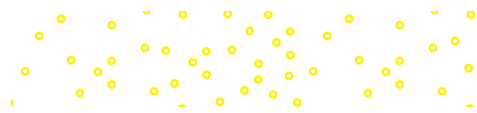


Operations and Supply Chain Management: The Core



The McGraw-Hill/Irwin Series in Operations and Decision Sciences

SUPPLY CHAIN MANAGEMENT

Benton

Purchasing and Supply Chain Management
Third Edition

Bowersox, Closs, Cooper, and Bowersox
Supply Chain Logistics Management
Fifth Edition

Burt, Petcavage, and Pinkerton
Supply Management
Eighth Edition

Johnson
Purchasing and Supply Management
Sixteenth Edition

Simchi-Levi, Kaminsky, and Simchi-Levi
Designing and Managing the Supply Chain:
Concepts, Strategies, Case Studies
Third Edition

Stock and Manrodt
Fundamentals of Supply Chain Management

PROJECT MANAGEMENT

Brown and Hyer

Managing Projects: A Team-Based
Approach

Larson and Gray

Project Management: The Managerial
Process
Seventh Edition

SERVICE OPERATIONS MANAGEMENT

Bordoloi, Fitzsimmons, and Fitzsimmons
Service Management: Operations, Strategy,
Information Technology
Ninth Edition

MANAGEMENT SCIENCE

Hillier and Hillier

Introduction to Management Science: A
Modeling and Case Studies Approach with
Spreadsheets
Sixth Edition

BUSINESS RESEARCH METHODS

Schindler

Business Research Methods
Thirteenth Edition

BUSINESS FORECASTING

Keating and Wilson

Forecasting and Predictive Analytics
Seventh Edition

LINEAR STATISTICS AND REGRESSION

Kutner, Nachtsheim, and Neter

Applied Linear Regression Models
Fourth Edition

BUSINESS SYSTEMS DYNAMICS

Sterman

Business Dynamics: Systems Thinking and
Modeling for a Complex World

OPERATIONS MANAGEMENT

Cachon and Terwiesch

Operations Management
Second Edition

Cachon and Terwiesch

Matching Supply with Demand: An
Introduction to Operations Management
Fourth Edition

Jacobs and Chase

Operations and Supply Chain Management
Fifteenth Edition

Jacobs and Chase

Operations and Supply Chain Management:
The Core
Fifth Edition

Jacobs, Berry, Whybark, and Vollmann

Manufacturing Planning & Control for
Supply Chain Management
Second Edition

Schroeder and Goldstein

Operations Management in the Supply
Chain: Decisions and Cases
Seventh Edition

Stevenson

Operations Management
Thirteenth Edition

Swink, Melnyk, and Hartley

Managing Operations Across the Supply
Chain
Fourth Edition

BUSINESS MATH

Slater and Wittry

Practical Business Math Procedures
Thirteenth Edition

Slater and Wittry

Math for Business and Finance: An
Algebraic Approach
Second Edition

BUSINESS STATISTICS

Bowerman, O'Connell, Drougas,

Duckworth, and Froelich

Business Statistics in Practice
Ninth Edition

Doane and Seward

Applied Statistics in Business and
Economics
Sixth Edition

Doane and Seward

Essential Statistics in Business and
Economics
Third Edition

Lind, Marchal, and Wathen

Basic Statistics for Business and Economics
Ninth Edition

Lind, Marchal, and Wathen

Statistical Techniques in Business and
Economics
Seventeenth Edition

Jaggia and Kelly

Business Statistics: Communicating with
Numbers
Third Edition

Jaggia and Kelly

Essentials of Business Statistics:
Communicating with Numbers
Second Edition

McGuckian

Connect Master: Business Statistics



Operations and Supply Chain Management: The Core



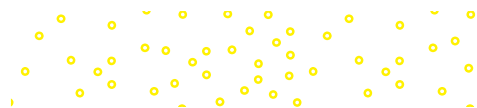
Fifth Edition

F. ROBERT JACOBS

Indiana University

RICHARD B. CHASE

University of Southern California





OPERATIONS AND SUPPLY CHAIN MANAGEMENT: THE CORE, FIFTH EDITION

Published by McGraw-Hill Education, 2 Penn Plaza, New York, NY 10121. Copyright © 2020 by McGraw-Hill Education. All rights reserved. Printed in the United States of America. Previous editions © 2017, 2013, and 2010. No part of this publication may be reproduced or distributed in any form or by any means, or stored in a database or retrieval system, without the prior written consent of McGraw-Hill Education, including, but not limited to, in any network or other electronic storage or transmission, or broadcast for distance learning.

Some ancillaries, including electronic and print components, may not be available to customers outside the United States.

This book is printed on acid-free paper.

1 2 3 4 5 6 7 8 9 LWI 21 20 19

ISBN 978-1-260-23888-4

MHID 1-260-23888-1

Portfolio Manager: *Noelle Bathurst*
 Product Developer: *Ryan McAndrews*
 Marketing Manager: *Harper Christopher*
 Content Project Managers: *Fran Simon/Jamie Koch*
 Buyer: *Sandy Ludovissy*
 Design: *Egzon Shaqiri*
 Content Licensing Specialists: *Shawntel Schmitt*
 Cover Image: © *jimwiltchko/gettyimages*
 Compositor: *SPi Global*

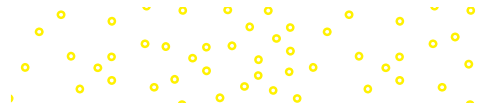
All credits appearing on page or at the end of the book are considered to be an extension of the copyright page.

Library of Congress Cataloging-in-Publication Data

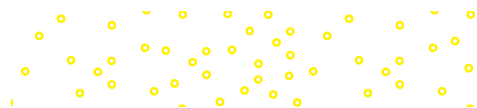
Names: Jacobs, F. Robert, author. | Chase, Richard B., author.
 Title: Operations and supply chain management. The core / F. Robert Jacobs,
 Indiana University, Richard B. Chase, University of Southern California.
 Description: Fifth edition. | New York, NY : McGraw-Hill Education, [2020]
 Identifiers: LCCN 2018044375 | ISBN 9781260238884 (alk. paper)
 Subjects: LCSH: Production management.
 Classification: LCC TS155 .J273 2017 | DDC 658.5—dc23
 LC record available at <https://lccn.loc.gov/2018044375>

The Internet addresses listed in the text were accurate at the time of publication. The inclusion of a website does not indicate an endorsement by the authors or McGraw-Hill Education, and McGraw-Hill Education does not guarantee the accuracy of the information presented at these sites.

mheducation.com/highered



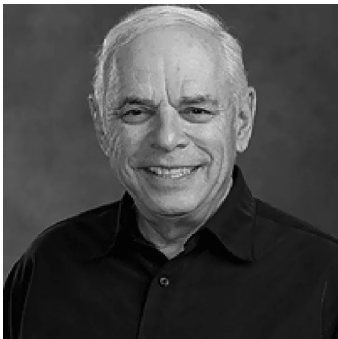
*To Cole, Connor,
and Grant—the next
generation.*



ABOUT THE AUTHORS



F. Robert Jacobs is Professor Emeritus of Operations and Decision Technologies at Indiana University. He received a BS in industrial engineering as well as computer and information science, an MBA, and a PhD in operations management all from The Ohio State University. He has also taught at the University of Houston and The Ohio State University. He has published 7 books and over 50 research articles on topics that include enterprise resource planning, inventory control, the design of manufacturing facilities, cellular manufacturing, and the scheduling of manufacturing operations. He is a Fellow of the Decision Sciences Institute and past president and has received teaching honors such as MBA Teaching Award, Students Award for Teaching Excellence in International Business Issues, and Teaching Excellence in Operations Management.



Richard B. Chase is Justin B. Dart Professor Emeritus of Operations Management at the Marshall School of Business, University of Southern California. He received his PhD in operations management, as well as an MBA and BS from UCLA. He has taught at the Harvard Business School, IMD (Switzerland), and the University of Arizona. His research examines service process design and service strategy. In 2006 he received a POMS Lifetime Achievement Award for his research in service operations and in 2004 received a Scholar of the Year Award by the Academy of Management. In 2009, he was honored in the *Production & Operations Management Journal* for his contributions to operations management. He is a Fellow of the Academy of Management, Production Operations Management Society, and the Decision Sciences Institute. He was also an examiner for the Malcolm Baldrige National Quality Award. Dr. Chase has lectured/consulted recently on service and excellence to such organizations as Cisco Systems, Four Seasons Resorts, General Electric, and the Gartner Group.

PREFACE

Just as lava flows from the core of the earth, operations and supply management is the core of business. Materials must flow through supply processes to create cash output and profits.

In Operations and Supply Management: The Core 2e, we take students to the center of the business and focus on the core concepts and tools needed to ensure that these processes run smoothly.

The goal of this book is to provide you with the essential information that every manager needs to know about operations and supply chain–related activities in a firm. Things have changed dramatically over the last few years. Organization structures are now much flatter, and rather than being functionally organized, companies often are organized by customer and product groups. Today’s manager cannot ignore how the real work of the organization is done. This book is all about how to get the real work done effectively. It makes little difference if you are officially in finance, marketing, accounting, or operations: The value-added work, the process of creating and delivering products, needs to be completed in a manner that is both high quality and maximally efficient. Many of the things you do, or will do, in your job are repetitive, even some of the most creative and high-profile activities. You should think of this course as preparing you to be your most productive and helping you help your organization be its most productive.

We can consider the importance of the material in this book on many levels, but let’s focus on three. First, consider your role as a business unit manager with people working under your supervision. Next, in the longer term, you probably have aspirations to become a senior executive with responsibility for multiple businesses or products. Finally, you may decide to specialize in operations and supply chain management as a long-term career.

In your role as a manager with people working under your supervision, one of your major duties will be to organize the way work is done. There needs to be some structure to the work process, including how information is captured and analyzed, as well as how decisions and changes and improvements are made. Without a logical or structured approach, even a small group may be subject to errors, inefficiencies, and even chaos.

Designing efficient process flows is an important element of getting a group to work together. If your group is involved in creative activities such as designing cars, buildings, or even stock portfolios, there still needs to be structure to how the work is done, who is responsible for what, and how progress is reported. The concepts of project management, manufacturing and service process design, capacity analysis, and quality in this text are all directly related to the knowledge you will need to be a great supervisor in your organization, and getting your group to work productively and efficiently will lead to success and more responsibility for you.

Next, think about becoming a senior executive. Making acquisitions, planning mergers, and buying and selling divisions will get your name and picture in business magazines. Deals are easily explained to boards, shareholders, and the media. They are newsworthy and offer the prospect of nearly immediate gratification, and being a deal maker is consistent with the image of the modern executive as someone who focuses on grand strategy and leaves operations details to others. Unfortunately, the majority of deals are unsuccessful. The critical element of success, even with the grandest deals, can still be found most often in the operational details.

Real success happens when operational processes can be improved. Productivity improvements from things such as sharing customer service processes, purchasing systems, distribution and manufacturing systems, and other processes can lead to great synergies and success. Operations accounts for 60 to 80 percent of the direct expenses that limit the profit of most firms. Without these operations synergies, designed and implemented by executives with a keen understanding of the concepts in this book, companies are often left with expensive debt, disappointed customers and shareholders, and pressure on the bottom line—on earnings.

Finally, you may be interested in a career in operations and supply chain management. Well, you are not alone. Professional organizations such as APICS, the Institute for Supply Management, and the Council of Supply Chain Management Professionals have well over 200,000 members participating in regular monthly meetings, annual conferences, and certification programs. Entry-level jobs might be as a forecast strategist, project manager, inventory control manager, production supervisor, purchasing manager, logistics manager, or warehouse specialist. In addition, top operations students may obtain their initial jobs with consulting firms, working as business process analysts and system design specialists.

We encourage you to talk to your instructor about what you want to get out of the course. What are your career aspirations, and how do they relate to the material in this course? Write your instructor a short e-mail describing what you want to do in the future—this is invaluable information for tailoring the material in the course to your needs. As you work through the text, share your experiences and insights with the class. Being an active student is guaranteed to make your experience more valuable and interesting.

ACKNOWLEDGMENTS

Special thanks to those who develop and market the book: Chuck Synovec, Director; Noelle Bathurst, Portfolio Manager; Harper Christopher, Executive Marketing Manager; Ryan McAndrews, Product Developer; Fran Simon, Content Project Manager; Jamie Koch, Assessment Project Manager; and Egzon Shaqiri, Senior Designer. The time spent talking to faculty at the conferences is appreciated. Also, thanks to Gary Black who keeps Connect current.

Thanks also to the many loyal adopters of the book. Tim Smunt (University of Wisconsin–Milwaukee) and Don Sheldon (Binghamton University SUNY) were particularly helpful with input for this edition.

Last, but certainly not least, we thank our families. We have stolen countless hours away for this project; time that would otherwise be spent with them. We sincerely appreciate their support.

F. Robert Jacobs
Richard B. Chase

A NOTE TO INSTRUCTORS

Operations and Supply Chain Management: The Core derives its title from a combination of ideas and trends. The book is designed to be lean and focused, much in the tradition of the concepts taught in the book. The topics selected are the result of the study of the syllabi of dozens of representative U.S. universities. There are a wide variety of topics covered, many more than could be covered in a single course. Our “big book,” *Operations and Supply Chain Management*, is comprehensive and is intended for those who want to pick and choose topics that best fit the objectives of their course. The “Core” book covers the topics most commonly included in these courses and has material sufficient for a 12- to 15-week course.

As is well known in the field, success for companies today requires successfully managing the entire supply flow, from the sources of the firm, through the value-added processes of the firm, and on to the customers of the firm.

In *Operations and Supply Chain Management: The Core 5e*, we take students to the center of the business and focus on the core concepts and tools needed to ensure that these processes run smoothly.

Discussion of Fifth Edition Revisions

Many of the revisions to the fifth edition have been driven by our focus on supply chain analytics. Supply chain analytics involves the analysis of data to better solve business problems. We recognize that this is not really new since data have always been used to solve business problems. But what *is* new is the reality that there are a great deal more data now available for decision making.

In the past, most analysis involved the generation of standard and ad hoc reports that summarized the current state of the firm. Software allowed query and “drill down” analysis to the level of the individual transaction, useful features for understanding what happened in the past. Decision making was typically left to the decision maker based on judgment or simple alerting rules. The new “analytics” movement takes this to a new level using statistical analysis, forecasting to extrapolate what to expect in the future, and even optimization, possibly in real time, to support decisions.

In this new edition we have refined the 11 Analytics Exercises that have proven to be so popular in our books. These Analytics Exercises use settings that are modern and familiar to students taking the course. They include Starbucks, cell phones, notebook computers, Taco Bell Restaurant, Tesla, a retail Web site-based company, and industrial products that are sourced from China/Taiwan and sold globally.

In this book, all of the chapters have been designed to be independent. We have put much effort into the organization of the book, but recognize that our organization might not align with the way you are using the material in your course. In addition, many of you may custom publish a version of the book to exactly meet your needs. The chapters have been designed to allow this type of customization.

The chapters are all now tightly organized by special learning objectives. The learning objectives for the chapter are defined at the start. Special contiguous sections are designed to cover each objective. The chapter summary and discussion and objective questions are also organized by learning objective. This new organization allows material to be assigned at the level of learning objective. If the desire might be to skip some advanced techniques, for example, this can be done easily by not assigning the specific learning objective. This allows considerable flexibility in how the material is used in a class.

The material has also been adapted to work well with electronic media, since this is now becoming the media of choice at many universities.

TECHNOLOGY

McGraw-Hill Connect Features

Connect offers a number of powerful tools and features to make managing assignments easier so faculty can spend more time teaching. With Connect, students can engage with their coursework anytime and anywhere making the learning process more accessible and efficient. Connect offers you the features described below.

Instructor Library

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

- PowerPoint Slides
- Text Figures
- Instructor's Solutions Manual
- Test Banks
- Excel Templates

Student Study Center

The Connect Student Study Center is the place for students to access additional resources. The Student Study Center offers students quick access to study and review material.

Tegrity Campus: Lectures 24/7



Tegrity Campus is a service that makes class time available 24/7 by automatically capturing every lecture in a searchable format for students to review when they study and complete assignments. With a simple one-click start-and-stop process, you capture all computer screens and corresponding audio. Students can replay any part of any class with easy-to-use browser-based viewing on a PC or Mac. Educators know that the more students can see, hear, and experience class resources, the better they learn. In fact, studies prove it. With Tegrity Campus, students quickly recall key moments by using Tegrity Campus's unique search feature. This search helps students efficiently find what they need, when they need it, across an entire semester of class recordings. Help turn all your students' study time into learning moments that are immediately supported by your lecture. To learn more about Tegrity, watch a two-minute Flash demo at www.tegrity.com.

OPERATIONS MANAGEMENT AND THE AACSB

Assurance of Learning Ready



Many educational institutions today are focused on the notion of *assurance of learning*, an important element of some accreditation standards. *Operations and Supply Chain Management* is designed specifically to support your assurance of learning initiatives with a simple yet powerful solution.

Each test bank question for *Operations and Supply Chain Management* maps to a specific chapter learning outcome/objective listed in the text. You can use our test bank

software, EZ Test and EZ Test Online, or *Connect Operations Management* to easily query for learning outcomes/objectives that directly relate to the learning objectives for your course. You can then use the reporting features of EZ Test to aggregate student results in similar fashion, making the collection, presentation, and assurance of learning data simple and easy.

AACSB Statement



McGraw-Hill Education is a proud corporate member of AACSB International. Understanding the importance and value of AACSB accreditation, *Operations and Supply Chain Management* recognizes the curricula guidelines detailed in the AACSB standards for business accreditation by connecting selected questions in the test bank to the six general knowledge and skill areas in the AACSB standards Assessment of Learning Standards.

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

McGraw-Hill Customer Experience Contact Information

At McGraw-Hill, we understand that getting the most from new technology can be challenging. That's why our services don't stop after you purchase our products. You can e-mail our Product Specialists 24 hours a day to get product-training online. Or you can search our knowledge bank of Frequently Asked Questions on our support Web site. For Customer Support, call **800-331-5094** or visit mpss.mhhe.com. One of our Technical Support Analysts will be able to assist you in a timely fashion.

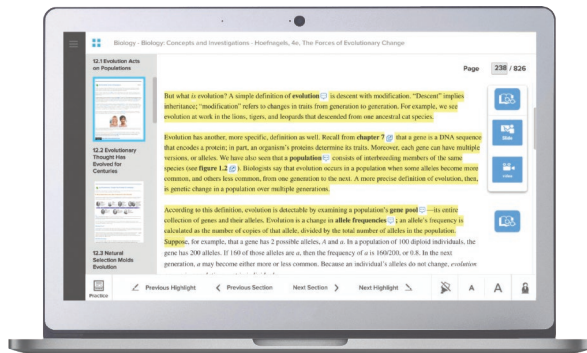
Students—study more efficiently, retain more and achieve better outcomes. Instructors—focus on what you love—teaching.

SUCCESSFUL SEMESTERS INCLUDE CONNECT

FOR INSTRUCTORS

You're in the driver's seat.

Want to build your own course? No problem. Prefer to use our turnkey, prebuilt course? Easy. Want to make changes throughout the semester? Sure. And you'll save time with Connect's auto-grading too.



65%
Less Time
Grading

They'll thank you for it.

Adaptive study resources like SmartBook® help your students be better prepared in less time. You can transform your class time from dull definitions to dynamic debates. Hear from your peers about the benefits of Connect at www.mheducation.com/highered/connect.

Make it simple, make it affordable.

Connect makes it easy with seamless integration using any of the major Learning Management Systems—Blackboard®, Canvas, and D2L, among others—to let you organize your course in one convenient location. Give your students access to digital materials at a discount with our inclusive access program. Ask your McGraw-Hill representative for more information.

©Hill Street Studios/Tobin Rogers/Blend Images LLC



Solutions for your challenges.

A product isn't a solution. Real solutions are affordable, reliable, and come with training and ongoing support when you need it and how you want it. Our Customer Experience Group can also help you troubleshoot tech problems—although Connect's 99% uptime means you might not need to call them. See for yourself at status.mheducation.com

FOR STUDENTS

Effective, efficient studying.

Connect helps you be more productive with your study time and get better grades using tools like SmartBook, which highlights key concepts and creates a personalized study plan. Connect sets you up for success, so you walk into class with confidence and walk out with better grades.

“I really liked this app—it made it easy to study when you don't have your textbook in front of you.”

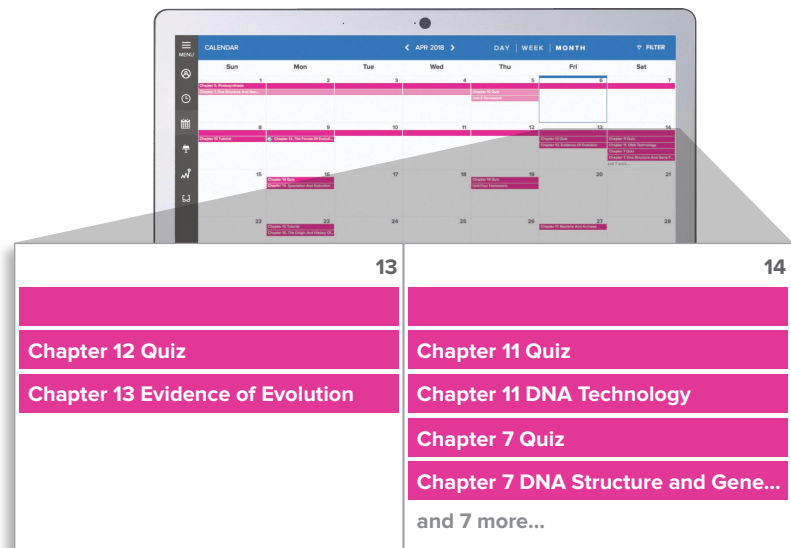
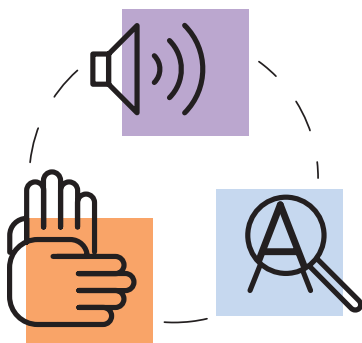
- Jordan Cunningham,
Eastern Washington University

Study anytime, anywhere.

Download the free ReadAnywhere app and access your online eBook when it's convenient, even if you're offline. And since the app automatically syncs with your eBook in Connect, all of your notes are available every time you open it. Find out more at www.mheducation.com/readanywhere

No surprises.

The Connect Calendar and Reports tools keep you on track with the work you need to get done and your assignment scores. Life gets busy; Connect tools help you keep learning through it all.



Learning for everyone.

McGraw-Hill works directly with Accessibility Services Departments and faculty to meet the learning needs of all students. Please contact your Accessibility Services office and ask them to email accessibility@mheducation.com, or visit www.mheducation.com/about/accessibility.html for more information.

Walkthrough

Major Study and Learning Features

The following section highlights the key features developed to provide you with the best overall text available. We hope these features give you maximum support to learn, understand, and apply operations concepts.

Chapter Opener



Opening Vignettes

Each chapter opens with a short vignette to set the stage and help pique students' interest in the material about to be studied. A few examples include:

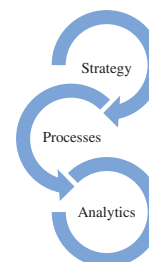
- Alphabet (Google) Operations Strategy, Chapter 2
- From Bean to Cup: Starbucks Global Supply Chain Challenge, Chapter 3
- Inside the iPhone X, Chapter 9
- Boeing 787 Dreamliner, Chapter 13

In the context of major business functions, operations and supply chain management involves specialists in product design, purchasing, manufacturing, service operations, logistics, and distribution. These specialists are mixed and matched in many different ways depending on the product or service. For a firm that sells electronic devices, like Apple, these are the functions responsible for designing the devices, acquiring materials, coordinating equipment resources to convert material to products, moving the product, and exchanging the final product with the customer. Some firms are focused on services, such as a hospital. Here, the context involves managing resources, including the operating rooms, labs, and hospital beds used to nurse patients back to health. In this context, acquiring materials, moving patients, and coordinating resource use are keys to success. Other firms are more specialized, such as Amazon. Here, purchasing, Web site services, logistics, and distribution need to be carefully coordinated for success.

In our increasingly interconnected and interdependent global economy, the process of delivering finished goods, services, and supplies from one place to another is accomplished by means of mind-boggling technological innovation, clever new applications of old ideas, seemingly magical mathematics, powerful software, and old-fashioned concrete, steel, and muscle. This book is about doing this at low cost while meeting the requirements of demanding customers. Success involves the clever integration of a great operations-related strategy, processes that can deliver the products and services, and analytics that support the ongoing decisions needed to manage the firm. Our goal in this book is to introduce students to basic operations and supply chain concepts so they understand how things should be done and the importance of these functions to the success of the firm.



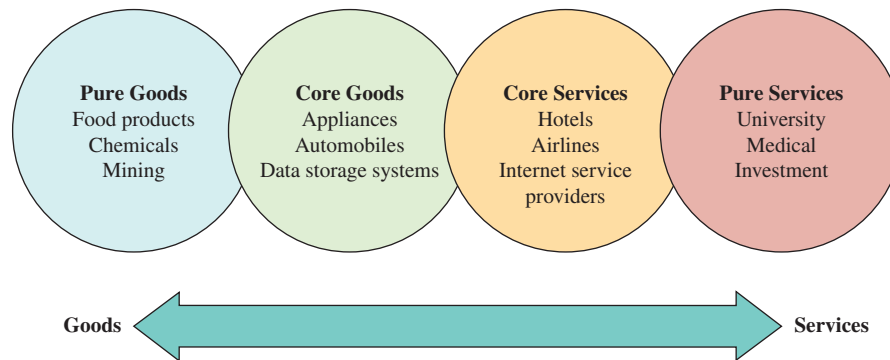
©franz12/Shutterstock



Photos and Exhibits

Photos and exhibits in the text enhance the visual appeal and clarify text discussions. Many of the photos illustrate additional examples of companies that utilize the operations and supply chain concepts in their business.

exhibit 1.3 The Goods–Services Continuum



MARSHMALLOW CANDY PEEPS CHICKS GET A QUALITY CONTROL CHECK AS THEY MOVE DOWN A CONVEYOR BELT INSIDE THE JUST BORN INC. MANUFACTURING FACILITY IN BETHLEHEM, PENNSYLVANIA.

©Mike Mergen/Bloomberg/Getty Images

Concept Connections

Concept Connections draws together various end-of-chapter sections including Key Terms, Solved Problems, Discussion Questions, Objective Questions, Cases, Analytics Exercises, and Practice Exams.

CONCEPT CONNECTIONS

LO1-1 Identify the elements of operations and supply chain management (OSCM).

- Processes are used to implement the strategy of the firm.
- Analytics are used to support the ongoing decisions needed to manage the firm.

Operations and supply chain management (OSCM) The design, operation, and improvement of the systems that create and deliver the firm's primary products and services.

Process One or more activities that transform inputs into outputs.

Product-service bundling When a firm builds service activities into its product offerings to create additional value for the customer.

Solved Problems

Representative problems are placed at the end of appropriate chapters. Each includes a worked-out solution giving students a review before solving problems on their own.

SOLVED PROBLEMS

SOLVED PROBLEM 1

Quick Lube Inc. operates a fast lube and oil change garage. On a typical day, customers arrive at the rate of three per hour, and lube jobs are performed at an average rate of one every 15 minutes. The mechanics operate as a team on one car at a time.

Assuming Poisson arrivals and exponential service, find:

- The utilization of the lube team.
- The average number of cars in line.
- The average time a car waits before it is lubed.
- The total time it takes to go through the system (that is, waiting in line plus lube time).

Solution

$$\lambda = 3, \mu = 4$$

$$a. \text{ Utilization } \rho = \frac{\lambda}{\mu} = \frac{3}{4} = 75 \text{ percent.}$$

$$b. L_q = \frac{\lambda^2}{\mu(\mu - \lambda)} = \frac{3^2}{4(4 - 3)} = \frac{9}{4} = 2.25 \text{ cars in line.}$$

$$c. W_q = \frac{L_q}{\lambda} = \frac{2.25}{3} = 0.75 \text{ hour, or 45 minutes.}$$

$$d. W_s = \frac{L_s}{\lambda} = \frac{\lambda}{\mu - \lambda} / \lambda = \frac{3}{4 - 3} / 3 = 1 \text{ hour (waiting + lube).}$$



Employee	
Name	
Edi Lee	
Shannon Phelan	
Patricia Overmyer	

Excel:
Queue

Practice Exam

The practice exam includes many straightforward review questions, but also has a selection that tests for mastery and integration/application level understanding—that is, the kind of questions that make an exam challenging.

PRACTICE EXAM

1. A strategy that is designed to meet current needs without compromising the ability of future generations to meet their needs.
2. The three criteria included in a triple bottom line.
3. The seven operations and supply chain competitive dimensions.
4. It is probably most difficult to compete on this major competitive dimension.
5. This occurs when a company seeks to match what a competitor is doing while maintaining its existing competitive position.
6. A criterion that differentiates the products or services of one firm from those of another.
7. A screening criterion that permits a firm's products to be considered as possible candidates for purchase.
8. A diagram showing the activities that support a company's strategy.
9. A measure calculated by taking the ratio of output to input.

Answers to Practice Exam 1. Sustainable 2. Social, economic, environmental 3. Cost or price, quality, delivery speed, delivery reliability, coping with changes in demand, flexibility and speed of new-product introduction, other product-specific criteria 4. Cost 5. Straddling 6. Order winner 7. Order qualifier 8. Activity-system map 9. Productivity

Cases

Cases allow students to think critically about issues discussed in the chapter. Cases include:

The Tao of Timbuk2, Chapter 2

Shouldice Hospital—A Cut Above, Chapter 4

Pro Fishing Boats—A Value Stream Mapping Exercise, Chapter 12

CASE: THE TAO OF TIMBUK2*

"Timbuk2 is more than a bag. It's more than a brand. Timbuk2 is a bond. To its owner, a Timbuk2 bag is a dependable, everyday companion. We see fierce, emotional attachments form between Timbuk2 customers and their bags all the time. A well-worn Timbuk2 bag has a certain patina—the stains and scars of everyday urban adventures. Many Timbuk2 bags are worn daily for a decade or more, accompanying the owner through all sorts of defining life events. True to our legend of 'indestructibility,' it's not uncommon for a Timbuk2 bag to outlive jobs, personal relationships, even pets. This is the Tao of Timbuk2."

What makes Timbuk2 so unique? Visit the Web site at www.timbuk2.com and see for yourself. Each bag is custom designed by the customer on the Web site. After the customer selects the basic bag configuration and size, colors for each of the various panels are presented; various lines, logos,

production line to make it as efficient as possible while producing the highest-quality messenger bags available.

The local manufacturing is focused on the custom messenger bag. For these bags, orders are taken over the Internet. Customers are offered many configuration, size, color, pocket, and strap options. The bag is tailored to the exact specifications of the customer on the Timbuk2 assembly line in San Francisco and sent via overnight delivery directly to the customer.

Recently, Timbuk2 has begun making some of its new products in China, which is a concern to some of its long-standing customers. The company argues that it has designed its new products to provide the best possible features, quality, and value at reasonable prices and stresses that these new products are designed in San Francisco. Timbuk2 argues that the new bags are much more complex to build and require

Analytics Exercises

There are so much more data now available for decision making. The analytics movement takes this to a new level using statistical analysis to extrapolate what to expect in the future to support operations and supply chain decisions. A series of 11 analytics exercises are spread through the chapters. These include:

- Forecasting Supply Chain Demand: Starbucks Corporation, Chapter 3
- Designing a Manufacturing Process: Notebook Computer Assembly Line, Chapter 6
- Processing Customer Orders: Analyzing a Taco Bell Restaurant, Chapter 7
- Global Sourcing Decisions—Grainger: Reengineering the China/U.S. Supply Chain, Chapter 13

ANALYTICS EXERCISE: DESIGNING A MANUFACTURING PROCESS

A Notebook Computer Assembly Line

A manufacturing engineering section manager is examining the prototype assembly process sheet (shown in Exhibit 6.8) for his company's newest subnotebook computer model. With every new model introduced, management felt that the assembly line had to increase productivity and lower costs, usually resulting in changes to the assembly process. When a new model is designed, considerable attention is directed toward reducing the number of components and simplifying parts production and assembly requirements. This new computer was a marvel of high-tech, low-cost innovation and should give the company an advantage during the upcoming fall/winter selling season.

Production of the subnotebook is scheduled to begin in 10 days. Initial production for the new model is to be 150 units per day, increasing to 250 units per day the following week (management thought that eventually production would reach 300 units per day). Assembly lines at the plant normally are staffed by 10 operators who work at a 14.4-meter-long assembly line. The line is organized in a straight line with workers shoulder to shoulder on one side. The line can accommodate up to 12 operators if there is a need. The line normally operates for 7.5 hours a day (employees work from 8:15 A.M. to 5:00 P.M. and regular hours include one hour of unpaid lunch and 15 minutes of scheduled breaks). It is possible to run one, two, or three hours of overtime, but employees need at least three days' notice for planning purposes.

CONTENTS IN BRIEF

- 1 Operations and Supply Chain Management 2**
Analytics Exercise: Comparing Companies Using Wall Street Efficiency Measures 23
- 2 Strategy and Sustainability 24**
- 3 Forecasting 44**
Analytics Exercise: Forecasting Supply Chain Demand—Starbucks Corporation 89
- 4 Strategic Capacity Management 92**
- 4a Learning Curves 114**
- 5 Projects 126**
Analytics Exercise: Product Design Project 164
- 6 Manufacturing Processes 166**
Analytics Exercise: Designing a Manufacturing Process 195
- 6a Break-Even Analysis 198**
- 7 Service Processes 202**
Analytics Exercise: Processing Customer Orders 235
- 8 Sales and Operations Planning 238**
Analytics Exercise: Developing an Aggregate Plan—Bradford Manufacturing 261
- 9 Material Requirements Planning 264**
Analytics Exercise: An MRP Explosion—Brunswick Motors 296
- 10 Quality Management and Six Sigma 298**
Analytics Exercise: Quality Management—Tesla 345
- 11 Inventory Management 348**
Analytics Exercise: Inventory Management at Big10Sweaters.com 392
- 12 Lean Supply Chains 396**
- 13 Global Sourcing and Procurement 428**
Analytics Exercise: Global Sourcing Decisions—Grainger: Reengineering the China/U.S. Supply Chain 451
- 14 Location, Logistics, and Distribution 454**
Analytics Exercise: Distribution Center Location—Grainger: Reengineering the China/U.S. Supply Chain 478

APPENDICES

-
- A** Linear Programming Using the Excel Solver 481
-
- B** Answers to Selected Objective Questions 504
-
- C** Present Value Table 506
-
- D** Negative Exponential Distribution: Values of e^{-x} 507
-
- E** Areas of the Cumulative Standard Normal Distribution 508
-

NAME INDEX 509

SUBJECT INDEX 510

CONTENTS

1 OPERATIONS AND SUPPLY CHAIN MANAGEMENT 2

- Strategy, Processes, and Analytics 2
- What Is Operations and Supply Chain Management? 4
- Operations and Supply Chain Processes* 6
- Differences between Services and Goods* 7
- The Goods–Services Continuum* 8
- Product–Service Bundling* 9
- Efficiency, Effectiveness, and Value 9
- How Does Wall Street Evaluate Efficiency?* 10
- Careers in Operations and Supply Chain Management 14
- Chief Operating Officer* 16
- Historical Development of Operations and Supply Chain Management 16
- Current Issues in Operations and Supply Chain Management* 19
 - Concept Connections* 19
 - Discussion Questions* 21
 - Objective Questions* 21
 - Analytics Exercise: Comparing Companies Using Wall Street Efficiency Measures* 23
 - Practice Exam* 23

2 STRATEGY AND SUSTAINABILITY 24

- Alphabet (Google) Operations Strategy 24
- A Sustainable Operations and Supply Chain Strategy 25
- What Is Operations and Supply Chain Strategy? 27
- Competitive Dimensions* 28
- The Notion of Trade-Offs* 30
- Order Winners and Order Qualifiers: The Marketing–Operations Link* 31
- Strategies Are Implemented Using Operations and Supply Chain Activities—IKEA's Strategy 31
- Assessing the Risk Associated with Operations and Supply Chain Strategies 33
- Risk Management Framework* 34
- Productivity Measurement 34
 - Concept Connections* 37
 - Solved Problem* 38
 - Discussion Questions* 39
 - Objective Questions* 39
 - Case: The Tao of Timbuk2* 42
 - Practice Exam* 43

3 FORECASTING 44

- From Bean to Cup: Starbucks Global Supply Chain Challenge 44
- Forecasting in Operations and Supply Chain Management 46
- Quantitative Forecasting Models 47
- Components of Demand* 48
- Time Series Analysis* 49
- Simple Moving Average* 50
- Weighted Moving Average* 52
- Exponential Smoothing* 53
- Exponential Smoothing with Trend* 55
- Linear Regression Analysis* 57
- Decomposition of a Time Series* 61
- Forecast Errors* 64
- Sources of Error* 64
- Measurement of Error* 65
- Causal Relationship Forecasting* 68
- Multiple Regression Analysis* 69
- Qualitative Techniques in Forecasting 70
- Market Research* 70
- Panel Consensus* 70
- Historical Analogy* 70
- The Delphi Method* 71
- Web-Based Forecasting: Collaborative Planning, Forecasting, and Replenishment (CPFR) 71
 - Concept Connections* 73
 - Solved Problems* 75
 - Discussion Questions* 80
 - Objective Questions* 81
 - Analytics Exercise: Forecasting Supply Chain Demand—Starbucks Corporation* 89
 - Practice Exam* 90

4 STRATEGIC CAPACITY MANAGEMENT 92

- Tesla—Manufacturing Capacity for the Model 3 93
- Capacity Management in Operations and Supply Chain Management 94
- Capacity Planning Concepts* 95
- Economies and Diseconomies of Scale* 95
- Capacity Focus* 96
- Capacity Flexibility* 96
- Capacity Planning 97

Considerations in Changing Capacity 97
Determining Capacity Requirements 99
 Using Decision Trees to Evaluate Capacity Alternatives 101
 Planning Service Capacity 104
Capacity Planning in Services versus Manufacturing 104
Capacity Utilization and Service Quality 105
 Concept Connections 106 *Solved Problem* 107
 Discussion Questions 109 *Objective Questions* 109
 Case: Shouldice Hospital—A Cut Above 111
 Practice Exam 113

4A LEARNING CURVES 114

The Learning Curve 114
 How Are Learning Curves Modeled? 116
Learning Curve Tables 119
 Concept Connections 122 *Solved Problems* 122
 Discussion Questions 123 *Objective Questions* 124

5 PROJECTS 126

Can a 15-Story Hotel Be Built in Less Than a Week? 126
 What Is Project Management? 127
 Organizing the Project Team 129
 Organizing Project Tasks 131
 Managing Projects 132
Earned Value Management (EVM) 134
 Network-Planning Models 138
 Critical Path Method (CPM) 138
 CPM with Three Activity Time Estimates 142
 Time–Cost Models and Project Crashing 145
 Project Management Information Systems 150
 Concept Connections 151 *Solved Problems* 152
 Discussion Questions 157 *Objective Questions* 157
 Analytics Exercise: Product Design Project 164
 Practice Exam 165

6 MANUFACTURING PROCESSES 166

Three-Dimensional Printing—The Technology Could Be Used to Make Parts That Perform Better and Cost Less 166
 Production Processes 167
 Production Process Mapping and Little's Law 170
 How Production Processes Are Organized 173
 Designing a Production System 175
 Assembly-Line and Continuous Process Layouts 178

Assembly-Line Design 178
Splitting Tasks 182
Flexible and U-Shaped Line Layouts 182
 Concept Connections 183 *Solved Problems* 185
 Discussion Questions 189 *Objective Questions* 190
 Advanced Problem 194
 Analytics Exercise: Designing a Manufacturing Process 195
 Practice Exam 197

6A BREAK-EVEN ANALYSIS 198

Solved Problems 199 *Objective Questions* 201

7 SERVICE PROCESSES 202

Amazon—A Retailer That Operates at a Different Level 202
 The Nature of Services 203
An Operational Classification of Services 204
Designing Service Organizations 204
Structuring the Service Encounter: Service–System Design Matrix 205
Web Platform Businesses 206
 Service Blueprinting and Fail-Safing 208
 Economics of the Waiting Line Problem 210
 The Practical View of Waiting Lines 210
 The Queuing System 212
 Waiting Lines and Servers 216
 Waiting Line Models 219
 Computer Simulation of Waiting Lines 224
 Concept Connections 227 *Solved Problems* 229
 Discussion Questions 230 *Objective Questions* 231
 Analytics Exercise: Processing Customer Orders 235
 Practice Exam 237

8 SALES AND OPERATIONS PLANNING 238

What Is Sales and Operations Planning? 240
Overview of Sales and Operations Planning Activities 240
The Aggregate Operations Plan 242
Production Planning Environment 243
Relevant Costs 245
 Aggregate Planning Techniques 246
A Cut-and-Try Example: The JC Company 246
 Yield Management 248
Operating Yield Management Systems 252

Concept Connections 253 *Solved Problems* 254
Discussion Questions 257 *Objective Questions* 257
*Analytics Exercise: Developing an Aggregate Plan—
Bradford Manufacturing* 261
Practice Exam 263

9 MATERIAL REQUIREMENTS PLANNING 264

Inside the iPhone X 264
Understanding Material Requirements
Planning 266
Where MRP Can Be Used 267
Master Production Scheduling 268
Time Fences 269
Material Requirements Planning System
Structure 270
Demand for Products 270
Bill-of-Materials 271
Inventory Records 273
The MRP Computer Program 274
An Example Using MRP 275
Forecasting Demand 275
Developing a Master Production Schedule 276
Bill-of-Materials (Product Structure) 276
Inventory Records 277
Performing the MRP Calculations 277
Lot Sizing in MRP Systems 281
Lot-for-Lot 281
Economic Order Quantity 282
Least Total Cost 283
Least Unit Cost 283
Choosing the Best Lot Size 284
Concept Connections 285 *Solved Problems* 286
Discussion Questions 291 *Objective Questions* 292
*Analytics Exercise: An MRP Explosion—Brunswick
Motors* 296
Practice Exam 297

10 QUALITY MANAGEMENT AND SIX SIGMA 298

Disney—An Obsession with Quality and
Innovation 298
Total Quality Management 300
Quality Specifications and Quality Costs 301
ISO 9000 and ISO 14000 304
External Benchmarking for Quality Improvement 307
Six Sigma Quality 307
Six Sigma Methodology 308

Analytical Tools for Six Sigma 309
Statistical Quality Control 312
Understanding and Measuring Process Variation 314
Process Capability 315
Statistical Process Control Procedures 321
*Process Control with Attribute Measurements: Using
p-Charts* 321
*Process Control with Attribute Measurements: Using
c-Charts* 324
*Process Control with Variable Measurements:
Using \bar{X} - and R-Charts* 325
How to Construct \bar{X} - and R-Charts 326
Acceptance Sampling 329
Design of a Single Sampling Plan for Attributes 329
Operating Characteristic Curves 331
Concept Connections 332 *Solved Problems* 335
Discussion Questions 338 *Objective Questions* 339
Analytics Exercise: Quality Management—Tesla 345
Practice Exam 346

11 INVENTORY MANAGEMENT 348

Amazon—The Master of Inventory Management 348
Understanding Inventory Management 350
Definition of Inventory 352
Purposes of Inventory 352
Inventory Costs 353
Independent versus Dependent Demand 354
Inventory Systems 355
A Single-Period Inventory Model 355
Multiperiod Inventory Systems 359
Fixed-Order Quantity Models 360
Establishing Safety Stock Levels 363
Fixed-Order Quantity Model with Safety Stock 364
Fixed-Time Period Models 368
Fixed-Time Period Model with Safety Stock 368
Inventory Turn Calculations 370
The Price-Break Model 371
Inventory Planning and Accuracy 373
ABC Classification 374
Inventory Accuracy and Cycle Counting 375
Concept Connections 377 *Solved Problems* 379
Discussion Questions 383 *Objective
Questions* 383
*Analytics Exercise: Inventory Management at
Big10Sweaters.com* 392
Practice Exam 395

12 LEAN SUPPLY CHAINS 396

- Toyota—New Global Architecture 396
- Lean Production 397
- The Toyota Production System* 399
- Lean Supply Chains 400
- Value Stream Mapping 402
- Lean Supply Chain Design Principles 404
- Lean Concepts* 406
- Lean Production Schedules* 407
- Lean Supply Chains* 412
- Lean Services 413
 - Concept Connections* 415 *Solved Problems* 417
 - Discussion Questions* 421 *Objective Questions* 421
 - Case: Quality Parts Company* 423
 - Case: Value Stream Mapping* 424
 - Case: Pro Fishing Boats—A Value Stream Mapping Exercise* 426
 - Practice Exam* 427

13 GLOBAL SOURCING AND PROCUREMENT 428

- Boeing 787 Dreamliner—Assembled in South Carolina from Components Sourced from around the World 428
- Strategic Sourcing 429
 - The Bullwhip Effect* 431
 - Supply Chain Uncertainty Framework* 432
- Outsourcing 435
 - Logistics Outsourcing* 436
 - Framework for Supplier Relationships* 436
 - Green Sourcing* 438
- Total Cost of Ownership 441
- Measuring Sourcing Performance 444
 - Concept Connections* 446 *Discussion Questions* 447 *Objective Questions* 448
 - Analytics Exercise: Global Sourcing Decisions—Grainger: Reengineering the China/U.S. Supply Chain* 451
 - Practice Exam* 453

14 LOCATION, LOGISTICS, AND DISTRIBUTION 454

- FedEx—Speed Is Hidden in Its Logo 454
- Logistics 455
- Decisions Related to Logistics 456
 - Transportation Modes* 457
 - Warehouse Design* 458
- Locating Logistics Facilities 458
 - Plant Location Methods* 460
 - Locating Service Facilities* 466
 - Concept Connections* 469 *Solved Problems* 470
 - Discussion Questions* 474 *Objective Questions* 475
 - Analytics Exercise: Distribution Center Location—Grainger: Reengineering the China/U.S. Supply Chain* 478
 - Practice Exam* 480

APPENDICES

- A** Linear Programming Using the Excel Solver 481
- B** Answers to Selected Objective Questions 504
- C** Present Value Table 506
- D** Negative Exponential Distribution: Values of e^{-x} 507
- E** Areas of the Cumulative Standard Normal Distribution 508

NAME INDEX 509

SUBJECT INDEX 510

Operations and Supply Chain Management: The Core



CHAPTER 2

STRATEGY AND SUSTAINABILITY

Learning Objectives

- LO2-1** Know what a sustainable business strategy is and how it relates to operations and supply chain management.
- LO2-2** Define operations and supply chain strategy.
- LO2-3** Explain how operations and supply chain strategies are implemented.
- LO2-4** Understand why strategies have implications relative to business risk.
- LO2-5** Evaluate productivity in operations and supply chain management.

ALPHABET (GOOGLE) OPERATIONS STRATEGY

Starting as Google in 1998 in the search engine business, Alphabet, now the parent company, has developed a diverse portfolio of products that include self-driving car technology, mapping-enabled cameras, thermostats that learn, smoke alarms, and electronic lighting switches. Each division of Alphabet operates as a separate brand such as Google, Calico, Nest, and others.

The divisions are run much like start-ups, where the entrepreneurs can build and run the entity with the autonomy and speed needed to develop innovative

products and interconnected services. The resources needed by these divisions are provided by Alphabet under the watchful eye of the founders of the company. Innovative apps like Google Drive, Maps, Play, YouTube, Chrome, Calendar, Gmail, and many others have each attracted over a billion users. These products are designed to engage customers in the Alphabet web ecosystem. Alphabet makes money by selling products and via advertising through the Internet platform.

More recently, machine learning and artificial intelligence (AI) has been the emphasis. This has resulted in the integration of the Android software platform with products like the Pixel cell phone and Google Home smart speaker with the search engine technology. Alphabet now has a rich bundle of products and services that continue to grow. This growth is often driven through acquisitions that are quickly integrated into the Alphabet corporate culture.



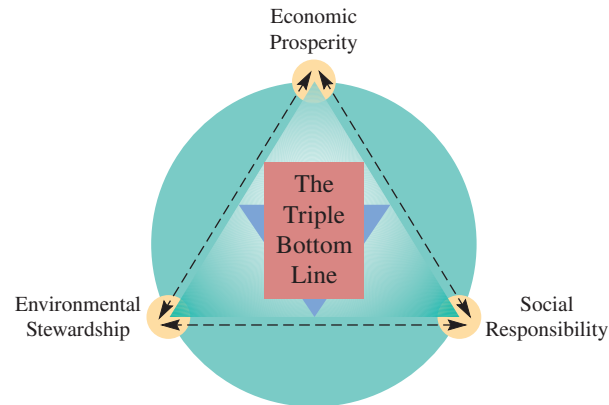
A SUSTAINABLE OPERATIONS AND SUPPLY CHAIN STRATEGY

Strategy should describe how a firm intends to create and sustain value for its current shareholders. By adding **sustainability** to the concept, we add the requirement to meet these current needs without compromising the ability of future generations to meet their own needs. *Shareholders* are those individuals or companies that legally own one or more shares of stock in the company. Many companies today have expanded the scope of their strategy to include stakeholders. *Stakeholders* are those individuals or organizations that are influenced, either directly or indirectly, by the actions of the firm. This expanded view means that the scope of the firm's strategy must not only focus on the economic viability of its shareholders, but should also consider the environmental and social impact on key stakeholders.

Sustainability

The ability to meet current resource needs without compromising the ability of future generations to meet their needs.

LO2-1 Know what a sustainable business strategy is and how it relates to operations and supply chain management.

exhibit 2.1 The Triple Bottom Line


Triple bottom line
Evaluating the firm against social, economic, and environmental criteria.

To capture this expanded view, the phrase **triple bottom line** has been coined. The triple bottom line, Exhibit 2.1, considers evaluating the firm against social, economic, and environmental criteria. Many companies have developed this expanded view through goals that relate to sustainability along each of these dimensions. Some alternative phrases for the same concept are “People, Planet, and Profit” used by Shell Oil Company, and “Folk, Work, and Place” which originated with the twentieth-century writer Patrick Geddes. The following expands on the meaning of each dimension of the triple bottom line framework.

- **Social responsibility** pertains to fair and beneficial business practices toward labor, the community, and the region in which a firm conducts its business. A triple bottom line company seeks to benefit its employees, the community, and other social entities that are impacted by the firm’s existence. A company should not use child labor, and should pay fair salaries to its workers, maintain a safe work environment with tolerable working hours, and not otherwise exploit a community or its labor force.

A business can also give back by contributing to the strength and growth of its community through health care, education, and other special programs.

- **Economic prosperity** means the firm is obligated to compensate shareholders who provide capital through stock purchases and other financial instruments via a competitive return on investment. Company strategies should promote growth and grow long-term value to this group in the form of profit. Within a sustainability framework, this dimension goes beyond just profit for the firm; it also provides lasting economic benefit to society.
- **Environmental stewardship** refers to the firm’s impact on the environment. The company should protect the environment as much as possible—or at least cause no harm. Managers



THE GAP CORPORATE HEADQUARTERS BUILDING UTILIZES A GREEN ROOF WITH SOLAR PANELS.

©Steve Proehl/Getty Images

should move to reduce a company's ecological footprint by carefully managing its consumption of natural resources and by reducing waste. Many businesses now conduct "cradle-to-grave" assessments of products to determine what the true environmental costs are—from processing the raw material to manufacture to distribution to eventual disposal by the final customer.

Conventional strategy focuses on the economic part of this framework. Because many of the processes that fall under the domain of operations and supply chain management have a social and environmental impact, it is important these criteria be considered as well. Some proponents argue that in many ways European Union countries are more advanced due to the standardized reporting of ecological and social losses that came with the adoption of the euro.

Although many company planners agree with the goals of improving society and preserving the environment, many others disagree. Dissenting arguments relate to the potential loss of efficiency due to the focus on conflicting criteria. Others argue that these goals may be appropriate only for rich societies that can afford to contribute to society and the environment. A company in a poor or developing society/nation must focus on survival. The economic benefit derived from the use of abundant local resources may be viewed as worth their destruction.

In this chapter, we take a customer-centered approach; issues associated with people and the environment are left to an individual case approach. Depending on the country, industry, and scope of the firm, these other issues vary widely, and it would be difficult to provide a general approach for analysis. The issues and their relationship to operations and supply chain management are very real, however, and we anticipate they will become even more relevant in the future.

WHAT IS OPERATIONS AND SUPPLY CHAIN STRATEGY?

Operations and supply chain strategy is concerned with setting broad policies and plans for using the resources of a firm and must be integrated with corporate strategy. So, for example, if the high-level corporate strategy includes goals related to the environment and social responsibility, then the operations and supply chain strategy must consider these goals. A major focus to the operations and supply chain strategy is operations effectiveness. **Operations effectiveness** relates to the core business processes needed to run the business. The processes span all the business functions, from taking customer orders, handling returns, manufacturing, and managing the updating of the Web site, to shipping products. Operational effectiveness is reflected directly in the costs associated with doing business. Strategies associated with operational effectiveness, such as quality assurance and control initiatives, process redesign, planning and control systems, and technology investments, can show quick near-term (12 to 24 months) results.

Operations and supply chain strategy can be viewed as part of a planning process that coordinates operational goals with those of the larger organization. Since the goals of the larger organization change over time, the operations strategy must be designed to anticipate future needs. A firm's operations and supply chain capabilities can be viewed as a portfolio best suited to adapting to the changing product and/or service needs of the firm's customers.

Next, we focus on integrating operations and supply chain strategy with a firm's operations capabilities. This involves decisions that relate to the design of the processes and

Operations and supply chain strategy

The setting of broad policies and plans that will guide the use of the resources needed by the firm to implement its corporate strategy.

LO2-2 Define operations and supply chain strategy.

Operations effectiveness

Performing activities in a manner that best implements strategic priorities at minimum cost.

infrastructure needed to support these processes. Process design includes selecting the appropriate technology, sizing the process over time, determining the role of inventory in the process, and locating the process. The infrastructure decisions involve the logic associated with the planning and control systems, quality assurance and control approaches, work payment structure, and organization of the operations and supply functions. A firm's operations capabilities can be viewed as a portfolio best suited to adapting to the changing product and/or service needs of a firm's customers.

Competitive Dimensions

Given the choices customers face today, how do they decide which product or service to buy? Different customers are attracted by different attributes. Some customers are interested primarily in the cost of a product or service and, correspondingly, some companies attempt to position themselves to offer the lowest prices. The major competitive dimensions that form the competitive position of a firm are discussed next.

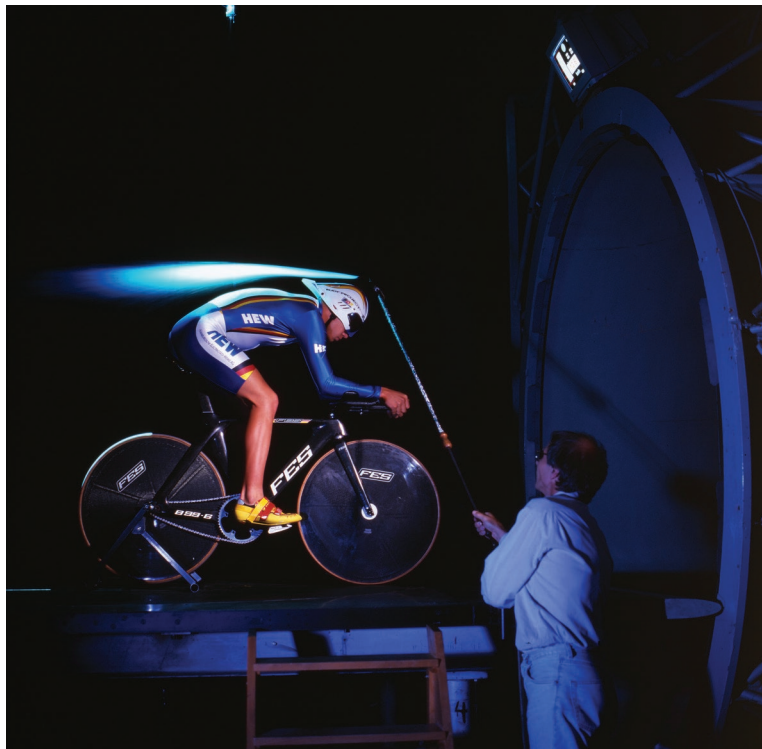
Cost or Price: “Make the Product or Deliver the Service Cheap” Within every industry, there is usually a segment of the market that buys solely on the basis of low cost. To successfully compete in this niche, a firm must be the low-cost producer, but even this does not always guarantee profitability and success. Products and services sold strictly on the basis of cost are typically commodity-like; in other words, customers cannot distinguish the product or service of one firm from that of another. This segment of the market is frequently very large, and many companies are lured by the potential for significant profits,

which they associate with the large unit volumes. As a consequence, however, competition in this segment is fierce—and the failure rate high. After all, there can be only one low-cost producer, who usually establishes the selling price in the market.

Price, however, is not the only basis on which a firm can compete (although many economists appear to assume it is!). Other companies, such as BMW, seek to attract people who want *higher quality*—in terms of performance, appearance, or features—than what is available in competing products and services, even though it means a higher price.

Quality: “Make a Great Product or Deliver a Great Service”

There are two characteristics of a product or service that define quality: design quality and process quality. Design quality relates to the set of features the product or service contains. Obviously, a child's first two-wheel bicycle is of significantly different quality than the bicycle of a world-class cyclist. The use of special aluminum alloys and special lightweight sprockets



AN AERODYNAMICS EXPERT LOGS RESULTS FROM A WIND TUNNEL TEST FOR CYCLING CLOTHING AND RACING BICYCLE DESIGN.

©imageBROKER/REX/Shutterstock

and chains is important to the performance needs of the advanced cyclist. These two types of bicycles are designed for different customers' needs. The higher-quality cyclist product commands a higher price in the marketplace due to its special features. The goal in establishing the proper level of design quality is to focus on the requirements of the customer. Overdesigned products and services with too many or inappropriate features will be viewed as prohibitively expensive. In comparison, underdesigned products and services will lose customers to products that cost a little more but are perceived by customers as offering greater value.

Process quality, the second characteristic of quality, is critical because it relates directly to the reliability of the product or service. Regardless of whether the product is a child's first two-wheeler or a bicycle for an international cyclist, customers want products without defects. Thus, the goal of process quality is to produce defect-free products and services. Product and service specifications, given in dimensional tolerances and/or service error rates, define how the product or service is to be made. Adherence to these specifications is critical to ensure the reliability of the product or service as defined by its intended use.

Delivery Speed: "Make the Product or Deliver the Service Quickly" In some markets, a firm's ability to deliver more quickly than its competitors is critical. A company that can offer an onsite repair service in only 1 or 2 hours has a significant advantage over a competing firm that guarantees service only within 24 hours.

Delivery Reliability: "Deliver It When Promised" This dimension relates to the firm's ability to supply the product or service on or before a promised delivery due date. For an automobile manufacturer, it is very important that its supplier of tires provide the needed quantity and types for each day's car production. If the tires needed for a particular car are not available when the car reaches the point on the assembly line where the tires are installed, the whole assembly line may have to be shut down until they arrive. For a service firm such as Federal Express, delivery reliability is the cornerstone of its strategy.

Coping with Changes in Demand: "Change Its Volume" In many markets, a company's ability to respond to increases and decreases in demand is important to its ability to compete. It is well known that a company with increasing demand can do little wrong. When demand is strong and increasing, costs are continuously reduced due to economies of scale, and investments in new technologies can be easily justified. But scaling back when demand decreases may require many difficult decisions about laying off employees and determining reductions in assets. The ability to effectively deal with dynamic market demand over the long term is an essential element of operations strategy.

Flexibility and New-Product Introduction Speed: "Change It" Flexibility, from a strategic perspective, refers to the ability of a company to offer a wide variety of products to its customers. An important element of this ability to offer different products is the time required for a company to develop a new product and to convert its processes to offer the new product.

Other Product-Specific Criteria: "Support It" The competitive dimensions just described are certainly the most common. However, other dimensions often relate to specific products or situations. Notice that most of the dimensions listed next are primarily services in nature. Often, special services are provided to augment the sales of manufactured products.

1. **Technical liaison and support.** A supplier may be expected to provide technical assistance for product development, particularly during the early stages of design and manufacturing.

2. **Ability to meet a launch date.** A firm may be required to coordinate with other firms on a complex project. In such cases, manufacturing may take place while development work is still being completed. Coordinating work between firms and having them work simultaneously on a project will reduce the total time required to complete the project.
3. **Supplier after-sales support.** An important competitive dimension may be the ability of a firm to support its product after the sale. This involves the availability of replacement parts and, possibly, the modification of older, existing products, bringing them up to new performance levels. The speed of response to these after-sale needs is often important as well.
4. **Environmental impact.** A dimension related to criteria such as carbon dioxide emissions, the use of nonrenewable resources, and other factors that relate to sustainability.
5. **Other dimensions.** These typically include such factors as the colors available, size, weight, location of the fabrication site, the customization available, and product mix options.

The Notion of Trade-Offs

Central to the concept of operations and supply chain strategy is the notion of operations focus and trade-offs. The underlying logic is that an operation cannot excel simultaneously on all competitive dimensions. Consequently, management has to decide which parameters of performance are critical to the firm's success and then concentrate the resources of the firm on these particular characteristics.

For example, if a company wants to focus on the speed of delivery, it cannot be very flexible in its ability to offer a wide range of products. Similarly, a low-cost strategy is not compatible with either speed of delivery or flexibility. High quality also is viewed as a trade-off to low cost.

A strategic position is not sustainable unless there are compromises with other positions. Trade-offs occur when activities are incompatible so that more of one thing necessitates less of another. An airline can choose to serve meals—adding cost and slowing turnaround time at the gate—or it can choose not to, but it cannot do both without bearing major inefficiencies.

Straddling occurs when a company seeks to match the benefits of a successful position while maintaining its existing position. It adds new features, services, or technologies onto the activities it already performs. The risky nature of this strategy is shown by Continental Airlines' ill-fated attempt to compete with Southwest Airlines. While maintaining its position as a full-service airline, Continental set out to match Southwest on a number of point-to-point routes. The airline dubbed the new service Continental Lite. It eliminated meals and first-class service, increased departure frequency, lowered fares, and shortened gate turnaround time. Because Continental remained a full-service airline on other routes, it continued to use travel agents and its mixed fleet of planes and to provide baggage checking and seat assignments.

Trade-offs ultimately grounded Continental Lite. The airline lost hundreds of millions of dollars, and the chief executive officer lost his job. Its planes were delayed, leaving hub cities congested, slowed at the gate by baggage transfers. Late flights and cancellations generated a thousand complaints a day. Continental Lite could not afford to compete on price and still pay standard travel agent commissions, but neither could it do without agents for its full-service business. The airline compromised by cutting commissions for all Continental flights. Similarly, it could not afford to offer the same frequent-flier benefits to travelers paying the much lower ticket prices for Lite service. It compromised again

Straddling

When a firm seeks to match what a competitor is doing by adding new features, services, or technologies to existing activities. This often creates problems if certain trade-offs need to be made.

by lowering the rewards of Continental's entire frequent-flier program. The results: angry travel agents and full-service customers. Continental tried to compete in two ways at once and paid an enormous straddling penalty.

Order Winners and Order Qualifiers: The Marketing–Operations Link

A well-designed interface between marketing and operations is necessary to provide a business with an understanding of its markets from both perspectives. The terms *order winner* and *order qualifier* describe marketing-oriented dimensions that are key to competitive success. An **order winner** is a criterion that differentiates the products or services of one firm from those of another. Depending on the situation, the order-winning criterion may be the cost of the product (price), product quality and reliability, or any of the other dimensions developed earlier. An **order qualifier** is a screening criterion that permits a firm's products to even be considered as possible candidates for purchase.

For example, consider your purchase of a notebook computer. You might think that such features as screen size, weight, operating system version, and cost are important *qualifying* dimensions. But the order-winning feature that actually *differentiates* one notebook computer candidate from another for you is battery life. In doing your search, you develop a list of computers that all have 14-inch screens, weigh less than three pounds, run the latest Microsoft Windows operating system, and cost less than \$1,000. From this list of acceptable computers, you select the one that has the longest battery life.

In an industrial setting where a firm is deciding on a supplier, the decision can be quite different. Here, consider a firm that is deciding on a supplier for its office supplies. Companies such as Office Depot, Quill, or Staples might be candidates. Here, the qualifying dimensions are the following: Can the company supply the items needed? Can the supplier deliver orders within 24 hours? Are the items guaranteed? And is a private Web-based catalog available? Companies that have these capabilities would *qualify* for consideration as possible suppliers. The order winner might be the discount schedule that the company offers on the price of the items purchased.

Order winners

One or more specific marketing-oriented dimensions that clearly differentiate a product from competing products.

Order qualifiers

Dimensions used to screen a product or service as a candidate for purchase.

STRATEGIES ARE IMPLEMENTED USING OPERATIONS AND SUPPLY CHAIN ACTIVITIES—IKEA'S STRATEGY

All the activities that make up a firm's operation relate to one another. To make these activities efficient, the firm must minimize its total cost without compromising customers' needs.

To demonstrate how this works, consider how IKEA, the Swedish retailer of home products, implements its strategy using a set of unique activities. IKEA targets young furniture buyers who want style at a low cost. IKEA has chosen to perform activities differently than its rivals.

Consider the typical furniture store, where showrooms display samples of the merchandise. One area may contain many sofas, another area displays dining tables, and there are many other areas focused on particular types of furniture. Dozens of books displaying fabric swatches or wood samples or alternative styles offer customers thousands of product varieties from which to choose. Salespeople escort customers through the store, answering questions and helping them navigate the maze of choices. Once a customer

LO2-3 Explain how operations and supply chain strategies are implemented.



©Michael Gordon/Shutterstock

decides what he or she wants, the order is relayed to a third-party manufacturer. With a lot of luck, the furniture will be delivered to the customer’s home within six to eight weeks. This is a supply chain that maximizes customization and service, but does so at a high cost.

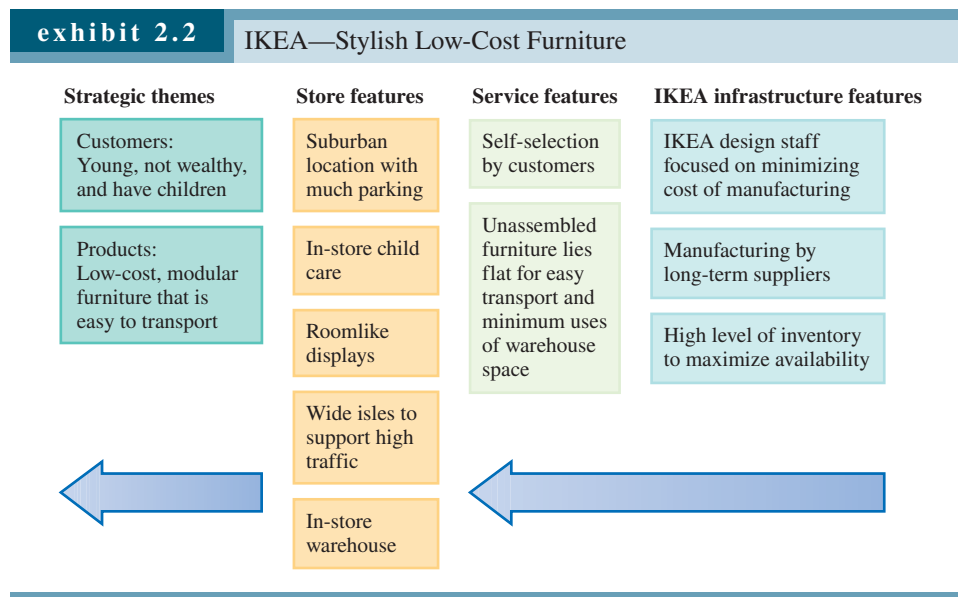
In contrast, IKEA serves customers who are happy to trade service for cost. Instead of using sales associates, IKEA uses a self-service model with roomlike displays where furniture is shown in familiar settings. Rather than relying on third-party manufacturers, IKEA designs its own low-cost, modular, ready-to-assemble furniture. In the store, there is a warehouse section with the products in boxes ready for delivery. Customers do their own picking from inventory and deliv-

ery. Much of its low-cost operation comes from having customers service themselves, yet IKEA offers extra services, such as in-store child care and extended hours. Those services align well with the needs of its customers, who are young, not wealthy, and likely to have children, and who need to shop at odd hours.

Exhibit 2.2 shows how IKEA’s strategy is implemented through a set of activities designed to deliver it. **Activity-system maps** such as the one for IKEA show how a company’s strategy is delivered through a set of tailored activities. In companies with a clear strategy, a number of higher-order strategic themes (in darker blue) can be identified and implemented through clusters of tightly linked activities. This type of map can be useful in understanding how good the fit is between the system of activities and the company’s strategy. Competitive advantage comes from the way a firm’s activities fit with and reinforce one another.

Activity-system maps

Diagrams that show how a company’s strategy is delivered through a set of supporting activities.



ASSESSING THE RISK ASSOCIATED WITH OPERATIONS AND SUPPLY CHAIN STRATEGIES

The devastating earthquake and tsunami that hit Japan in March 2011 are a grim reminder that managing risk is a critical part of developing an effective operations and supply chain strategy.

The uncertainty in the global environment where most supply chains operate requires strategic planners to evaluate the relative riskiness of their operations and supply chain strategies. **Supply chain risk** is defined as the likelihood of a disruption that would impact the ability of the company to continuously supply products or services. Supply chain disruptions are unplanned and unanticipated events that disrupt the normal flow of goods and materials within a supply chain, and that expose firms within the supply chain to operational and financial risks. Operations and supply chain strategies must consider the risk in their supply chains and develop initiatives to cope with these disruptions and mitigate their impact on the business.

We can categorize risk by viewing the inherent uncertainties related to operations and supply chain management along two dimensions: (1) supply chain coordination risks that are associated with the day-to-day management of the supply chain, which are normally dealt with using safety stock, safety lead time, overtime, and so on; and (2) disruption risks, which are caused by natural or human-made disasters, such as earthquakes, hurricanes, and terrorism.

In this section, our focus is on the concepts and tools that are useful for managing the problems related to disruption risks. The events related to these risks are highly random and virtually impossible to predict with any precision.

LO2-4 Understand why strategies have implications relative to business risk.

Supply chain risk

The likelihood of a disruption that would impact the ability of a company to continuously supply products or services.



THE PORT OF TOKYO IS EMPTY OF SHIPPING VESSELS TWO WEEKS AFTER THE DEVASTATING EARTHQUAKE AND TSUNAMI IN 2011 THAT TRIGGERED A NUCLEAR CRISIS. SHIPPING COMPANIES AVOIDED DOCKING THEIR SHIPS DUE TO RADIATION FEARS, CAUSING MAJOR DELAYS IN JAPAN'S SUPPLY CHAIN.

©ASSOCIATED PRESS ©GAMMA/Gamma-Rapho/Getty Images

Risk Management Framework

The nature of these types of risks lends them to a three-step risk management process that can be applied to situations where disruptions are possible. The three steps are as follows:

1. *Identify the sources of potential disruptions.* Assessing a type of vulnerability is the first step in the risk management framework. These are highly situation-dependent, but the focus should be on highly unlikely events that would cause a significant disruption to normal operations. Such types of events include: natural disasters, capacity failures, infrastructure failures (e.g., air traffic system), terrorists, supplier failures, labor actions, equipment failures, commodity price volatility, and military/civil conflict.
2. *Assess the potential impact of the risk.* Here the goal is to quantify the probability and the potential impact of the risk. Depending on the specific incident, this assessment could be based on financial impact, environmental impact, ongoing business viability, brand image/reputation, potential human lives, and so on.
3. *Develop plans to mitigate the risk.* A detailed strategy for minimizing the impact of the risk could take many different forms, depending on the nature of the problem.

Risk mapping involves assessment of the probability or relative frequency of an event against the aggregate severity of the loss. Depending on the evaluation, some risks might be deemed acceptable and the related costs considered a normal cost of doing business. In some cases, the firm may find it is possible to insure against the loss. There may be other cases where the potential loss is so great that the risk would need to be avoided altogether.

A matrix (see Exhibit 2.3) that maps risks against specific operations and supply chain strategies is commonly used. The matrix helps us understand the impact of different types of supply chain disruptions when using specific operations and supply chain strategies. For example, the first column evaluates the impact of natural hazards. Here, we see that sole sourcing, lean practices, and the use of distribution hubs can have a major impact on the firm.

Unfortunately, some of the most cost-effective strategies are also the riskiest. It is important to keep this in mind as you consider each concept. Thus far in the book, we have not discussed specific operations and supply chain strategies, such as outsourcing and sole sourcing. You will learn about these as we progress through the book.

PRODUCTIVITY MEASUREMENT

LO2-5 Evaluate productivity in operations and supply chain management.

Productivity

A measure of how well resources are used.

Productivity is a common measure of how well a country, industry, or business unit is using its resources (or factors of production). Since operations and supply chain management focuses on making the best use of the resources available to a firm, productivity measurement is fundamental to understanding operations-related performance. In this section, we define various measures of productivity. Throughout the rest of the book, many other performance measures will be defined as they relate to the material.

In its broadest sense, productivity is defined as

$$\text{Productivity} = \frac{\text{Outputs}}{\text{Inputs}} \quad [2.1]$$

To increase productivity, we want to make this ratio of outputs to inputs as large as practical.

Risk Mitigation Strategies		exhibit 2.3							
Risks	RISK MITIGATION STRATEGY								
Natural disaster (e.g., climate change, weather)	Contingency planning (alternate sites, etc.), insurance								
Country risks	Currency hedging, locally producing/sourcing								
Supplier failures	Multiple suppliers								
Network provider failure	Support of redundant digital networks								
Regulatory risk (e.g., licensing and regulation issues)	Up-front and continuing research; good legal advice, compliance								
Commodity price risks	Multisourcing, commodity hedging								
Logistics failure	Safety stock, detailed tracking, and alternate suppliers								
Inventory risks	Pool inventory, safety stock								
Major quality failure	Careful selection and monitoring of suppliers								
Loss of customers	Service/product innovation								
Theft and vandalism	Insurance, security precautions, knowledge of likely risks, patent protection, etc.								

	Natural/ human-made disasters	Country risks	Supplier failure	Network provider failure	Regulatory risk	Commodity price risks	Logistics failure	Inventory risks	Quality risks
Outsourcing	High impact	High impact	No impact	High impact	High impact	No impact	Moderate impact	No impact	High impact
Sole sourcing	High impact	Moderate impact	High impact	High impact	No impact	Moderate impact	No impact	No impact	High impact
Lean practices	High impact	No impact	Moderate impact	No impact	No impact	Moderate impact	High impact	High impact	Moderate impact
Distribution hubs	High impact	No impact	No impact	Moderate impact	No impact	Moderate impact	High impact	No impact	No impact

High impact	Moderate impact	No impact
-------------	-----------------	-----------

Productivity is what we call a *relative measure*. In other words, to be meaningful, it needs to be compared with something else. For example, what can we learn from the fact that we operate a restaurant and that its productivity last week was 8.4 customers per labor hour? Nothing!

Productivity comparisons can be made in two ways. First, a company can compare itself with similar operations within its industry, or it can use industry data when such data are available (e.g., comparing productivity among the different stores in a franchise). Another approach is to measure productivity over time within the same operation. Here we would compare our productivity in one time period with that in the next.

As Exhibit 2.4 shows, productivity may be expressed as partial measures, multifactor measures, or total measures. If we are concerned with the ratio of some output to a single input, we have a *partial productivity measure*. If we want to look at the ratio of some output to a group of inputs (but not all inputs), we have a *multifactor productivity measure*. If we want to express the ratio of all outputs to all inputs, we can use a *total factor measure of productivity* to describe the productivity of an entire organization or even a nation.

exhibit 2.4

Partial measure	$\frac{\text{Output}}{\text{Labor}}$ or $\frac{\text{Output}}{\text{Capital}}$ or $\frac{\text{Output}}{\text{Materials}}$ or $\frac{\text{Output}}{\text{Energy}}$
Multifactor measure	$\frac{\text{Output}}{\text{Labor} + \text{Capital} + \text{Energy}}$ or $\frac{\text{Output}}{\text{Labor} + \text{Capital} + \text{Materials}}$
Total measure	$\frac{\text{Output}}{\text{Inputs}}$ or $\frac{\text{Goods and services produced}}{\text{All resources used}}$

INPUT AND OUTPUT PRODUCTION DATA (\$1,000) PRODUCTIVITY MEASURE EXAMPLES

OUTPUT		Total measure
1. Finished units	\$10,000	$\frac{\text{Total output}}{\text{Total input}} = \frac{13,500}{15,193} = 0.89$
2. Work-in-process	2,500	
3. Dividends	1,000	
Total output	\$13,500	Multifactor measures: $\frac{\text{Total output}}{\text{Labor} + \text{Material}} = \frac{13,500}{3,153} = 4.28$ $\frac{\text{Finished units}}{\text{Labor} + \text{Material}} = \frac{10,000}{3,153} = 3.17$
INPUT		Partial measures:
1. Labor	\$ 3,000	$\frac{\text{Total output}}{\text{Energy}} = \frac{13,500}{540} = 25$
2. Material	153	
3. Capital	10,000	$\frac{\text{Finished units}}{\text{Energy}} = \frac{10,000}{540} = 18.52$
4. Energy	540	
5. Other expenses	1,500	
Total input	\$15,193	



**Excel:
Productivity
Measures**

Partial Measures of Productivity

BUSINESS	PRODUCTIVITY MEASURE
Restaurant	Customers (meals) per labor hour
Retail store	Sales per square foot
Chicken farm	Pounds of meat per pounds of feed
Utility plant	Kilowatt-hours per ton of coal
Paper mill	Tons of paper per cord of wood

A numerical example of productivity appears in Exhibit 2.4. The data reflect quantitative measures of input and output associated with the production of a certain product. Notice that for the multifactor and partial measures, it is not necessary to use total output as the numerator. Often, it is desirable to create measures that represent productivity as it relates to some particular output of interest. Using Exhibit 2.4 as an example, total units might be the output of interest to a production control manager, whereas total output may be of key interest to the plant manager. This process of aggregation and disaggregation of productivity measures provides a means of shifting the level of the analysis to suit a variety of productivity measurement and improvement needs.

Exhibit 2.4 shows all units in dollars. Often, however, management can better understand how the company is performing when units other than dollars are used. In these

cases, only partial measures of productivity can be used, because we cannot combine dissimilar units such as labor hours and pounds of material. Examples of some commonly used partial measures of productivity are presented in Exhibit 2.4. Such partial measures of productivity give managers information in familiar units, allowing them to easily relate these measures to the actual operations.

Each summer, *USA Today* publishes annual reports of productivity gains by the largest U.S. firms. Productivity has been on the rise for many years now, which is very good for the economy. Productivity often increases in times of recession; as workers are fired, those remaining are expected to do more. Increases also come from technological advances. Think of what the tractor did for farm productivity.

CONCEPT CONNECTIONS

LO2-1 Know what a sustainable business strategy is and how it relates to operations and supply chain management.

- A strategy that is sustainable needs to create value for the firm's shareholders and stakeholders.
- The shareholders are equity owners in the company.
- The stakeholders are those individuals and organizations that are influenced by the actions of the firm.
- This view means that a firm's strategy must focus not only on economic viability, but also on the environmental and social impact of its actions.

Sustainability The ability to meet current resource needs without compromising the ability of future generations to meet their needs.

Triple bottom line Evaluating the firm against social, economic, and environmental criteria.

LO2-2 Define operations and supply chain strategy.

- This involves setting the broad policies of a firm and creating a plan for using that firm's resources.
- The operations and supply chain strategy coordinates operational goals with those of the larger organization.
- A firm's operational capabilities should match the changing product or service needs of the firm's customers.

Major competitive dimensions that form the competitive position of a firm include:

- Cost
- Quality
- Delivery speed and reliability
- Changes in volume
- Flexibility and new-product introduction speed
- Other product-specific criteria

Usually there are trade-offs that occur relative to these competitive dimensions.

Operations and supply chain strategy The setting of broad policies and plans that will guide the use of the resources needed by the firm to implement its corporate strategy.

Operations effectiveness Performing activities in a manner that best implements strategic priorities at minimum cost.

Straddling When a firm seeks to match what a competitor is doing by adding new features, services, or technologies to existing activities. This often creates problems if certain trade-offs need to be made.

Order winners One or more specific marketing-oriented dimensions that clearly differentiate a product from competing products.

Order qualifiers Dimensions used to screen a product or service as a candidate for purchase.

LO2-3 Explain how operations and supply chain strategies are implemented.

- Strategies are implemented through a set of activities designed to deliver products and services in a manner consistent with the firm's overall business strategy.

Activity-system maps Diagrams that show how a company's strategy is delivered through a set of supporting activities.

LO2-4 Understand why strategies have implications relative to business risk.

- Operations and supply chain strategies need to be evaluated relative to their riskiness.
- Supply chain disruptions are unplanned and unanticipated events that disrupt the normal flow of goods and materials.
- Risks can be categorized along two dimensions: supply chain coordination risks and disruption risks.
- A three-step risk management framework involves identifying the potential disruptions, assessing the potential impact of the risk, and developing plans to mitigate the risk.

Supply chain risk The likelihood of a disruption that would impact the ability of a company to continuously supply products or services.

LO2-5 Evaluate productivity in operations and supply chain management.

- Productivity measures are used to ensure that the firm makes the best use of its resources.
- Since these are relative measures, they are meaningful only if they are compared to something else. Often, the comparison is to another company.

Productivity A measure of how well resources are used.

$$\text{Productivity} = \frac{\text{Outputs}}{\text{Inputs}} \quad [2.1]$$

SOLVED PROBLEMS

A furniture manufacturing company has provided the following data (units are \$1,000). Compare the labor, raw materials and supplies, and total productivity for the past two years.

		LAST YEAR	THIS YEAR
Output:	Sales value of production	\$22,000	\$35,000
Input:	Labor	10,000	15,000
	Raw materials and supplies	8,000	12,500
	Capital equipment depreciation	700	1,200
	Other	2,200	4,800

Solution

	LAST YEAR	THIS YEAR
Partial productivities		
Labor	2.20	2.33
Raw materials and supplies	2.75	2.80
Total productivity	1.05	1.04

DISCUSSION QUESTIONS

- LO2-1** 1. What is meant by a triple bottom line strategy? Give an example of a company that has adopted this type of strategy.
2. Find examples where companies have used features related to environmental sustainability to win new customers.
- LO2-2** 3. What are the major priorities associated with operations and supply chain strategy? For each major priority, describe the unique characteristics of the market niche with which it is most compatible.
4. Why does the proper operations and supply chain strategy keep changing for companies that are world-class competitors?
5. What do the expressions *order winner* and *order qualifier* mean? What was the order winner for your last major purchase of a product or service?
- LO2-3** 6. Pick a company that you are familiar with and describe its operations strategy and how it relates to winning customers. Describe specific activities used by the company that support the strategy (see Exhibit 2.2 for an example).
- LO2-4** 7. At times, the dollar shows relative weakness with respect to foreign currencies such as the yen, euro, and pound. This stimulates exports. Why would long-term reliance on a lower-valued dollar be at best a short-term solution to the competitiveness problem?
8. Identify an operations and supply chain-related disruption that recently impacted a company. What could the company have done to minimize the impact of this type of disruption prior to it occurring?
- LO2-5** 9. What do we mean when we say productivity is a relative measure?

OBJECTIVE QUESTIONS

- LO2-1** 1. Shell Oil Company's motto "People, Planet, and Profit" is a real-world implementation of what OSCM concept?
2. A firm's strategy should describe how it intends to create and sustain value for what entities?
3. What is the term used to describe individuals or organizations that are influenced by the actions of a firm?
- LO2-2** 4. How often should a company develop and refine the operations and supply chain strategy?
5. What is the term used to describe product attributes that attract certain customers and can be used to form the competitive position of a firm?
6. What are the two main competitive dimensions related to product delivery?
7. What are the two characteristics of a product or service that define quality?
- LO2-3** 8. What is the diagram that shows how a company's strategy is delivered by a set of supporting activities called?
9. In implementing supply chain strategy, a firm must minimize its total cost without compromising the needs of what group of people?
- LO2-4** 10. What is defined as the likelihood of disruption that would impact the ability of a company to continuously supply products or services?
11. What are risks caused by natural and human-made disasters, which are impossible to reliably predict, called?

12. Match the following common risks with the appropriate mitigation strategy:
- | | |
|-----------------------------|--|
| _____ Country risks | A. Detailed tracking, alternate suppliers |
| _____ Regulatory risk | B. Careful selection and monitoring of suppliers |
| _____ Logistics failure | C. Contingency planning, insurance |
| _____ Natural disaster | D. Good legal advice, compliance |
| _____ Major quality failure | E. Currency hedging, local sourcing |
13. What is the term used to describe the assessment of the probability of a negative event against the aggregate severity of the related loss?
- LO2-5** 14. As operations manager, you are concerned about being able to meet sales requirements in the coming months. You have just been given the following production report:

	JAN	FEB	MAR	APR
Units produced	2,300	1,800	2,800	3,000
Hours per machine	325	200	400	320
Number of machines	3	5	4	4

Find the average of the monthly productivity figures (units per machine hour).

15. Sailmaster makes high-performance sails for competitive windsurfers. Below is information about the inputs and outputs for one model, the Windy 2000. Calculate the productivity in sales revenue/labor expense.

Units sold	1,217
Sale price each	\$1,700
Total labor hours	46,672
Wage rate	\$12/hour
Total materials	\$60,000
Total energy	\$4,000

16. Live Trap Corporation received the data below for its rodent cage production unit. Find the total productivity.

OUTPUT	INPUT
50,000 cages	Production time 620 labor hours
Sale price: \$3.50 per unit	Wages \$7.50/hour
	Raw materials (total cost) \$30,000
	Component parts (total cost) \$15,350

17. Two types of cars (Deluxe and Limited) were produced by a car manufacturer last year. Quantities sold, price per unit, and labor hours are given below. What is the labor productivity for each car? Explain the problem(s) associated with the labor productivity.

	QUANTITY	\$/UNIT
Deluxe car	4,000 units sold	\$8,000/car
Limited car	6,000 units sold	\$9,500/car
Labor, Deluxe	20,000 hours	\$12/hour
Labor, Limited	30,000 hours	\$14/hour

18. A U.S. manufacturing company operating a subsidiary in an LDC (less-developed country) shows the following results:

	U.S.	LDC
Sales (units)	100,000	20,000
Labor (hours)	20,000	15,000
Raw materials (currency)	\$20,000 (US)	20,000 (FC)
Capital equipment (hours)	60,000	5,000

- Calculate partial labor and capital productivity figures for the parent and subsidiary. Do the results seem confusing?
 - Compute the multifactor productivity figures for labor and capital together. Do the results make more sense?
 - Calculate raw material productivity figures [units/\$ where \$1 = 10 (FC)]. Explain why these figures might be greater in the subsidiary.
19. Various financial data for the past two years follow. Calculate the total productivity measure and the partial measures for labor, capital, and raw materials for this company for both years. What do these measures tell you about this company?

	LAST YEAR	THIS YEAR
Output: Sales	\$200,000	\$220,000
Input: Labor	30,000	40,000
Raw materials	35,000	45,000
Energy	5,000	6,000
Capital	50,000	50,000
Other	2,000	3,000

20. An electronics company makes communications devices for military contracts. The company just completed two contracts. The navy contract was for 2,300 devices and took 25 workers two weeks (40 hours per week) to complete. The army contract was for 5,500 devices that were produced by 35 workers in three weeks. On which contract were the workers more productive?
21. A retail store had sales of \$45,000 in April and \$56,000 in May. The store employs eight full-time workers who work a 40-hour week. In April, the store also had seven part-time workers at 10 hours per week, and in May the store had nine part-timers at 15 hours per week (assume four weeks in each month). Using sales dollars as the measure of output, what is the percentage change in productivity from April to May?
22. A parcel delivery company delivered 103,000 packages last year, when its average employment was 84 drivers. This year, the firm handled 112,000 deliveries with 96 drivers. What was the percentage change in productivity over the past year?
23. A fast-food restaurant serves hamburgers, cheeseburgers, and chicken sandwiches. The restaurant counts a cheeseburger as equivalent to 1.25 hamburgers and chicken sandwiches as 0.8 hamburger. Current employment is five full-time employees who each work a 40-hour week. If the restaurant sold 700 hamburgers, 900 cheeseburgers, and 500 chicken sandwiches in one week, what is its productivity? What would its productivity have been if it had sold the same number of sandwiches (2,100), but the mix was 700 of each type?

CASE: THE TAO OF TIMBUK2*

“Timbuk2 is more than a bag. It’s more than a brand. Timbuk2 is a bond. To its owner, a Timbuk2 bag is a dependable, everyday companion. We see fierce, emotional attachments form between Timbuk2 customers and their bags all the time. A well-worn Timbuk2 bag has a certain patina—the stains and scars of everyday urban adventures. Many Timbuk2 bags are worn daily for a decade or more, accompanying the owner through all sorts of defining life events. True to our legend of ‘indestructibility,’ it’s not uncommon for a Timbuk2 bag to outlive jobs, personal relationships, even pets. This is the Tao of Timbuk2.”

What makes Timbuk2 so unique? Visit the Web site at www.timbuk2.com and see for yourself. Each bag is custom designed by the customer on the Web site. After the customer selects the basic bag configuration and size, colors for each of the various panels are presented; various lines, logos, pockets, and straps are selected so that the bag is tailored to the exact specifications of the customer. A quick click of the mouse and the bag is delivered directly to the customer in only two days. How does Timbuk2 do this?

This San Francisco–based company is known for producing high-quality custom and classic messenger bags. It has a team of approximately 25 hardworking cutters and sewers in its San Francisco plant. Over the years, it has fine-tuned its

production line to make it as efficient as possible while producing the highest-quality messenger bags available.

The local manufacturing is focused on the custom messenger bag. For these bags, orders are taken over the Internet. Customers are offered many configuration, size, color, pocket, and strap options. The bag is tailored to the exact specifications of the customer on the Timbuk2 assembly line in San Francisco and sent via overnight delivery directly to the customer.

Recently, Timbuk2 has begun making some of its new products in China, which is a concern to some of its long-standing customers. The company argues that it has designed its new products to provide the best possible features, quality, and value at reasonable prices and stresses that these new products are designed in San Francisco. Timbuk2 argues that the new bags are much more complex to build and require substantially more labor and a variety of very expensive machines to produce. It argues that the San Francisco factory labor cost alone would make the retail price absurdly high. After researching a dozen factories in China, Timbuk2 found one that it thinks is up to the task of producing these new bags. Much as in San Francisco, the China factory employs a team of hardworking craftspeople who earn good wages and an honest living. Timbuk2 visits the China factory every four to eight weeks to ensure superior quality standards and working conditions.

*Special thanks to Kyle Cattani of Indiana University for this case.



©Bloomberg/Getty Images

On the Timbuk2 Web site, the company argues that its team members are the same hardworking group of bag fanatics as before, designing and making great bags and supporting the local community and an increasingly competitive global market. The company reports that demand is still strong for the custom messenger bags made in San Francisco and that the new laptop bags sourced from China are receiving rave reviews. The additional business is allowing the company to hire more people in all departments at its San Francisco headquarters—creating even more jobs locally.

Questions

1. Consider the two categories of products that Timbuk2 makes and sells. For the custom messenger bag, what key competitive dimensions are driving sales? Are the company's competitive priorities different for the new laptop bags sourced in China?
2. Compare the assembly line in China to that in San Francisco along the following dimensions: (1) volume or rate of production, (2) required skill of the workers, (3) level of automation, and (4) amount of raw materials and finished goods inventory.
3. Draw two diagrams, one depicting the supply chain for those products sourced in China and the other depicting the bags produced in San Francisco. Show all the major steps, including raw material, manufacturing, finished goods, distribution inventory, and transportation. Other than manufacturing cost, what other costs should Timbuk2 consider when making the sourcing decision?

PRACTICE EXAM

1. A strategy that is designed to meet current needs without compromising the ability of future generations to meet their needs.
2. The three criteria included in a triple bottom line.
3. The seven operations and supply chain competitive dimensions.
4. It is probably most difficult to compete on this major competitive dimension.
5. This occurs when a company seeks to match what a competitor is doing while maintaining its existing competitive position.
6. A criterion that differentiates the products or services of one firm from those of another.
7. A screening criterion that permits a firm's products to be considered as possible candidates for purchase.
8. A diagram showing the activities that support a company's strategy.
9. A measure calculated by taking the ratio of output to input.

Answers to Practice Exam 1. Sustainable 2. Social, economic, environmental 3. Cost or price, quality, delivery speed, delivery reliability, coping with changes in demand, flexibility and speed of new-product introduction, other product-specific criteria 4. Cost 5. Straddling 6. Order winner 7. Order qualifier 8. Activity-system map 9. Productivity