleveland Clinic is a global-leading U.S.-based hospital group whose expertise is in specialized medical care. In addition to its 165-acre campus near downtown Cleveland, it has 11 regional hospitals throughout Northeast Ohio; 5 hospitals in Florida; a hospital in Abu Dhabi, UAE; and facilities in Las Vegas, Nevada, and Toronto, Canada. We have added four videos and cases that demonstrate the outstanding level of operations at Cleveland Clinic and how the coronavirus pandemic has affected them. You will first learn how Cleveland Clinic has addressed process-design challenges in Chapter 2, “Process Strategy and Analysis,” to set the stage. Then, in subsequent chapters, you will see managerial responses to operations issues related to managing constraints in Chapter 6, “Constraint Management,” planning for resources in Chapter 11, “Resource Planning,” and the coordination of supply chain activities and information flows throughout the organization in Chapter 14, “Supply Chain Integration.” It’s the first time we have woven a single organizational focus into the text. After reading the cases and watching the videos, we hope you will agree that such an emphasis provides the opportunity to really appreciate how broad the brush of operations management reaches in supporting the success of world-class organizations.

VIDEO CASE Managing Constraints for Caregivers and Patients at Cleveland Clinic During COVID-19

Beginning in January of 2020, the United States faced an unprecedented health crisis of epic and global proportions. The COVID-19 coronavirus, originating in China, quickly spread around the globe, causing hundreds of thousands of deaths and impacting the lives of millions everywhere. In the United States, one of the country's leading healthcare organizations, Cleveland Clinic, realized that this virus was here for the foreseeable future and would touch every aspect of healthcare delivery. Demand for COVID-19 care very rapidly exceeded the demand for other types of patient services. In addition, Cleveland Clinic had to effectively respond to a historic supply bottleneck where demand for personal protective equipment (PPE) was rapidly increasing between 300% to 1000%, but supply chain production for existing PPE, and related supplies could only increase up to 50% of that demand. As Cleveland Clinic supply chain managers readily identified, most of the PPE used in its facilities were sourced off-shore in China, and those supply lines quickly dried up as the pandemic escalated.

Under normal operating conditions, Cleveland Clinic's PPE that came from suppliers and distributors was stored in distribution warehouses after arriving on-shore. This warehouse inventory served as buffers from which the healthcare system could pull needed PPE on a defined schedule based on its historic demand patterns. With the dramatic increase in demand caused by COVID-19, the pull of PPE quickly depleted stored supplies.



The Ohio Department of Health, in response to the COVID-19 pandemic, on March 19th, 2020, suspended all non-essential or elective surgeries and procedures that utilized personal protective equipment (PPE) so that essential surgeries could proceed. Here Cleveland Clinic cardiothoracic surgeon, Edward Soltau, MD, MPH, leads a team performing open-heart surgery.

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 seven new vignettes highlighting the operations at Apple, Lego, Nike, 3M, Starbucks, Oasis of the Seas, and Coca-Cola, Inc.

New Technologies In the Thirteenth Edition, we have taken care to include the latest technologies being used to improve business operations. Here are some of those technologies you can look forward to:

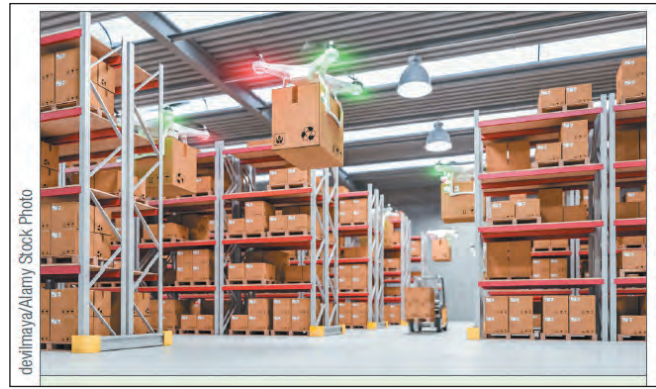
- **Fourth Industrial Revolution (Industry 4.0).** Chapter 1, “Using Operations to Create Value,” describes Industry 4.0, which is the ongoing automation of traditional manufacturing and industrial practices using modern smart technology. The discussion categorizes the Industry 4.0 technologies into four groups: Smart Manufacturing, Smart Products, Smart Supply, and Base Technologies.
- **Autonomous Supply Chains.** Chapter 12, “Supply Chain Design,” discusses the concept of autonomous supply chains, which is a digital transformation in which the latest in digital technology is used to facilitate and automate decision making up and down the supply chain and thereby transform the way supply chains operate.

3M



Minnesota Mining and Manufacturing (3M) company is a diversified conglomerate that has operations in more than 70 countries. It manufactures over 60,000 products, such as adhesives, window films, paint protection films, laminates, and consumer products like Scotch tape and Post-its, among others, that are used in the health care, manufacturing, and construction industries, as well as several others. With nearly \$33 billion in sales and 99,500 employees in 2018, 3M has been an icon of innovation and steady growth since its founding as a mining company in Minnesota in 1902.

- **Autonomous Warehouse Operations.** Chapter 13, “Supply Chain Logistics Networks,” addresses the use of automated guided vehicles, automated mobile robots, and aerial drones in warehouse operations.
- **Blockchains.** Chapter 14, “Supply Chain Integration,” defines the concept of blockchain, differentiates it from cloud computing, and shows an example of its use in supply chains.



Managerial Challenges We believe that the principles of operations management are useful to managers of all disciplines. To demonstrate, we have added Managerial Challenges to each chapter, starting with Chapter 2, “Process Strategy and Analysis.” These challenges are realistic scenarios, based on extensive research, that describe meaningful operations decision problems in which managers of various disciplines find themselves taking a leading role. The featured disciplines include accounting, finance, human resources, information systems, logistics, marketing, and operations, and cover both manufacturing and service companies.

MANAGERIAL CHALLENGE Finance

Raphael Sanchez is the chief financial officer (CFO) of Medco, a manufacturer of medical technologies. The company has multiple manufacturing facilities located throughout the Western Hemisphere. In his role he is responsible for his company’s business plan, which drives the planning process; consequently, to assemble the plan, he must secure information from the different divisions within the organization. Recently, Raphael noticed that a key financial measure in the plan, return on assets (net income divided by total assets), has been slipping. Key investors are getting nervous. He realized that a number of factors could be in play; however, the need for working capital, a key element of total assets, has been increasing. Inventory is financed by working capital. Raphael suspected that Medco could be more efficient with respect to its inventory investment. He gave Sara Kowalski, financial analyst in the corporate office, the task of reporting to him how inventories can be reduced without affecting the customers of Medco.

Managerial Practices It is important for the understanding of operations management to provide many examples of current practices. In this edition, we have added four new Managerial Practices, ranging from the inventory system at IKEA to the shortage of toilet paper due to the coronavirus pandemic.

MANAGERIAL PRACTICE 14.1 Coronavirus and the Supply Chain: Where is the Toilet Paper?

What do you hear the most? Falling into a pit of spiders? Getting eaten by a zombie? Running out of toilet paper? If it is the latter, you are not alone. The coronavirus pandemic of 2020 has caused shortages of many products, but running out of toilet paper causes nightmares. What could be worse than walking into your local supermarket, armed with your mask and maintaining social distancing, and seeing the paper products aisle so barren as the Grand Canyon in January? Asking a stock clerk about the toilet paper gets you a shrug of the shoulders and a promise that an order has been placed with the distributor, and will take a week or so.

Before we get into theories of why this has happened, let’s take a peek at the supply chain for toilet paper. Toilet paper is made from one of two sources: virgin pulp from trees in Canada and the United States, or recycled pulp obtained from materials like discarded copy paper that is reprocessed and turned into pulp. The pulp is delivered to paper mills that turn it into large rolls of paper over 100 inches wide. The rolls are then shipped to a paper-converting facility, which cuts and packages them into the deconstructed end product like toilet paper or kitchen towels, depending on the quality of the paper. Packaging and shipping are the final steps in the chain. The mills typically run 24 hours, 7 days a week—in other words, round the clock. However, with the pandemic, mills have adjusted their work hours for the safety of their employees, limiting their capacity to respond to demand increases. Retailers have a set amount of toilet paper inventory that is determined on the basis of historic demand levels; however, a shock to demand can exceed the safety stocks in their warehouses.

Large rolls of toilet paper are shipped to a paper-converting facility to produce the product you buy in the store. Here the rolls have been cut out to the paper size and are conveyed to the packaging process.

More often, but because they are using more of it at home, it is estimated that the demand for consumer toilet paper increased 40 percent, a huge increase for a supply chain designed for constant demand. That leaves a lot of com-

Detailed Chapter-by-Chapter Changes

We have meticulously revised the text to enhance its readability and update all the references and business examples. Here are the major changes in each chapter.

Chapter 1: Using Operations to Create Value We added a new opening vignette featuring Apple that explains how its superior operations and supply chain capabilities are the reasons for its success. The 10 decision areas of operations management that Apple uses to maximize its operational efficiency and build strategic capabilities provide a nice entrée to the remainder of the text. We added a new section titled “Fourth Industrial Revolution (Industry 4.0),” which defines the four distinct categories of modern technologies: Smart Manufacturing, Smart Products, Smart Supply, and Base Technologies. We also put the Internet of Things (IoT) and additive manufacturing under this umbrella to make a succinct, but comprehensive, overview of modern technologies for improved operations. A new learning objective was added to cover this important material.

PART 1: Managing Processes The first part of the text lays the foundation for why a process view is critical for utilizing operations management as a strategic weapon by showing how to design and manage the internal processes in a firm, regardless of the functional area.

Chapter 2: Process Strategy and Analysis In addition to updating the opening vignette on CVS and the Managerial Practice on Ford Camacari, we added a Managerial Challenge focusing on the vice president of marketing and sales for Templeton’s Packaging Products Division, who must figure out why machine repair requests coming into her department from customers are

experiencing lengthy delays. Finally, a new video case featuring the Cleveland Clinic shows how management used the Six Sigma Improvement Model to resolve a workflow problem involving skilled and licensed staff.

Chapter 3: Quality and Performance We added a new opening vignette describing the precise quality standards of Lego, which produces 36 billion plastic bricks a year with a process that produces only 18 defects per million bricks. We also added a Managerial Challenge involving the corporate controller of Star Industries, who last year initiated a major overhaul of their payroll and customer billing processes and now has to determine if significant improvements were made. We updated the Managerial Practice on Santa Cruz Guitar Company and changed Figure 3.2 to be more consistent with the ISO 9001:2015 terminology.

Chapter 4: Lean Systems We moved this chapter, which was Chapter 6 in the Twelfth Edition, to next in line because the content and techniques strongly support the methods we describe in Chapter 3, “Quality and Performance.” We added a new opening vignette on Nike, Inc., that tells the engaging story of how Nike, Inc., applied the principles of lean systems to its factories and supply chain to become a leader in the industry. We updated the Managerial Practice on Alcoa and completely revamped the illustration of the Kanban system, including a new Figure 4.6 with multiple subparts, eliminating the two-card system and simplifying the discussion. Finally, we added a Managerial Challenge in which the VP of finance for Oak Grove Health System was given the assignment of figuring out how to combat the rising cost of patient care and declining revenues.

Chapter 5: Capacity Planning In keeping with the currency of the topics in the Thirteenth Edition, the new opening vignette on 3M shows how a top-notch company can cope with an unexpected capacity crunch brought on by the coronavirus pandemic. We also added a Managerial Challenge in which the facility manager for Tower Medical Center must determine how to cope with dramatically increased visits to the emergency department and a surge in surgery requests. The Managerial Practice on PacifiCorp was also updated.

Chapter 6: Constraint Management We created a new Managerial Practice on Steelo Limited that illustrates the application of the theory of constraints and the drum-buffer-rope system. A Managerial Challenge was also added that features the marketing manager at Schmidt Industries, who found out that his sales process was a bottleneck to the sales of the company’s winch product. Finally, we added a Video Case on constraint management at the Cleveland Clinic that shows how management analyzed and solved a personal protective equipment (PPE) bottleneck due to the COVID-19 virus pandemic.

Chapter 7: Project Management Cleveland Clinic, a main attraction of the Thirteenth Edition, is featured in a new Managerial Practice that discusses a project to build a new hospital in London, England. Also added to this chapter is a Managerial Challenge that involves the head of the marketing department for a large financial services firm who is tasked with overseeing a project within her department to design and implement a new process to deal with requests for creative ads, innovative communications, printed brochures, new web content, and continual sales support from units all over the company. Finally, we added a section addressing project risk caused by changing requirements. It describes an approach called *scrum*, which is an “Agile” project management framework that focuses on allowing teams to respond rapidly, efficiently, and effectively to change.

PART 2: Managing Customer Demand The second part of the text shows how to estimate customer demands and satisfy those demands through inventory management, operations planning and scheduling, and resource planning.

Chapter 8: Forecasting We begin this chapter with a new opening vignette describing how Starbucks uses big data for managing demands. We also added a Managerial Challenge featuring a recent information system graduate who was assigned the task of reviewing the forecasting system and software at Kramer Health Clinic because staffing levels of critical employees have been too low due to excessive forecast errors.

Chapter 9: Inventory Management The opening vignette on Ford’s Smart Inventory Management System was revised to include CarStory, which uses predictive analytics to determine how long used vehicles will remain on the lot. We added a new Managerial Practice describing how IKEA manages its large inventories at retail outlets. Finally, a Managerial Challenge presents a scenario in which the chief financial officer (CFO) of Medco, a manufacturer of medical technologies, is concerned about declining return on assets (ROA) and assigns his financial analyst in the corporate office the task of reporting to him how inventory investment can be reduced without affecting the customers of Medco.

Chapter 10: Operations Planning and Scheduling We updated the opening vignette on Cooper Tire and revised the Managerial Practice on umpire scheduling to include the 2019 World Series. We added a Managerial Challenge in which the director of human resources for Redwood Hotel, faced with staffing problems, must find a staffing plan that meets the hotel's revenue targets.

Chapter 11: Resource Planning We updated the opening vignette on Philips and the Managerial Practice on Valle del Lili Foundation Hospital for recent events. We also added a Managerial Challenge in which the VP of manufacturing and her staff at Rennseler Industries, Inc., an original equipment manufacturer (OEM) of automotive parts, was tasked with recommending changes to the current master production scheduling process and resolving a problem in delivery performance. Finally, there is a new Video Case that reveals how Cleveland Clinic ensures that the required resources are available for the large number of complicated surgeries and procedures performed daily.

PART 3: Managing Supply Chains The third part of the text builds upon the tools for managing processes and customer demands at the level of the firm and provides the tools and perspectives to manage the flows of materials, information, and funds between suppliers, the firm, and its customers.

Chapter 12: Supply Chain Design We added a Managerial Challenge in which the supply chain manager of Adorn, a leading manufacturer of women's apparel, must analyze the supply chain to see how Adorn can get its products to market faster. We simplified the discussion of what a supply chain is by removing the distinction between service supply chains and manufacturing supply chains and instead focusing on the structure of a supply chain with its tiers of suppliers and distribution channels. Finally, we added a new section titled "Autonomous Supply Chains," which describes the trend toward automating elements of supply chains and the advantages it can have.

Chapter 13: Supply Chain Logistics Networks We added a Managerial Challenge involving the director of human resources for EuroTran AG, a producer of transmissions, steering and axle systems, and driver assistance features for the automobile industry; this director was assigned to a committee analyzing the location for a new plant and finds that she must argue for the inclusion of key factors associated with labor climate and quality of life at the potential sites. We also added a major section titled "Warehouse Strategy in Logistics Networks," in which we discuss inventory placement and autonomous warehouse operations, such as automated guided vehicles, autonomous mobile robots, and aerial drones.

Chapter 14: Supply Chain Integration This chapter underwent a major revision to drive home the importance of supply chain integration. The new opening vignette describes the Oasis of the Seas and the need for an integrated supply chain, especially when faced with unexpected disruptions such as the coronavirus pandemic. We added a Managerial Challenge in which the director of information technology for Crestview Food, Inc., whose stores were experiencing severe stock outages, had to devise a plan to facilitate information exchanges up and down the supply chain. We moved the section on additive manufacturing to Chapter 1, "Using Operations to Create Value," and moved the section "Supply Chain Risk Management" to just after the section "Supply Chain Disruptions" to reinforce the tactics used to cope with disruptions in supply chains. We added a new Managerial Practice on the coronavirus and its effect on the supply of toilet paper. We also incorporated a major section titled "Cloud Computing and Blockchains," which provides a thorough discussion of new technologies for integrating supply chains. The concept of a blockchain in a supply chain is explained with examples and two new figures. We discuss how it works, its benefits, and its uses. We also added a discussion question on cloud computing and blockchains. Finally, there is a new Video Case at Cleveland Clinic that shows the advantage of having an integrated supply chain to support the goal of a patient first enterprise in light of the COVID-19 pandemic.

Chapter 15: Supply Chain Sustainability A new opening vignette describes how Coca-Cola has worked on decreasing its water footprint in an industry that uses 69 percent of the world's fresh-water supply. We also added a Managerial Challenge at Eagle Trucking Company, a transportation company serving the oil and gas, health care, and food industries, in which the CEO has tasked his vice presidents to devise a plan to reduce the company's carbon footprint. We expanded the section on transportation mode to include a discussion of electric trucks.

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, the Thirteenth Edition has four pillars:

Four Pillars of Motivational Learning

- **Practical.** This text is written from a managerial perspective. The Managerial Challenges show how students of any business major can find usefulness in the topics of this text. Further, 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 Thirteenth 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 Thirteenth 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 objective for a chapter is repeated at the end of the chapter with guidelines for review. All of these features are in the Thirteenth Edition to enhance clarity and make the text much more accessible to students of all majors.

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

EXAMPLE 4.2
Determining the Value Stream Map, Takt Time, and Total Capacity

Jensen Bearings Incorporated, a ball-bearing manufacturing company located in Lexington, South Carolina, receives raw material sheets from Kline Steel Company every Monday for a product family of retainers (casings in which ball bearings are held), and then ships its finished product on a daily basis to a second-tier automotive manufacturing customer named GNK Enterprises. The product family of the bearing manufacturing company under consideration consists of two types of retainers—large (L) and small (S)—that are packaged for shipping in returnable trays with 40 retainers in each tray. The manufacturing process consists of a value stream containing pressing operation; a piercing and forming cell, and a finish grind operation, after which the two types of retainers are staged for shipping. The information collected by the operations manager at Jensen Bearings Inc. is shown in Table 4.3.

Solved Problem 2

Metcalf, Inc., manufactures engine assembly brackets for two major automotive customers. The manufacturing process for the brackets consists of a cell containing a forming operation, a drilling operation, a finish grinding operation, and packaging, after which the brackets are staged for shipping. The information collected by the operations manager at Metcalf, Inc., is shown in Table 4.4.

Learning by Example

Many students struggle with quantitative problem solving. To help students who have difficulty, in the Thirteenth 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.

Developing Critical Problem-Solving Skills

Instructors can use the thought-provoking *discussion questions* in class to spark dialog of various issues and managerial situations. The *problems* are grouped under learning objectives to make it easier for instructors to assign problems that cover all objectives.

Discussion Questions

1. Figure 8.9 shows summer air visibility measurements for Denver, Colorado. The acceptable visibility standard is 100, with readings above 100 indicating clean air and good visibility, and readings below 100 indicating temperature inversions caused by forest fires, volcanic eruptions, or collisions with comets.
 - a. Is a trend evident in the data? Which time-series techniques might be appropriate for estimating the average of these data?
 - b. A medical center for asthma and respiratory diseases located in Denver has great demand for its services when air quality is poor. If you were in charge of developing a short-term (say, 3-day) forecast of visibility, which causal factor(s) would you analyze? In other words, which external factors hold the potential to significantly affect visibility in the *short term*?
 - c. Tourism, an important factor in Denver's economy, is affected by the city's image. Air quality, as measured by visibility, affects the city's image. If you were responsible for development of tourism, which causal factor(s) would you analyze to forecast visibility for the *medium term* (say, the next two summers)?
 - d. The federal government threatens to withhold several hundred million dollars in Department of Transportation funds unless Denver meets visibility standards within 8 years. How would you proceed to generate a *long-term* judgment forecast of technologies that will be available to improve visibility in the next 10 years?
2. Kay and Michael Passe publish *What's Happening?*—a biweekly newspaper to publicize local events. *What's Happening?* has few subscribers; it typically is sold at checkout stands. Much of the revenue comes from advertisers of garage sales and supermarket specials. In an effort to reduce costs associated with printing too many papers or delivering them to the wrong location, Michael implemented a computerized system to collect sales data. Sales-counter scanners accurately record sales data for each location. Since the system was implemented, total sales volume has steadily declined. Selling advertising space and maintaining shelf space at supermarkets are getting more difficult.

Helping Students Apply Their Skills

Students can test their understanding of the content using *cases* in two ways. First, the Thirteenth Edition has 14 *video cases*, 4 of which are new to this edition. 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 showing the actual setting for the case and discussions with managers regarding the problem. Each format provides a rich environment in which to discuss the topic of the chapter. The second way instructors can engage students is to use any of the 13 written cases in the text. These cases often provide data that students can use with techniques in the text to analyze and resolve an issue.

CASE Wolverine, Inc.

Wolverine is a medium-sized firm employing 900 persons and 125 managerial and administrative personnel. The firm produces a line of automotive electrical components. It supplies about 95 auto parts stores and several car dealers in its region. Johnny Bennett, who serves as the president, founded the company by producing cable assemblies in his garage. By working hard, delivering consistent product quality, and by providing good customer service, he expanded his business to produce a variety of electrical components. Bennett's commitment to customer service is so strong that his company motto, "Love Thy Customers as Thyself," is etched on a big cast-iron plaque under his giant oil portrait in the building's front lobby.

The company's two most profitable products are the automotive front sidelamp and the headlamp. With the rising popularity of Eurosport sedans, Wolverine has enjoyed substantial demand for these two lamp items.

Last year, Kathryn Marley, the vice president of operations and supply chain management, approved the installation of a new MRP system. It is a first important step toward the eventual goal of a full-fledged ERP system. Marley worked closely with the task force that was created to bring MRP online. She frequently attended the training sessions for selected employees, emphasizing how MRP should help Wolverine secure a better competitive edge.

A year later, the MRP system is working fairly well. However, Marley believes that there is always a better way and seeks to continually improve the company's processes. To get a better sense for potential improvements, she met with the production and inventory control manager, the shop supervisor, and the purchasing manager. Here are some of their observations.

can be just the opposite—so many new orders with short fuses that almost everyone needed to work overtime or else the scheduled receipt quantities are reduced to cover immediate needs. It is feast or famine, unless they make things work on the shop floor! They do make inventory transactions to report deviations from plan for the scheduled receipts, but these "overrides" make the scheduled receipt information in the MRP records more uncertain for the planners. A particular concern is to make sure that the bottleneck workstations are kept busy.

Purchasing

Buyers are putting out too many fires, leaving little time for creative buying. In such cases, their time is spent following up on orders that are required in the very near future or that are even late. Sometimes, the MRP plan shows planned order releases for purchased items that are needed almost immediately, not allowing for the planned lead time. In checking the MRP records, the planned lead times are realistic and what the suppliers expect. Last week, things were fine for an item, and this week a rush order needs to be placed. What is the problem?

Marley tried to assimilate all this information. She decided to collect all the required information about the sidelamps and headlamps (shown in Tables 11.23 through 11.26 and in Figure 11.49) to gain further insight into possible problems and identify areas for improvement.

VIDEO CASE Quality at Axon

Protect life. Protect truth. That's the mission of Axon, the company that produces public safety technologies such as Taser electrical smart weapons and body cameras for law enforcement around the globe. In business since 1993, the company manufactures three weapons lines inside its high-tech headquarters in Scottsdale, Arizona. Ninety-nine percent of its customers are in law enforcement, military, correctional, and professional security organizations.

Designing and manufacturing smart weapons technologies requires precise engineering and production processes that can ensure both accuracy and operational safety for its organizational customers and personal protection buyers. This attention to detail is evidenced in the company's commitment to quality, and can be seen in the way the manufacturing operation is organized. Axon's manufacturing operations are ISO 9001:2008 certified.

All finished goods are produced to stock, so that the company can be responsive when an order is received. Sales history data help dictate which items to make to stock, and which could sit in inventory between 6 and 12 weeks before being sold. Most employees have undergone voluntary exposure to the weapons, including the founders.

Axon's work cells are arranged by product. At the start of the week, each cell is given a "production order" document that lists the bill of materials for the finished goods that cell must produce during the week. The production order is released by Axon's Enterprise Resource Planning (ERP) system, with raw materials required for assembly pulled and staged at each cell weekly. In addition to supporting the informational needs of all the functional areas of a firm, ERP systems support the manufacture of a firm's products by scheduling the fabrication of components and the arrival of purchased materials in support of the overall production plan.

Axon's attention to quality is embedded throughout its manufacturing processes. Raw materials are tested and inspected for quality conformance at the supplier to be certain no faulty components are shipped. Circuit boards, which are assembled domestically, are each tested prior to shipment, and then acceptance sampling at Axon's receiving dock confirms shipment conformance. The same process occurs for the supplier of injection molded components, such as weapons casings. Testing includes functionality checks, drop tests to ensure the product can withstand being dropped, and temperature checks to make sure the weapons will work between a temperature range

Bill's project sought to engage manufacturing engineering in the automation of test data collection to develop baselines for processes and establish upper and lower control limits. Line workers were given explicit parameters for processes, and they immediately took ownership of those processes. As a result, it quickly became evident when something in the work cell was trending out of control so the issue could be resolved within hours. A formal escalation process further ensured that the right individuals were notified to get action.

In 2013, Axon installed computer monitors above each work cell so that all manufacturing employees could see the data related to how they were doing. The data include scrap dollars as a percentage of total production, process yield (units produced), average labor cost per unit compared to expected labor cost, average material costs per unit compared to expected material costs, daily/monthly/quarterly production output compared to planned output, throughput times compared to standards, and more.



The AXON bodycams on their charge and download cradle. Body worn video cameras are being introduced into the South Wales Police force as part of operational equipment and will be rolled out over the next few months.

EXPERIENTIAL LEARNING 6.1

Min-Yo Garment Company

The Min-Yo Garment Company is a small firm in Taiwan that produces sports-wear for sale in the wholesale and retail markets. Min-Yo's garments are unique because they offer fine embroidery and fabrics with a variety of striped and solid patterns. Over the 20 years of its existence, the Min-Yo Garment Company has become known as a quality producer of sports shirts with dependable deliveries. However, during that same period, the nature of the apparel industry has undergone change. In the past, firms could be successful producing standardized shirts in high volumes with few pattern or color choices and long production lead times. Currently, with the advent of regionalized merchandising and intense competition at the retail level, buyers of the shirts are looking for shorter lead times and much more variety in patterns and colors. Consequently, many more business opportunities are available today than ever before to a respected company such as Min-Yo.

Even though the opportunity for business success seemed bright, the management meeting last week was gloomy. Min-Yo Lee, president and owner of Min-Yo Garment, expressed concerns over the performance of the company: "We are facing strong competition for our products. Large apparel firms are driving prices down on high-volume licensed brands. Each day more firms enter the customized shirt business. Our profits are lower than expected, and delivery performance is deteriorating. We must reexamine our capabilities and decide what we can do best."

Currently, only one licensed brand is manufactured by Min-Yo. The brand, called the Muscle Shirt, is owned by a large "virtual corporation" in Italy that has no manufacturing facilities of its own. Min-Yo has been licensed to manufacture Muscle Shirts and sell them to large retail chains in Taiwan. The retail chains require prompt shipments at the end of each week. Because of competitive pressures from other licensed brands, low prices are important. Min-Yo sells each Muscle Shirt to retail chains for \$6.

The demand for Muscle Shirts averages 900 shirts per week. The demand for Muscle Shirts shown below has been forecasted for the next 12 weeks.

Min-Yo's forecasts of Muscle Shirts are typically accurate to within ± 200 shirts per week. If demand exceeds supply in any week, the excess demand is lost. No backorders are taken, and Min-Yo incurs no cost penalty for lost sales.

Subcontracted Brands

Manufacturers in the apparel industry often face uncertain demand. To maintain level production at their plants, many manufacturers seek subcontractors to produce their brands. Min-Yo is often considered a subcontractor because of its reputation in the industry. Although price is a consideration, the owners of subcontracted brands emphasize dependable delivery and the ability of the

Working in Teams and Gaining Valuable Decision-Making Experience

Perhaps the most engaging and fun activities in the Thirteenth 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. The Active Models assignments are supported by online tools that are available to all students.

Active Model Exercise

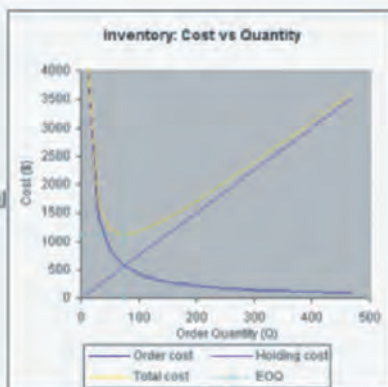
Active Model 9.1, "Economic Order Quantity," is available online. It allows you to evaluate the sensitivity of the EOQ and associated costs to changes in the demand and cost parameters.

QUESTIONS

1. What is the EOQ and what is the lowest total cost?
2. What is the annual cost of holding inventory at the EOQ and the annual cost of ordering inventory at the EOQ?

Economic Order Quantity (EOQ) Model

Real Data		Questions	
Annual demand rate, D	936		
Order cost, S	45		
Holding cost percent	25%		
Unit price, P	60		
Optimal Other			
Order quantity, Q^*	75	300	
Maximum inventory	75	390	
Average inventory	37	195	
Num orders per year	12.48	2.40	
Annual holding cost	\$ 562.05	\$ 2,925.00	
Annual ordering cost	\$ 562.05	\$ 108.00	
Total	\$1,124.10	\$3,033.00	
Difference		\$1,908.90	
% Difference		169.62%	



All told, the Thirteenth 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.

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 Thirteenth Edition map into those essential skills.

Employability Skills in the 13e

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 Challenges	✓	✓	✓				
Managerial Practices				✓	✓		
Numerical Examples		✓					✓
OM Explorer and POM for Windows						✓	
Photo Illustrations				✓			
Problems		✓		✓		✓	✓
Solved Problems		✓					✓

Additional Resources

Resources available to instructors and students at www.pearsonglobal editions.com	Features of the Resource
Online Supplements	Supplement Sections E through K provide students and instructors with additional content on important topics such as Simulation, Financial Analysis, Acceptance Sampling, Measuring Output Rates, Learning Curve Analysis, Operations Scheduling, and Layout.
OM Explorer	This text-specific software consists of Excel worksheets and includes tutors and solvers. <ul style="list-style-type: none"> • Tutors provide coaching for more than 60 analytical techniques presented in the text. The tutors also provide additional examples for learning and practice. • Solvers provide powerful general-purpose routines often encountered in practice. These are great for experiential exercises and homework problems.
POM for Windows	An easy-to-use software program that covers over 25 common OM techniques.
Active Models	These 29 spreadsheets require students to evaluate different situations based on problem scenarios. They are excellent for doing “what-if” analyses.
SimQuick	An Excel spreadsheet (with macros) for building simulation models of processes: waiting lines, supply chains, manufacturing facilities, and project scheduling. SimQuick is easy to learn, easy to use, and flexible in its modeling capability.
SmartDraw	Draw diagrams, flowcharts, organization charts, and more in minutes with SmartDraw’s diagram software. Thousands of included diagram templates and symbols.

Detailed information and additional resources are available at www.pearsonglobaleditions.com.

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Manoj K. Malhotra

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USING OPERATIONS TO CREATE VALUE

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

- 1.1** Describe the role of operations in an organization and its historical evolution over time.
- 1.2** Describe the process view of operations in terms of inputs, processes, outputs, information flows, suppliers, and customers.
- 1.3** Describe the supply chain view of operations in terms of linkages between core and support processes.
- 1.4** Define an operations strategy and its linkage to corporate strategy and market analysis.
- 1.5** Identify nine competitive priorities used in operations strategy, and explain how a consistent pattern of decisions can develop organizational capabilities.
- 1.6** Identify the latest trends in operations management and understand how firms can address the challenges facing operations and supply chain managers in a firm.
- 1.7** Define the fourth industrial revolution (Industry 4.0) and understand how its embedded technologies and automation are transforming the practice of operations and supply chain management.
- 1.8** Understand how to develop skills for your career using this textbook.

Apple Inc.



SOPA Images Limited/Alamy Stock Photo

The brand new Apple Store at Central World during the first day opening event, Bangkok, Thailand.

Apple Incorporated is the world's largest multinational technology company: It has over 137,000 employees and 510 retail stores in 25 countries. Robust sales of consumer electronics, computer software, and online

services have made it the most valued company in the world, with a market capitalization of \$1.953 trillion as of August 12, 2020. Apple's brand loyalty is legendary, with a cult-like following of customers who often stand in long lines to buy new products when they are launched. Even though its stellar reputation has been built on innovative designs and trendsetting new products like the iPhone, few realize that Apple's distinctiveness and competitive superiority arise just as strongly, if not more so, from its outstanding manufacturing, operations, and supply chain management practices.

The 10 decision areas of operations management that Apple measures to maximize its operational efficiency and build strategic capabilities are (i) design of goods and services, (ii) quality management, (iii) process and capacity design, (iv) location strategy for stores, (v) layout design and strategy, (vi) job design and human resources, (vii) supply chain management, (viii) inventory management, (ix) scheduling, and (x) maintenance. A dedicated team of senior managers establish and implement a well-calibrated set of metrics that establish different standards, benchmarks, and criteria for productivity in different decision areas.

So, what drives Apple's operational excellence? It is not any single decision area mentioned above that stands out in particular, but how well operations and supply chain decisions are intertwined into every other decision that the company makes in its fairly well-controlled ecosystem, ranging from product design to component sourcing, manufacturing, distribution, and retail store design and location. By focusing on a narrow product line, Apple can make each product in larger volumes and get quantity discounts from suppliers. By investing in advanced component material and manufacturing process technologies, coupled with a superior understanding of the markets, Apple can anticipate customer needs ahead of time and give customers what they want through innovative products that competitors cannot easily copy or reproduce.

Apple's long-term investments in its processes, supply chains, and human resource practices also make it very resilient in managing its complex multinational supply chains. Even in the midst of the coronavirus pandemic, Foxconn, Apple's contract manufacturer, was running night shifts at its iPhone factory in Zhengzhou, Henan Province, China. While it will not escape completely unscathed, Apple has built contingency plans and managed disruptions in its supply chains better than many of its competitors. Its launch of potential new products like iPhone 12, Apple TV, and an Apple Watch will not occur within the usual time frame of September 2020, but are on track to show up a few weeks later. Despite store closures and inventory shortages, Apple reported on July 30, 2020, that its revenue was the highest that the company has ever reported in its third quarter, up 11 percent year-over-year. And so the juggernaut continues, powered by its vaunted world-class skills and capabilities in operations and supply chain management.¹

¹*Sources:* Christine Rowland, "Apple Inc. Operations Management: 10 Decisions, Productivity," *Panmore Institute* (February 19, 2019), <http://panmore.com/apple-inc-operations-management-10-decisions-areas-productivity> (August 10, 2020); Jonny Evans, "Apple's Operations Teams Must Be Struggling to Pull Things Together," *Computerworld* (March 2, 2020), <https://www.computerworld.com/article/3530037/apples-operations-teams-must-be-struggling-to-pull-things-together.html> (August 10, 2020); Kif Leswing, "Apple Posts Blowout Third Quarter, with Sales up 11% Despite Coronavirus Disruptions," *cnbc.com* (July 30, 2020), <https://www.cnbc.com/2020/07/30/apple-aapl-earnings-q3-2020.html> (August 10, 2020); Marty Lativiere, "Operations: Apple's Secret Sauce?" *The Operations Room* (November 4, 2011), <https://operationsroom.wordpress.com/2011/11/04/operations-apples-secret-sauce/> (August 10, 2010); https://en.wikipedia.org/wiki/Apple_Inc. (August 10, 2020).

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 Apple, 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.² 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 main-line 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.

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.

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.

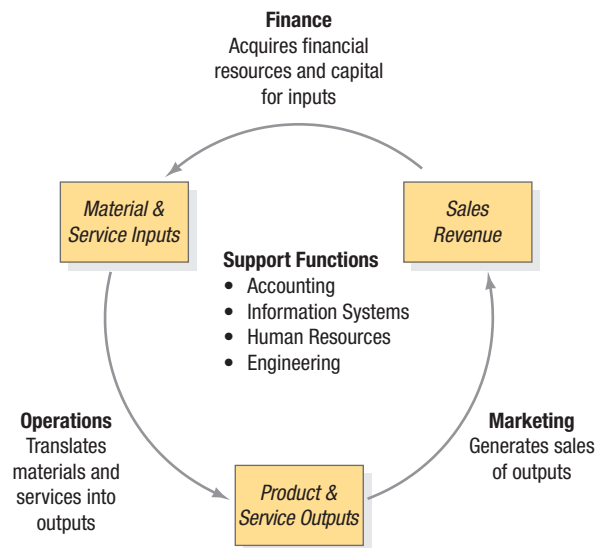
supply chain

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.

▼ **FIGURE 1.1**
Integration Between Different Functional Areas of a Business



²The terms *supply chain* and *value chain* are sometimes used interchangeably.



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

Philip Arno Photography/Shutterstock

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.

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, in which 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 Amazon, 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 modern smart technologies, sustainability and the natural environment. We cover all these ideas and topical areas in greater detail throughout this book.

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 workflow 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.

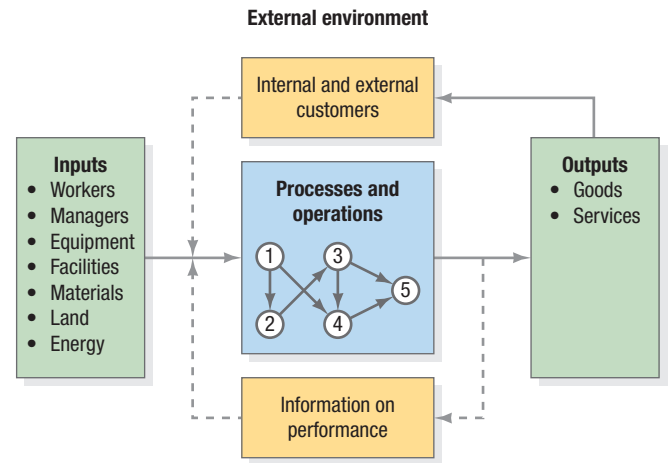
Nested Processes

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, whereas other parts may be geared for customized work. The concept of nested processes is 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, they are more capital intensive, and their quality can be measured more easily than those of service processes.



▲ 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

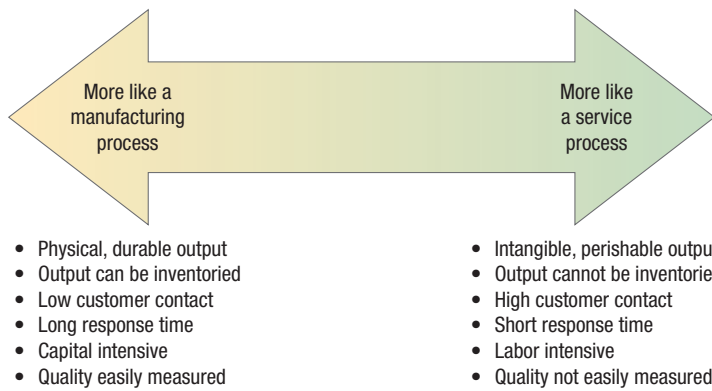
The businesses or individuals who provide the resources, services, products, and materials for the firm’s short-term and long-term needs.

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

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, in contrast, 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 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.



Image Source/Alamy Stock Photo



Iakov Filimonov/Shutterstock

(a) A manufacturing process showing workers on a production line in a factory.
(b) A service process showing a hospitable cheerful server helping customers with the menu and taking their orders in a restaurant.

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.

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*.

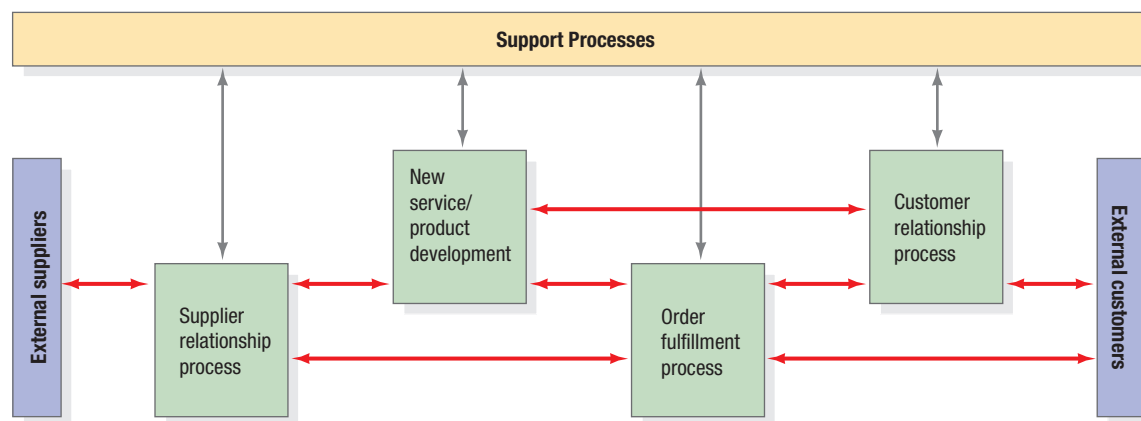


FIGURE 1.4 Supply Chain Linkages Showing Work and Information Flows

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 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

support process

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

puts in place support processes ensuring 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 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
Outsourcing	Exploring available suppliers for the best options to perform processes in terms of price, quality, delivery time, and environmental issues	Customer Service	Providing information to answer questions or resolve problems using automated information services as well as voice-to-voice contact with customers
Warehousing	Receiving shipments from suppliers, verifying quality, placing in inventory, and reporting receipt for inventory records	Logistics	Selecting transportation mode (train, ship, truck, airplane, or pipeline), scheduling both inbound and outbound shipments, and providing intermediate inventory storage
Sourcing	Selecting, certifying, and evaluating suppliers and managing supplier contracts	Cross-docking	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

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

Operations Strategy

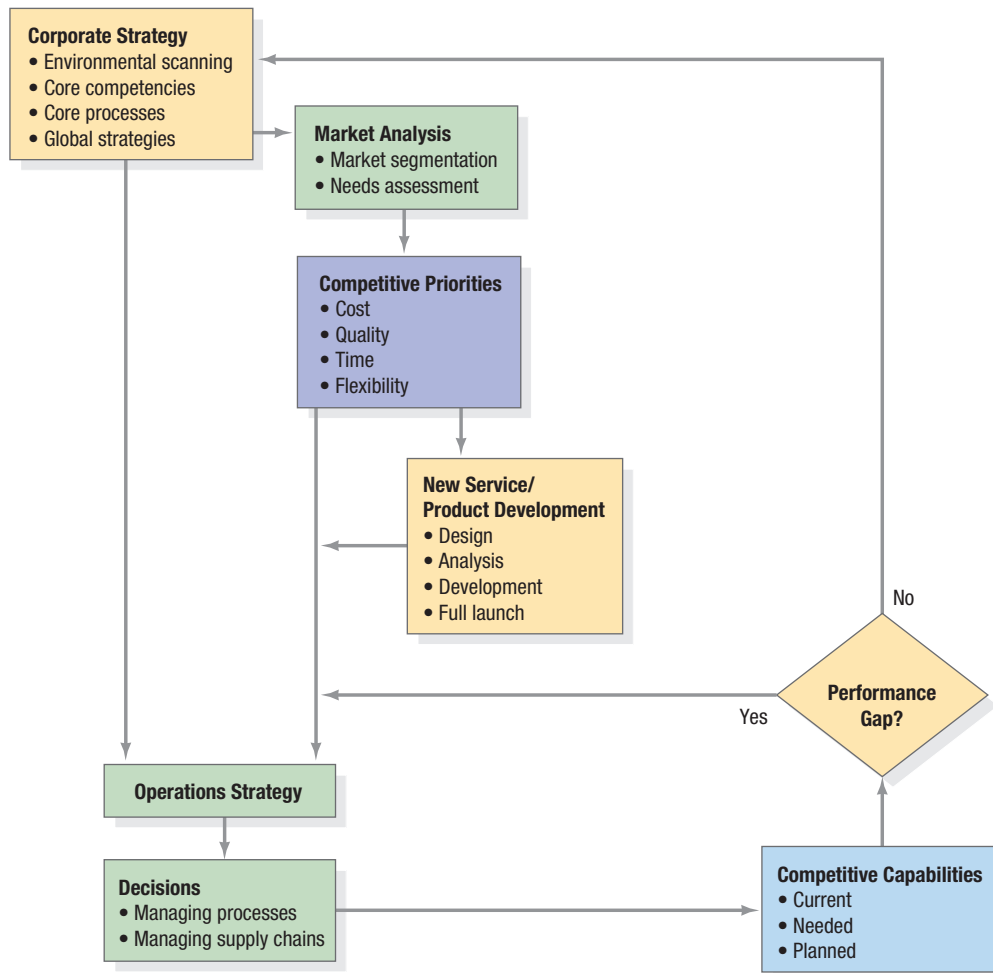
Operations strategy specifies the means by which operations implements corporate strategy and helps to build a customer-driven firm. It links long-term and short-term operations decisions to corporate strategy and develops the capabilities the firm needs to be competitive. It is at the heart of managing 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.

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

Developing a corporate strategy involves four considerations: (1) environmental scanning: monitoring and adjusting to changes in the business environment, (2) identifying and developing the firm’s core competencies, (3) developing the firm’s core processes, and (4) developing the firm’s global strategies.

Environmental Scanning The external business environment in which a firm competes changes continually, and an organization needs to adapt to those changes. Adaptation begins with *environmental scanning*, the process by which managers monitor trends in the environment (e.g., the industry, the marketplace, and society) for potential opportunities or threats. A crucial reason for environmental scanning is to stay ahead of the competition. Competitors may be gaining an edge by broadening service or product lines, improving quality, or lowering costs. New entrants into the market or competitors that offer substitutes for a firm's service or product may threaten continued profitability. Other important environmental concerns include economic trends, technological changes, political conditions, social changes (i.e., attitudes toward work), and the availability of vital resources. For example, car manufacturers recognize that dwindling oil reserves will eventually require alternative fuels for their cars. Consequently, they have designed prototype cars that use hydrogen or electric power as supplements to gasoline as a fuel.

Developing Core Competencies Good managerial skill alone cannot overcome environmental changes. Firms succeed by taking advantage of what they do particularly well—that is, the organization's unique strengths. **Core competencies** are the unique resources and strengths that an organization's management considers when formulating strategy. They reflect the collective learning of the organization, especially in how to coordinate processes and integrate technologies. These competencies include the following:

1. *Workforce.* A well-trained and flexible workforce allows organizations to respond to market needs in a timely fashion. This competency is particularly important in service organizations, where customers come in direct contact with employees.
2. *Facilities.* Having well-located facilities (offices, stores, and plants) is a primary advantage because of the long **lead time** needed to build new ones. In addition, flexible facilities that can handle a variety of services or products at different levels of volume provide a competitive advantage.

3. *Market and Financial Know-How.* An organization that can easily attract capital from stock sales, market and distribute its services or products, or differentiate them from similar services or products on the market has a competitive edge.
4. *Systems and Technology.* Organizations with expertise in information systems have an edge in industries that are data intensive, such as banking. Particularly advantageous is expertise in Internet technologies and applications, such as business-to-consumer and business-to-business systems. Having the patents on a new technology is also a big advantage.

Developing Core Processes A firm's core competencies should drive its core processes: customer relationship, new service or product development, order fulfillment, and supplier relationship. Many companies have all four processes, whereas others focus on a subset of them to better match their core competencies, since they find it difficult to be good at all four processes and still be competitive. For instance, in the credit card business within the banking industry, some companies primarily specialize in finding customers and maintaining relationships with them. American Airlines' credit card program reaches out and achieves a special affinity with customers through its marketing database. In contrast, specialized credit card companies, such as Capital One, focus on service innovation by creating new features and pricing programs. Finally, many companies are taking over the order fulfillment process by managing the processing of credit card transactions and call centers. The important point is that every firm must evaluate its core competencies and choose to focus on those processes that provide it the greatest competitive strength.

Developing Global Strategies Identifying opportunities and threats today requires a global perspective. A global strategy may include buying foreign services or parts, combating threats from foreign competitors, or planning ways to enter markets beyond traditional national boundaries. Although warding off threats from global competitors is

core competencies

The unique resources and strengths that an organization's management considers when formulating strategy.

lead time

The elapsed time between the receipt of a customer order and filling it.



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