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Processes and Supply Chains

ELEVENTH EDITION

Lee J. Krajewski • Manoj K. Malhotra • Larry P. Ritzman

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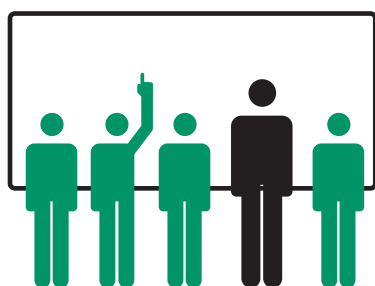
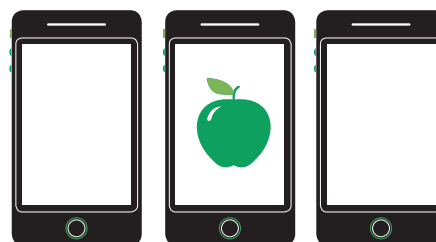
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Operations Management

PROCESSES AND SUPPLY CHAINS

Eleventh Edition

Global Edition

LEE J. KRAJEWSKI

Professor Emeritus at
The Ohio State University
and the University of Notre Dame

MANOJ K. MALHOTRA

University of South Carolina

LARRY P. RITZMAN

Professor Emeritus at
The Ohio State University and Boston College

PEARSON

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Dedicated with love to our families.



Judie Krajewski

Christine and Gary; Gabrielle

Selena and Jeff; Alex

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Maya Malhotra

Vivek, Pooja, and Neha

Santosh and Ramesh Malhotra

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Barbara Ritzman

Karen and Matt; Kristin and Alayna

Todd; Cody, Cole, Taylor, and Clayton

Kathryn and Paul

Mildred and Ray

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About the Authors



Lee J. Krajewski is Professor Emeritus at The Ohio State University and Professor Emeritus at the University of Notre Dame. While at The Ohio State University, he received the University Alumni Distinguished Teaching Award and the College of Business Outstanding Faculty Research Award. He initiated the Center for Excellence in Manufacturing Management and served as its director for four years. At the University of Notre Dame, he held the William and Cassie Daley Chair in Management. In addition, he received the National President's Award and the National Award of Merit of the American Production and Inventory Control Society. He served as president of the Decision Sciences Institute and was elected a Fellow of the Decision Sciences Institute in 1988. He received the Distinguished Service Award in 2003.

Lee received his PhD from the University of Wisconsin. Over the years, he has designed and taught courses at both graduate and undergraduate levels on topics such as operations strategy, introduction to operations management, operations design, project management, and manufacturing planning and control systems.

Lee served as the editor of *Decision Sciences*, was the founding editor of the *Journal of Operations Management*, and has served on several editorial boards. Widely published himself, Lee has contributed numerous articles to such journals as *Decision Sciences*, *Journal of Operations Management*, *Management Science*, *Production and Operations Management*, *International Journal of Production Research*, *Harvard Business Review*, and *Interfaces*, to name just a few. He has received five best-paper awards. Lee's areas of specialization include operations strategy, manufacturing planning and control systems, supply chain management, and master production scheduling.



Manoj K. Malhotra is the Jeff B. Bates Professor in the Darla Moore School of Business and has served as the chairman of the Management Science Department at the University of South Carolina (USC), Columbia, since 2000. He is also the founding director of the Center for Global Supply Chain and Process Management (GSCPM), which has been in operation since 2005. He earned an engineering undergraduate degree from the Indian Institute of Technology (IIT), Kanpur, India, in 1983, and a PhD in operations management from The Ohio State University in 1990. He is a Fellow of the Decision Sciences Institute (DSI) and the American Production and Inventory Management Society (APICS). Manoj has conducted seminars and consulted with firms such as Avaya, Continental, Cummins Turbo

Technologies, John Deere, Metso Paper, Palmetto Health, Sonoco, Prysmian, Verizon, Walmart, and Westinghouse-Toshiba among others.

Apart from teaching operations management, supply chain management, and global business issues at USC, Manoj has also taught at the Terry School of Business, University of Georgia; Wirtschaftsuniversität Wien in Austria; and the Graduate School of Management at Macquarie University, Australia. His research has thematically focused on the deployment of flexible resources in manufacturing and service firms, operations and supply chain strategy, and on the interface between operations management and other functional areas of business. His work on these and related issues has been published in the leading refereed journals of the field such as *Decision Sciences*, *European Journal of Operational Research*, *Interfaces*, *Journal of Operations Management*, and *Production and Operations Management*. Manoj has been recognized for his pedagogical and scholarly contributions through several teaching and discipline-wide research awards. He is the recipient of the Michael J. Mungo Outstanding Graduate Teaching Award in 2006, the Carolina Trustee Professor Award in 2014, and the Breakthrough Leadership in Research Award in 2014 from the University of South Carolina. He is active in professional organizations such as Decision Sciences Institute (DSI) and Production and Operations Management Society (POMS), and has served as the program chair for international conferences at both DSI and POMS. He also serves on the editorial boards of top-tier journals in the field.



Larry P. Ritzman is Professor Emeritus at The Ohio State University and Professor Emeritus at Boston College. While at The Ohio State University, he served as department chairman and received several awards for both teaching and research, including the Pace Setters' Club Award for Outstanding Research. While at Boston College, he held the Thomas J. Galligan, Jr. chair and received the Distinguished Service Award from the School of Management. He received his doctorate at Michigan State University, having had prior industrial experience at the Babcock and Wilcox Company. Over the years, he has been privileged to teach and learn more about operations management with numerous students at all levels—undergraduate, MBA, executive MBA, and doctorate.

Particularly active in the Decision Sciences Institute, Larry has served as council coordinator, publications committee chair, track chair, vice president, board member, executive committee member, doctoral consortium coordinator, and president. He was elected a Fellow of the Decision Sciences Institute in 1987 and earned the Distinguished Service Award in 1996. He has received three best-paper awards. He has been a frequent reviewer, discussant, and session chair for several other professional organizations.

Larry's areas of particular expertise are service processes, operations strategy, production and inventory systems, forecasting, multistage manufacturing, and layout. An active researcher, Larry's publications have appeared in such journals as *Decision Sciences*, *Journal of Operations Management*, *Production and Operations Management*, *Harvard Business Review*, and *Management Science*. He has served in various editorial capacities for several journals.

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Preface

Creating Value through Operations Management

Operations management is a vital topic that every business student needs to understand because it is at the heart of the creation of wealth for businesses, value for customers, and the improvement in the living standard of citizens of all countries. Operations managers are responsible for the production of services and products in an ethical and environmentally responsible way while being responsive to the market. Sound like a challenge? Add to it the need to manage supply chains of materials, information, and funds reaching to all areas of the world. While challenging, there are concepts, tools, and methods that managers use to deal with operating problems in a global environment. The mission of this text is to provide you with a comprehensive framework for addressing operational and supply chain issues. We accomplish this mission by using a systemized approach while focusing on issues of current interest to you. It is important to be efficient and capable with respect to internal processes; however, it is critical for organizations to be able to link those processes to those of their customers and their suppliers to provide competitive supply chains. This text is unique in that it builds the concept of a supply chain from the ground up. Starting with the analysis of business processes and how they relate to the overall operational goals of a firm, our text proceeds to show how these processes are integrated to form supply chains and how they can be managed to obtain efficient flows of materials, information, and funds. This approach reinforces the concept that supply chains are only as good as the processes within and across each firm in them.

This text has been thoroughly revised to meet your needs regardless of your major. Any manager needs to know the global implications of supply chains and how to make decisions in a dynamic environment. We address these contemporary issues of interest through opening vignettes and managerial practices in each chapter. We show you the essential tools you will need to improve process performance. Irrespective of your chosen career path or the industry in which you are seeking a career, you will encounter processes and supply chains. We will show you how to analyze and manage those processes and supply chains from the perspective of service as well as manufacturing firms. Our philosophy is that you will learn by doing; consequently, the text has ample opportunities for you to experience the role of a manager with challenging problems, cases, a library of videos customized to the individual chapters, simulations, experiential exercises, and tightly integrated online computer resources. With this text, you will develop the capability to analyze problems and support managerial decisions.

What's New in the Eleventh Edition?

Since the *tenth* edition, we have been hard at work to make the *eleventh* edition even better, based on the suggestions of adopters and nonadopters. We have carefully monitored for errors in the book and all supplements. We have more figures, photos, company examples, cases, and problems to test your understanding of the material. Here are some of the highlights of the many changes:

1. Increased clarity of every chapter by organizing each major head to address one of the learning goals in the chapter.
2. Ten new chapter openers highlighting the operations of Disney Corporation, QVC, Inc., Tesla Motors, Aldi Supermarkets, Kimberly-Clark, Netflix, Cooper Tire and Rubber Company, Philips, Amazon.com, and *Coral Princess* cruise liner.
3. New Chapter 2, "Process Strategy and Analysis," which combines the strategy and analysis chapters of the tenth edition and streamlines the presentation of these important topics.
4. Improved understanding of independent demand inventory control systems, facility location analysis, and inventory placement with the addition of new figures and numerical examples.
5. Expanded presentation of the bill of resources for services, including figures and a numerical example, which demonstrates the use of the dependent-demand concept for estimating resource requirements in a service setting.
6. New section on supply chain risk management that addresses the operational, financial, and security risks facing supply chain managers today.
7. Five new videos and video cases featuring Crayola, Continental Tire, Some Burros, and W-T Graphix addressing the topics of operations strategy, process choice, inventory management, supply chain design, and facility location.
8. New videos of Solved Problems demonstrating concepts and skills students need to master to make effective decisions in the operations management workplace. Look for [MyOMLab Video](#) in the margin next to these Solved Problems.

9. Animations that help students understand movement and processes shown in figures that might be difficult to grasp just by looking at static figures in the printed text. [MyOMLab Animation](#) appears in the margin next to figures that are animated.
10. New MyOMLab Supplement K, “Layout,” which presents techniques for analyzing layouts in service as well as manufacturing settings.
11. Updated Managerial Practices, giving current examples of operations management to students.
12. New Learning Goals in Review at the end of each chapter, which highlights where each goal is addressed in the chapter and cross references them with a rich set of MyOMLab resources at the student’s disposal including Videos, Active Models, Tutors, OM Explorer, and POM for Windows.
13. Refreshed or added nearly 20 percent of the Problems, all of which are now fully coded for difficulty, arranged by major chapter heads, and represented in MyOMLab.
14. Major overhaul of references, located by chapter sequence at the end of the text.

Chapter-by-Chapter Changes

Using Operations to Create Value

PROCESS MANAGEMENT

Process Strategy and Analysis
 Managing Quality
 Planning Capacity
 Managing Process Constraints
 Designing Lean Systems
 Managing Effective Projects

CUSTOMER DEMAND MANAGEMENT

Forecasting Demand
 Managing Inventories
 Planning and Scheduling
 Operations
 Efficient Resource Planning

SUPPLY CHAIN MANAGEMENT

Designing Effective Supply Chains
 Supply Chains and Logistics
 Integrating the Supply Chain
 Managing Supply Chain
 Sustainability

- **Chapter Count**—Relative to the *tenth* edition, we have streamlined this edition by combining two chapters for a total of only 15 chapters, retaining four supplements in the book, and adding one new supplement in MyOMLab for a total of seven supplements. A central figure in the margin of each chapter shows how each chapter fits into our general theme of processes to supply chains.
 - Chapter 1, “Using Operations to Create Value,” defines operations management, supply chain management, and the overall framework for linking corporate strategy to key operations management decisions.
- **Part 1: Process Management**—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 you how to design and manage the internal processes in a firm.
 - Chapter 2, “Process Strategy and Analysis,” draws together two chapters from the tenth edition to simplify the discussion of the important topic of process choice, introduce the Six Sigma DMAIC model as a systematic approach to process analysis, and introduce the design-to-order production and inventory strategy.
 - Chapter 3, “Managing Quality,” with a new opener on QVC, Inc., continues to address ethics and the environment and provide the essential statistical tools for identifying the onset of process performance problems.
 - Chapter 4, “Planning Capacity,” has a new opener on Tesla Motors and focuses on the long-term capacity decisions that define the process capacities of the firm to do business in the future.
 - Chapter 5, “Managing Process Constraints,” shows how you can get the best output rates within the process capacities you have to work with.
 - Chapter 6, “Designing Lean Systems,” with a new opener on Aldi, a global supermarket chain, shows value stream mapping (VSM) as a major tool for analyzing and improving lean systems and reveals other methods that you can use to improve system performance.
 - Chapter 7, “Managing Effective Projects,” shows the tools managers use to implement the projects needed to achieve efficient processes and supply chains.
- **Part 2: Customer Demand Management**—The second part of the text shows how you can estimate customer demands and satisfy those demands through inventory management, operations planning and scheduling, and resource planning.
 - Chapter 8, “Forecasting Demand,” now has a new opener about Kimberly-Clark, a new section on managing demand, and expanded coverage of collaborative planning, forecasting, and replenishment (CPFR) to demonstrate the importance of collaborating up and down the supply chain to identify service and product demands.
 - Chapter 9, “Managing Inventories,” begins with a new opener on Netflix, includes a simplified presentation of the types of inventories, and has two new examples and supporting figures for the continuous review and the periodic review systems.
 - Chapter 10, “Planning and Scheduling Operations,” has a new opener on Cooper Tire and Rubber Company and shows how operations planning, resource planning, and operations scheduling are linked to provide the core for supply chain design and integration.
 - Chapter 11, “Efficient Resource Planning,” in addition to a new opener on Philips, presents a new approach for resource planning in services using the bill-of-resources method and includes a new Solved Problem example with this technique.

- **Part 3: Supply Chain Management**—The third part of the text, building upon the tools for managing processes and customer demands at the level of the firm, provides the tools and perspectives you will need to manage the flow of materials, information, and funds between your suppliers, your firm, and your customers.
 - Chapter 12, “Designing Effective Supply Chains,” with a new opener on Amazon.com, now has new sections addressing “Creating an Effective Supply Chain” and “Strategic Options for Supply Chain Design” to clarify what managers must consider when designing supply chains, and has an expanded discussion of outsourcing strategies to include next-shoring and new decision factors.
 - Chapter 13, “Supply Chains and Logistics,” has been thoroughly revised to clarify the role of quantitative techniques and how to bring together the quantifiable and non-quantifiable factors in location decisions. It also has a new section on “Inventory Placement” with two new figures that clarify the distinction between centralized and forward inventory placement options.
 - Chapter 14, “Integrating the Supply Chain,” with a new opener on the *Coral Princess* cruise ship, has been thoroughly revised to explain the nature and source of supply chain disruptions, reveal what supply chain integration is and how it mitigates disruptions between the firm and other entities in the supply chain. It also includes a new section “Supply Chain Risk Management,” which explains how to mitigate operational, financial, and security risks.
 - Chapter 15, “Managing Supply Chain Sustainability,” addresses sustainability, focuses on how supply chains can support the environment and be socially responsible, and provides quantitative tools to analyze these issues.
- **Supplements**—The book also offers four supplements that dig deeper on technical topics, and seven other MyOMLab supplements.

Helping You Learn

Key Features

Several new additions and changes have been made to the book to retain and enhance its theme of processes and supply chains and to expand these themes through new content, improved Learning Goals, Managerial Practices, Examples, and End-of-Chapter Problems and Cases. Several key features designed to help aid in the learning process are highlighted next:

Chapter Opening Vignettes engage and stimulate student interest by profiling how real companies apply specific operational issues addressed in each chapter.



4

PLANNING
CAPACITY

Steve Hordula/AFP/Getty Images/Newscom
 Tesla's battery charging station emphasizes the close connection between the electric car and the batteries that serve as the main source of energy for this new generation automobile. Tesla's long-term growth strategies are therefore tied to also expanding its battery manufacturing capacity.

Tesla Motors

Driven by a need to reduce dependence on petroleum-based transportation, a new automobile manufacturing company, Tesla Motors, was formed by Silicon Valley engineers in 2003 with the idea of making fuel efficient electric cars that do not have an internal combustion engine and that run only on rechargeable batteries. Headquartered in Palo Alto, California, Tesla has over 600 employees and an expected revenue of over \$3 billion in 2014. Its premium sedan Model S and cross-over utility vehicle Model X are sold through a network of 125 company-owned stores and service locations in North America, Europe, and Asia. Apart from a planned European Research and Development Center in the United Kingdom in 2015 or 2016, Tesla plans to open manufacturing plants in China and Europe once global sales pass 500,000 vehicles a year.

In order to meet the growing energy needs of its next-generation battery automobiles, Tesla announced plans in 2014 to build the world's largest battery factory at an expense of \$4–5 billion. This gigantic Gigafactory would occupy 10 million square feet and employ about 6,500 workers once completed. It would manufacture the 18/650 cell, a cylindrical battery format that is 18 mm wide and 65 mm tall and favored by Tesla and some laptop manufacturers. About 8000 such cells, modified with Tesla's own proprietary chemistry, are needed to power the 85 kWh drive model S car. The completion of this plant in 2016–2017 is slated to coincide with the production of a third-generation Tesla

Learning Goals improve learning by matching each learning goal with a major head in the chapter.

Managerial Practices provide current examples of how companies deal—successfully or unsuccessfully—with process and supply chain issues facing them as they run their operations.

MANAGERIAL PRACTICE 15.1
Recycling at Walmart

All companies can save money by reducing the amount of waste they must dispose. Walmart, owing to its size, is certainly no exception. In the United States alone, Walmart has over 4,000 stores and serves 130 million shoppers a week. You can imagine the amount of trash that accumulates on a daily basis. Many trash items, such as loose plastic, plastic hangers, office paper, and aluminum cans, are unruly and difficult to collect for recycling. To attack this problem, Walmart initiated the “super sandwich bale (SSB)” at all of its stores and clubs in the United States. The SSB is an invention of Jeff Ashby, national accounts manager for Rocky Mountain Recycling in Salt Lake City. The associates place 10 to 20 inches of cardboard at the bottom of large trash compactors. Commodities, such as loose plastic bags, aluminum cans, plastic hangers, and plastic water and soda bottles, are loaded in, and another layer of cardboard is placed on top. The compactor then presses the bale into a “sandwich” with 9 to 18 inches of recyclables in the middle. The bales are then loaded onto a truck to be recycled into various raw materials that will ultimately become products once again. For example, in one of its sustainability programs, Walmart directs recycled plastics and cardboard to Worldwise, a leader in developing, manufacturing, and marketing sustainable pet products, where they are transformed into a stylish and durable line of dog beds. Plastic hangers are turned into litter pans, plastic bags into litter liners, and corrugated cardboard into cat scratchers. To get a sense of the value involved, Walmart used to pay trash companies to haul more than one billion plastic hangers from its stores and clubs each year. Now, it gets paid 15 to 20 cents a pound for them. The money adds up in a hurry. Who said that reverse logistics supply chains are not profitable? It is clear that environmentally conscious supply chain operations can literally turn “trash” into “cash.”



A Walmart employee throws used packaging boxes into a compactor as a first step in building a super sandwich bale at a Cincinnati area Walmart. The giant retailer is urging its suppliers to reduce greenhouse gas emissions on top of its own moves to build more energy-efficient stores, use alternative fuels for its truck fleet, and reduce packaging.

Source: Marc Gunther, “The End of Garbage,” *FORTUNE*, (March 19, 2007), pp. 158–166; “Waste,” <http://www.walmartstores.com>, (2014); Elaine Janik, “Super sandwich bale—Utah Man’s Idea Nets Wholesale Recycling,” *Desert News*, (April 22, 2008); “Walmart Rolls Out the Plastic Sandwich Bale,” <http://www.walmartstores.com>, 2005; “Walmart Annual report 2013,” <http://www.walmart.com>.

Examples demonstrate how to apply what students have learned and walk them through the solution process modeling good problem-solving techniques. These examples always close with a unique feature called **Decision Point**, which focuses students on the decision implications for managers.

EXAMPLE 9.1
Estimating Inventory Levels

MyOMLab
Tutor 9.1 in MyOMLab provides a new example to practice the estimation of inventory levels.

A plant makes monthly shipments of electric drills to a wholesaler in average lot sizes of 280 drills. The wholesaler’s average demand is 70 drills a week, and the lead time from the plant is 3 weeks. The wholesaler must pay for the inventory from the moment the plant makes a shipment. If the wholesaler is willing to increase its purchase quantity to 350 units, the plant will give priority to the wholesaler and guarantee a lead time of only 2 weeks. What is the effect on the wholesaler’s cycle and pipeline inventories?

SOLUTION
The wholesaler’s current cycle and pipeline inventories are

$$\text{Cycle inventory} = \frac{Q}{2} = \frac{280}{2} = 140 \text{ drills}$$

$$\text{Pipeline inventory} = \bar{D}_L = \bar{d}L = (70 \text{ drills/week})(3 \text{ weeks}) = 210 \text{ drills}$$

Figure 9.3 shows the cycle and pipeline inventories if the wholesaler accepts the new proposal.

1. Enter the average lot size, average demand during a period, and the number of periods of lead time:

Average lot size	350
Average demand	70
Lead time	2

2. To compute cycle inventory, simply divide average lot size by 2. To compute pipeline inventory, multiply average demand by lead time:

Cycle inventory	175
Pipeline inventory	140

DECISION POINT
The effect of the new proposal on cycle inventories is to increase them by 35 units, or 25 percent. The reduction in pipeline inventories, however, is 70 units, or 33 percent. The proposal would reduce the total investment in cycle and pipeline inventories. Also, it is advantageous to have shorter lead times because the wholesaler only has to commit to purchases 2 weeks in advance, rather than 3 weeks.

End of Chapter Resources

- **Learning Goals in Review** guidelines for mastering each learning goal and a list of resources found in MyOMLab relating to the goal.
- **Key Equations** for review purposes, organized by major chapter head.
- **Key Terms** for review purposes; the page references highlight where the concept was first discussed.
- **Solved Problems** reinforce and help students prepare their homework assignments by detailing how to solve model problems with the appropriate techniques presented in the chapter.
- **Discussion Questions** test student comprehension of the concepts through the use of short scenarios.

- **Problems** sharpen students' quantitative skills by providing a bridge between chapter materials with a wide selection of homework material. Advanced problems are marked with **D** to indicate an increased level of difficulty. Most of the homework problems can be done manually, or students can utilize a variety of software tools through MyOMLab, which is discussed in a later section.
- **Conceptual Questions Coverage** at least four conceptual questions for each major topic in the book have been added to MyOMLab.
- **Active Model Exercises** enable students to use provided spreadsheets to do “what-if” analysis of examples presented in the text to see what would happen if certain parameters were changed.
- **Video Cases** provide a summary of content covered in a series of on-location video profiles of real-world service and manufacturing companies and challenges they face in their operations. Questions are included for classroom discussion or assignment purposes.
- **Cases** challenge students to grapple with a capstone problem that can be used as an in-class exercise, a homework assignment, or team project.
- **Experiential Learning** forms students into teams who work both in and out of class on exercises that actively involve them in team-based discussion questions and decisions. The six exercises reinforce student learning. Each exercise has been thoroughly tested in class and proven to be a valuable learning tool.
- A **Video Library** in MyOMLab offers at least one video case for each chapter, which makes for excellent class discussion and learning. Three tutorials are also included.

Teaching and Learning Support

MyOMLab A key capability of MyOMLab is as an online homework and assessment tool designed to help students practice operations management problems and improve their understanding of course concepts, and to give their instructors feedback on their performance. This online product expands the student's learning experience with out-of-class quizzes that are automatically graded and tutorials to guide the problem solving process, keeping students up to date, and freeing instructors for more creative use of class time. It also has a wealth of resources to assist students in preparing for class, working on assignments, and achieving the learning goals for each chapter.

MyOMLab lets you teach your course your way. Use MyOMLab as an out-of-the-box resource for students who need extra help, or take full advantage of its advanced customization options.

MyOMLab

For Instructors

Instructor's Resource Center—Reached through a link at <http://www.pearsonglobaleditions.com/Krajewski>, the Instructor's Resource Center contains the electronic files for the complete Instructor's Solutions Manual, PowerPoint lecture presentations, and the Test Bank.

Instructor's Solutions Manual—Prepared by Jack Jensen at The University of South Carolina, this resource begins with the video notes and solutions, followed by chapter-by-chapter solutions to end-of-chapter questions, problems, and cases. This manual is available for download in both Word and PDF versions by visiting <http://www.pearsonglobaleditions.com/Krajewski>.

Instructor's Resource Manual—Prepared by Jack Jensen at The University of South Carolina, this resource begins with sample syllabi for the course suited to various situations: with or without MyOMLab, quarter versus seven-week course, undergraduate versus MBA, quantitative versus qualitative orientation, and process versus supply chain orientation. It then offers generic Instructor and Student Notes, both of which must be revised to reflect the instructor's approach to the course. The Student Notes can be handed out or posted so that the students can have them during class to simplify note taking and concentrate more on what is being said. Both Word and PDF files of this manual are available for download by visiting <http://www.pearsonglobaleditions.com/Krajewski>.

PowerPoint Lecture Slides—Chapter-by-chapter files for classroom presentation purposes are available for download by visiting <http://www.pearsonglobaleditions.com/Krajewski>. PowerPoint slides can be customized by the instructor and contain most of the images and illustrations featured in the text as well as lecture notes.

Test Bank—This resource offers an array of questions and problems ranging from easy to difficult. It includes true/false and multiple-choice questions, which can be accessed by MyOMLab, and short answer and essay questions. These files are available for download by visiting <http://www.pearsonglobaleditions.com/Krajewski>.

TestGen—Pearson Education’s test-generating software is available from <http://www.pearsonglobaleditions.com/Krajewski>. The software is PC-compatible and preloaded with all of the Test Bank questions. You can manually or randomly view test questions and drag and drop to create a test. You can add or modify test bank questions as needed.

For Students

Besides having access to study plans and tutorial resources in MyOMLab, students can utilize the following additional course resources within MyOMLab:

OM Explorer—This text-specific software tool consists of Excel worksheets and includes tutors and solvers.

- **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 covers over 25 common OM techniques.

Active Models—These 29 included spreadsheets require students to evaluate different situations based on problem scenarios.

Download Page—This offers access to OM Explorer, POM for Windows, SimQuick, and Active Models, and a link to a free trial of SmartDraw software.

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Guido Cozzi/Atlantide/Phototravel/Corbis



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

1

USING OPERATIONS TO CREATE VALUE

Disney

Disney Corporation is an internationally diversified entertainment and media enterprise comprising of 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 \$45 billion in 2013, Disney is particularly well known for its theme parks that had a 17 percent increase in operating income to \$2.2 billion in the last fiscal year alone. 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 e-mail 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 the 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> (August 18, 2014).

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.

Operations management refers to the systematic design, direction, and control of processes that transform inputs into services and products for internal, as well as external customers. As exemplified by Disney, it can be a source of competitive advantage for firms in both service as well as 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.¹ 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 in Figure 1.1 highlight the importance of the coordination among the three mainline functions of any business, namely, (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

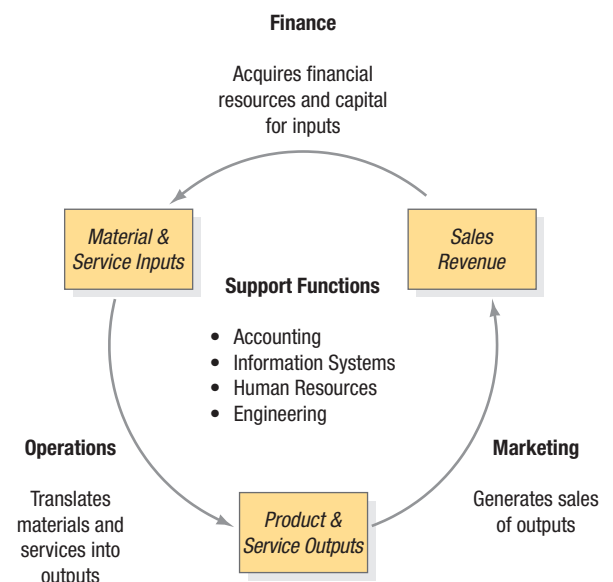
A group of resources performing all or part of one or more processes.

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

¹The terms *supply chain* and *value chain* are sometimes used interchangeably.

Historical Evolution and Perspectives

The history of modern operations and supply chain management is rich and over two hundred years old, even though its practice has been around in one form or another for centuries. James Watt invented



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

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 nineteenth 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 nineteenth 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 twentieth 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.

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 in Figure 1.2 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.

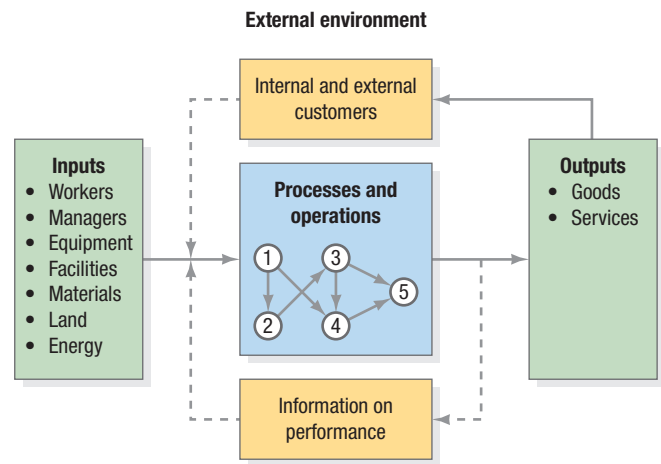
Nested Processes

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 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.



▲ 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

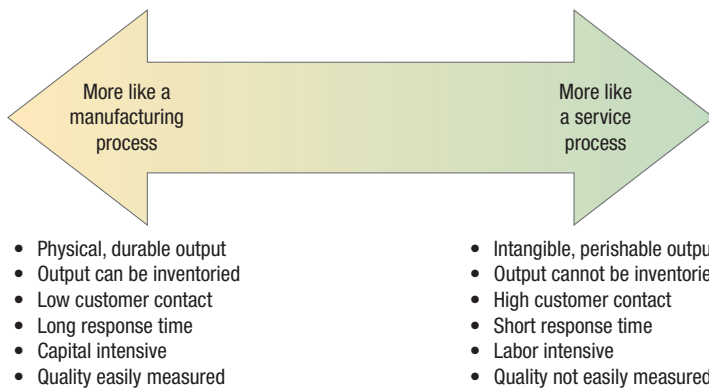
The businesses or individuals who provide the resources, services, products, and materials for the firm’s short-term and long-term needs.

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 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.

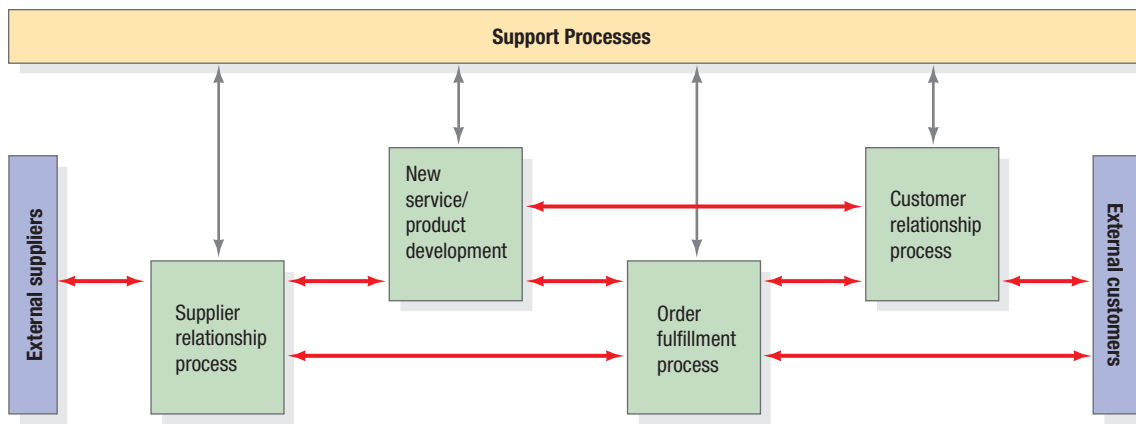
Similarities At the level of the firm, service providers do not just offer services and manufacturers do not just offer products. Patrons of a restaurant expect good service and good food. A customer purchasing a new computer expects a good product as well as a good warranty, maintenance, replacement,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



▲ FIGURE 1.4
Supply Chain Linkages Showing Work and Information Flows

MyOMLab Animation

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 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.

All of these support processes must be managed to create as much value for the firm and its customers 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.

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.

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

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.

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, 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

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.

Operations Strategy

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

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