SECOND EDITION

# MANAGING SUPPLY CHAIN AND OPERATIONS

## An Integrative Approach


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*For Camille*
*—T. F.*

*For Kristen*
*—S. S.*

*For David and Joyce Wallin*
*—C. W.*

*For my best friend, Mary*
*—S. W.*

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Foster has served on the editorial boards of the *Journal of Operation Management* and *Decision Sciences* and is Editor in Chief of the *Quality Management Journal*. He has published more than 80 articles in journals such as *Decision Sciences*, *Journal of Operations Management*, *International Journal of Production Research*, and *Quality Management Journal*. His book *Quality Management: Integrating the Supply Chain* is an international best seller. He recently served on the Malcolm Baldrige Board of Overseers and was awarded the prestigious Instructional Innovation Award from the Decision Sciences Institute.

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Before pursuing her doctoral studies, Wallin was a commodity team manager for Intel Corporation. During her eight years at Intel, she also held the positions of senior buyer, purchasing manager, stores manager, and commodity manager. Before her graduate studies, Wallin also worked as an auditor for the Defense Contract Audit Agency.

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# Preface

## NEW TO THIS EDITION

With this edition of *Managing Supply Chain and Operations: An Integrative Approach*, we wanted to up our game. Every new edition of a textbook must represent a step forward. We feel like we met that goal with this edition. At the same time, you will see that this edition maintains the strengths of the first edition with additional features.

**Series Reliability** < SOLVED PROBLEM 3.5

**Problem:** Your manager has asked you to compute reliability for the following system.

**Solution:** The overall reliability for this system is

$$R = 0.98 \times 0.99 \times 0.90 \times 0.97 = 0.847$$

- **Analytics Emphasis** We have added analytics to the core model in the book. We have also honed our focus on analytics. For every quantitative example in the text, we have added analytics icons to show students that they are learning tools they can use in their careers. We have also included discussion of the importance of analytics in the early parts of the book.

- **Cutting Edge** Almost all of the vignettes and examples in the book have been updated. For example, the forecast section includes discussion of the work being done to use social media to forecast trends and preferences. New supply chain and operations vignettes are used to amplify and contextualize the techniques and tools taught in the book. More up-to-date information is provided on our *Managing Supply Chain and Operations* Facebook page, including all source articles for every vignette in the text.

### Is Big Data the Key to Better Forecasting?

As you will see in this chapter, a lot of forecasting requires the gathering of historical data, which can be time consuming to gather and to analyze. However, data is everywhere; it comes from social media, search engines, and online retailing. Can this data provide a key to predicting the future? Giselle Guzman thinks it can. She is the founder of Now-Cast Data Corp, a company that uses big data and crowdsourcing to help create financial forecasts and trends.

For example, Now-Cast[1] has found that by scrubbing data on prices from online sources, it can predict inflation much more quickly than the U.S. government can. By monitoring searches on the word *inflation*, it can better gauge consumer expectations and worries relative to price increases.

Giselle has worked closely with eminent researchers in forecasting such as Nobel Laureates Joseph Stiglitz and Lawrence Klein. She believes that there is wisdom in crowds and that their data can be explored and analyzed on a moment-by-moment basis. Analytics can be used to monitor this data, but external variables, such as terrorism or natural disasters, can also be followed to adjust expectations. Next, machine learning can be used to improve forecasting.

While the jury is still out concerning the use of big data in forecasting, it is intriguing to think that this data may be useful in predicting trends like future spending and demand. In this chapter, we introduce you to forecasting methods that use data as a foundation for decision making in firms. We'll return to Now-Cast at the chapter's end.

[1]Pisani, B., "Finding a Better Way to Do Economic Forecasting," CNBC, 24 Mar. 2016.



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### Supply Chain and Operational Social Responsibility at Apple

As you will learn in this class, supply chain managers concern themselves daily with social responsibility. This involves being sensitive to the rights and dignity of individuals in the global supply chain and putting systems and reporting in place to ensure compliance with company standards in this area. Apple currently has more than 1.6 million people working its supply chain. To manage in a way that is responsive to the needs of all these people is a big job.

To help with managing supply chain and operations social responsibility, Apple has established a supplier code of conduct. The Apple supplier code of conduct addresses safety, working conditions, fair employee treatment, and environmental performance. This requires more than just satisfying local laws. It means meeting world-class requirements for global supply chain practices.

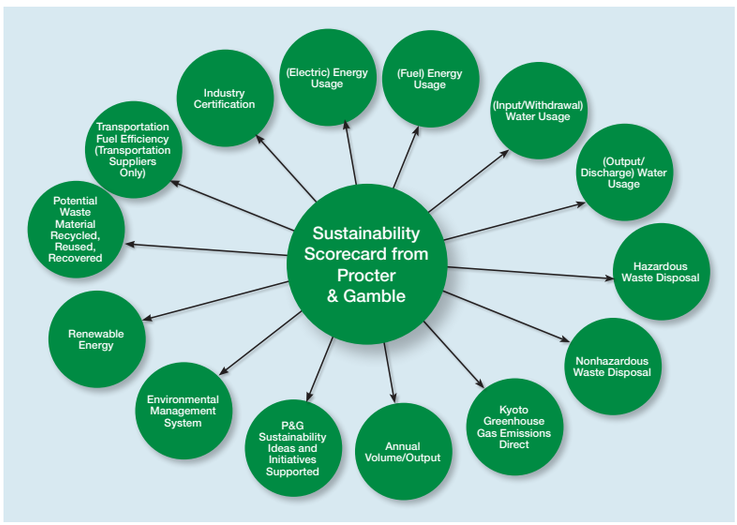
In this chapter, we will introduce supply chain and operations. As a supply chain and operations manager, you will have an opportunity to make the world a better place. We will revisit social responsibility at Apple later in the chapter.

*Source:* Supplier Responsibility 2016 Progress Report, Apple Corporation, 2016.

- **Streamlined** We have analyzed areas where the first edition could be simplified and have done so for this second edition. This has reduced the number of pages while still providing the same outstanding content coverage. We believe that students will find the text readable.

- **Increased Coverage of Sustainability and Social Responsibility** We have made an effort to increase our discussion of these important topics that resonate with students. This will make your course more relevant for your students.

**FIGURE 2.5 v**
Sustainability Scorecard from Procter & Gamble



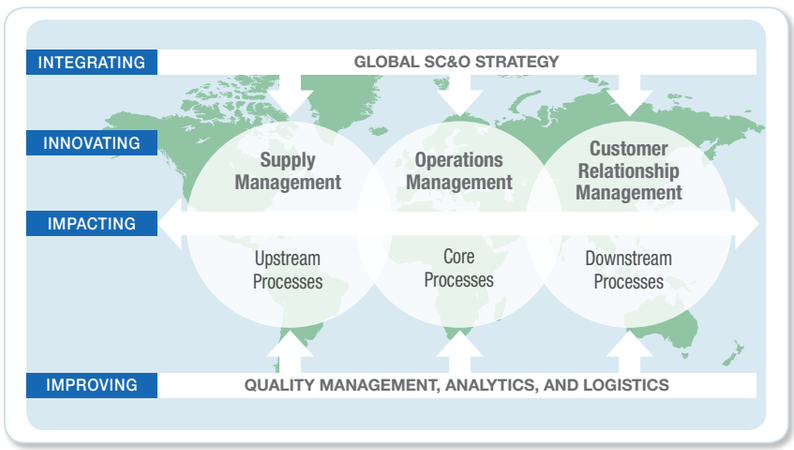

*Source:* Based on Sustainability Scorecard from Procter & Gamble.

## SOLVING TEACHING AND LEARNING CHALLENGES

The second edition of *Managing Supply Chain and Operations* is targeted toward undergraduate- and graduate-level operations management courses that link to supply chain management in an effective and meaningful way. When we implemented this approach at our own university, we saw a tenfold increase in student enrollment in our major. Students are responding to the global nature of business, which has led to a realization that firms do not act alone to produce products and services. Although it may sound like a cliché, supply chains do compete against other supply chains. This text benefits from the fact that the authors have taught at both research and teaching universities such as Brigham Young, Florida State, Boise State, and Georgia Southern.

This book takes a balanced approach and, although rigorous, is not solely focused on quantitative material. We approach the quantitative material from a managerial perspective,

answering the question: "Where does the analytical tool fit into a supply chain and operations (SC&O) management system?" We also recognize that most students in introductory operations courses are not operations or supply chain management majors. Because this course is often a service course, our approach will help students understand how and why this subject area applies to their roles as future managers.




A second motivation for our writing this book emerges from the field. The field of SC&O management has developed from the three academic disciplines of purchasing, logistics, and operations. Faculty members who are coming from these differing fields do not always see the world the same way, which has created some fragmentation within the course. By putting together a world-class team from these three different academic traditions, we have developed the integrative model for SC&O management that brings these areas together. This model presents the glue that integrates these areas to provide a robust and complete textbook for students. Following are other teaching features in the text:

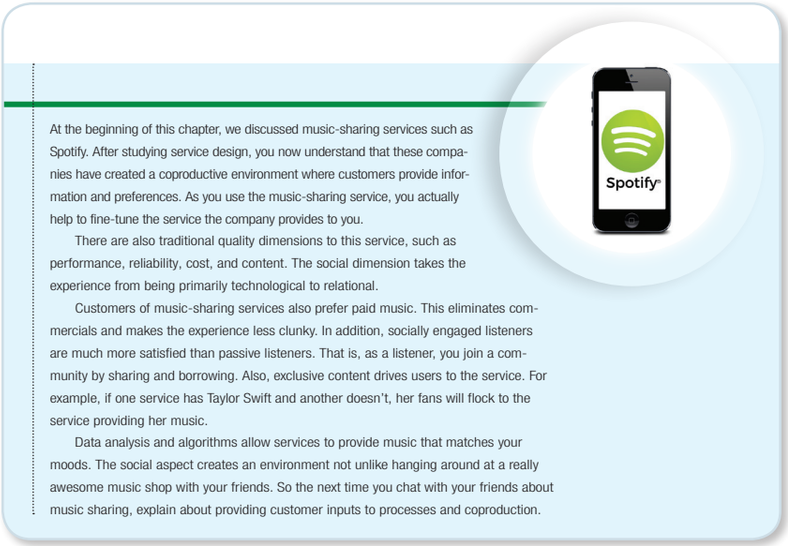
**CHAPTER OUTLINE AND LEARNING OBJECTIVES**

1. **Understand the Relationships between Services and Tangibles**
   - Identify How Services and Nonservices Differ
2. **Identify and Apply the Key Elements of Service Design**
   - Describe how managers design for service quality.
   - Explain how managers and designers design products for service recovery.
   - Explain the differences between business-to- consumer (B2C) and business-to-business (B2B) services.
   - Describe customer-interactive services and the components of the customer experience.
3. **Understand and Apply the Process Chain Network (PCN) Tool for Service Design**
   - Understand process chain networks.
   - Explain process positioning.
   - List the three process principles.
   - List and use the steps in developing a PCN diagram.
4. **Describe and Use the Planning Service Capacity for Uncertain Demand**
   - Understand the components of capacity planning.
   - Describe the tools that managers use to plan and manage capacity.
5. **Apply Queuing Theory**
   - Understand queuing psychology.
   - Apply analytic queuing models to improve service performance.

- Each chapter has a defined set of **Learning Objectives**. Because AACSB is requiring faculty to identify learning objectives, we provide them as an aid for faculty and students.

- **Managing Across Majors** boxes directly address how students in different majors and disciplines will use SC&O concepts upon graduation. Making a clear connection between the concepts and how students will use them reinforces the importance and relevance of these concepts.

**Managing Across Majors 4.1** Marketing majors, remember that service operations need information from marketing to help identify and understand customer needs.



At the beginning of this chapter, we discussed music-sharing services such as Spotify. After studying service design, you now understand that these companies have created a coproductive environment where customers provide information and preferences. As you use the music-sharing service, you actually help to fine-tune the service the company provides to you.

There are also traditional quality dimensions to this service, such as performance, reliability, cost, and content. The social dimension takes the experience from being primarily technological to relational.

Customers of music-sharing services also prefer paid music. This eliminates commercials and makes the experience less clunky. In addition, socially engaged listeners are much more satisfied than passive listeners. That is, as a listener, you join a community by sharing and borrowing. Also, exclusive content drives users to the service. For example, if one service has Taylor Swift and another doesn't, her fans will flock to the service providing her music.

Data analysis and algorithms allow services to provide music that matches your moods. The social aspect creates an environment not unlike hanging around at a really awesome music shop with your friends. So the next time you chat with your friends about music sharing, explain about providing customer inputs to processes and coproduction.

- **Opening Vignettes** introduce a problem or scenario that an actual company has encountered. At the end of the chapter, we discuss how that company used concepts from the chapter to address its needs. **End-of-Chapter Vignettes** also require assessment and application. These exercises provide students with the skills they will need when they become managers.

- Each chapter spotlights current events and ties them directly to the chapter's concepts. Students see how managers apply the information they are learning in the field. Every chapter has multiple **SC&O Current Events** boxes that make the material relevant to the students.

### SCOR at Ford

A good example of a company that used SCOR to become more effective is Ford Motor Company. The parts, supply, and logistics division of Ford used SCOR to improve its forecasting, inventory planning, electronic supplier communication, and management. Ford's extremely complex supply chain contains thousands of parts, thousands of suppliers, and millions of end consumers. Although Ford's functional areas within purchasing and logistics were individually effective, they were not structured to make integrated supply chain decisions. Ford identified the problems in its as-is state and then used SCOR to map and describe important inventory processes that flowed through the functional silos. Understanding how these processes affected each area of the company helped employees understand the holistic nature of their siloed decisions. Ford managers used SCOR to measure and benchmark these processes against others doing similar processes. Ford was then able to standardize processes and help each business area understand its responsibility for the entire process.

Ford has benefited substantially from using SCOR. Ford's recurring inventory has been greatly reduced due to attention to variation in inventory policies. Focusing on customer requirements has led to a 20 percent reduction in open back orders, improved customer satisfaction, and a 25 percent reduction in forecast inaccuracies. Because employees are focused on the total process rather than their own silo, Ford has reduced total inventory cycle time by 30 percent. Ford's return on investment was calculated to be five times the cost of implementing the SCOR system.

### Managing Flow for Fast Fashion

We discussed Zara from a strategic perspective in Chapter 2. We now discuss it from a logistics perspective. Zara, the Spanish fast-fashion retailer, uses logistics to ensure that the most recent fashion trends are on store shelves quickly. The secret to Zara's business strategy is the quick turnover of product lines within retail stores. In fact, Zara frequently stocks its shelves with fashion apparel that was displayed on fashion runways only three weeks earlier.

So how does Zara accomplish this fast-fashion supply chain? Zara has created a very cohesive logistics strategy between its factory operations and its retail stores. Zara creates clothing using just-in-time manufacturing and small batch sizes. Zara then ships these batches to retail stores to see what customers prefer. When Zara is informed about what is selling, not selling, or not available at retail stores, the factory produces what customers value most. The factory then uses its excess capacity and agile capabilities to manufacture the most popular styles.

Zara's commitment to a fast and steady tempo paced by order fulfilment to stores allows Zara to keep minimal inventory while still meeting customers' needs. Logisticians for Zara know that it delivers twice weekly from the factories in Bangladesh to the central distribution center in Spain. The shipments are then broken up and delivered to stores, usually in less than 24 hours to European stores and 40 hours to U.S. stores. The logistics costs of rapidly shipping inventory to stores are much more expensive than traditional, slower fashion

- **Global Connections** boxes focus on how SC&O management ties together supply chains across international boundaries. Learning how managers can use global supply chains and how international linkages benefit firms provides students an advantage once they enter the workforce.

- **Using Technology** boxes walk students through the ways managers use technology to solve SC&O problems in the workplace. Step-by-step tutorials break down problems and solutions and provide computer-based fundamentals for SC&O problem solving.

You can also use Excel to apply newsvendor analysis to Solved Problem 4.2.

| | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|
| 1 | **Example 4-1 Newsvendor Analysis** | | | | | | | | |
| 2 | | | | | | | | | |
| 3 | | **Cost of understocking ($):** | 30 | | **Critical Fractile:** | 0.75 | | | |
| 4 | | **Cost of overstocking ($):** | 10 | | | | | | |
| 5 | | **Average demand (tables):** | 25 | | **Optimal Number of Tables:** | 28.375 | | | |
| 6 | | **Std dev of demand (tables):** | 5 | | | | | | |
| 7 | | **z value:** | 0.675 | | | | | | |
| 8 | | **(Use =norm.s.inv(G3) command)** | | | | | | | |
| 9 | | | | | | | | | |
| 10 | | | | | | | | | |
| 11 | | | | | | | | | |
| 12 | | | | | | | | | |

=C3/(C4+C3)

=C5+C6*C7

^ **FIGURE 4.5**
Newsvendor Excel Spreadsheet

SOLVED PROBLEM 4.2 >
MyLab Operations Management Video

**The Newsvendor Problem in Action**

**Problem:** In service environments, an inventory issue is capacity. Service operations have a capacity for meeting customer demand according to how they are designed. If there is not enough capacity, customer demand may not turn into sales. Excess capacity comes with a cost as well.

For example, a restaurant chain is opening a new location in a business district. The question is how many tables to design in the restaurant. The key revenue period is the weekday lunch seating, so the restaurant desires to plan capacity for that demand. Lunchtime demand is forecast to be normally distributed with a mean of 25 parties and a standard deviation of 5 parties. (Assume one party per table.) How many tables should the restaurant have?

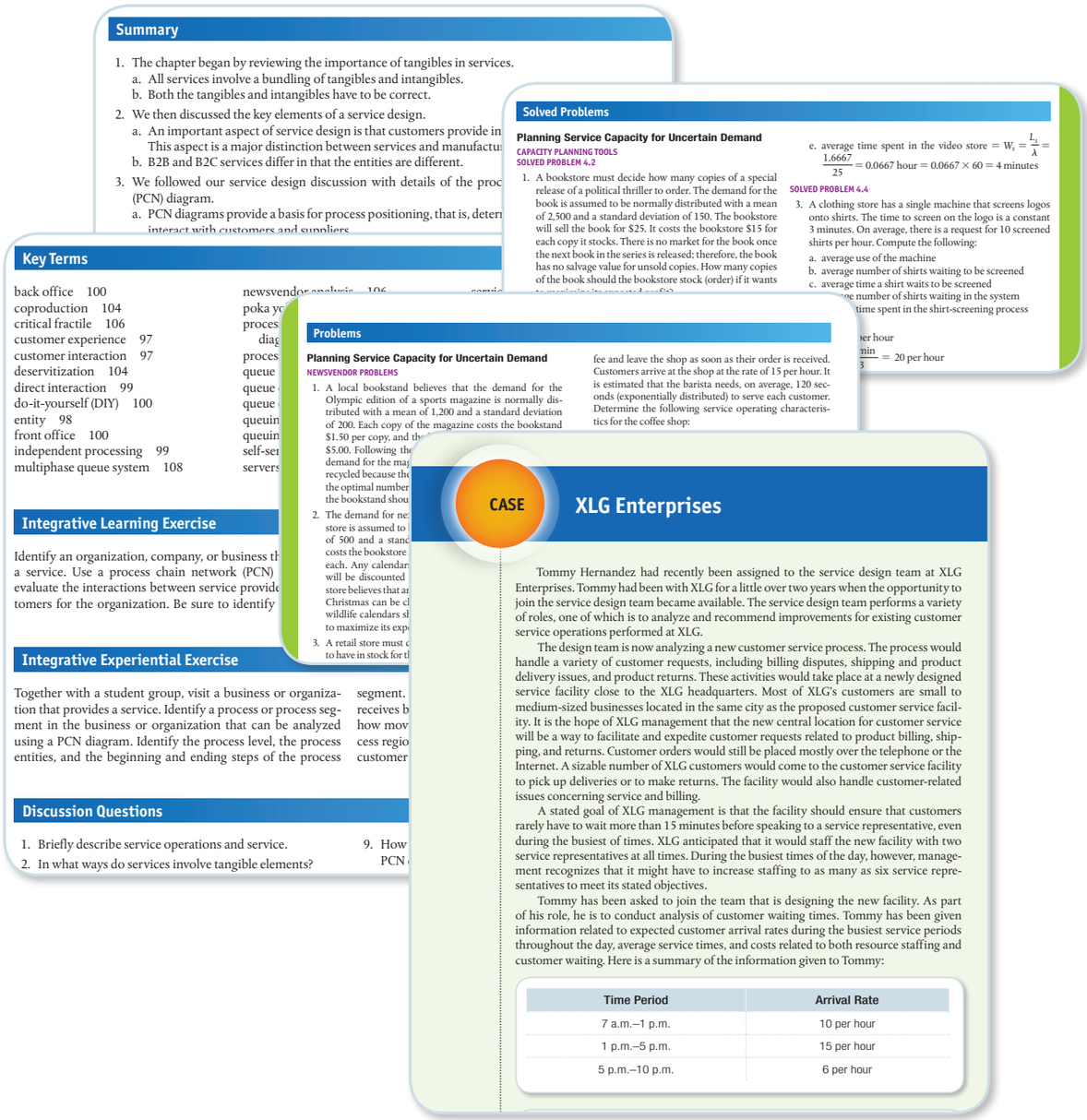
A naive view would have 25 tables, but that ignores the asymmetric cost structure. The average party spends $40 for lunch, with ingredient costs being 25 percent of that amount.

**Solution:** Therefore, the cost of insufficient tables ($C_U$) is $40 - ((40 \times 0.25) = \$30$ per table, which is the average profit contribution per party. Each table takes up 100 square feet of space, and space costs $3 per square foot per month (approximately $0.10 per square foot per day).

Therefore, the cost of an extra table is $100 \times 0.10 = \$10$ per table per day. This cost suggests that an optimal number of tables would have $CF = 30/(10 + 30) = 0.75$, or 75 percent of the cumulative distribution. Looking up 0.75 in the normal cumulative distribution table (see Appendix Table A-2) shows that $z = 0.675$. Therefore, the optimal number of tables is $25 + (0.675 \times 5) = 28.375$, or approximately 28 tables. See FIGURE 4.5 for the formulas and a sample layout for a newsvendor problem.

- The text includes videos in MyLab Operations Management for over 70 **Solved Problems** from the text, allowing students to practice quantitative material prior to coming to class.

## End-of-Chapter Resources




- **Summaries** review the important topics discussed in the chapter.
- **Key Terms** are listed for review purposes. Each list includes page references showing where the concept was first discussed in each chapter.
- **Integrative Learning Exercises** are designed to get students to integrate multiple concepts throughout the chapter.
- **Integrative Experiential Exercises** are designed to get students out into the real world by visiting companies and learning how supply chain and operations concepts are applied.
- **Discussion Questions** test student comprehension of the concepts presented.
- **Solved Problems** detail how to solve model problems using the techniques presented in the chapter.
- **Problems** sharpen students' skills by providing a wide selection of homework material.
- **Cases** challenge students to grapple with a problem. Each case can be used as an in-class exercise, a homework assignment, or a team project.

# MYLAB OPERATIONS MANAGEMENT

## Reach Every Student by Pairing This Text with Mylab Operations Management

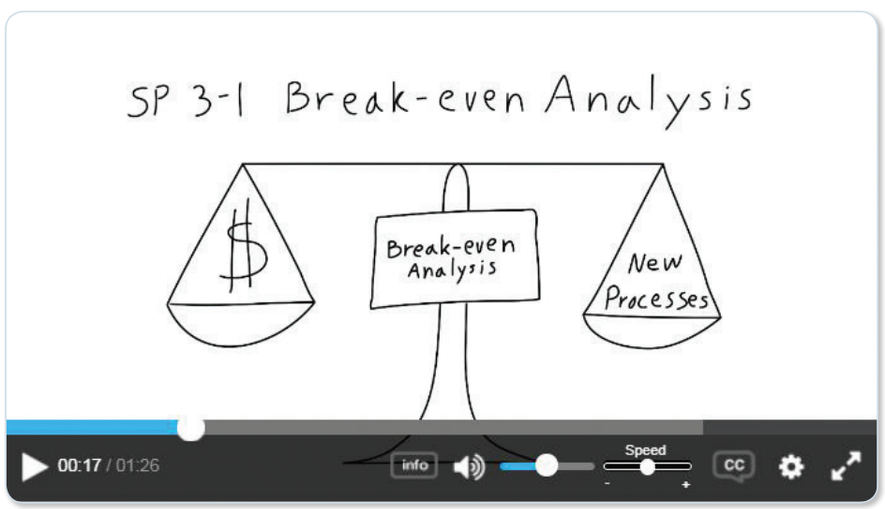
MyLab is the teaching and learning platform that empowers you to reach *every* student. By combining trusted author content with digital tools and a flexible platform, MyLab personalizes the learning experience and improves results for each student. Learn more about MyLab Operations Management at www.pearson.com/mylab/operations-management.

## Deliver Trusted Content

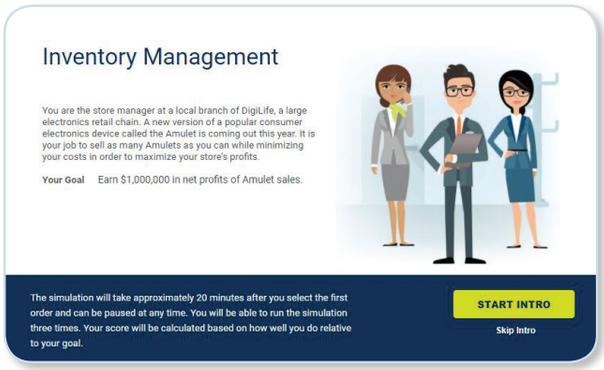
You deserve teaching materials that meet your own high standards for your course. That's why we partner with highly respected authors to develop interactive content and course-specific resources that you can trust—and that keep your students engaged.

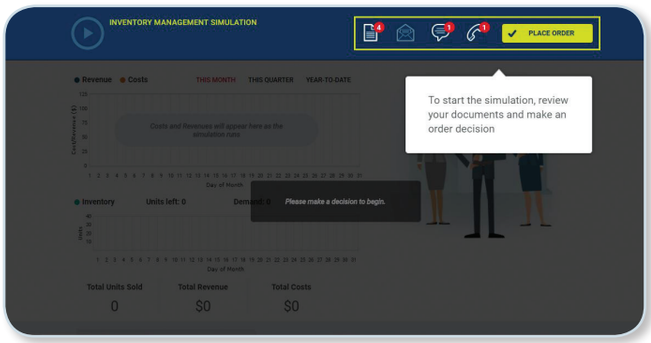
This text is totally integrated with MyOMLab. Among the features that have proven popular are:

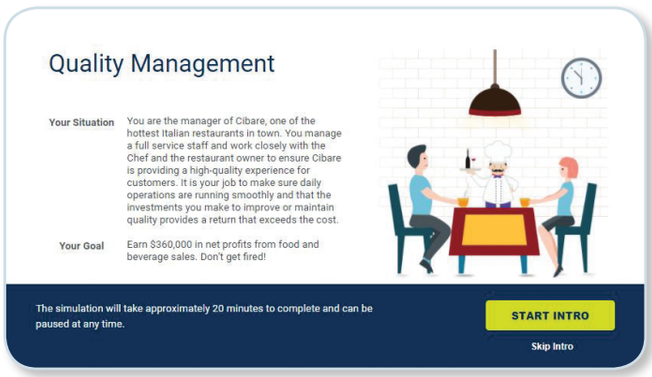
- **Over 80 videos.** Every solved example in the main body of every chapter has a video that shows step-by-step how to solve the problems. Students love this feature of the book. We believe that our videos are best-in-class. We used the talent of BYUTv to develop these videos.

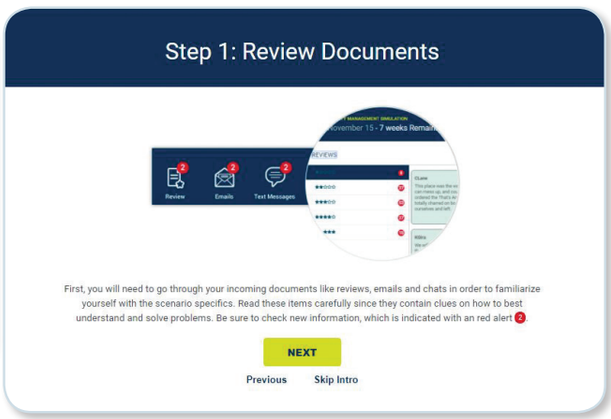


- **Simulations** A series of simulations created by Pearson educational specialists are available for use in your SC&O course at various times. These make great team in-class activities that you can use to drive home key concepts and to make SC&O fun!

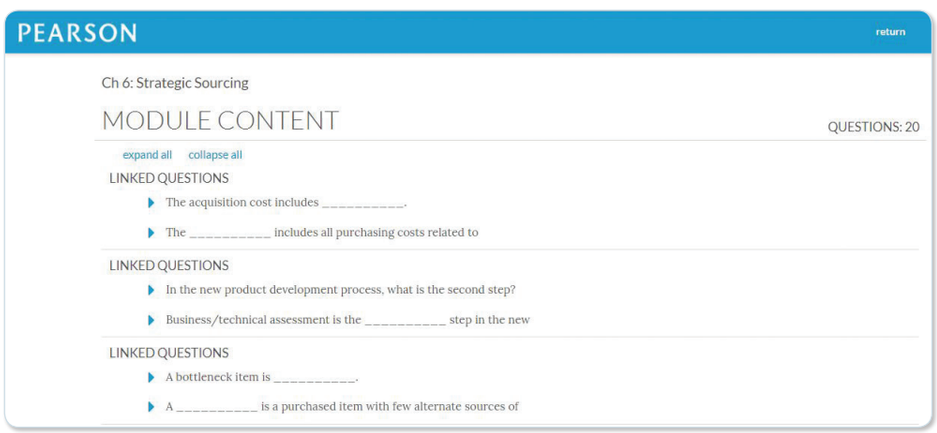



- **Dynamic Study Modules** These are fantastic utilities that help tutor students on key SC&O concepts.




- **E-text** Students can save money by utilizing the e-text and bypassing the need to have a paper text. Red Shelf and other tools are available to make this access very economical for the students. Just contact your Pearson rep to find out about this alternative. We do this at BYU and have saved our students a lot of money.

## Empower Each Learner

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

## Teach Your Course Your Way

Your course is unique. Whether you'd like to build your own assignments, teach multiple sections, or set prerequisites, MyLab gives you the flexibility to easily create *your* course to fit *your* needs.

- You can create quizzes using prewritten editable questions from Tom Foster or you can create your own quizzes that students can complete either before, during, or after class.

## Improve Student Results

When you teach with MyLab, student performance improves. That's why instructors have chosen MyLab for over 15 years, touching the lives of over 50 million students.

## DEVELOPING EMPLOYABILITY SKILLS

This book is designed to provide a basic understanding of supply chain and operations management. For SC&O majors, this is a great platform for other, more advanced classes. For non-majors, in addition to other skills, they will be learning the basic concepts and important tools for managing:

- Logistics
- Purchasing
- Operations Management
- Inventory Management
- Project Management
- Process Management
- Process Improvement
- Six Sigma

This class will provide tools and concepts that you can use on the first day of your job. Pay attention. This is a growing field that is full of excitement and relevance for your future.

### Integrative Experiential Exercise

Together with a student group, visit a business or organization that provides a service. Identify a process or process segment in the business or organization that can be analyzed using a PCN diagram. Identify the process level, the process entities, and the beginning and ending steps of the process segment. Be sure to identify the points where the customer receives benefits and the provider incurs costs. Comment on how moving and rearranging steps across and between process regions might affect the value proposition by increasing customer benefits, decreasing provider costs, or both.

### Discussion Questions

1. Briefly describe service operations and service.
2. In what ways do services involve tangible elements?
3. Identify the customer input resources and the service provider outputs for the following service operations: accounting, education, computer repair, and healthcare.
4. What is meant by simultaneity in services? What is a major consequence of simultaneity?
5. What are some long-term responses for increasing and decreasing service capacity?
6. What is meant by the term *time-perishable capacity* as it relates to service operations? Provide an example.
7. Customers are generally involved in the service delivery process. What are some negative consequences associated with customer interaction in the service operation?
8. Briefly define and describe how a process chain network (PCN) diagram can be used in designing service delivery systems.
9. How can you shift the focus of your operations using a PCN diagram?
10. What trade-offs are generally made when making capacity decisions?
11. How do capacity choices vary in the near and long terms?
12. How can queuing theory be used to help evaluate capacity decisions for service providers?
13. Queuing psychology identifies ways that service operations managers can improve waits by improving the perception of those customers who do wait. What are some of the fundamental points related to queuing psychology?
14. In waiting lines, sometimes technological advances cannot make it easier to manage queues. How can psychology help with this problem?
15. How does the newsvendor model allow service firms to evaluate capacity decisions?

## Expanding Your Career Skills or Building Your Career Skills

As educators and practitioners, we are aware of the changing landscape of the workplace and the needs of managers in various industries. This category of activities encourages students to research data, identify patterns and facts in data, take initiative, work in groups, and clearly communicate their findings to others.

## INSTRUCTOR TEACHING RESOURCES

This program comes with the following teaching resources.

| Supplements available to instructors at www.pearsonhighered.com | Features of the Supplement |
|---|---|
| **Instructor's Resource Manual, authored by Khurrum Bhutta from Ohio University** | • Chapter-by-chapter summaries<br>• A sample syllabus and course outline<br>• Teaching tips<br>• Examples and activities not in the main book<br>• Class discussion questions<br>• Video suggestions |
| **Solutions Manual, authored by Mahesh Srinivasan from The University of Akron** | Solutions to all discussion questions, problems, and case questions |
| **Test Bank, authored by Mahesh Srinivasan from The University of Akron** | More than 1,000 multiple-choice, true/false, short-answer, and graphing questions with these annotations:<br>• Difficulty level (easy, moderate, difficult)<br>• Type (multiple-choice, true/false, short-answer, essay)<br>• Learning objective<br>• AACSB learning standard (Written and Oral Communication; Ethical Understanding and Reasoning; Analytical Thinking; Information Technology; Interpersonal Relations and Teamwork; Diverse and Multicultural Work; Reflective Thinking; Application of Knowledge) |
| **Computerized TestGen** | TestGen allows instructors to:<br>• Customize, save, and generate classroom tests<br>• Edit, add, or delete questions from the test item files<br>• Analyze test results<br>• Organize a database of tests and student results |
| **PowerPoints, authored by Scott Webb from Brigham Young University** | Slides include all the figures, tables, and equations in the textbook. PowerPoints meet accessibility standards for students with disabilities. Features include, but are not limited to:<br>• Keyboard and screen reader access<br>• Alternative text for images<br>• High color contrast between background and foreground colors |

If assistance is needed, our dedicated technical support team is ready to help with the media supplements that accompany this text. Visit **support.pearson.com/getsupport** for answers to frequently asked questions and toll-free user support phone numbers.

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