RAY R. VENKATARAMAN ▪ JEFFREY K. PINTO

# OPERATIONS MANAGEMENT

## Managing Global Supply Chains

SECOND EDITION

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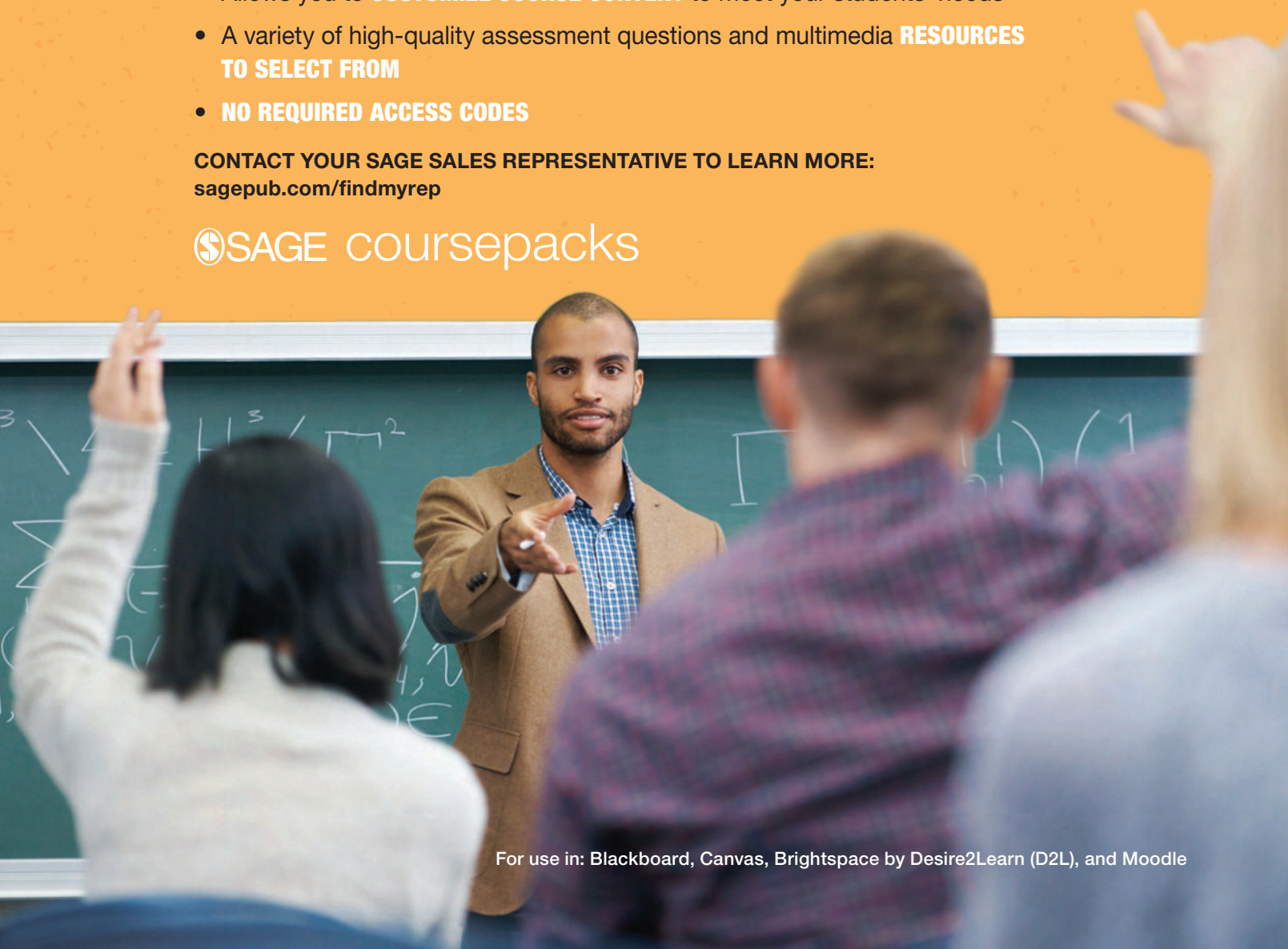

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# Operations Management

## Managing Global Supply Chains

### Second Edition

*To my loving wife, Uma, for her patience and unwavering support without which this project would not have been possible; to my daughters, Vidhya and Aruna, for the joy they bring to my life; to my sister and brother-in-law, Radha and Jambunathan, for their encouragement in every venture of my life; and finally, to my late parents, Rajam and Ramanathan, for their selfless love and dedication to the well-being and success of their children.*

–Ray

*For Mary Beth, Emily, Josh, Ezekiel, Adrian (AJ), Kristi, and Joe, whose presence in my life continually reminds me that family is what counts.*

–Jeff

# Operations Management

## Managing Global Supply Chains

### Second Edition

**Ray R. Venkataraman**

*Penn State Erie, The Behrend College*

**Jeffrey K. Pinto**

*Penn State Erie, The Behrend College*

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Los Angeles | London | New Delhi
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FOR INFORMATION:

SAGE Publications, Inc.
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E-mail: order@sagepub.com

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# PREFACE

Operations and supply chain management are among the most critical components of modern organizations. Effectively managing complex and often far-flung supply chains, coordinating vendor and customer relationships, and developing supply chain and operations strategies are the hallmarks of successful for-profit and nonprofit organizations worldwide. Whether organizations operate in service or manufacturing settings, they must actively utilize the myriad opportunities and challenges their supply chain strategies identify. In modern business enterprises, operations and supply chain management integrate directly into the broader context of organizational activities, and the current global economy dictates that companies take an international perspective on these topics. Marketing, new product or service development, and retail strategies all directly depend on a firm's ability to successfully manage both its operations and supply chain activities in efficient and effective ways. Decisions about opening new facilities in foreign countries and finding global sources for supplies are elements in operations and supply chain management that directly contribute to an organization's bottom line. In short, operations and supply chains are not issues that can be addressed—or taught—separately from each other. They must be combined into a fully integrated package, bringing attention to both concepts simultaneously from a global perspective. Our motivation is to write a textbook that adopts a joint supply chain/operations focus for each chapter, highlighting how these concepts must integrate for companies to be successful in the global marketplace.

## Approach

At one time, the primary focus of the operations function was to streamline costs and improve internal efficiency. As we have noted here, through the joint pressures of global competition and the need to manage supply chains, a broadening of our understanding of the meaning of "operations," along with the requirement for ethical and sustainable practices, the operations and supply discipline in many ways bears a faint resemblance to the manner in which previous generations of business students learned and practiced this functional discipline. Modern operations and supply chain management is an exciting career opportunity that rewards creativity, technical mastery, and the desire to think globally. This textbook supports and represents the broader—and ultimately, we believe, a far more interesting—perspective, recognizing several critical and simultaneously occurring elements: supply chain management, global operations, sustainability and business ethics, and a focus on the service industry.

### Supply Chain Management

Operations managers must recognize the inextricable links to the larger supply chain. Looking at the internal operations of the organization, in either service or production settings, is one important but limited perspective that successful firms must address. Today, effective organizations are characterized by their outward-looking focus, linking internal operations to external suppliers, customers, and delivery systems. Firms that master the management of their supply chains tend to become leaders in their respective industries.

### Global Operations

The business setting we operate within is truly worldwide; an international focus is not a distraction but a necessity when considering how best to manage operations and supply chains. As its starting point, this text takes this global perspective. Examples used throughout the text employ international settings, showing the ways in which manufacturing or strategic decisions taken in China, for example, have far-reaching implications for economic and commercial outcomes in the European Union or North America.

### Sustainability and Business Ethics

Because we live in a world defined by scarce resources, operations managers must take a sustainability perspective when identifying and exploiting resources, raw materials, and methods for transporting and disposing of goods. This text deliberately addresses sustainability within each chapter, showing that sustainable operations and supply chain practices are not only attainable but critical and often profitable practices for organizations to undertake. In tandem with the focus on sustainability, an additional point of emphasis in this text is the use of a business ethics mindset. It is beneficial to recognize that many operations and supply chain challenges also carry ethical considerations with them. Thus, while we advocate for better operations and supply chain management techniques throughout this text, we also lay the foundation for students to recognize that in managing operations and global supply chains, it is possible to "do well by doing good." Operations and supply chain management offers a number of critical lessons for businesses that are adopting sustainable practices. We have included these important issues within every chapter and have added some cases and critical thinking exercises focusing on sustainability and ethical business practices. Our goal is to highlight the ways in which global operations and supply chain management challenges must be considered within the broader context of managing for sustainable and ethical standards.

## The Service Industry

It is critical to recognize that the business environment we live in today is characterized by an explosion in service firms; in fact, service industries continue to outpace more traditional manufacturing in the number of new startups, revenue generated, and jobs created. As a result, this text deliberately adopts a joint focus of manufacturing and service operations throughout the chapters. We demonstrate the application of important techniques and methods for production organizations while also spotlighting the manner in which these methods can be employed in service settings, making this text more relevant to the job environment our readers will enter.

This text takes a holistic, integrated approach to managing operations and supply chains, exploring both technical and managerial challenges. It not only emphasizes specific operations methods and current practices, focusing on managing the wide variety of challenges operations professionals face, but throughout, we emphasize the strategic implications of many of these activities on their companies' supply chains, showing that supply chain and operations decisions have important implications for wider organization success.

# Organization of the Book

This textbook is organized to address the subject matter of operations management from a global supply chain perspective. The book provides treatment of operations and supply chain management in a hierarchical framework of strategic, integrative, tactical, and operational decisions. The book is organized into five major sections:

- **Part I: Introduction** provides an overview of the field of operations management in a supply chain framework and its strategic importance to businesses in both the manufacturing and service sectors.
- **Part II: Strategic Decisions** discusses the strategic operations and supply chain decisions that guide a company's subsequent activities in its operations and supply chain. This section examines strategic concepts such as product and service design, quality, supply chain design, process design, and layout planning.
- **Part III: Integrative Decisions** deals with integrative decisions such as supplier management, logistics management, and demand management and forecasting that cut across strategic, tactical, and operational decision levels.
- **Part IV: Tactical Decisions** addresses the important tactical planning decisions such as lean operations and supply chains, sales and operations planning, and inventory management.
- **Part V: Operational Decisions** examines key operational decision topics such as master scheduling, material and capacity requirements planning, and scheduling.
- **Part VI: Quantitative Modules** keeps the vast and varied audience of operations management instructors in mind, in that we deliberately separate the majority of the quantitative material from the "managerial" or theoretical topics associated with each of these chapters into chapter supplements and end-of-book modules. This allows instructors the flexibility to decide which chapters and topics they would prefer to treat from a broader perspective and which they require their students to delve into in a more quantitative manner. Moreover, within the quantitative chapters and supplements themselves, we offer a comprehensive treatment of this material, allowing instructors to decide which of the various models and methods they choose to apply to the subject at hand. We have found that from a pedagogical perspective, separating the theory from the more in-depth quantitative solutions allows faculty to teach this material in ways that can be best tailored to their audience, as well as their own comfort level.

# Features

## In-Chapter Features

### OPERATIONS PROFILE

This textbook employs a managerial, business-oriented approach to the management of operations and supply chains. To demonstrate these concepts in real-world settings, we have integrated Operations Profiles into the text. Each chapter contains one or more of these features to highlight current examples of operations and/or supply chain management in action. Some reflect on significant achievements; others detail important examples of operations challenges. Because they cover service operations, manufacturing, successes, and failures, there will be at least one profile per chapter that is meaningful to the class's focus. These stories of success and failure align with the chapters to which they are attached. For example, as we study supplier management in Chapter 10, it is useful to consider the tragic implications of poor supervision and corruption that contribute to the incidence of factory fires in third world countries like Bangladesh.

### OPERATIONS MANAGEMENT: LESSONS LEARNED

A unique feature of this text is the inclusion of a feature box titled "Operations Management: Lessons Learned." The purpose of this feature is to highlight companies that have made significant supply chain or operations mistakes and, as a result, are discovering the negative consequences of these decisions. One of the benefits of these examples is to help students understand

the critical cause-and-effect relationships between decisions made (or not made) and subsequent problems resulting from these choices. These boxes are placed within the chapters to coincide with important topics and can serve as an excellent source of in-class discussion or as a means to get students to explore the topics in more detail.

### EXAMPLES WITH MS EXCEL®

An additional feature of the text is the inclusion within several chapters of sample problems and activities that require students to generate MS Excel output files. Excel is a very useful device for solving a variety of operations problems, and we deliberately used it throughout the text to highlight its usefulness. It is the purpose of this text not to fully develop these skills but rather to plant the seeds for future application.

### CONSIDER THIS

"Consider This" feature boxes discuss examples, both successful and unsuccessful, of companies addressing various challenges with their operations and supply chain management. "Consider This" boxes help personalize the content for students and convert the theory found in the chapters into practice. These up-to-date examples demonstrate the many ways in which companies are addressing various challenges in managing their service or product operations and supply chains.

## End-of-Chapter Features

### DISCUSSION AND REVIEW QUESTIONS

Discussion questions serve as a means to review just-completed chapter content and are intended to help students better understand the content they have read by posing some thoughtful questions for classroom discussion. Many of the discussion questions offer opportunities for instructors to frame the discussion in the form of debates, as students examine the pros and cons of specific operations and supply chain challenges.

### SOLVED PROBLEMS

Most chapters include a number of Solved Problems as a means for students to have actual examples that can guide them as they answer many of the quantitative problems they will solve in the chapters and supplements.

### PROBLEMS

We have included more than 500 practice problems in this text to give students as many opportunities as possible to practice and apply chapter concepts. Although many of these problems are quantitative and follow standard formats to allow students to practice what they have learned in the book, we have also included a number of qualitative problems that require critical thinking and reflection. As a result, most chapters contain a combination of qualitative and quantitative problems that give good practice opportunities to demonstrate the mastery of the subject matter.

### CASE STUDIES

This text blends operations and supply chain management within the context of any successful organization, whether publicly held, private, or not-for-profit. Furthermore, the discussion is deliberately global, highlighting operations challenges across the widest possible spectrum. The modern business student must become familiar with and comfortable dealing with supply chain issues whether their origin is North or South America, Asia, Europe, or Africa. We illustrate this through the use of within-chapter and end-of-chapter cases. At the end of each chapter are case studies that take specific examples of the material covered in the chapter and apply them in a narrative format. Some of the cases are fictitious, but the majority of them are based on real situations. These cases include discussion questions to evoke recollection, understanding, critical thinking, and application for the reader that can be used either for homework or to facilitate classroom discussions.

### CRITICAL THINKING EXERCISES

Each chapter contains at least one critical thinking exercise that requires students to reflect on the main points of the chapter and apply them to other, equally important problems as a result of expanding on either theory or practical implications. These critical thinking exercises may require students to use Internet search engines to come up with solutions, or they may be broader, allowing students to work in teams to formulate possible solutions for the challenges posed.

# New to This Edition

*Chapter 1*

- Updates to statistics throughout
- An update to the Operations Profile: Lessons Learned from Apple
- Added new discussion of the role of technology and data analytics on supply chain management
- Updates to the cases discussed in the text

*Chapter 2*

- New Operations Profile: Chubbies' Supply Chain Strategy Keeps the Fun in Short-Shorts
- Updates to statistics throughout
- Added information on how to improve sustainability of a supply chain

*Chapter 3*

- New Operations Profile: Apple's New Headquarters
- Updated Operations Profile: The Expeditionary Fighting Vehicle
- Added new example of Google Glass
- Addition of one new Solved Problem

*Chapter 4*

- Updates throughout
- Added example of Coca-Cola's response to changing consumer tastes
- Added example of product failure of t-shirt line produced by the Jenners
- Added discussion of the design of products for the Internet of Things

*Chapter 4S*

- Updated Operations Profile: Computer Glitch Grounds United Airlines
- Added current examples where appropriate

*Chapter 5*

- Updated Operations Profile: Louis Vuitton Spares No Expense to Gain the Quality "Seal of Approval" for Its Watches
- Added current examples where appropriate: Takata airbags, Apple's AirPods, Samsung's Galaxy Note 7
- New Consider This feature highlighting Winner of the Baldrige Award: Memorial Hermann Sugar Land Hospital

*Chapter 6*

- New Operations Profile: Automated Quality Control at Electronic Arts—Avoiding the Effect of "Crunch"

*Chapter 7*

- New Operations Profile: For Its Capacity Planning, UPS Asks Retailers to Help Out
- Added an example from Tesla
- Added callouts to where the quantitative tools are discussed in other areas of the book

*Chapter 8*

- Updates to Operations Profile: Mexico, The Next Great Automaker showing the impact of the U.S. Presidential Election
- Updated Case Study 8.1
- Added Case Study 8.2—Alpharetta Tools

*Chapter 9*

- New Operations Management: Lessons Learned: Facing Declining Sales, Subway Redesigns Its Stores
- Updated table on 10 Biggest Users of Solar Power in U.S.
- New Case Study 9.1: Challenges of Designing a Plant Layout

*Chapter 10*

- New Operations Profile: Got Milk? A Lot More Than We Need
- Added discussion of 2017 investigation into Spanish slaughterhouses for shipping horse meat illegally
- Discussion of Sage mobile app for assistance in grocery shopping

*Chapter 11*

- New Operations Profile: Challenges With River Transportation—The Cost of Crumbling Infrastructure
- Updated statistical information throughout
- Added discussion of California port trucking companies' unethical operations
- Added discussion of improvement in fuel efficiency and environmental issues
- Added Case Study 11.2: Third-Party Logistics and the Mistreatment of Workers
- New Critical Thinking exercise

*Chapter 12*

- New Operations Profile: The Challenge of Demand Management for Popular Items—Fitness Trackers
- New Consider This 12.1: Hurricane Harvey Leads to Surge in Demand for Automobiles

- Addition of recent delays on Air Transat flight from Brussels, Belgium to Montreal, Canada
- Added discussion of United Airlines incident with Dr. David Dao

*Chapter 13*

- Minor statistical updates where appropriate
- Addition of discussion of predicting demand for Super Bowl 2016

*Chapter 14*

- Added discussion of the Boeing 787 Dreamliner
- New Operations Management: Lessons Learned: Learning to be Lean at Amazon
- New Case Study 14.1: Lean Sustainable Supply Chains at Unilever

*Chapter 15*

- New Operations Management: Lessons Learned: Toyota—Why Inventory Matters and the Challenge of Just-in-Time

*Chapter 16*

- Updated Operations Profile: Walgreens Fights to Stay Profitable Through Inventory Management
- Updated Operations Management: Lessons Learned: Inventory Management Helps Sink Target Canada

*Chapter 17*

- Updated Operations Profile: Black Friday Shopping in the United States—The Experience Is Quickly Changing

*Chapter 18S*

- Updated Operations Management: Lessons Learned: Surviving an ERP System Disaster with a discussion of Washington State's Community College System

*Chapter 19*

- Updated the statistics in Operations Profile: Scheduling at Walt Disney World

*Module B*

- Updates to Operations Profile: Tesla and the Challenge of Locating a Battery Factory

*Module E*

- Updates to Operations Profile: Boeing: Relying on Learning Curves for Cost Analysis

## AACSB Statement

The Association to Advance Collegiate Schools of Business (AACSB) is a global association that provides business schools with accreditation standards for the advancement of management education. Dr. Venkataraman, Dr. Pinto, and SAGE Publishing understand the value of these accreditation standards to the success of business students and have tied test bank questions that accompany *Operations Management: Managing Global Supply Chains, 2e* to the general knowledge and skill areas identified by AACSB.

## SAGE edge and Online Resources

Additional resources for instructors are available on a password-protected website at **edge.sagepub.com/venkataraman2e**. These materials include a test bank with close to 100 questions per chapter, a solutions manual for the practice problems in the book, additional auto-gradable practice problems to assign as homework, PowerPoint slides, lecture notes, case notes, sample answers to the questions in the book, class activities, a sample syllabus, tables and figures from the book, Excel templates for selected formulas, and video and multimedia resources.

SAGE coursepacks, available for download at edge.sagepub.com/venkataraman2e, are available for a variety of learning management systems. The SAGE coursepacks for *Operations Management* include a video case study for each chapter, demonstrating what operations management looks like in real organizations, with quiz questions accompanying each video. The SAGE coursepacks also feature additional assessment questions for each chapter, supplement, and module, as well as video walkthroughs of solved problems in the book.

Online resources for students are open-access and free at **edge.sagepub.com/venkataraman2e**. These include, for each chapter, learning objectives with summaries, mobile-friendly practice quizzes and eflashcards, Excel templates that can be used with practice problems, and numerous multimedia resources to keep students engaged and better able to see operations management concepts from multiple perspectives.

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Janice Cerveny, Florida Atlantic University

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Christian Grandzol, Bloomsburg University of Pennsylvania

Haresh Gurnani, University of Miami

David O. Hartman, Quinnipiac University

Jose Humberto Ablanedo Rosas, University of Texas at El Paso

Faizal Huq, Ohio University

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Joseph Ingles, Lynn University

Xin James He, Fairfield University

Jian-yu Ke, California State University, Dominguez Hills

Sunder Kekre, Carnegie Mellon University

Burcu B. Keskin, The University of Alabama

Beate Klingenberg, Marist College

Jun-Yeon Lee, California State University, Northridge

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Heather Lutz, Penn State University

Christian N. Madu, Pace University

William A. Maligie, California State University, Chico

Chris McCart, Roanoke College

Philip Musa, The University of Alabama at Birmingham

Seong-Hyun Nam, University of North Dakota

Ravi Narayanaswamy, University of South Carolina Aiken

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## Feedback

We and the textbook team would appreciate hearing from you. Let us know what you think about this textbook by writing to orders@sagepub.com. Please include "Feedback about Venkataraman and Pinto" in the subject line.

Ray R. Venkataraman, PhD
*Professor and Chair of Project and Supply Chain Management, Sam and Irene Black School of Business, Penn State Erie, The Behrend College, rrv2@psu.edu*

Jeffrey K. Pinto, PhD
*Andrew Morrow and Elizabeth Lee Black Chair in the Management of Technology, Sam and Irene Black School of Business, Penn State Erie, The Behrend College, jkp4@psu.edu*

Sara Miller McCune founded SAGE Publishing in 1965 to support the dissemination of usable knowledge and educate a global community. SAGE publishes more than 1000 journals and over 800 new books each year, spanning a wide range of subject areas. Our growing selection of library products includes archives, data, case studies and video. SAGE remains majority owned by our founder and after her lifetime will become owned by a charitable trust that secures the company's continued independence.

# ABOUT THE AUTHORS

**Dr. Ray R. Venkataraman** is a Professor of Project and Supply Chain Management at the Sam and Irene Black School of Business at Penn State Erie, The Behrend College. He has a PhD in Management Science from Illinois Institute of Technology and has over 30 years of teaching experience. He has taught a variety of courses including Operations Planning and Control, Supply Chain Management, Operations Strategy, Purchasing, Business Statistics, and Project Management. He has received the Ideal Industries Award for Excellence in Business Teaching at Northern Illinois University. He currently teaches online courses in Planning and Resource Management in Projects, and Cost and Value Management in projects at the master's level. Dr. Venkataraman has several research publications in top-tier operations management journals. He has published in journals such as *The International Journal of Production Research, Omega, International Journal of Operations and Production Management, Production and Operations Management (POMS), Production and Inventory Management, Production Planning and Control*, *The International Journal of Quality and Reliability Management,* and *Interfaces*. In addition, he has coauthored books titled *Cost and Value Management in Projects* and *Decision Making in Project Management*. His current research interest is in the area of sustainability integration in project and supply chain management. As an assistant manager with a multinational bank in India, Dr. Venkataraman has several years of industry experience in the financial services industry. He has served on the editorial review boards of the *Production and Operations Management (POMS)* and *IEEE Transactions on Engineering Management* journals.

**Dr. Jeffrey K. Pinto** is the Andrew Morrow and Elizabeth Lee Black Chair in the Management of Technology in the Sam and Irene Black School of Business at Penn State Erie, The Behrend College. Dr. Pinto held previous academic appointments at the University of Cincinnati and the University of Maine. In 2016, he was a visiting scholar at the Kemmy School of Business, University of Limerick, Ireland. He is the lead faculty member for Penn State's Master of Project Management program. The author or editor of 26 books and over 150 scientific papers that have appeared in a variety of academic and practitioner journals, books, conference proceedings, video lessons, and technical reports, Dr. Pinto's work has been translated into nine languages. He served as editor of the *Project Management Journal* from 1990 to 1996, is past-department editor for R&D and engineering projects with *IEEE Transactions on Engineering Management,* and serves on several other journal editorial boards. With over 25 years' experience in the field of project management, Dr. Pinto is a two-time recipient of the Distinguished Contribution Award from the Project Management Institute for outstanding service to the project management profession. He received PMI's Research Achievement Award in 2009 for outstanding contributions to project management research. In 2017, he received the Research Achievement Award from the International Project Management Association for shaping the discipline of project management through his work.

Dr. Pinto has taught and consulted widely in the United States and Europe on a variety of topics, including project management, supply chain management, new product development, information system implementation, organization development, leadership, and conflict resolution.

CHAPTER

# 1

# Introduction to Managing Global Operations and Supply Chains

## LEARNING OBJECTIVES

After studying this chapter, you should be able to:

1.1 Explain how globalization has influenced the management of supply chains and their operations.

1.2 Describe the role of operations management within a company and in society.

1.3 Trace the path of a raw material from the start of the supply chain to the final consumer.

1.4 Explain why it is important to have an integrated view of operations from a larger supply chain framework.

1.5 Describe the evolution of operations and supply chain management from the Industrial Revolution to the present.

1.6 Identify some of the emerging trends in operations and supply chain management.

# OPERATIONS PROFILE:
## *Intel Uses Quality Control to Achieve World Domination*

Intel Corporation (Santa Clara, CA) is the world's largest manufacturer of microprocessor chips. Having captured 80% of its market, the company's microprocessors power personal computers (PCs), servers, and smartphones manufactured worldwide. Staying on top of the fast-paced microprocessor-chip industry, however, is complicated.

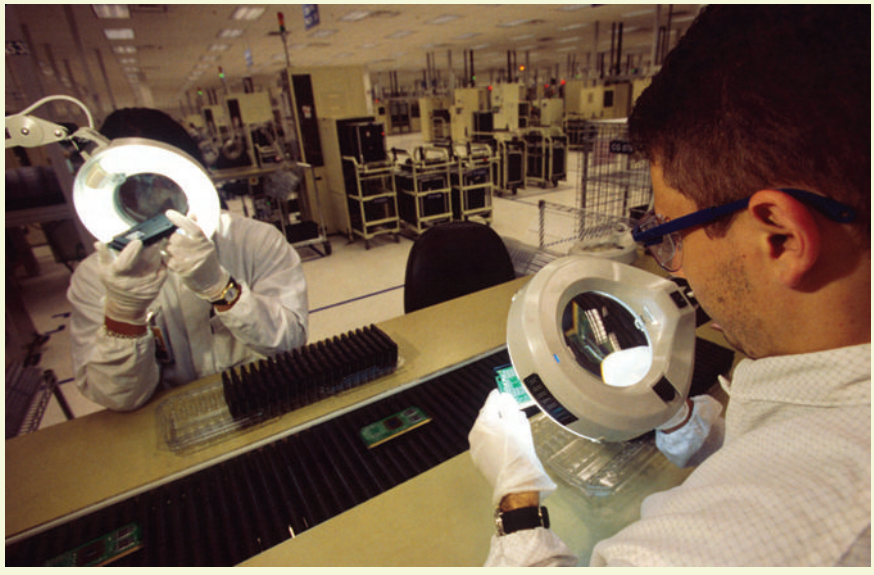
The development and manufacture of computer chips is a fantastic and complex global voyage: Chips start out as single crystals and are grown into large ingots of silicon by Toshiba Ceramics Co., Ltd. (Tokyo, Japan). Toshiba Ceramics then slices the ingots into thin wafers, which are flown across the Pacific Ocean to one of Intel's semiconductor fabricating plants in Arizona or Oregon. At the fabricating facilities, hundreds of integrated circuits are etched and layered on each wafer, forming individual dies on the wafers. The finished wafers are then packed and flown *back* across the Pacific to Intel's Assembly and Test Operations in Malaysia, where they are treated and cut, and the dies are sealed in ceramic packages. The packages are then placed in shipping trays that are put into Intel boxes and packed again for shipment back across the Pacific to Intel's warehouses in Arizona.

Having traveled across the Pacific three times, the chips are then shipped to computer manufacturers around the globe. Dell Inc. (Round Rock, TX), for example, has factories in Texas, Tennessee, Ireland, Brazil, Malaysia, and China. HP Inc.'s (formerly Hewlett-Packard, Palo Alto, CA) factories operate in South Africa, Saudi Arabia, Vietnam, Russia, China, and Taiwan. The journey ends when the product ships from the PC manufacturer to the customer's home or office anywhere in the world.

Quality control practices ensure that Intel's chips are nearly identical and of the highest possible quality. Achieving this level of quality is difficult. No other mass-produced item in the history of humankind is as complicated or as challenging to make as a computer chip. The average size of a typical transistor that goes on the chips, for instance, is 22 nanometers, or less than one thousandth the size of the period at the end of this sentence. Moreover, each chip has more than 2 *billion* transistors connected to one another by several layers of stacked copper wiring. How difficult is it to achieve superior quality control when you are making intricate products that are microscopic in size? Very.

How does Intel manage the task? It does so by isolating and controlling the phenomenal number of tiny inputs required to produce the ever-shrinking chip. Everything from dust to water purity is carefully controlled. In developing this process, Intel created one perfect plant and one ideal chip-making process, and then it copied everything. Whether its chips are made in Arizona, New Mexico, Ireland, or any of its 10 other factories, they are made the same way, with the same equipment, with workers performing the same tasks in the same order.

What sets Intel apart from other manufacturers is its devotion to this process, even copying what may seem to be random elements in its manufacturing centers. For example, if a pipe that delivers chemicals to one of the chip-making machines is 20 feet longer in one factory than in another, Intel will make it match (and it will even match the number of bends in the pipe). If the water quality is different among the factories, then a purification system is used to eliminate the differences. Intel spent two years developing one of its newest chips in a plant in Oregon. Before transferring the chip-making process to its New Mexico plant, the company noticed that the barometric pressure differed between the sites, so it adjusted the New Mexico plant's internal heating, ventilation, and air conditioning (HVAC) system to replicate the pressure of the Oregon facility.



Note the sterile suits worn by all employees at this Intel chip manufacturing center as a further guard against any contamination of the manufacturing process. Intel doesn't apologize about its near-obsessive quality control efforts; it believes they have helped make it the most advanced manufacturer in its business.

Gilles Mingasson/Hulton Archive/Getty Images

1.1 Explain how globalization has influenced the management of supply chains and their operations.

# 1.1 Supply Chains and Operations Management in the Global Economy

We live in an interconnected world. To a greater degree than ever before, companies can sell their products and services internationally. Likewise, customers are better able to purchase products or services from firms, regardless of where they are located. Today, consumers living in the far corners of the world can watch MTV (Viacom Media Networks, New York, NY); wear Levi's (Levi Strauss & Co., San Francisco, CA); or eat at McDonald's (Oak Brook, IL) or Pizza Hut (Dallas, TX). The rapid advancements in information technology (IT) and the elimination of trade barriers between countries are the primary reasons for this accelerated pace of global interaction. These changes have helped customers and companies transcend cultural and language boundaries and interact in real time.

Currently, more than two thirds of businesses operate in global markets. Even small businesses that typically lack resources can now cater to the needs of consumers in other countries. This all happened as a result of the globalization of markets. Globalization means that a business can sell in a foreign country, manufacture products in a foreign land, buy materials from an overseas supplier, operate as franchises, or partner with a foreign company.

**! Why *Managing Global Operations and Supply Chains* Matters**

Conducting business internationally presents many unique challenges; companies that perform in the competitive global marketplace must understand how to manage their internal operations to anticipate and navigate these challenges. Viewing operations decisions in the context of a global supply chain allows companies to see how one affects the other.

## Offshoring and Outsourcing

Two prominent phenomena have accompanied the globalization of business—offshoring and outsourcing. **Offshoring** refers to sourcing from overseas or getting work done in a foreign country. For example, China has now become the preeminent source of low-cost offshore manufacturing. Chinese exports had been low and stable until 1990 and then rose dramatically from 1991 to 2005, particularly after China joined the World Trade Organization. The benefits of offshoring include being able to tap a larger pool of skilled people, get work done faster, and lower a company's labor costs. Risks of offshoring include transfer of jobs to other countries, geopolitical risk, language differences, and poor communication.

Figure 1.1 compares the average hourly compensation costs in U.S. dollars for manufacturing employees in 25 countries. The hourly amount includes the payments made directly to workers as well as employers' expenditures on benefits and social insurance.[1]

Figure 1.1 shows why many of the manufacturing jobs are outsourced to countries such as China, India, and Sri Lanka. The hourly employee compensation is less than US$2 in these countries. By contrast, a U.S. manufacturing worker's average hourly compensation is about the weekly average compensation for a Sri Lankan manufacturing worker.

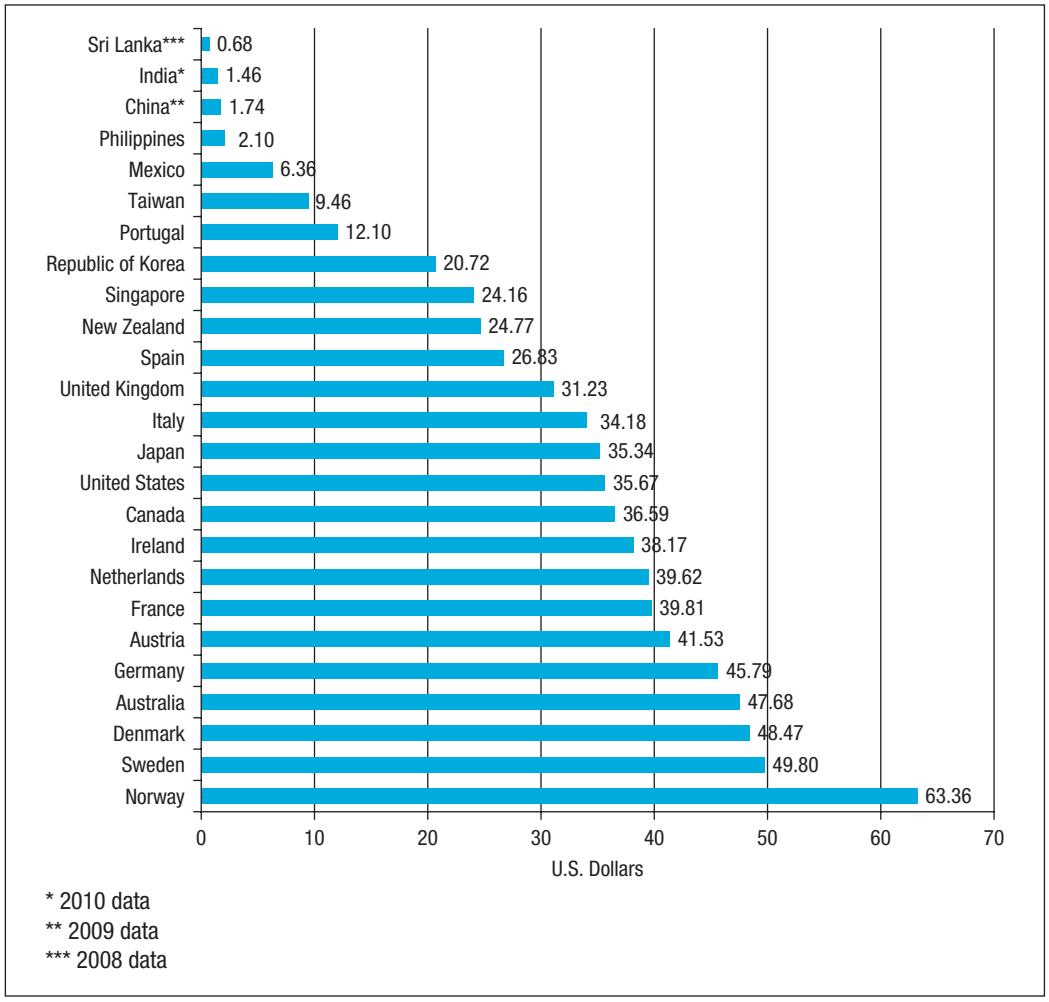
**Offshoring**: sourcing from overseas or getting work done in a foreign country

**Outsourcing**: contracting with a third party or an external company to manufacture a good or deliver a service

**Outsourcing** refers to contracting with a third party or an external company to manufacture a good or deliver a service. The external company may or may not be a foreign company. India has now become the hotspot for outsourcing many business processes, such as accounting, data entry, customer service, and research and development. GE Transportation (Chicago, IL) is one of the many U.S. companies that have outsourced some of their business processes to India. This company has outsourced all of its design work on locomotives to Bangalore, India. A company usually outsources work to take advantage of specialized skills, cost efficiencies, or operational flexibility that they may lack. Risks of outsourcing include conflicting interests of the company and the third-party provider, excessive reliance on third parties, and lack of in-house knowledge of critical business operations.

Because of the continuing offshoring and outsourcing, manufacturing in the United States has declined from nearly 30% of the gross domestic product (GDP) after World War II to just under 12% by 2017. Despite this decline, Western manufacturers remain competitive because of their higher productivity. Globally, productivity rates continue to remain the highest in North America.

**FIGURE 1.1:** Average Hourly Compensation Costs for Manufacturing Employees in 25 Countries, 2012 (in U.S. dollars)




**SOURCE:** Adapted from the U.S. Bureau of Labor Statistics, International Comparisons of Hourly Compensation in Manufacturing, August 9, 2013.

**Supply chain:** a sequence of interconnected organizations that help develop, produce, distribute, and sell a product to the final consumer

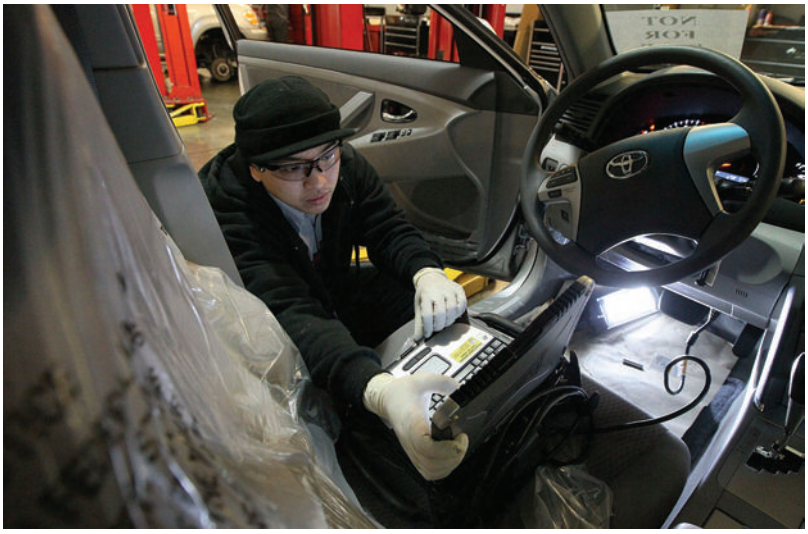
Global Supply Chains

Charges of defective electrical systems and sticking accelerators were thought to be the result of Toyota's decision to outsource the production of some of the critical components of its cars. As a result, the Japanese automaker was forced to recall and repair millions of vehicles beginning in 2009.

Justin Sullivan/Getty Images News/Getty Images

## Globalization, Supply Chains, and Operations Management

Offshoring and outsourcing have had a huge impact not only on trade but also on supply chains and operations management—which is, of course, the subject of this book. A **supply chain** is a sequence of interconnected organizations that help develop, produce, distribute, and sell a product to the final consumer. The supply chain also includes organizations that help consumers return products as well as dispose of them. Each organization adds value in some way to the product as it moves along the supply chain toward its destination to the final consumer and beyond. For this reason, a supply chain is often called a



## CONSIDER THIS 1.1:
### *Is American Manufacturing Dead?*

Can American manufacturers survive the onslaught of offshoring and outsourcing? A study conducted by the Boston Logistics Group (Wellesley, MA), a global supply chain research and consulting company, found that American manufacturers have a better chance of success if they adhere to the following principles:[2]

1. Build technologies that cannot be duplicated. Developing cutting-edge technologies that cannot be readily copied and reproduced by firms in other regions can help a company maintain a manufacturing advantage.
2. Bundle value-added services along with manufactured products. Including add-on services such as technical support and special design engineering can increase the appeal of manufactured goods.
3. Manufacture high-quality, high-priced goods in-house, and outsource low-profit and labor-intensive work. That is, do not attempt to compete on the basis of the volume of output, but instead focus on producing those goods that require special skills and can be priced at a premium.

Value chain: *See* **supply chain**

Operations management (OM): the process of managing the system of designing, producing, and delivering goods or services that add value throughout the supply chain and benefit the final consumer

value chain. Global supply chains are a global network of organizations involved in these activities. Operations management (OM) is the process of managing the system of designing, producing, and delivering goods or services that add value throughout the supply chain and benefit the final consumer.

The good news is that, because managing global supply chains and operations is challenging, people and companies that do it well can gain a significant competitive advantage over their rivals. This advantage is particularly true for supply chain management. Supply chain management is the next great competitive frontier. For decades, firms have sought to fine-tune their operations and have done so. Supply chains are next. Nevertheless, supply chains are more difficult to manage because they involve not just your firm, but all of the firms you do business with. Consider This 1.2 describes the exciting kinds of supply chain and operations management careers you might pursue.

1.2 Describe the role of operations management within a company and in society

## 1.2 What Does Operations Management Entail?

Each organization in a supply chain has internal operations that it has to manage effectively. When run well, these internal operations create and enhance the value of products and services by lowering costs to the consumer (adding economic value), improving the quality of goods and services produced (adding functional value), and improving products' appearance and desirability (adding aesthetic value). Managing operations within each company in a supply chain requires planning, organizing, and executing both long-term and short-term tasks. Effectively managing operations requires cross-functional cooperation not only within your own company but also with other businesses, or partners, in the supply chain.

Operations management plays a pivotal role in our lives. The food that we eat in restaurants, the movies that we watch at home or in theaters, the modes of travel that we use, and our shopping needs in retail and grocery stores are all made possible by people working in the operations functions of these businesses and their managers. There are operations functions in the traditional manufacturing or goods-producing industry and in service industries such as banks, hospitals, food service, communications, and government. Let's now look at how the two types of outputs—goods and services—and the operations related to them differ.

# CONSIDER THIS 1.2:

## *Why You Should Consider a Career in Operations and Supply Chain Management*

Managing operations and supply chains has become the focus of every senior executive and is at the top of the corporate agenda. In 2016, American firms spent $1.39 trillion (7.5% of the nation's GDP) on just the logistical activities of wrapping, bundling, loading, unloading, sorting, reloading, and transporting goods. In the face of increasing global competition, streamlining operations and supply chain activities have become incredibly important for improving bottom-line profitability as well as for enhancing a firm's reputation for reliability. Therefore, operations and supply chain management professionals are in high demand.[3]

Career opportunities in operations and supply chain management (SCM) exist in every sector, whether they are manufacturing and service industries, governmental organizations, educational institutions, or retail industries. In particular, the phenomenal rate of growth in the service sector has expanded the opportunities for operations and supply chain professionals. According to the U.S. Bureau of Labor Statistics, a significant percentage of jobs in the operations area in the foreseeable future will be in the service industry. Graduates with specialization in service operations will be hired to work in areas such as data services, IT, telecommunications, freight and courier services, transport, aviation, consulting, entertainment, hospitality, environmental services, design of service facilities, management of service quality, and management of day-to-day operations.[4]

People who work in operations or supply chain management typically start out as college graduates and then become line associates reporting to a supply chain or plant manager. Their specific job responsibilities may vary from being a purchasing or quality control associate to monitoring warehouse inventory levels to managing vendors and supervising shifts. For those with quantitative skills, it is possible to work on more rigorous, mathematical applications, such as scheduling in the airline industry. All operations and supply chain jobs require people management skills, quantitative skills, problem-solving skills, and familiarity with IT.[5]

An undergraduate degree in operations or supply chain management is good preparation for entry-level positions. There are many career opportunities in a variety of organizations for people with these credentials. Those who have proven themselves in the field become senior operations managers and product managers, and some cross over into more general corporate positions, such as vice president of procurement, operations, or logistics; chief financial officer (CFO); industrial relations manager; or even chief executive officer (CEO). According to PayScale.com, as of January 2016, a U.S. operations manager earns an average salary of US$60,572. Note, however, that salary ranges vary from one geographic region to another. In addition to securing a degree in operations or supply chain management, you can enhance your education and career opportunities by joining professional organizations that offer certifications. Some of these professional organizations are:

- APICS, Association for Operations Management (www.apics.org)
- ISM, Institute for Supply Management (www.instituteforsupplymanagement.org)
- ASQ, American Society for Quality (www.asq.org)
- Council of Supply Chain Management Professionals (www.cscmp.org)
- PMI, Project Management Institute (www.pmi.org)

You may be hired by traditional manufacturers, retailers, supply chain specialists such as consulting firms, or transportation services providers. Table 1.1 shows some common career positions available to those with operations and supply chain management credentials.

**TABLE 1.1:** Careers in Operations and Supply Chain Management[6]

| Job Title | Responsibilities |
|---|---|
| Chief Operating Officer (COO) | A top-level executive of a company. Responsible for the entire company's operations and ensuring that the company is profitable. |
| Operations or Supply Chain Manager | Supervises and manages the work environment, vendor selection process, supply chains, real estate, and budgets. |
| Materials Manager | Supervises and manages product storage through all phases from production to finished goods; shipping between departments; and transportation to distribution centers, warehouses, and customers. Ensures that the company has the right goods and services at the right time, at the right place, and for the right price. Responsibilities for service firms include ordering, receiving, storing, and distributing any resources required to perform the service. Other titles for this job are traffic manager, warehouse manager, and logistics manager. |
| Purchasing Manager | Supervises and manages the purchase of goods and services, including raw materials and supplies required by the firm for its operation. Responsibilities include coordinating the quantity, quality, price, and timing of the delivery of appropriate materials for the firm's needs. Other related jobs in this area are expediter, buyer, and purchasing agent. |
| Industrial Production Manager | Supervises and manages the activities of production of goods. Responsibilities include production scheduling, staffing, quality control, equipment operation and maintenance, inventory control, and interfacing and coordinating the production activities with those of other departments. Other related jobs in this area are line supervisor, manufacturing manager, and production planner. |
| Operations Research Analyst | Ensures that resources of the firm such as time, money, people, space, and raw materials are allocated most efficiently. Analysts also select from competing research projects and choose those that perform best in terms of time, results, and cost, given the constraints of resource availability. |
| Quality Assurance Manager | Responsible for the elimination of product defects through prevention, detection, and correction to ensure preestablished quality standards are met. The quality assurance manager is an integral part of a firm's total quality management strategic initiatives. |
| Facilities Coordinator | Responsible for designing the physical environment of a company, such as building design, furniture, and related equipment. |
| Logistics Manager | Responsible for the accurate and efficient transportation and storage of goods and materials for both the outbound and inbound areas of the supply chain. |
| Warehouse Operations Manager | Responsible for the efficient and cost-effective operation of commercial or industrial distribution centers or warehousing facilities. Manages inbound activities related to the receipt and storage of goods, inventory management, and claims. Oversees the outbound activities related to filling orders, replenishing stock, and shipping. Responsible for budgeting, customer service, and facility and equipment operations. Administers overall inventory management, productivity, accuracy, and loss prevention programs to ensure that customer requirements are met. Related positions are director of logistics, distribution supervisor, distribution center manager, warehouse manager, warehouse and delivery manager, and director of warehouse operations. |

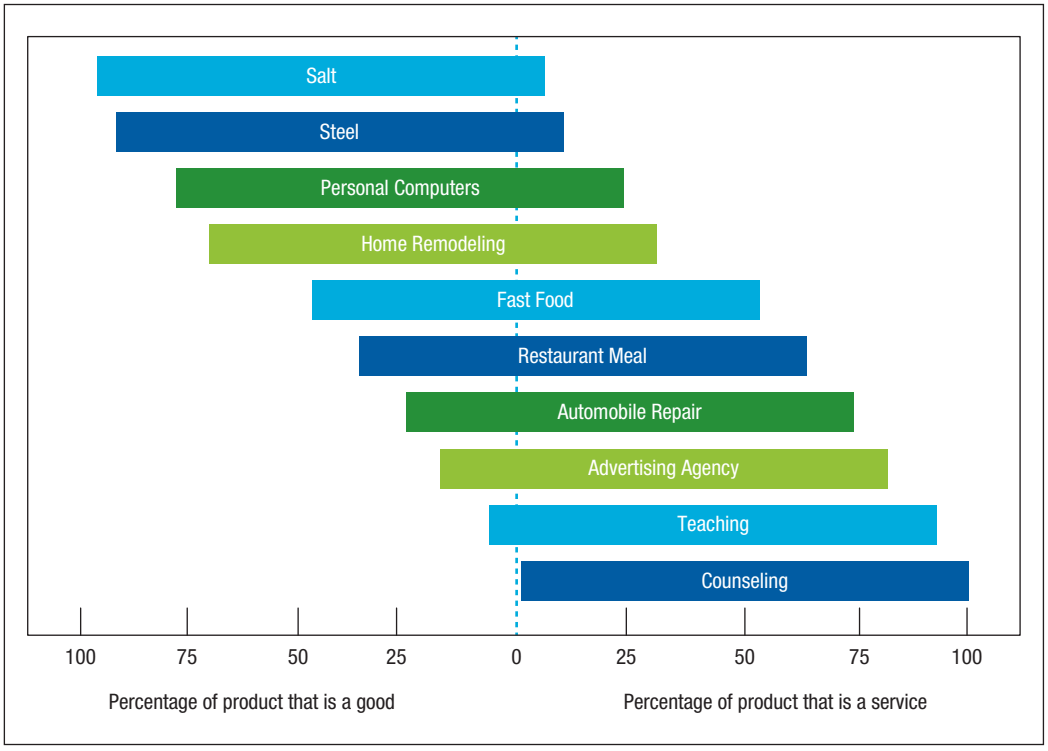
A good is a tangible physical entity such as a car, camera, or television set. Services are intangible in the sense that they are a set of benefits that may or may not be accompanied by a tangible good. A pure service is a set of benefits with no accompanying physical good. For example, when you visit a hair stylist, you receive a service—ideally, an enhancement in your looks. Table 1.2 compares goods and services.

The operations functions of most businesses provide a mixture of both goods and services. Figure 1.2 illustrates the degree to which different products are considered to be either a good or a service. Some organizations, however, such as sugar and oil refineries, predominantly produce goods. Other entities, such as hospitals, law offices, and educational institutions, predominantly focus on the delivery of services. There are also key structural differences in the operational

**TABLE 1.2:** Differences Between Goods and Services

| Goods | Services |
|---|---|
| Tangible physical entity | Intangible bundle of benefits |
| Can be stored for future use | Cannot be stored—the service is produced and consumed simultaneously |
| Often capital intensive | Often labor intensive |
| Low level of customer contact | High level of customer contact |
| Quality assurance and control are relatively easy | Quality assurance and control relatively more difficult |
| Physical transformation of materials | Physical or psychological transformation of customer |

**FIGURE 1.2:** Goods-Services Continuum




processes required to design a service system as opposed to a process required to design a tangible product. We will discuss these differences in Chapter 4 on product and service design.

The second major difference between goods and services is that goods can be produced and stored in inventory until they are sold to end customers. The inventory serves as a buffer to bridge the gap between the demand for the product by customers and a firm's operational, or production, capacity. For example, manufacturers produce toys throughout the year and store them so that they don't run out of stock during the holiday shopping season.

Unlike goods, services can't be stored. Instead, their production and consumption occurs concurrently. Firms that provide services must maintain enough capacity to meet peak-demand periods or they will face a physical backlog of customers. In the case of air travel, if you fly during peak periods, you will join a queue of fellow passengers waiting in line to check their luggage.

Hatchimals were the runaway hit of the 2016 Christmas holiday season—and also in short supply. The shortage occurred even though Toronto-based Spin Master, the maker of the toys, increased factory output in China and tried to keep up with demand by abandoning normal shipping methods and flying planeloads of Hatchimals from their Chinese factories to North American and European markets, rather than wait for slower boat delivery.[8]

Jean-Pierre Muller/AFP/Getty Images

What Is Operations Management?

To reduce the backlog, most service delivery systems use reservations and appointments. Services are *time perishable*. An empty seat at a theater or an empty hotel room will never be available again for that particular play or for that specific night, which demonstrates why services cannot be inventoried and stored for later use. Services cannot be transferred or reused but must be sold directly to a customer.

Third, in the case of services, customers are directly involved and interact in the production and consumption of those services. In a classroom, both the teacher and the student are directly involved in the transfer of knowledge of specific subject matter. Likewise, if you were to consult with an attorney, the attorney produces a service (legal advice) that you consume immediately. By contrast, goods-producing firms such as a petrochemical company have very little interaction or contact with the final users of their products.

Fourth, most goods-producing businesses have capital-intensive equipment. Equipment of this type is expensive and requires a major investment. By contrast, services are often labor intensive. Many goods-producing organizations have computer systems and machinery that reduce their labor costs. For example, Anheuser Busch InBev's (Leuven, Belgium) automated production lines control the entire sterilization, filling, and storage process for beer kegs with minimal need for workers. This type of automation is not possible in service organizations, such as restaurants. If you want a beverage at a restaurant, you depend on your server to get it for you quickly.

Some industries, such as the airline industry, are both capital and labor intensive. Airline companies invest heavily in planes and other flight equipment, but they also invest in labor. Airlines require pilots, flight attendants, mechanics, and support staff to keep their businesses running.[7]

Finally, it is easy to measure and control the quality of a good because standards can be set before manufacturing to ensure the good performs its function. During production, these quality levels can be monitored using quality control tools. Potato chip consumers are aware that the quality of a potato chip depends on its crunchiness and salt content. A company such as Frito-Lay, Inc. (Plano, TX) has preestablished standards to measure the crunchiness of its chips and monitor their salt content during the production process.

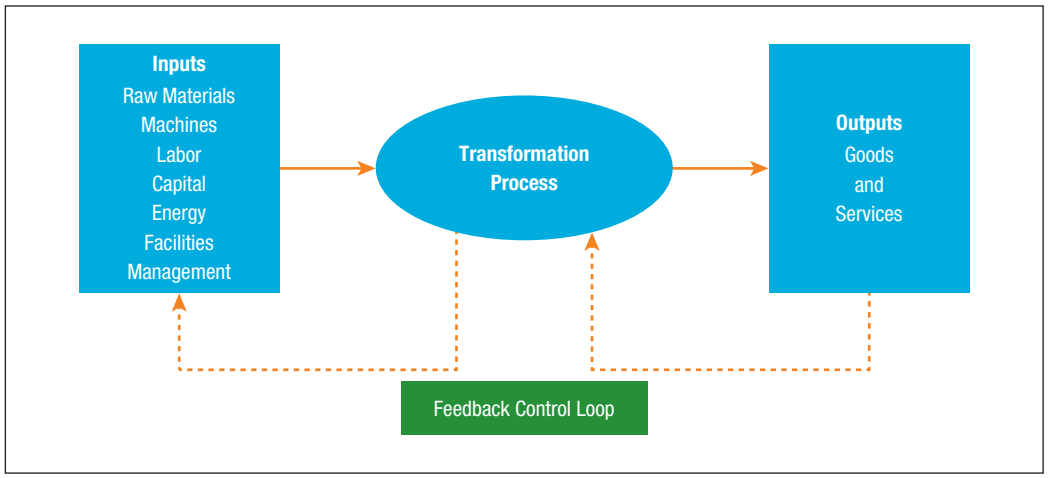
Measuring and monitoring the quality of a service is much more difficult because the view of what constitutes good quality in a service is much more subjective. Consider times when you shopped at a high-end department store. At some stores, a salesperson will greet you immediately, whereas in other stores, employees are advised not to intrude on you too quickly as it might seem invasive and pushy. Clearly, in the case of services, no uniform standard of quality can be applied to all individuals.

Operations management is a system that transforms inputs into outputs. As Figure 1.3 shows, the inputs may be raw materials, machines, labor, management, capital, or energy. Such inputs are transformed into outputs to produce the desired products and services. Value is created in the transformation process. In an automobile factory, sheets of steel transformed into different shapes and sizes are assembled together with thousands of component parts and are then painted and finished to create a brand-new automobile. In a bakery, flour, yeast, and other ingredients are converted into dough and baked to produce a loaf of bread. In service operations, such as hospitals, doctors help restore sick patients to health through diagnosis, medication, and surgical procedures. In each situation, the transformation process of the operations system creates value—a new automobile, a loaf of bread, or a healthy person.

The transformation and value creation of operations systems can take many different forms. The transformation process can be[9]

- *physical*, as in manufacturing operations
- *locational*, as in transportation and warehouse operations
- *transactional*, as in banking and retail operations
- *physiological*, as in health care
- *psychological*, as in entertainment
- *informational*, as in teaching and communication

**FIGURE 1.3:** Operations as a Transformation System




Operations Management and Value Creation

In any operations management system, certain inputs are expected to produce certain outputs, and the outputs produced should meet preestablished standards (such as high quality or low cost) for that system. If the output does not meet the standards, then changes need to be made to the transformation process, the inputs, or both. In an educational system, such as a college or university, the students and faculty, among others, would be inputs. The output of this system would be high-quality graduating students who have acquired the necessary knowledge in their major fields. If the output does not measure up to this preestablished standard of quality, then changes need to be made to the inputs (recruit better students or faculty) or to the transformation process (make changes in the teaching approaches). The feedback control loop in Figure 1.3 represents changes to the operations management system.

From the perspective of both an individual firm and its supply chain, several key points describe the operations management function. The operations management function has some key characteristics:

- The operations management function transforms inputs such as materials, energy, information, and capital and labor to produce goods and services, thereby creating value.
- The operations management function is responsible for designing, operating, and improving the processes used to produce goods and services that the final consumer values.
- The operations management function is concerned with the acquisition, efficient use, and disposal of resources in an environmentally and socially responsible manner.
- In the context of a global supply chain, the operations management function brings together five sets of players: the individual firm; global suppliers; logistics providers (companies that provide services such as transportation, warehousing, and distribution); global customers; and stakeholders (persons, groups, or companies that have an impact on an organization or are affected by the organization's actions).
- To be effective, the goals and objectives of the operations function of each business in the supply chain should align, not only with the strategic goals of the individual firm, but also with the overall goals of the firm's supply chain strategy.
- The operations management function must be dynamic to respond to continual changes in customers' demands, technology, competition, and resources.

Operations management is a multifaceted and complex field of study. Anyone pursuing a career in business, whether interested in marketing, finance, accounting, IT, or human resources, should

have a thorough grounding in the fundamental concepts and challenges of managing operations. Decisions made in any functional areas have an impact on operations, and vice versa. This is how typical functions, or departments, interface with operations:[10]

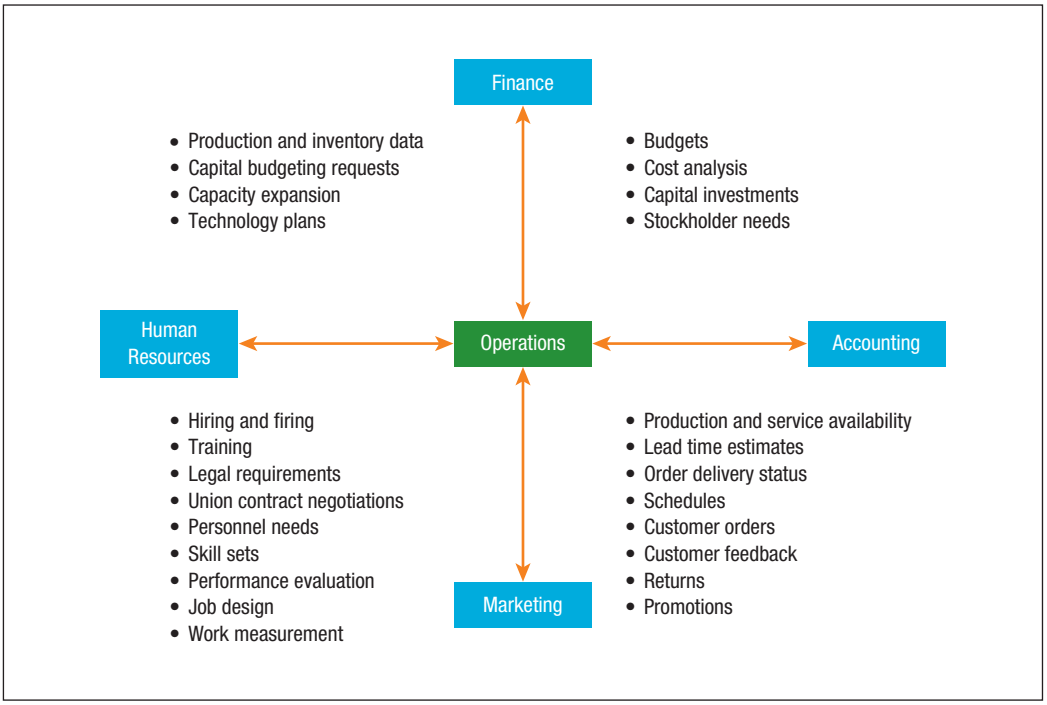
- *Finance* provides funding that allows a firm's operations group to produce products and invest in new production equipment.
- *Marketing* gathers market intelligence and can provide the operations group with meaningful ideas for product improvement programs.
- *IT* provides the operations group with technical information support.
- *Human resources* (HR) provides the recruitment, hiring, and training of operations personnel as well as health-and-safety compliance training and advice related to current environmental and regulatory issues.
- *Research and development* develops product and service ideas for the operations group to pursue.

Figure 1.4 shows the internal interfaces between operations and the four primary functional areas of finance, accounting, marketing, and human resources.[11]

The operations function also interfaces with groups and organizations outside of the firm:[12]

- External suppliers who provide the components and materials used by the operations group
- In the case of services, the customer during the delivery of the service
- Competitors so as to monitor their activities and improve the development of new products and processes that lower the firm's costs
- External agencies such as regulators and trade associations to ensure the firm complies with current laws and codes of practice

**FIGURE 1.4:** Operations Management Internal Interfaces



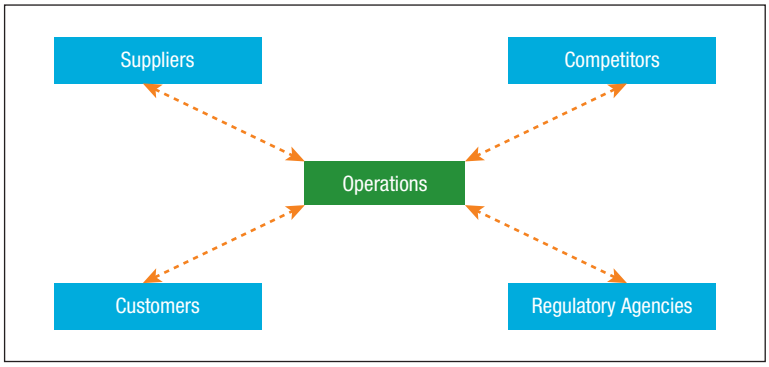

**SOURCE:** Adapted from Russell, R. S., & Taylor III, B. W. (2011) *Operations management: Creating value along the supply chain* (7th ed., p. 4). Hoboken, NJ: John Wiley and Sons.

## CONSIDER THIS 1.3:
### *Service Operations in India*

China is a giant in international trade and global supply chain management (see Case Study 1.1). But it's not the only developing country that is making great economic strides. Although India is not a major manufacturer, it is the world's leading service provider. In the past 20 years, there has been a dramatic increase in the global sourcing of services. The global sourcing of services that initially began with routine office work such as accounting, claims processing, and computer programming has expanded to include more advanced work in IT, call centers, financial analysis, brokerage firms, research and development, medical diagnosis, engineering, and architectural design. India has a large pool of highly skilled and technically trained workers, talented engineers, and scientists whose services are available at less than half the cost of similar workers in more developed countries. Many Indian companies such as Tata Consultancy Services (TCS, Mumbai, India); WIPRO Limited (Bangalore, India); Infosys Limited (Bengaluru, India); and Tech Mahindra Limited (Mumbai, India) are global leaders in software development and business processes. These companies are continuing to expand not only in India but also in many of their client countries, including the United States and United Kingdom. In IT services alone, India exported US$111 billion in 2017, and by 2020, this figure is expected to be around US$200 billion. Many multinational companies such as Microsoft Corporation (Redmond, WA); IBM (International Business Machines Corporation, Armonk, NY); PepsiCo Inc. (Purchase, NY); The Coca-Cola Company (Atlanta, GA); Siemens AG (Munich, Germany); BP plc (aka British Petroleum, London, U.K.); Nike, Inc. (Beaverton, OR); and Nestlé S.A. (Vevey, Switzerland) have established operations in India to take advantage of India's low-cost services. For example, PepsiCo established its business operations in India in 1989 and is now the fourth largest consumer products company in India, having invested more than US$1 billion in its operations. PepsiCo provides direct and indirect employment to 150,000 people in India and has 38 bottling plants. In addition, it has three state-of-the-art food plants in the Indian states of Punjab, Maharashtra, and West Bengal.[13]

Figure 1.5 shows some external interfaces with the operations function.

**FIGURE 1.5:** Operations Management External Interfaces




## 1.3 What Does Supply Chain Management Entail?

1.3 Trace the path of a raw material from the start of the supply chain to the final consumer.

Firms have many challenges when managing their supply chains globally. A company has to decide which functions it should outsource and which functions it should perform in-house. Companies that choose to locate their manufacturing facilities overseas face such logistical problems as deciding

on the number of plants that will be needed and where they should be located. These companies must also examine these issues from the perspective of the global supply chain. For example, if a company uses several raw material suppliers around Dacca, Bangladesh, then it also might want to locate its manufacturing facilities in or around Dacca to avoid shipping the materials to other production facilities.

The recent financial turmoil and economic turbulence have made the job of managing supply chains even more complex. One vice president of supply chain management summed up today's issues this way: "We seem to have every issue coming at us at once. We have supplier insolvency, supply disruptions, port closings, volatile commodity prices, quality issues. My second e-mail this morning was about a supplier that literally caught on fire. They'll be out of business for a year. How many different risks can you handle at once?"[14] The following Operations Profile shows how the clothing company Zara (Coruña, Spain) has not only managed its supply chain risks but also used its supply chain to gain a competitive advantage.

## Supply Chain Structures and Partners

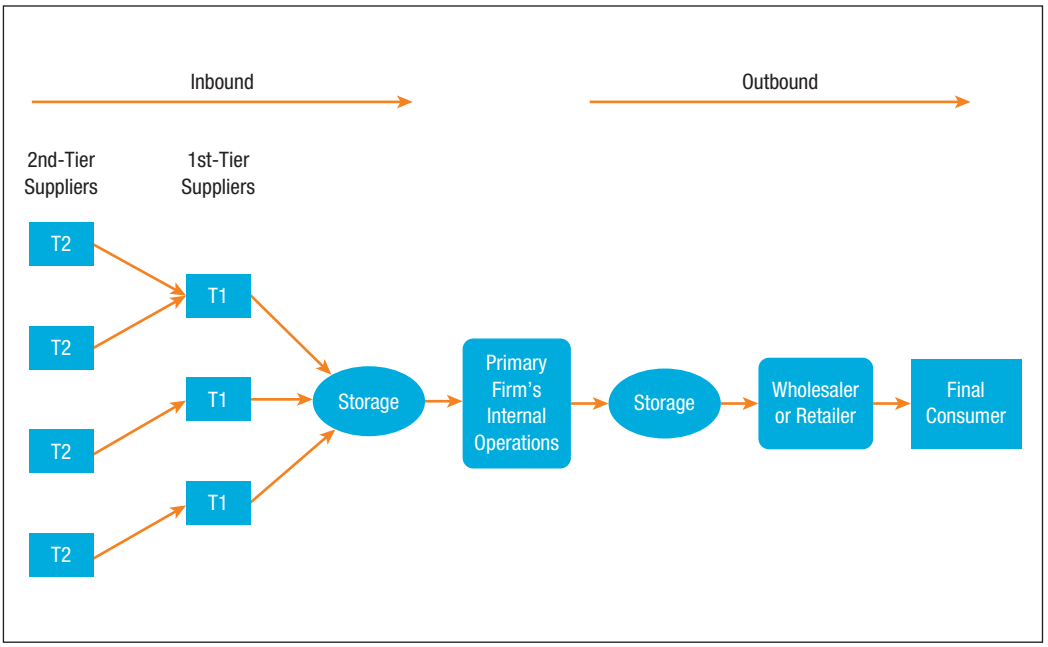
Figure 1.6 illustrates a typical global supply chain for a manufacturing company. Each organization's supply chain has inbound and outbound elements. The **inbound portion** can consist of local or foreign suppliers of product ideas, designs, basic raw materials and components, transportation links, and warehouses. It ends with the internal operations of the company.

The **outbound portion** begins when the organization delivers its output to its immediate customers in the supply chain. This portion of the supply chain might include globally dispersed wholesalers, retailers, distribution centers, and transportation companies; the consumer; and companies that facilitate the return of products or their disposal. Many online businesses often contract with other companies to handle the return of products purchased online by their customers.

**Inbound portion:** elements of a supply chain that consist of local or foreign suppliers of product ideas, designs, basic raw materials and components, transportation links, and warehouses, and end with the internal operations of the company

**Outbound portion:** elements of a supply chain that begin when the organization delivers its output to its immediate customers in the supply chain and may consist of globally dispersed wholesalers, retailers, distribution centers, and transportation companies; the consumer; and companies that facilitate the return of products or their disposal

**FIGURE 1.6:** Standard Global Supply Chain Model



## OPERATIONS PROFILE:
### *Zara: Bringing Speed to Fashion Through Supply Chain Management*

"Fashion doesn't sleep." Miss a new trend or fail to capitalize on an emerging opportunity in the fast-paced, frenetic fashion industry, and it is usually gone for good. As a result, the fashion industry and its retailers spend thousands of hours studying the latest styles and trying to anticipate hot new trends. The Spanish firm Zara has taken a bold new approach to fashion by pioneering an innovative technique for fashion retailing through the clever design of its supply chain. On average, it takes Zara 3 weeks to spot, design, manufacture, and ship one of the 300,000 different pieces of clothing it sells to stores each year. In doing so, Zara can beat the high-end fashion houses to the market with similar designs, made from cheaper materials, and costing much less than haute couture. A new PRADA (PRADA Group, Milan, Italy) handbag costs US$500, but Zara sells the same design for US$109.

Zara has initiated Z-days at its stores, which take place twice a month, when new shipments of styles are delivered to the shops. The promotion attracts shoppers who know that if they hesitate, the style will be gone. Zara thrives on creating immediate but only temporary buzz for any of its fashions. Unlike other retailers, Zara is not concerned about products being out of stock. Instead, they count on shoppers being attracted by styles in limited supply. Speed to market, rapid turnaround, and the equally rapid introduction of new styles keep Zara store shoppers motivated to return constantly just to find out what's new.

The secret to Zara's success is a well-developed supply chain that includes the firm's own retail stores, distribution centers, a design and manufacturing center, and textile-milling factories. Thus, the retailer does not have to depend on any other firm in the chain, allowing the company to move quickly. A second advantage Zara has is that, because it controls the entire supply chain, it can make limited runs of clothing and accessories. That is, the company does not depend on another manufacturer that will insist on producing large, lengthy runs to maximize efficiency. Zara can spot a fashion trend in one region or country and create items for just that opportunity without having to inundate all its regions with similar designs.

Zara is able to develop, change, or drop clothing styles in a matter of days; in fact, in time for the next Z-day at its stores. The firm also makes it easy on its retailers near the end of the chain because Zara presses, wraps, and tags all clothing, even hanging it on hangers, at their distribution centers. Retail shops only have to open the boxes and transfer the goods directly to their shelves and displays, with no delays in getting the goods in front of customers. By paying careful attention to supply chain management, Zara has managed to stay ahead in the fashion industry and create a unique niche for itself.[15]

Let us consider each element in the supply chain to understand better its characteristics and how the elements relate to each other.

## First-Tier Suppliers

*First-tier suppliers* provide components, systems, or finished goods and services to the primary firm, which can be a manufacturing, retail, or service organization. For example, L. L. Bean, Inc. (Freeport, ME) contracts with shirt makers worldwide to produce the company's wide assortment of shirts for men and women. These shirt manufacturers represent first-tier suppliers for L. L. Bean, while they themselves depend on a wide assortment of second-tier suppliers at textile mills, cotton plantations, and so on. In short, although the first-tier suppliers are directly connected to the production or service organization, they, too, represent just another link in the delivery chain by playing an important role in moving the products forward that can be sold as goods or services.

The Crest SpinBrush quickly became the best-selling electric toothbrush in the world after it hit the marketplace. But Procter & Gamble (P&G), the maker of Crest, didn't actually invent the device. Instead, the company purchased the design from Nottingham Spirk, an external product development company. It is a supply chain practice that P&G has begun to use more frequently to remain competitive.



Managing a Supply Chain

1.4 Explain why it is important to have an integrated view of operations from a larger supply chain framework.

### Second-Tier Suppliers

*Second-tier suppliers* are firms that provide raw materials, basic services, or manufacturing components for the primary firm's manufacturing or service production processes. Because these items can often be unfinished or raw goods, they are acquired at the source. For example, raw palladium, which is used in automobile catalytic converters, is mined in South Africa and Russia. It is shipped as a raw material to the first-tier supplier's processing centers to be converted into a useful commodity for the automotive industry. Second-tier suppliers typically link to their own supply chains and pass their commodities, services, or components along to first-tier suppliers.

### Inbound and Outbound Storage

Storage refers to the warehousing function that organizations must use to varying degrees, depending on the products they sell. Companies often store inbound materials to prevent shortages that could curtail their manufacturing activities. Outbound warehousing is common for storing finished goods prior to their shipment to a wholesale or retail destination. Note that within a supply chain there could be multiple storage facilities, such as warehouses and distribution centers, on both the inbound and the outbound side.

### Wholesalers and Retailers

Wholesalers receive goods directly from an organization and are responsible for providing the goods to end-point retailers, who sell directly to consumers. Note that the outbound portion of a company's supply chain could have many wholesalers and retailers. Sometimes a firm will use wholesalers, and sometimes it will sell directly to retail establishments. Some firms bypass retailers altogether and sell their products directly to customers.

### Final Consumers

The people and firms that consume the good produced by the organization are the final consumers or end users of the product. The organization is responsible for producing a product that gives customers value. A product's value is determined by the end user, not by the manufacturer. Thus, if BlackBerry Limited (formerly Research in Motion Ltd., Waterloo, Ontario, Canada) manufactures a new model BlackBerry smartphone that customers find difficult to use, although it may be high quality, its value is diminished in the eyes of customers.

## 1.4 An Integrated Perspective on Operations and Supply Chain Management

In Section 1.2, we examined operations management, and we described it as managing a set of processes required to design, produce, and deliver products or services that add value throughout the supply chain and, ultimately, to the final consumer. Then in Section 1.3, we saw that successful supply chain management requires the firm to manage its business processes; relationships; and *flows* of materials, information, money, and people, with the ultimate goal of creating value to customers and stakeholders. Both operations management and supply chain management have the same goal

of producing and delivering products or services that create value for customers. Firms integrate the two, and we describe how that is done for firms producing products and firms producing services. First, however, we start with an overview of the kinds of decisions firms must make in managing their operations and supply chains.

## Decisions in Operations and Supply Chain Management

There are three general types of decisions in operations and supply chain management: *strategic decisions*, *tactical decisions*, and *operational decisions*. These types of decisions fall into a hierarchy, as shown in Figure 1.7. The decisions at a higher level in the pyramid will set the constraints for lower level decisions. Strategic decisions have a long-term impact on the firm, whereas tactical decisions are made for the medium term and operational decisions are short-term, day-to-day decisions.

Here are some examples of tasks that fall into each decision category:

*Strategic Decisions*: Product and service design, process design, plant and warehouse location, layout planning, supplier selection, outsourcing and offshoring, choosing transportation modes, and quality management

*Tactical Decisions:* Sales and operations planning, inventory management, master production scheduling, material requirements planning, distribution, and transportation planning

*Operational Decisions*: Inventory control, quality control, production scheduling, supplier evaluation, performance measurement, and customer relations management

The tasks in this list are not all-inclusive. In addition, decisions about these tasks as indicated in Figure 1.7 are not as sharply delineated as the illustration implies. Strategic decisions may be interrelated. For example, the strategic decision of choosing a transportation mode such as rail, water, truck, or air depends on the strategic decision of choosing a location for manufacturing plants.

In addition, there is no clear separation between tactical and operational decisions. Although managing customer relations is a day-to-day, ongoing activity, customer relationship planning is often a tactical decision. Thus, decisions in the hierarchy can subsequently affect other decisions.

Operations and Decision Making

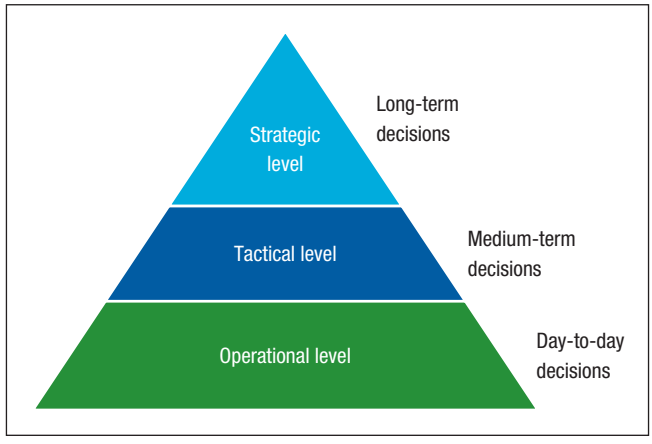
Decisions at the strategic, tactical, and operational levels need to be aligned. That is, tactical and operational decisions have to conform to their higher order, strategic choices. The decision hierarchy requires that choices be naturally linked and internally coherent.

## Operations Interfaces in a Product Supply Chain

Figure 1.8, which expands Figure 1.6, shows a detailed view of the interrelationship between operations and supply chain activities with operations at the core of a business. Three interfaces, or relationships, need to be managed effectively:

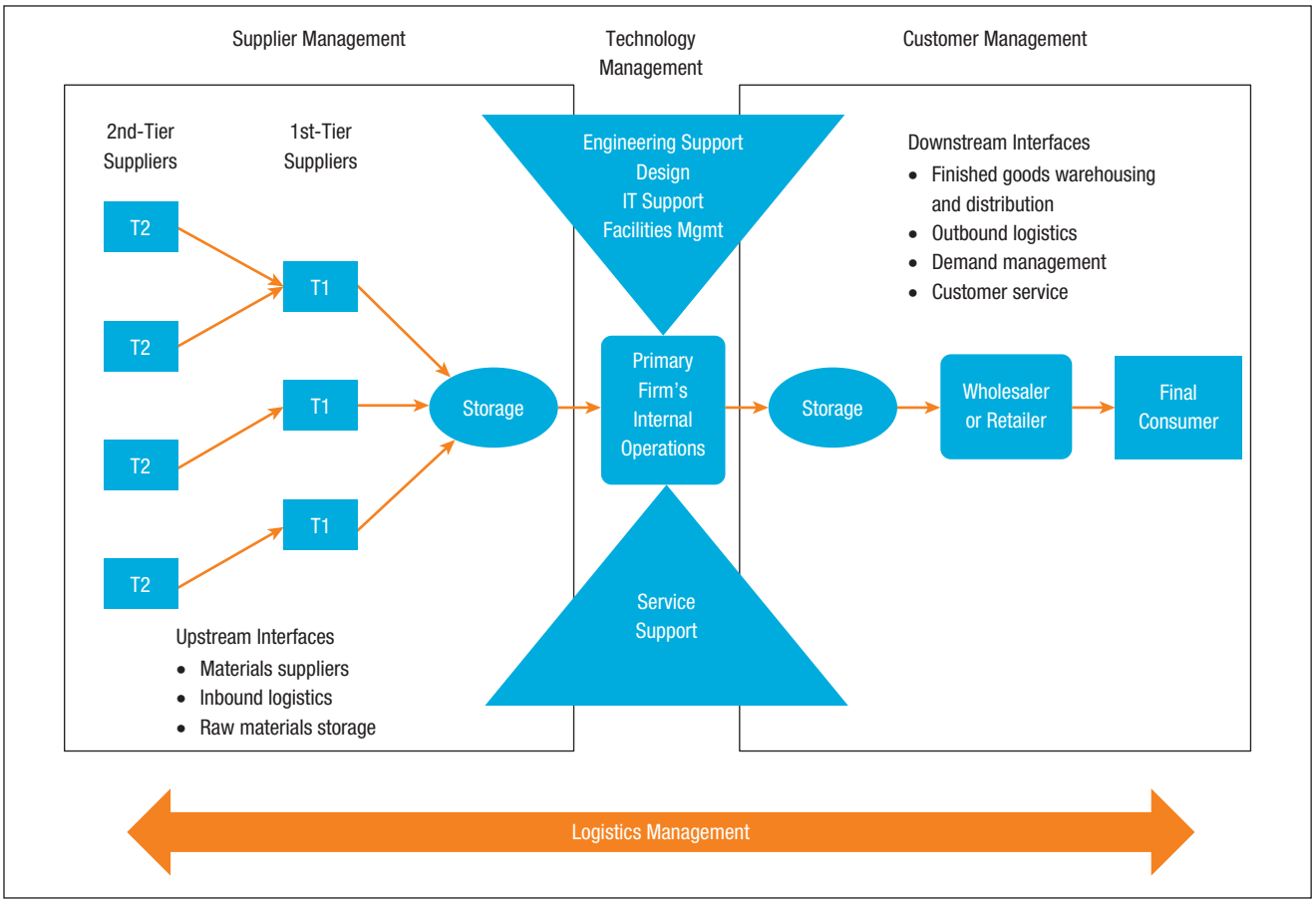
- *Upstream Interfaces: Supplier Management.* Upstream interfaces typically include suppliers that provide raw materials, components, and parts required in the downstream operations process. The management activities in this interface include prequalifying suppliers, selecting and negotiating contracts with them, and materials storage and planning—that is, purchasing the materials, managing their inbound transportation, and inspecting and warehousing them.

**FIGURE 1.7:** Hierarchy of Supply Chain and Operations Decisions




**SOURCE:** Reprinted with permission from Mark S. Fox, Department of Mechanical & Industrial Engineering, University of Toronto. Enterprise Integration Laboratory (EIL). (n.d.). *Supply chain management.* Toronto, Ontario, Canada: University of Toronto. Retrieved from http://www.eil.utoronto.ca/profiles/rune/node5.html.

**FIGURE 1.8:** Expanded Supply Chain Model With Operations Interfaces




- *Downstream Interfaces: Customer Management*. Interfaces downstream include individuals or companies that buy and use the finished products. These customers could be internal to the firm, external intermediate customers, or the final consumer of the firm's product. Consider Sony, a manufacturer of electronic products. For the television sets manufactured by Sony Corporation (Tokyo, Japan), the distribution center owned by Sony is an internal customer, whereas a retail Best Buy (Richfield, MN) store is an external intermediate customer; you, as the potential buyer of that TV set, are the final consumer. Although each of these consumer groups is important, the operations group of a firm has to identify which consumer groups are critical and pay closest attention to these groups because they have the greatest impact on the firm's sales, product designs, and future growth. This process is part of **demand management** used to anticipate and manage customer demand for a product or service. See the Lessons Learned box, which shows how Apple failed to manage the demand for its iPhone. In addition, the operations management function interacts with the firm's external partners that provide additional downstream services such as outbound transportation, packaging, warehousing, and storage of the company's products.
- *Vertical Interfaces: Technology Management and Service Support*. An operations management group interfaces vertically with suppliers that provide the technology and the skilled labor needed to design products, processes, and other services. If the firm contracts with other firms to supply it with IT services, engineering or design services, or facility management, this would be an example of vertical interfaces. Operations management's vertical interfaces also include interacting with suppliers that provide the company with support such as equipment maintenance, recycling, disposal, and repair services.

**Demand management:** the process of anticipating and managing customer demand for a product or service

## OPERATIONS PROFILE:
### *Lessons Learned: Apple Puts All Its Eggs in One (Very Expensive) Basket*

The 2014 release of the Apple iPhone 6 was, as are all of Apple Inc.'s (Cupertino, CA) product release announcements, one that was greatly anticipated. In addition to its desire to maintain a technological lead in the highly competitive smartphone industry, Apple knows that product release announcements have a direct impact on its stock price and the valuation of the corporation. As a result, nothing is left to chance. All technology is carefully verified, products must be available on the announced delivery date, and all suppliers have been certified and the quality of their materials checked and rechecked.

It came as a huge surprise to Apple's executives when GT Advanced Technologies (Merrimack, NH), the chief supplier of one of the iPhone's most technologically advanced features, called them to say that it was going out of business. GT was Apple's sole supplier of the super-hard sapphire smartphone screen that Apple was counting on to give them a notable advantage over their chief competitors, such as Samsung (Ridgefield Park, NJ). The sapphire screen, a crystalized form of aluminum oxide, was scratch resistant and could withstand shocks and accidental drops better than the standard Gorilla Glass (Corning Inc., Corning, NY) used by other phone makers. Sapphire screens are expensive—more than five times the cost of regular glass. Apple was so set on this technology that it had just entered a joint venture with GT to build a US$1 billion manufacturing plant in Arizona to provide 30 times as many sapphire screens as any other plant in the world.

Problems with quality control plagued the GT manufacturing process from the beginning. GT had never mass-produced sapphire glass, and early test batches were flawed and unusable. Meanwhile, GT had hired workers too quickly, and hundreds of them ended up cleaning floors or sitting around and waiting while the company got the manufacturing process right. The company's executives blamed Apple for their problems, arguing that Apple had turned them into a captive supplier, required to bear all risks and costs under Apple's restrictive contracts. Apple, in turn, put the blame squarely on GT's management, arguing that they overpromised on their ability to supply the new iPhone's screen when they were still working out the flaws in their production systems and were still developing the huge furnaces needed to produce sapphire glass. Meanwhile, the quality of the product failed to improve as GT got further and further behind on its commitments for quality and delivery schedules. Apple was forced to offer GT more than US$100 million in loans to keep it in business throughout these development problems. Finally, GT company officials realized they would not be able to honor their supplier commitments to Apple and, in August 2014, sought bankruptcy protection.

Cole Bennetts/Getty Images News/Getty Images

The loss of their chief supplier of sapphire simply reinforced Apple's problems with the material and its inability to find a suitable replacement source. This issue is complicated by the huge popularity of the iPhone, which posted its strongest quarter ever in early 2017, selling over 78 million units. Not only does Apple need a sapphire supplier, but it needs one that can provide the screens in huge quantities, a source the company has not yet been able to identify. These issues have continued to plague Apple's iPhone offerings, as the 2016 release of its next model, the iPhone 7, also did not come with a sapphire screen. Despite promising this hardened screen (one that is starting to be used by competitors such as HTC and Samsung), Apple continues to delay the introduction of this feature because of the higher cost and still-questionable quality and supply problems. The iPhone 8, released in late 2017, employed an updated Corning screen, which the company argues is 50% more durable than Gorilla Glass, without divulging how it was developed. However, disappointing independent tests of the glass seem to confirm Apple's continuing problems in finding a reliable and cost-effective method for getting sufficient supplies of sapphire. Apple's only logical response to the GT disaster has been to use the standard glass screen for these iPhone releases. Apple continues to investigate the possibility of sapphire glass for future model releases, but it has learned a hard lesson about using a sole-source supplier for such a critical product.[16]

**Supplier management**: a business process that enables a company to identify and select the best possible suppliers and negotiate the best possible prices for the resources it purchases from them

**Technology management**: the process of continuously looking for ways to improve the design of facilities and engineering of processes to make production more efficient

**Service support**: the process of interfacing with suppliers that provide the company with support

**Customer management**: the process of interfacing with individuals or companies that buy and use finished products

Integrating Operations and the Supply Chain

Consider a practical example of the operational interfaces in a product supply chain. Suppose a company was part of an organization that specialized in the manufacturing of marble countertops and sinks for residential bathrooms. The company requires raw materials—such as rosin; marble powder; assorted chemicals; molds; pouring equipment; and grinding, sanding, and finishing equipment—to maintain its production levels and meet the demand of building contractors. To avoid bottlenecks or delayed deliveries, it is critical that the company creates and maintains a supply chain that ensures the timely arrival of all of these materials when the company needs them. Therefore, it might contract with first-tier suppliers for the chemicals and marble powder that, in turn, would contact their suppliers to make sure that they had sufficient quantities of these materials to sell to the company when needed.

All of the critical supplies arrive at the company's warehouse for storage. They store a certain amount of them to guard against unexpected disruptions in their suppliers' deliveries. All of these activities are part of **supplier management** and are focused on upstream processes.

Inside the factory, **technology management** and **service support** functions must be managed. First, with technology management, we are continuously looking for ways to improve the design of facilities and to engineer our processes to make our production more efficient. Perhaps, for example, we determine that the current design of the factory is inefficient and leads to long delays, or bottlenecks, at the grinding station. Facilities engineering would correct these process deficiencies and redesign the production process to make it more efficient. At the same time, we use logistics and distribution strategies to improve the flow of inbound and outbound materials and finished goods. In addition, we are concerned with ensuring that no critical shortages in production materials occur during our manufacturing process, so we design a supply system that ensures on-time deliveries. Finally, we must attend to critical downstream processes as part of our **customer management**, including warehousing for the storage of finished goods until orders arrive or transportation to the construction site can be arranged. Overall, Figure 1.8 demonstrates the complexity of supply chain and operations management through identifying the variety of critical interfaces organizations must address. These challenges range from horizontal supply chain issues related to upstream and downstream activities, to the more fully integrated, vertical processes that form a critical element in operations management.

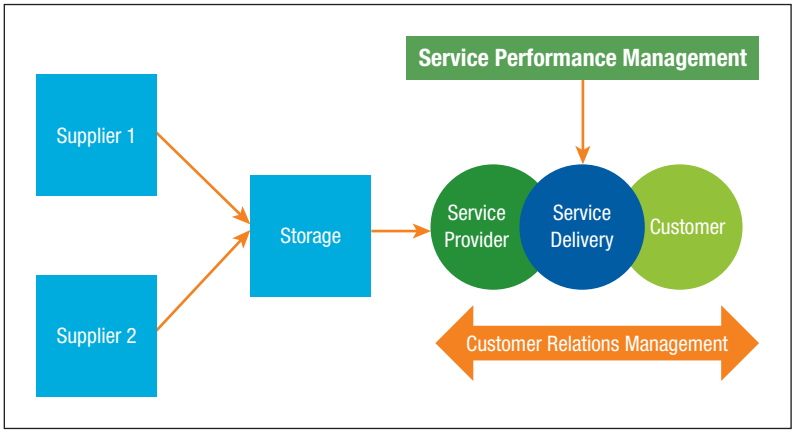
## Operations Interfaces in a Service Supply Chain

Let's now look at the relationships and interfaces in a service supply chain. A service supply chain is a network of interconnected organizations that transforms inputs (such as resources, skills, and knowledge) into services.[17]

Figure 1.9 represents a service supply chain, showing the interfaces and relationships for an operations service delivery system. The interfaces and activities such as supplier relationship management, demand management, and customer relationship management are identical to those that exist in a product supply chain. The only significant differences are the overlapping ovals that indicate direct interaction between the service provider and the customer because the service is provided and consumed simultaneously. An electrical power service provider's supply chain might look like the one shown in Figure 1.9. The electrical service provider would purchase fuel (coal, oil, or natural gas) from a supplier of fuel sources. The company would then convert the fuel energy into electric power for transmission to the consumer.

Service businesses are a rapidly growing (and, indeed, dominant) sector of many western European and North American economies. Throughout this text, we describe their operations and incorporate service firms into our discussions of operations management and supply chains.

**FIGURE 1.9:** Standard Service Supply Chain Model




**SOURCE:** Baltacioglu, T., Ada, E., Kaplan, M., Yurt, O., & Kaplan, C. (2007). A new framework for service supply chains. *Services Industry Journal, 27,* 105–124.

## 1.5 The Evolution of Operations and Supply Chain Management

1.5 Describe the evolution of operations and supply chain management from the Industrial Revolution to the present.

The concept of production is as old as humanity itself. If we look back in history and reflect on the great civilizations, such as those in China, Rome, and Egypt, we find example after example of the marvelous production accomplishments of the builders of these civilizations. Stonehenge, the pyramids of Egypt, the Great Wall of China, and the aqueducts and theaters of Rome are all examples of astounding production feats. Production during those early days was performed by skilled artisans who produced customized goods for individual customers. Nevertheless, organized and large-scale production of consumer goods began during the Industrial Revolution, generally around the late 18th to mid-19th century. Although the Industrial Revolution vastly changed how products were produced, it was during the 20th century that most operations innovations occurred.

Table 1.3 traces the evolution of production in today's state-of-the-art operations and global supply chain management. Most of the dramatic and accelerated changes in operations and supply chain management have taken place since the 1980s. We will discuss each of these topics in greater detail in subsequent chapters, but for now, the table offers a glimpse at how the operations management discipline has evolved.

During the late 1970s and early 1980s, intense global competition caused many companies to lose their competitive edge and market share. Until the early 1980s, people in the operations

**TABLE 1.3:** Evolution of Operations and Supply Chain Management

| Time Period | Innovations and Events | Production Emphasis | Nomenclature (Common Terminology) |
|---|---|---|---|
| 1700–1900 | • Steam engine<br>• Interchangeable parts<br>• Division of labor<br>• Improvements in manufacturing technology<br>• Formation of transportation networks | Internal production in factories | Factory management |
| 1900–1920 | • Application of scientific principles to manufacturing<br>• Time and motion studies<br>• Moving assembly lines | Internal and mass production | Scientific manufacturing and management |
| 1920–1960 | • Production of war goods<br>• Hawthorne studies<br>• Motivational theories<br>• Introduction of computers and quantitative tools | Internal mass production | Production management and operations research |
| 1960–1980 | • Just-in-time (JIT) and material requirements planning (MRP) systems<br>• Statistical process control<br>• Increasing global competition | Internal production with some outsourcing, and the production of services | Production and operations management |
| 1980–2000 | • Increased computerization<br>• Business process reengineering<br>• Total quality management (TQM)<br>• Six Sigma quality<br>• Lean manufacturing<br>• Enterprise resource planning (ERP)<br>• The Internet and electronic commerce (e-commerce)<br>• Emerging global economies such as China and India as a result of reduced governmental trade barriers<br>• Increased global sourcing and adoption of supply chain management practices for both goods and services | Emphasis on managing both internal operations and supply chains | Operations and supply chain management |
| 2000–present | • Global and sustainable supply chains<br>• Advances in communication and transportation technologies, agile manufacturing | Emphasis on managing both global supply chains and operations across supply chains | Operations and global supply chain management |

function were never involved in the formulation of a corporate strategy. Nevertheless, organizations began to realize that one way to survive was to define and execute a strategy through effective and efficient operations. That is, firms had to formulate **operations strategies**. An operations strategy uses an organization's resources efficiently to gain a competitive edge in the marketplace by achieving key operations objectives related to product quality, delivery, flexibility, cost, service, and innovation. That is, an operations strategy should outline the vision and road map for a firm's operational decision making.

**Operations strategies:** strategies that use an organization's resources efficiently to gain a competitive edge in the marketplace by achieving key operations objectives related to product quality, delivery, flexibility, cost, service, and innovation. These strategies should outline the vision and road map for a firm's operational decision making.

In the 1980s, facing the threat of global competition, companies adopted TQM programs to regain their competitive edge and achieve customer satisfaction. **Total quality management (TQM)** is a management philosophy that focuses on continuously improving the quality of a company's products and processes. According to the philosophy, every employee is responsible for improving the quality of a company's products and processes, and a quality culture should pervade the entire organization. Achieving total quality requires not only the commitment of the top managers of the company and its employees but also the involvement of the company's suppliers and even its customers. Furthermore, pursuing TQM is not the privilege of only large organizations. Even small companies can implement and reap the benefits of TQM. Pennril Datacomm Networks Inc. (Gaithersburg, MD), a designer and manufacturer of data communications and equipment, was experiencing defect rates that were so high that the company was reworking or scrapping about a third of everything it was producing. After embracing and implementing TQM, defects decreased by 81% and failures by 83% in the first 3 months, with a 73% reduction in warranty repairs in the first year.[18]

**Total quality management (TQM):** a management philosophy that focuses on continuously improving the quality of a company's products and processes

Motorola Solutions, Inc. (aka Motorola, Schaumburg, IL), in its efforts to reduce variations in its processes, started the **Six Sigma** quality initiative in 1986. The focus of Six Sigma is on improving quality through reducing the number of defects. Since the 1990s, several world-class corporations, such as General Electric (aka GE, Fairfield, CT), have embraced the Six Sigma methodology and have witnessed dramatic improvements in product and process quality and profitability. The application of Six Sigma methodology has now expanded in scope and is used not only in the manufacturing sector but also in the service sector and in supply chains.

**Six Sigma:** the methodology of improving quality through reducing the number of defects in a given process

**Lean manufacturing** or **lean production** was championed as a management philosophy that originated in the 1990s based on the automaker Toyota Motor Corporation's (aka Toyota, Toyota City, Japan) production system. The basic idea behind lean production is that any activity or process that does not add value to the product or service is a waste and, therefore, should be eliminated. Several companies have benefited from adopting lean manufacturing methods. For example, in 1997, Porsche AG (Stuttgart, Baden-Württemberg, Germany) was on the verge of bankruptcy before going lean and turning steady losses into profits. The success of the Porsche Boxter is the direct result of the company adopting lean manufacturing methods.

**Lean manufacturing:** a management philosophy that originated in the 1990s based on Toyota's production system that states that any activity or process that does not add value to the product or service is a waste and, therefore, should be eliminated

**Lean production:** *See* **lean manufacturing**

An extension of lean manufacturing is **agile manufacturing**, which is the ability of an organization to respond quickly to market changes with a set of processes, tools, and training available as needed. Whereas lean manufacturing can reduce, and perhaps eliminate, waste from production processes, it doesn't necessarily allow a company to respond quickly to sudden changes in customers' needs. Agile manufacturing, by contrast, uses technology to bring together a firm's marketing, design, and operations functions to do so. The Benetton Group (aka United Colors of Benetton, Treviso, Italy), a leading apparel manufacturer, was one of the pioneers in deploying and reaping the benefits of agile manufacturing. Zara, as the earlier Operations Profile demonstrated, is another clothing manufacturer that has successfully implemented agile manufacturing.

**Agile manufacturing:** the ability of an organization to respond quickly to market changes with a set of processes, tools, and training available as needed

Fueled by a global recession and increasing foreign competition in the 1990s, companies were seeking innovative ways to improve their business processes, cut costs, reestablish their competitive advantage, and increase customer satisfaction. A business process is a series of tasks or activities designed to produce a specific product, service, or output. For example, a company's accounting function is a business process that involves several individual activities such as accounts payable, accounts receivable, and billing, all of which are designed to move financial information within the company. Efforts to improve a company's business processes led to the approach of **business process reengineering (BPR)**. BPR is the radical redesign of a firm's existing workflows and resources to reduce operational costs, better meet the needs of customers, and support a firm's overall mission. The key focus of BPR is to achieve dramatic cost, quality, speed, and customer service improvements. By the mid-1990s, many Fortune 500 companies had initiated BPR efforts. More

recently, **business process management (BPM)** has begun to replace BPR. BPM is a management approach that, like BPR, focuses on continuously improving the efficiency of business processes but also focuses on innovation, flexibility, and the seamless integration of technology.

**Enterprise resource planning (ERP)** systems were developed in the late 1990s. An ERP system is an information system that integrates information across all departments of an organization, such as finance, accounting, manufacturing, sales, and service. The purpose of ERP systems is to facilitate and manage the flow of information across all functions not only within an enterprise but also with its external stakeholders, including its suppliers and customers.

Of course, as we explained at the beginning of the chapter, the evolution of operations and supply chain management has continued to occur in the 21st century as a result of globalization and outsourcing. Many joint initiatives undertaken by countries around the world have provided an impetus for the globalization of businesses. For example, in 1947, to promote international trade, member countries of the United Nations negotiated and signed an international treaty called the General Agreement on Tariffs and Trade (GATT). The purpose of this agreement was to encourage free trade between member states by regulating and reducing tariffs on traded goods and by providing a forum for resolving trade disputes.

GATT lasted until 1993 and was replaced by the World Trade Organization (WTO) in 1995. In addition, in 1994, the United States, Canada, and Mexico negotiated and implemented the North American Free Trade Agreement (NAFTA) to improve trade relations. NAFTA removed most barriers to trade and investment among these countries. Recently, the WTO expanded the scope of the rules of international trade to include services in addition to goods. Furthermore, the WTO also relaxed the restrictions and opened the markets for highly regulated industries such as agriculture, textiles, and telecommunications. Similarly, the formation of the European Union not only eliminated trade barriers among European countries but also led to strict quality and environmental standards that companies have to meet to do business with member countries. As a result of globalization, among global business partners, there has been a proliferation of strategic partnerships, joint ventures, licensing agreements, research consortia, direct marketing agreements—and above all—the formation of global supply chains.

**Business process reengineering (BPR):** the radical redesign of a firm's existing workflows and resources to reduce operational costs, better meet the needs of customers, and support a firm's overall mission

**Business process management (BPM):** a management approach that focuses on continuously improving the efficiency of business processes through innovation, flexibility, and the seamless integration of technology

**Enterprise resource planning (ERP):** an information system that integrates information across all departments of an organization, as well as facilitates and manages the flow of information across all functions within an enterprise and to its external stakeholders

## 1.6 Current and Emerging Issues in Operations and Supply Chain Management

1.6 Identify some of the emerging trends in operations and supply chain management.

Companies competing in today's global business environment are facing challenges and trade-offs that are making their operations and supply chains increasingly complex. Many companies are ill-equipped to do business in today's global markets and in the face of political upheaval. For most companies, the operations function and supply chains were designed to manage stable, high-volume production by capitalizing on low-cost labor opportunities available in China and other emerging economies. Nevertheless, with increasing global competition, the relative attractiveness of manufacturing locations (based on costs and availability of labor), as well as the ability to produce in high volumes at low costs, will change quickly in the future. That is, what makes us profitable today may not generate profits next year.

Fueled by the recent global economic downturn, some challenges, such as turbulent trade, are likely to become perennial problems for supply chain managers. The rising wealth of workers in many developing countries, especially those in central and eastern Europe, will make it harder to find reliable, low-cost suppliers. Many of these changes are beyond a company's control, and therefore, the senior executives responsible for formulating operations and supply chain strategies run a greater risk of making key decisions that could become unprofitable. To meet these challenges, companies worldwide will need to be aware of and capitalize on the operations and management trends we describe in this section.[19]

### The Continuous Optimization of Resources

The trend toward optimizing the use of raw materials and labor by eliminating waste and maximizing productivity will continue. The application of lean and agile manufacturing techniques in conjunction with Six Sigma quality programs will gain popularity in both the manufacturing and

service sectors. To demonstrate, the Korean steel manufacturer POSCO (Seoul, South Korea) combined lean manufacturing and Six Sigma methodologies to establish itself in the global marketplace as the leading provider of innovative steel products and services. In addition, firms will continue to optimize their inventory levels strategically throughout their supply chains along with their use of other resources, such as their transportation and production equipment. The responsibility to balance the supply and demand of resources rests on the operations managers of every company within the supply chain.[20]

## Greater Supply Chain Risks and Supply Chain Restructuring

Supply chain risk has been increasing sharply as a result of greater levels of outsourcing and offshoring, production of more complex products and services, fluctuating energy prices, and increasing financial volatility. As supply chains become more global, the greatest supply chain risks that companies are facing are the ability to obtain resources and labor and the integration of their IT systems with those of companies in their supply chains. Nevertheless, very few companies have meaningful strategies to respond to these risks.[21] To address these potential problems, companies need to invest in operations and supply chain management capabilities to respond more quickly to changes in the marketplace—much as Zara has done.[22]

Some organizations are responding to these challenges by restructuring their old supply chains. First, these organizations are **splintering** their traditional supply chains into smaller and more agile supply chains that can better respond to higher levels of business complexity, save money, and improve customer service. Second, these companies are reconfiguring their manufacturing facilities to respond to a range of potential market scenarios. Essentially, the firms are using their supply chains to hedge against uncertainty in the marketplace. Consider the example of a consumer durables manufacturer that manufactured most of its products in China. Because the delivery of the products from China took a long time, the company had to maintain high inventory levels. As a result, the firm was rapidly losing ground to competitors. To regain its market share, the company split its traditional one-size-fits-all supply chain into four smaller supply chains, or splinters. Products for which there was high, stable demand were assigned to the first splinter and continued to be manufactured in China. Products for which there was low, volatile demand were assigned to the second splinter and manufactured in the United States. The manufacturing of products with low but regular demand was split between the United States and Mexico and assigned to the third and fourth splinters. These changes helped the company reduce its cost of goods sold by 15%. Furthermore, the company was able to improve its quality levels across its full range of products, receive its products faster, and most important, improve its customer service levels by having the right goods available for customers to purchase at the right times.[23]

Trends in Operations Management

**Splintering**: the practice of breaking traditional supply chains into smaller and more agile supply chains that can better respond to higher levels of business complexity, save money, and improve customer service

## Role of Technology and Data Analytics

New and emerging technologies that can have both an incremental and a transformational impact can be deployed to improve supply chain visibility and performance. Some such technologies include the **Internet of Things (IoT)**, **3-D printing**, and **drones**. For example, Internet of Things (IoT) can help companies to improve their products and their overall customer experience. IoT, simply defined, is the concept of connecting any device to the Internet and/or to each other with an on-off switch. IoT can include any number of products or components (washing machines, mobile phones, kitchen appliances, jet engines, etc.) that you can think of. By using this technology, companies can gather a vast amount of information about their products, including where and how the products are being used, and at any given time, which of the company's customers are using them. Thus, with a product connected to the IoT, a company will be alerted if its product is defective, and with this advance knowledge, the company can contact its customers to report the problem and seek to address it before it becomes a bigger issue.[24]

**Internet of Things (IoT)**: the concept of connecting any device to the Internet and/or to each other with an on-off switch

**3-D printing**: a process of making three-dimensional solid objects from a digital file

**Drones**: unmanned aerial vehicles that can be navigated and controlled from the ground by using a GPS tracking system

3-D printing, a process of making three-dimensional solid objects from a digital file, is another technology that has helped companies improve their supply chain performance. Amazon has filed a patent for a mobile 3-D printing delivery truck that would print out customers' orders on the fly and deliver them instantly. This technological innovation would help Amazon not only get the items to shoppers more quickly, but also save money by eliminating the need to import items and reducing its warehouse space.[25]

Drones, despite the restrictions placed on them by the FAA, represent yet another technology that can provide significant opportunities for affordable and flexible solutions in the areas of asset monitoring and delivery side of a company's supply chain. For example, in industries such as agriculture, oil and gas, and mining, drones are used for the purposes of asset monitoring and survey work and have contributed to significant cost savings in these industries. Similarly, through the use of drone technology, DHL (Bonn, Germany), the logistics firm, has been able to establish regular delivery services in remote German islands in the North Sea.[26]

Drones have been effectively used to monitor crops in the supply chain.
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Another emerging trend in the field of supply chain management is the use of data analytics. In particular, "big data" analytics, which involves the analysis of huge, rapidly growing, and very messy unstructured datasets, is becoming very important in every industry's supply chain. The use of advanced analytics can help managers to identify supply chain performance issues, develop strategies to deal with supply chain disruptions, and improve delivery service and speed to customers. For example, a global life-sciences company uses advanced analytics for its replenishment and inventory planning. By analyzing the pattern of customer clicks on the company's website in a country or region, a supply chain team member can adjust inventories prior to their customers placing orders. The net result is that the company holds the right amount of inventory in the right locations, reducing the lead time promised to customers, which, in turn, increases the likelihood of customers placing orders.[27]

## Sustainability

In recent years, customers have demanded that businesses operate in a socially responsible manner and produce products that do not harm the environment. Therefore, operations and supply chain strategies that focus solely on costs and time efficiency may not be enough. These strategies should also incorporate responsible labor practices and practices that minimize harm to the environment and use the world's resources wisely. Collectively, these initiatives are referred to as **sustainability**. Sustainability is the use of methods, systems, and materials that won't deplete resources or harm natural cycles.[28] Companies need to integrate sustainability not only internally but also through all tiers of their supply chains, including their suppliers in developing countries. McDonald's, for example, forged closer relationships with its suppliers and provided them with a tool called the "environmental scorecard." The suppliers were expected to improve over time their sustainability practices by measuring their use of water, their use of energy, their production of waste, and their air emissions. Such sustainable sourcing practices have not only improved McDonald's sales, but they have also helped reestablish the McDonald's brand. The company placed 12th on the 2016 Interbrand Best Global Brands list.[29]

Companies that take a creative and proactive approach to incorporating sustainability into their operations and supply chains can often drive down costs, mitigate risks, discover innovative approaches to developing products and services, and share the risks and rewards among their supply chain partners. Incorporating sustainability into a company's strategies, as cosmetics company Aveda (Aveda Corporation, Blaine, MN) does, also improves its reputation among consumers, which can allow a company to charge more for its products. Patagonia, Inc. (Ventura, CA), the seller of outdoor clothing and equipment, is known for its sustainability initiatives and enjoys its reputation as an enlightened employer and champion of the environment. The company has a very simple but challenging goal: to produce the highest quality products with minimum possible harm to the environment. The company donates 1% of its total sales or 10% of its profit, whichever is greater, to environmental groups. Since 1985, Patagonia has donated more than US$80 million to thousands of local organizations, including giving its entire $10 million profit from its 2016 "Black

**Sustainability:** the use of methods, systems, and materials that won't deplete resources or harm natural cycles


Patagonia, the seller of outdoor clothing and equipment, is known for its sustainability initiatives and enjoys its reputation as an enlightened employer and champion of the environment.

AP Photo/Rick Bowmer

Corporate Social Responsibility

Friday" sales to charity. Although the company's products are priced higher than those of its competitors, the firm's operating margins typically are high for its industry—even with the donations figured in.[30]

In recent years, many businesses worldwide have begun adopting practices that reflect a greater degree of **corporate social responsibility (CSR)**. CSR is the process of incorporating the interests of the public into a company's core business. One principle of CSR is that companies should make decisions with an eye toward what's good for the triple bottom line—which consists of people (social value), the planet (environmental value), and profits (economic value). Sony, for example, approaches CSR from two different perspectives. The first relates to the way it procures its materials. In March 2002, Sony established a set of "management regulations for environment-related substances to be controlled which are included in parts and materials."[31] These internal regulations require identification of environment-related substances that are banned or to be reduced along with applications where they are used. The second perspective relates to the environment, human rights, and labor conditions. In supporting this initiative, Sony closely monitors and manages the chemicals used in its products at all stages of the manufacturing cycle, from the raw materials and components through the final shipment. To promote its social agenda, Sony procures parts and materials only from those suppliers who are designated as green partners.

## 1.7 Road Map: How This Text Is Organized

Figure 1.10 shows the organization of this text. This figure outlines the flow of chapters against the backdrop of strategic, tactical, and operational decisions OM managers face. These decisions become progressively more relevant, affecting not just internal operations but also inbound and outbound elements of the supply chain. Some chapters fit cleanly into this classification, and others, as we shall see, are not so easily categorized or operate on multiple levels. We will also consider them in turn.

- The remainder of Part 1 (Chapters 2 through 9) corresponds to the strategic view of managing global supply chains and operations. The topics covered deal with such critical elements in supply chain and operations strategy as the design of products and services, project management, quality planning, location and capacity planning, and process selection and layout planning.
- Part 2, on the integrative decisions of supply chain and operations management, covers topics that are not easily categorized as strategic, tactical, or operational. The chapters on supplier management, logistics management, and demand management contain topics that are critical at each level and, thus, must be considered more comprehensively. Although they are not a separate part of the text, it is critical to understand these integrative concepts across all decision levels in the supply chain and operations hierarchy.
- Part 3, on the tactical decisions of supply chain and operations management, discusses critical issues in lean operations and supply chains, inventory management, and sales and operations planning.
- Part 4 covers operational issues in supply chain and operations management. It includes chapters on materials, capacity, and distribution requirements planning, as well as detailed operations scheduling.

**Corporate social responsibility (CSR):** the process of incorporating the interests of the public into a company's core business

The goal of this text is to present supply chain and operations management in global service and product industries.