

INTRODUCTION TO

FIFTH EDITION

OPERATIONS AND SUPPLY CHAIN MANAGEMENT



CECIL C. BOZARTH
ROBERT B. HANDFIELD

INTRODUCTION TO

FIFTH EDITION

OPERATIONS AND SUPPLY CHAIN MANAGEMENT

Cecil C. Bozarth

North Carolina State University

Robert B. Handfield

North Carolina State University



New York, NY

Vice President, Business, Economics, and UK Courseware:
Donna Battista
Director of Portfolio Management: Stephanie Wall
Editorial Assistant: Linda Siebert Albelli
Vice President, Product Marketing: Roxanne McCarley
Senior Product Marketer: Product Marketer: Kaylee Carlson
Product Marketing Assistant: Marianela Silvestri
Manager of Field Marketing, Business Publishing:
Adam Goldstein
**Executive Field Marketing Manager: Field Marketing
Manager:** Nicole Price
**Vice President, Production and Digital Studio, Arts and
Business:** Etain O'Dea
Director of Production, Business: Jeff Holcomb
Managing Producer, Business: Melissa Feimer
Content Producer: Yasmita Hota

Operations Specialist: Carol Melville
Design Lead: Kathryn Foot
Manager, Learning Tools: Brian Surette
Content Developer, Learning Tools: Lindsey Sloan
**Managing Producer, Digital Studio and GLP, Media
Production and Development:** Ashley Santora
Managing Producer, Digital Studio: Diane Lombardo
Digital Studio Producer: Regina DaSilva
Digital Studio Producer: Alana Coles
Digital Content Project Lead: Courtney Kamauf
Project Management: Thistle Hill Publishing Services
Interior and Cover Design: Cenveo® Publisher Services
Cover Art: Oscar Sanchez/EyeEm/Getty Images
Printer/Binder: LSC Communications, Inc./Willard
Cover Printer: Phoenix Color/Hagerstown

Microsoft and/or its respective suppliers make no representations about the suitability of the information contained in the documents and related graphics published as part of the services for any purpose. All such documents and related graphics are provided “as is” without warranty of any kind. Microsoft and/or its respective suppliers hereby disclaim all warranties and conditions with regard to this information, including all warranties and conditions of merchantability, whether express, implied or statutory, fitness for a particular purpose, title and non-infringement. In no event shall Microsoft and/or its respective suppliers be liable for any special, indirect or consequential damages or any damages whatsoever resulting from loss of use, data or profits, whether in an action of contract, negligence or other tortious action, arising out of or in connection with the use or performance of information available from the services.

The documents and related graphics contained herein could include technical inaccuracies or typographical errors. Changes are periodically added to the information herein. Microsoft and/or its respective suppliers may make improvements and/or changes in the product(s) and/or the program(s) described herein at any time. Partial screen shots may be viewed in full within the software version specified.

Microsoft® and Windows® are registered trademarks of the Microsoft Corporation in the U.S.A. and other countries. This book is not sponsored or endorsed by or affiliated with the Microsoft Corporation.

Copyright © 2019, 2016, 2013 by Pearson Education, Inc. or its affiliates. All Rights Reserved. Manufactured in the United States of America. This publication is protected by copyright, and permission should be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise. For information regarding permissions, request forms, and the appropriate contacts within the Pearson Education Global Rights and Permissions department, please visit www.pearsoned.com/permissions/.

Acknowledgments of third-party content appear on the appropriate page within the text, which constitutes an extension of this copyright page.

PEARSON, ALWAYS LEARNING, and MYLAB are exclusive trademarks owned by Pearson Education, Inc. or its affiliates in the U.S. and/or other countries.

Unless otherwise indicated herein, any third-party trademarks, logos, or icons that may appear in this work are the property of their respective owners, and any references to third-party trademarks, logos, icons, or other trade dress are for demonstrative or descriptive purposes only. Such references are not intended to imply any sponsorship, endorsement, authorization, or promotion of Pearson's products by the owners of such marks, or any relationship between the owner and Pearson Education, Inc., or its affiliates, authors, licensees, or distributors.

Library of Congress Cataloging-in-Publication Data

Names: Bozarth, Cecil C., author. | Handfield, Robert B., author.
Title: Introduction to operations and supply chain management / Cecil C. Bozarth, North Carolina State University,
Robert B. Handfield, North Carolina State University.
Description: Fifth edition. | New York, NY : Pearson, [2019] | Includes bibliographical references and index.
Identifiers: LCCN 2017050841 | ISBN 9780134740607 (hardcover) | ISBN 0134740602 (hardcover)
Subjects: LCSH: Management. | Production management. | Business logistics.
Classification: LCC HD31.2 .B69 2019 | DDC 658.5—dc23
LC record available at <https://lccn.loc.gov/2017050841>

To Andrea, James, and Philip

C.B.

To Sandi, Simone, and Luc

R.H.

ABOUT THE AUTHORS



Cecil Bozarth is Professor of Operations and Supply Chain Management at the Poole College of Management at N.C. State University, where he has received awards for teaching excellence at both the undergraduate and graduate levels. He is a former chair of the Operations Management Division of the Academy of Management, and in 1999 was recognized by APICS as a subject matter expert (SME) in the area of supply chain management. His particular areas of interest are operations and supply chain strategy and supply chain information systems. Cecil's consulting experience cuts across a wide range of industries, including such companies as BlueCross BlueShield of North Carolina, Daimler-Benz, John Deere, Duke Energy, Eisai, Ford Motor Company, GKN, IBM, GlaxoSmithKline, Milliken, Patheon, Sonoco, and others. For thirteen years, Cecil was an associate editor for the *Journal of Operations Management*; he now serves on the journal's editorial advisory board. Cecil has also served as a guest editor for the *Academy of Management Journal*, as well as the *Journal of Operations Management*.



Robert Handfield is the Bank of America Professor and a Distinguished University Professor at N.C. State University. Handfield has consulted with over 25 Fortune 500 companies, including Biogen Idec, Caterpillar, John Deere, GlaxoSmithKline, Boston Scientific, Delphi, Chevron, British Petroleum, Chevron Phillips, Bank of America, Sensata, Honda of America, KPMG, Conoco Phillips, Federal Express, SAP, and others, and is a world-renowned expert in the areas of purchasing and logistics. Rob is the former editor-in-chief of the *Journal of Operations Management* and has written several books on SCM topics, including *Introduction to Supply Chain Management* (Prentice Hall, with Ernest L. Nichols; translated into Japanese, Korean, Chinese, and Indonesian), *Supply Chain Redesign* (Prentice Hall Financial Times), and *Purchasing and Supply Chain Management*, 5th edition (South-Western College Publishing, with Robert M. Monczka, Larry C. Giunipero, and James L. Patterson).

BRIEF CONTENTS

Preface xi

PART I CREATING VALUE THROUGH OPERATIONS AND SUPPLY CHAINS 1

- 1 Introduction to Operations and Supply Chain Management 1
- 2 Operations and Supply Chain Strategies 20

PART II ESTABLISHING THE OPERATIONS ENVIRONMENT 40

- 3 Process Choice and Layout Decisions in Manufacturing and Services 40
- 4 Business Processes 74
- 5 Managing Quality 108
- 6 Managing Capacity 142
- 6S Advanced Waiting Line Theory and Simulation Modeling 175

PART III ESTABLISHING SUPPLY CHAIN LINKAGES 189

- 7 Supply Management 189
- 8 Logistics 221

PART IV PLANNING AND CONTROLLING OPERATIONS AND SUPPLY CHAINS 254

- 9 Forecasting 254
- 10 Sales and Operations Planning (Aggregate Planning) 299
- 11 Managing Inventory throughout the Supply Chain 331
- 12 Managing Production across the Supply Chain 364
- 12S Supply Chain Information Systems 399
- 13 JIT/Lean Production 408

PART V PROJECT MANAGEMENT AND PRODUCT/SERVICE DEVELOPMENT 429

- 14 Managing Projects 429
- 15 Developing Products and Services 451

Appendices 469

Glossary 475

Index 487

CONTENTS

Preface xi

PART I

Creating Value through Operations and Supply Chains 1

1 Introduction to Operations and Supply Chain Management 1

- Introduction 2
- 1.1 Why Study Operations and Supply Chain Management? 3
 - Operations Management 4
 - Supply Chain Management 6
- 1.2 Important Trends 9
 - Agility 10
 - Information Technologies 10
 - People 10
- 1.3 Operations and Supply Chain Management and You 11
 - Professional Organizations 12
 - Cross-Functional and Interorganizational Linkages 13
- 1.4 Employability Skills 14
 - Critical Thinking 14
 - Collaboration 15
 - Knowledge Application and Analysis 15
 - Information Technology Application and Computing Skills 15
- 1.5 Purpose and Organization of This Book 15
- Chapter Summary 17
- Key Terms 17
- Discussion Questions 17
- Problems 17
- Case Study 18
- References 19

2 Operations and Supply Chain Strategies 20

- Introduction 22
- 2.1 Elements of the Business 22
- 2.2 Strategy 22
- 2.3 Operations and Supply Chain Strategies 25
 - Customer Value 26
 - Four Performance Dimensions 27
 - Trade-Offs among Performance Dimensions 29
 - Order Winners and Order Qualifiers 29
 - Stages of Alignment with the Business Strategy 30
 - Core Competencies in Operations and Supply Chains 32
- Chapter Summary 33
- Key Formula 34
- Key Terms 34
- Solved Problem 34

- Discussion Questions 36
- Problems 36
- Case Study 38
- References 39

PART II

Establishing the Operations Environment 40

3 Process Choice and Layout Decisions in Manufacturing and Services 40

- Introduction 41
- 3.1 Manufacturing Processes 42
 - Production Lines and Continuous Flow Manufacturing 43
 - Job Shops 44
 - Batch Manufacturing 45
 - Fixed-Position Layout 45
 - Hybrid Manufacturing Processes 45
 - 3D Printing 46
 - Linking Manufacturing Processes across the Supply Chain 47
 - Selecting a Manufacturing Process 47
 - The Product-Process Matrix 47
- 3.2 Product Customization within the Supply Chain 48
 - Four Levels of Customization 48
 - The Customization Point 48
- 3.3 Service Processes 51
 - Service Packages 52
 - Service Customization 52
 - Customer Contact 53
 - Service Positioning 56
 - Services within the Supply Chain 57
- 3.4 Layout Decision Models 58
 - Line Balancing 59
 - Assigning Department Locations in Functional Layouts 62
- Chapter Summary 66
- Key Formulas 66
- Key Terms 67
- Solved Problem 67
- Discussion Questions 69
- Problems 70
- Case Study 72
- References 73

4 Business Processes 74

- Introduction 75
- 4.1 Business Processes 76
 - Improving Business Processes 76
- 4.2 Mapping Business Processes 79
 - Process Maps 79
 - Swim Lane Process Maps 82

4.3 Managing and Improving Business Processes 84
 Measuring Business Process Performance 84
 Productivity 84
 Efficiency 86
 Cycle Time 87
 Benchmarking 88
 The Six Sigma Methodology 89
 Continuous Improvement Tools 91

4.4 Business Process Challenges and the SCOR Model 98
 How Standardized Should Processes Be? 98
 Business Process Reengineering (BPR) 99
 Coordinating Process Management Efforts across the Supply Chain 99
 The SCOR Model 99

Chapter Summary 101
 Key Formulas 101
 Key Terms 102
 Solved Problem 102
 Discussion Questions 104
 Problems 104
 Case Study 106
 References 107

5 Managing Quality 108

Introduction 110

5.1 Quality Defined 110

5.2 Total Cost of Quality 113

5.3 Total Quality Management 114
 TQM and the Six Sigma Methodology 117

5.4 Statistical Quality Control 117
 Process Capability 117
 Six Sigma Quality 120
 Control Charts 121
 Acceptance Sampling 127
 Taguchi's Quality Loss Function 129

5.5 Managing Quality across the Supply Chain 130
 ISO 9000 Family 130
 External Failures in the Supply Chain 131

Chapter Summary 131
 Key Formulas 131
 Key Terms 133
 Using Excel in Quality Management 134
 Solved Problem 134
 Discussion Questions 135
 Problems 136
 Case Study 140
 References 141

6 Managing Capacity 142

Introduction 143

6.1 Capacity 144
 Measures of Capacity 144
 Factors That Affect Capacity 145
 Supply Chain Considerations 145

6.2 Three Common Capacity Strategies 145

6.3 Methods of Evaluating Capacity Alternatives 146
 Cost 146
 Demand Considerations 149
 Expected Value 149
 Decision Trees 150

Break-Even Analysis 152
 Learning Curves 153
 Other Considerations 156

6.4 Understanding and Analyzing Process Capacity 157
 The Theory of Constraints 157
 Waiting Line Theory 160
 Little's Law 164

Chapter Summary 166
 Key Formulas 166
 Key Terms 168
 Using Excel in Capacity Management 168
 Solved Problem 169
 Discussion Questions 170
 Problems 170
 Case Study 174
 References 174

6S Advanced Waiting Line Theory and Simulation Modeling 175

Introduction 176

6S.1 Alternative Waiting Lines 176
 Assumptions behind Waiting Line Theory 177
 Waiting Line Formulas for Three Different Environments 177

6S.2 Simulation Modeling 181
 Monte Carlo Simulation 182
 Building and Evaluating Simulation Models with SimQuick 184

Supplement Summary 187
 Discussion Questions 188
 Problems 188
 References 188

PART III

Establishing Supply Chain Linkages 189

7 Supply Management 189

Introduction 190

7.1 Why Supply Management Is Critical 191
 Global Sourcing 191
 Financial Impact 192
 Performance Impact 194

7.2 The Strategic Sourcing Process 195
 Step 1: Assess Opportunities 195
 Step 2: Profile Internally and Externally 197
 Step 3: Develop the Sourcing Strategy 200
 Step 4: Screen Suppliers and Create Selection Criteria 207
 Step 5: Conduct Supplier Selection 208
 Step 6: Negotiate and Implement Agreements 210

7.3 The Procure-to-Pay Cycle 212
 Ordering 212
 Follow-Up and Expediting 212
 Receipt and Inspection 212
 Settlement and Payment 213
 Records Maintenance 213

7.4 Trends in Supply Management	213
Sustainable Supply	213
Supply Chain Disruptions	214
Chapter Summary	215
Key Formulas	215
Key Terms	215
Solved Problem	216
Discussion Questions	217
Problems	217
Case Study	219
References	220

8 Logistics 221

Introduction	223
8.1 Why Logistics Is Critical	223
8.2 Logistics Decision Areas	225
Transportation	225
Selecting a Transportation Mode	226
Multimodal Solutions	227
Warehousing	228
Logistics Information Systems	231
Material Handling and Packaging	233
Inventory Management	234
8.3 Logistics Strategy	234
Owning versus Outsourcing	235
Measuring Logistics Performance	236
Landed Costs	237
Reverse Logistics Systems	238
8.4 Logistics Decision Models	239
Weighted Center of Gravity Method	239
Optimization Models	241
The Assignment Problem	241
Chapter Summary	246
Key Formulas	247
Key Terms	247
Solved Problem	248
Discussion Questions	249
Problems	250
Case Study	252
References	253

PART IV

Planning and Controlling Operations and Supply Chains 254

9 Forecasting 254

Introduction	255
9.1 Forecast Types	256
Demand Forecasts	256
Supply Forecasts	256
Price Forecasts	256
9.2 Laws of Forecasting	257
Law 1: Forecasts Are Almost Always Wrong (But They Are Still Useful)	258
Law 2: Forecasts for the Near Term Tend to Be More Accurate	258

Law 3: Forecasts for Groups of Products or Services Tend to Be More Accurate	258
Law 4: Forecasts Are No Substitute for Calculated Values	258

9.3 Selecting a Forecasting Method	258
9.4 Qualitative Forecasting Methods	259
9.5 Time Series Forecasting Models	260
Last Period	261
Moving Average	262
Weighted Moving Average	264
Exponential Smoothing	264
Adjusted Exponential Smoothing	267
Linear Regression	268
Seasonal Adjustments	272
9.6 Causal Forecasting Models	276
Linear Regression	276
Multiple Regression	278
9.7 Measures of Forecast Accuracy	281
9.8 Computer-Based Forecasting Packages	283
9.9 Collaborative Planning, Forecasting, and Replenishment (CPFR)	283
Chapter Summary	288
Key Formulas	288
Key Terms	290
Solved Problem	290
Discussion Questions	293
Problems	293
Case Study	297
References	298

10 Sales and Operations Planning (Aggregate Planning) 299

Introduction	300
10.1 S&OP in the Planning Cycle	300
10.2 Major Approaches to S&OP	302
Top-Down Planning	303
Level, Chase, and Mixed Production Plans	305
Bottom-Up Planning	309
Cash Flow Analysis	311
10.3 Organizing for and Implementing S&OP	313
Choosing between Alternative Plans	313
Rolling Planning Horizons	314
Implementing S&OP in an Organization	315
10.4 Services Considerations	316
Making Sales Match Capacity	316
Making Capacity Match Sales	318
10.5 Linking S&OP throughout the Supply Chain	319
10.6 Applying Optimization Modeling to S&OP	319
Chapter Summary	323
Key Formulas	323
Key Terms	323
Solved Problem	323
Discussion Questions	325
Problems	325
Case Study	329
References	330

11 Managing Inventory throughout the Supply Chain 331

- Introduction 333
- 11.1** The Role of Inventory 334
 - Inventory Types 334
 - Inventory Drivers 336
 - Independent versus Dependent Demand Inventory 338
- 11.2** Periodic Review Systems 338
 - Restocking Levels 339
- 11.3** Continuous Review Systems 340
 - The Economic Order Quantity (EOQ) 341
 - Reorder Points and Safety Stock 343
 - Quantity Discounts 346
- 11.4** Single-Period Inventory Systems 348
 - Target Service Level 348
 - Target Stocking Point 350
- 11.5** Inventory in the Supply Chain 352
 - The Bullwhip Effect 352
 - Inventory Positioning 353
 - Transportation, Packaging, and Material Handling Considerations 354
- Chapter Summary 355
- Key Formulas 355
- Key Terms 356
- Using Excel in Inventory Management 356
- Solved Problem 357
- Discussion Questions 358
- Problems 358
- Case Study 362
- References 363

12 Managing Production across the Supply Chain 364

- Introduction 365
- 12.1** Master Scheduling 366
 - The Master Schedule Record 367
 - Using the Master Schedule 372
- 12.2** Material Requirements Planning 373
 - The MRP Record 375
 - The Advantages of MRP 380
 - Special Considerations in MRP 380
- 12.3** Production Activity Control and Vendor Order Management Systems 382
 - Job Sequencing 382
 - Monitoring and Tracking Technologies 383
- 12.4** Synchronizing Planning and Control across the Supply Chain 384
 - Distribution Requirements Planning 384
- Chapter Summary 387
- Key Formulas 389
- Key Terms 389
- Solved Problem 390
- Discussion Questions 390
- Problems 391
- Case Study 398
- References 398

12S Supply Chain Information Systems 399

- Introduction 400
- 12S.1** Understanding Supply Chain Information Needs 401
 - Differences across Organizational Levels 401
 - Direction of Linkages 402
- 12S.2** Supply Chain Information Systems 402
- 12S.3** Trends to Watch 405
 - BPM Tools 405
 - Cloud Computing 405
 - Internet of Things (IoT) 406
- Supplement Summary 406
- Key Terms 407
- Discussion Questions 407
- References 407

13 JIT/Lean Production 408

- Introduction 410
- 13.1** The Lean Perspective on Waste 411
- 13.2** The Lean Perspective on Inventory 412
- 13.3** Recent Developments in Lean Thinking 413
- 13.4** Kanban Systems 414
 - Controlling Inventory Levels Using Kanbans 419
 - Synchronizing the Supply Chain Using Kanbans 421
 - Using MRP and Kanban Together 422
- Chapter Summary 423
- Key Formula 423
- Key Terms 424
- Solved Problem 424
- Discussion Questions 425
- Problems 425
- Case Study 426
- References 428

PART V

Project Management and Product/Service Development 429

14 Managing Projects 429

- Introduction 430
- 14.1** The Growing Importance of Project Management 431
- 14.2** Project Phases 432
 - Concept Phase 432
 - Project Definition Phase 432
 - Planning Phase 433
 - Performance Phase 433
 - Postcompletion Phase 433
- 14.3** Project Management Tools 434
 - Gantt Charts 434
 - Network Diagrams 436
 - Constructing a Network Diagram 436
 - Crashing a Project 440

X CONTENTS

14.4	Project Management Software	442
14.5	PMI and the <i>Project Management Body of Knowledge</i> (PMBOK®)	445
	Chapter Summary	445
	Key Formulas	445
	Key Terms	446
	Solved Problem	446
	Discussion Questions	447
	Problems	448
	Case Study	450
	References	450

15 Developing Products and Services 451

	Introduction	453
	Product Design and the Development Process	453
	Four Reasons for Developing New Products and Services	453
15.1	Operations and Supply Chain Perspectives on Design	454
	Repeatability, Testability, and Serviceability	455
	Production Volumes	455
	Product Costs	455
	Match with Existing Capabilities	456
15.2	The Development Process	457
	A Model of the Development Process	457
	Sequential Development versus Concurrent Engineering	459

15.3	Organizational Roles in Product and Service Development	460
	Engineering	460
	Marketing	460
	Accounting	460
	Finance	460
	Designers	461
	Purchasing	461
	Suppliers	462
	Who Leads?	462
15.4	Approaches to Improving Product and Service Designs	462
	DMADV (Define–Measure–Analyze–Design–Verify)	462
	Quality Function Deployment (QFD)	463
	Computer-Aided Design (CAD) and Computer-Aided Design/Computer-Aided Manufacturing (CAD/CAM)	464
	The “Design for . . .” Approaches	464
	Target Costing and Value Analysis	466
	Chapter Summary	466
	Key Terms	467
	Discussion Questions	467
	Case Study	467
	References	468

Appendices 469

Glossary 475

Index 487

PREFACE

When we set out to write the first edition of this book, we wanted to create an introductory text that provides an integrated and comprehensive treatment of both operations *and* supply chain management. That goal has remained the same through this, our fifth, edition.

NEW TO THIS EDITION

PROFESSIONAL PROFILE

MANDY ALTHOFF, METLIFE

MetLife is a well-respected financial services company that provides life insurance, annuities, employee benefits, and asset management services. Whenever MetLife issues an insurance policy, it takes on some financial risk in exchange for the premiums paid by the customer. Sound business practice and regulatory requirements dictate that MetLife keep enough cash reserves to pay off expected claims by the customers. In some instances, it makes good business sense for MetLife to outsource bundles of existing policies to another insurance company who “reinsures” the policies and takes the financial risk, while MetLife, in some cases, continues to provide service support to the customers.

Reaching an outsourcing agreement that is a win-win-win for MetLife, the reinsurer, and the final customer is a complicated task. While actuaries and underwriters perform much of the financial analysis, someone has to help manage the actual negotiation process (see Chapter 7). Enter Mandy Althoff, a Service Sourcing Consultant at MetLife. As Mandy puts it, “The idea of having someone from sourcing involved in helping arrange these outsourcing agreements is relatively new—these agreements used to be purely finance driven.” Mandy continues: “The business leadership team has been open to my creative approach to negotiation, allowing me a unique seat at the table. It all goes back to my undergraduate sourcing class.”



PROFESSIONAL PROFILE

DWIGHT HENDRICKSON, CATERPILLAR

Throughout this book, we have made the point that supply chains cover everything from sourcing-to-producing-to-delivering the final product or service. Furthermore, supply chain management takes place at the strategic planning level, looking years into the future, down to the execution of day-to-day activities.

In over 20 years at Caterpillar, Dwight Hendrickson has experienced all of this firsthand. He has been a commercial purchasing analyst and a lead buyer, a general operations supervisor and certified Six Sigma black belt, and a logistics manager and product program manager. In fact, Dwight's experience is so comprehensive that outside professional organizations regularly look to him for his expertise and leadership. He currently serves on the North Carolina District Export Council (NCDEC), which is made up of professionals who act as consultants to small- and medium-sized businesses that want to export goods into markets outside of the United States.



be like? Since the demand for building construction products is tightly tied to the overall health of the world economy and other geopolitical factors, Dwight has to make sure Caterpillar is ready to increase volumes dramatically when the economy is strong and scale down again.

With this new edition, we have continued our strategy of providing detailed coverage of important SCM topics while still maintaining a trim, integrated book. One of the most notable changes is the **professional profiles** found in selected chapters. These half-page profiles focus on individuals working in the operations and supply chain area—their company and industry, experiences and responsibilities, and their advice to others entering the field. These professional profiles are positioned to coincide with the relevant chapter topics so that readers can make the connection between what we are talking about in the book and how this plays out in practice.

We also added a section in Chapter 1 discussing the various employability skills that students can develop by studying the course and incorporating the learnings from this book into their daily lives. We have also updated Chapter 1's discussion of long-term trends to include the concepts of agility.

Chapter 3 now includes a discussion of 3D printing, also known as additive manufacturing. Long used in prototyping new products, 3D printing promises to change the volume/variety trade-offs for many manufactured items. Last, we have updated the opening case study in many of the chapters to reflect the changing business conditions and challenges facing operations and supply chain managers.

SOLVING TEACHING AND LEARNING CHALLENGES

The Six Sigma Methodology

Of all the various approaches to organizing for business process improvement, the Six Sigma methodology arguably best represents current thinking. It certainly is popular, with many top companies, such as GE, Motorola, and Bank of America, citing it as a key element of their business strategy. Six Sigma has its roots in the quality management discipline. (Quality management is such an important topic to operations and supply chain managers that we have devoted Chapter 5 to the subject.)

The term Six Sigma refers to both a quality metric and a methodology. In statistical terms, a process that achieves Six Sigma quality will generate just 3.4 defects per 1 million opportunities (DPMO). As a methodology for process improvement, Six Sigma has a much broader meaning. Motorola¹⁹ describes the **Six Sigma methodology** as:

A business improvement methodology that focuses an organization on:

- Understanding and managing customer requirements
- Aligning key business processes to achieve those requirements
- Utilizing rigorous data analysis to understand and ultimately minimize variation in those processes
- Driving rapid and sustainable improvement to business processes

Let's consider this definition for a moment. The first two points reinforce the idea that busi-

5.4 STATISTICAL QUALITY CONTROL

Instructors teaching operations and supply chain management face several challenges. The first is helping students **make the connection** between the needs of the business and the tools and techniques operations covered in the book. A second challenge is deciding exactly *what* tools and techniques to cover, especially in an introductory course. Finally, some of the more quantitative tools can be quite complex, requiring a variety of learning approaches to help students master them. This book addresses these challenges in the following manner:

- The book contains **comprehensive coverage** of the tools and techniques in the traditional OM areas (quality, capacity, queuing, forecasting, inventory, planning and control, and project management), *as well as* the purchasing and logistics areas.

Decision Trees

Decision tree
A visual tool that decision makers use to evaluate capacity decisions. The main advantage of a decision tree is that it enables users to see the interrelationships between decisions and possible outcomes. Decision trees are particularly good at helping users visualize complex series of decisions and outcomes.

The basic rules for using decision trees are as follows:

1. Draw a tree from left to right, starting with a decision point or an outcome point, and develop branches from there.
2. Represent each decision point with a square, with the different branches coming out of the square representing alternative choices.
3. Represent outcome points (which are beyond the control of the decision maker) with circles. Each possible outcome is represented by a branch off the circle. Another

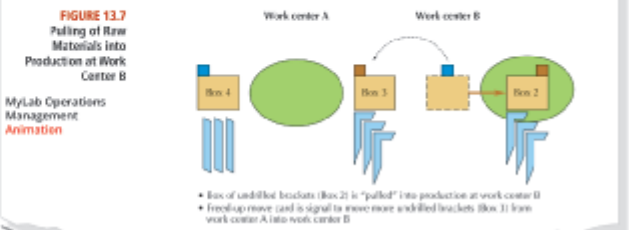
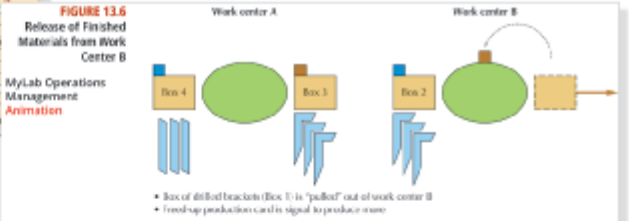
14.3 PROJECT MANAGEMENT TOOLS

Practitioners and academics have developed a host of tools to aid organizations in their project management efforts. Project management tools are used to plan, measure, and track a project's progress. In this section, we introduce two well-accepted tools: Gantt charts and network diagrams. These tools help managers understand what activities need to be completed, who is responsible for various activities, and when the activities should be completed. These tools also allow managers to track the time it takes to complete activities as well as costs. With the proper planning and control information, managers can take corrective actions when necessary to meet project objectives.

- Tools and techniques are always introduced **within the context** of the OM and SCM issues at hand. For example, we show how sales and operations planning (Chapter 10) can be used to coordinate activity *across* supply chain partners, as well as in its traditional role as an intra-firm planning approach.
- In addition to the extensive use of solved problems, students are shown how tools and techniques can be applied using **Microsoft Excel spreadsheets**. Learning is reinforced through homework problems that provide the students with a template and hints for checking their answers.
- An **Enhanced eText**, available in **MyLab Operations Management**, gives instructors and students the ability to highlight the text, bookmark, search the glossary, and take notes. More importantly, the eText provides a new way of learning that is particularly useful to today's students. Students are able to review animations of figures, indicated by **MyLab Operations Management Animation**, and videos of solved problems available on MyLab Operations Management with a simple click of an icon. Visit www.pearson.com/mylab/operations-management for more information.

FIGURE 12.18 Complete MRP Records for the King Philip Chair

		WEEK										
		1	2	3	4	5	6	7				
** Chair kit	MRP due date				500	400	100					
IT (weeks) = 1	Start assembly				500	400	300					
** Seat	Gross requirements				500	-400	300					
IT (weeks) = 2	Scheduled receipts											
	Projected ending inventory	0	0	0	0	0	0	0	0	0	0	0
	Net requirements				500	-400	300					
Min. order = 1	Planned receipts				500	-400	300					
	Planned orders		500	400	300							
** Leg set	Gross requirements				500	-400	300					
IT (weeks) = 1	Scheduled receipts											
	Projected ending inventory	25	25	25	25	25	25	25	25	25	25	25
	Net requirements				475	-475	175					
Min. order = 1,000	Planned receipts				1,000		1,000					
	Planned orders				1,000		1,000					
** Back seat	Gross requirements				500	-400	300					
IT (weeks) = 1	Scheduled receipts											
	Projected ending inventory	250	250	250	250	250	250	250	250	250	250	250
	Net requirements				250	-250	50					
Min. order = 250	Planned receipts				250		250					
	Planned orders				250		250					
** Legs	Gross requirements				2,000		2,000					
IT (weeks) = 2	Scheduled receipts											
	Projected ending inventory	25	25	25	0	0	0	0	0	0	0	0
	Net requirements				1,975		2,000					
Min. order = 1	Planned receipts				1,975		2,000					
	Planned orders				1,975		2,000					
** Side rails	Gross requirements				500	400	600					
IT (weeks) = 2	Scheduled receipts											
	Projected ending inventory	100	600	600	300	0	0	0	0	0	0	0
	Net requirements				700	-400	600					
Min. order = 500	Planned receipts				700		600					
	Planned orders				700		600					
** Back slats	Gross requirements				750	5,100	900					
IT (weeks) = 2	Scheduled receipts						75					
	Projected ending inventory	0	0	0	0	0	0	0	0	0	0	0
	Net requirements				750	5,100	825					



Tools and Techniques Integrated Throughout

TOOLS AND TECHNIQUES	SOLVED EXAMPLES	HOMEWORK PROBLEMS	EXCEL EXAMPLES/ PROBLEMS
Chapter 2: Operations and Supply Chain Strategies			
Value index	✓	✓	✓
Chapter 3: Process Choice and Layout Decisions in Manufacturing and Services			
Service blueprinting	✓		
Line balancing	✓	✓	
Assigning department locations	✓	✓	
Chapter 4: Business Processes			
Performance measures (productivity, efficiency, cycle time, percent value-added time)	✓	✓	
Process mapping	✓	✓	
Six Sigma methodology and DMAIC process	✓		
Continuous improvement tools (root cause analysis, scatter plots, check sheets, Pareto charts)	✓	✓	
Cause-and-effect diagrams	✓		
Chapter 5: Managing Quality			
Process capability ratio	✓	✓	
Process capability index	✓	✓	
Six Sigma quality	✓	✓	
\bar{X} and R charts	✓	✓	✓
p charts	✓	✓	✓
Acceptance sampling	✓		
Chapter 6: Managing Capacity			
Expected value analysis	✓	✓	✓
Decision trees	✓	✓	
Break-even analysis	✓	✓	✓
Indifference point	✓	✓	✓
Learning curves	✓	✓	
Theory of constraints	✓		
Waiting lines (queuing analysis)	✓	✓	
Little's Law	✓	✓	
Simulation analysis	✓		✓
Chapter 7: Supply Management			
Total cost analysis	✓	✓	
Weighted-point evaluation system	✓	✓	✓
Profit leverage	✓	✓	
Spend analysis	✓	✓	
Chapter 8: Logistics			
Shipment consolidation	✓	✓	✓
Perfect order calculation	✓	✓	
Landed costs	✓	✓	
Weighted center of gravity model	✓	✓	✓
Optimization modeling (assignment problem using Excel Solver function)	✓	✓	✓
Chapter 9: Forecasting			
Moving average model	✓	✓	✓
Exponential smoothing model	✓	✓	✓
Adjusted exponential smoothing model	✓	✓	✓
Linear regression	✓	✓	✓
Seasonal adjustments	✓	✓	✓
Multiple regression	✓	✓	✓

(Continued)

TOOLS AND TECHNIQUES	SOLVED EXAMPLES	HOMEWORK PROBLEMS	EXCEL EXAMPLES/ PROBLEMS
MAPE, MAD, MFE, and tracking signal	✓	✓	✓
Chapter 10: Sales and Operations Planning (Aggregate Planning)			
Top-down sales and operations planning	✓	✓	✓
Bottom-up sales and operations planning	✓	✓	
Cash flow analysis	✓	✓	
Load profiles	✓	✓	
Optimization modeling (top-down sales and operations planning using Excel Solver function)	✓	✓	✓
Chapter 11: Managing Inventory throughout the Supply Chain			
Periodic review systems	✓	✓	
Economic order quantity	✓	✓	✓
Reorder points and safety stock	✓	✓	✓
Quantity discounts	✓	✓	
Single-period inventory systems (newsboy problem)	✓	✓	
Pooling safety stock	✓	✓	✓
Chapter 12: Managing Production across the Supply Chain			
Master scheduling	✓	✓	
Material requirements planning (MRP)	✓	✓	
Job sequencing rules	✓	✓	
Distribution requirements planning (DRP)	✓	✓	
Chapter 13: JIT/Lean Production			
Kanban sizing	✓	✓	
Linking MRP and kanban	✓	✓	
Chapter 14: Managing Projects			
Gantt charts	✓	✓	
Activity on node (AON) diagrams and critical path method (CPM)	✓	✓	Microsoft Project example
Project crashing	✓	✓	
Chapter 15: Developing Products and Services			
Quality function deployment (QFD)	✓		

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.

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. So 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.

Improve Student Results. When you teach with MyLab, student performance improves. That’s why instructors have chosen MyLab for more than 15 years, touching the lives of over 50 million students.

DEVELOPING EMPLOYABILITY SKILLS

This book covers many skills that hiring managers identify as important to success in a variety of business settings, including small and large firms, nonprofit organizations, and public service.

Critical Thinking

Critical thinking involves purposeful and goal-directed thinking used to define and solve problems, make decisions, or form judgments related to a particular situation or set of circumstances. This book is filled with dozens of useful frameworks that managers regularly use to support problem solving, including the Six Sigma methodology (Chapter 4), decision tree analysis (Chapter 6), sourcing portfolio analysis (Chapter 7), and project management tools (Chapter 14). It is not an exaggeration to say that critical thinking and fact-based decision making are built into the DNA of the operations and supply chain discipline.

Collaboration

Many key operations and supply chain activities require close collaboration with participants from other areas, such as marketing, engineering, and finance. Throughout this book, we will emphasize the importance of cross-functional collaboration as well as collaboration with outside supply chain partners. Forecasting (Chapter 9) and inventory management (Chapter 11) are just two areas in which collaboration is essential for the process to work. Chapter 10, in fact, is devoted to sales and operations planning, an approach to planning that depends entirely on collaboration and negotiation between operations, marketing, finance, and human resources in order to succeed.



Knowledge Application and Analysis

Knowledge application and analysis is defined as the ability to learn a concept and then apply that knowledge in another setting to achieve a higher level of understanding. Put another way, understanding is more than just memorizing formulas and cranking out answers. As such, this book seeks to move students “beyond the formulas” by illustrating how the concepts can be applied in a wide range of settings, using both extended examples and in-chapter case studies.

EXAMPLE 4.6
Applying DMAIC and Continuous Improvement Tools at the Bluebird Café

Katie Farre, owner of the Bluebird Café, is browsing a Web site that allows individuals to rate restaurants on a 1-to-5 scale, with 1 = “Highly Dissatisfied” and 5 = “Highly Satisfied.” Katie is disappointed to learned that, based on several hundred responses, the average rating for the Bluebird Café is only 3.83 and that 12% of respondents their dining experience as a 1 or 2. Unfortunately, the Web site does not provide information about why the customers rated the café as they did. Katie greets in the reputation of the Bluebird Café, and she decides to use the DM and continuous improvement tools to tackle the customer satisfaction issue.

Step 1: Define the Goals of the Improvement Activity

At a meeting with the management team, Katie emphasizes the importance of customer satisfaction to the ongoing success of the business. The Bluebird Café is in a college town and has plenty of competitors; local customers can go they are dissatisfied, and out-of-town visitors often depend on Internet to decide where they will dine. With this in mind, Katie and the manager set a target average rating of 4.5 or greater for any future Internet ratings, with more than 2% of respondents giving a rating of 1 or 2.

Step 2: Measure the Existing Process

Katie already has a process map that identifies the major steps required to serve a customer (Figure 4.5). While this is a good start, the team feels that more data

CASE STUDY
Swim Lane Process Map for a Medical Procedure

Figure 4.21 shows the swim lane process map for a patient undergoing a lumpectomy (the surgical removal of a small tumor from the breast). Nine parties, including the patient, were involved in the process. For many of the steps in Figure 4.21, a box has been drawn around multiple parties, indicating that two or more parties were involved in the step. For example, the “surgery” step involved three parties: the patient, the surgeon, and the hospital.

During the treatment process, the patient (who was a registered nurse) detected two errors. Error 1 occurred when the surgeon intended to employ a needle locator to identify the location of the tumor, but failed to forward an order to that effect to the hospital. The patient identified the omission prior to surgery. No harm occurred. Error 2 was a typographic error on the pathology report, indicating that the tumor was 1.6 millimeters diameter when in fact it was 1.6 centimeters. This could have been a more serious mistake, but a phone call to confirm the correction avoided any harm.

Questions

1. Who or what organization is responsible for this process? How often to finish? What are the implications for monitoring and improving the business process?
2. Which process steps should be standardized? Which process steps should be more artistic? Explain.
3. Consider the errors that occurred during the treatment process. How might you use the Six Sigma methodology and continuous improvement tools to keep these errors from reoccurring? Looking ahead, what kinds of solutions might you see coming out of such an analysis?

FIGURE 4.21
Swim Lane Process Map for a Surgical Procedure
Source: John D. Lee, “Swim Lane,” <http://www.pdpc.com/wordpress/wp-content/uploads/2012/07/swimlane.jpg>

Information Technology Application and Computing Skills

Finally, information technology application and computing skills are defined as the ability to select and use appropriate technology to accomplish a given task. This book covers this skill set in a couple different ways. First, the book includes numerous, detailed examples of how Microsoft Excel can be used to carry out the various calculations covered in the text. Second, we have devoted the Chapter 12 supplement to understanding supply chain information system needs and reviewing recent trends in the area.

TABLE OF CONTENTS OVERVIEW

I. Creating Value through Operations and Supply Chains

Ch. 1: Introduction to Operations and Supply Chain Management	Introduces basic concepts and definitions that lay the groundwork for future chapters
Ch. 2: Operations and Supply Chain Strategies	Discusses operations and supply chain strategies, including what they are, how they support the organization’s overall strategy, and how they help a firm provide value to the customer

II. Establishing the Operations Environment

Ch. 3: Process Choice and Layout Decisions in Manufacturing and Services	Describes the manufacturing and service processes that firms put in place to provide products or services
Ch. 4: Business Processes	Introduces the topic of business processes, which can be thought of as the “molecules” that make up all operations and supply chain flows
Ch. 5: Managing Quality	Provides an overview of the different perspectives on quality, as well as some of the tools and techniques companies use to improve and monitor quality levels
Ch. 6: Managing Capacity	Discusses capacity and introduces several tools that managers use to evaluate capacity choices, including expected value analysis, waiting line theory, and Little’s Law

III. Establishing Supply Chain Linkages

Ch. 7: Supply Management	Describes the broad set of activities carried out by organizations to analyze sourcing opportunities, develop sourcing strategies, select suppliers, and carry out all the activities required to procure goods and services
Ch. 8: Logistics	Discusses the physical flow of goods throughout the supply chain and covers such areas as transportation, warehousing, and logistics decision models

IV. Planning and Controlling Operations and Supply Chains

Ch. 9: Forecasting	Discusses the different types of forecasts firms use, and covers the most common quantitative forecasting methods
Ch. 10: Sales and Operations Planning (Aggregate Planning)	Describes S&OP process and major approaches to developing plans. Additional topics include cash flow analysis and linking S&OP throughout the supply chain
Ch. 11: Managing Inventory throughout the Supply Chain	Discusses the critical role of inventory, and tools and techniques for managing it
Ch. 12: Managing Production across the Supply Chain	Introduces some of the systems manufacturers use to manage production and to coordinate these activities with their supply chain partners
Ch. 13: JIT/Lean Production	Introduces the just-in-time (JIT)/Lean philosophy, and provides coverage of kanban production techniques

V. Project Management and Product/Service Development

Ch. 14: Managing Projects	Describes how organizations manage projects, and covers common project management tools, including network-based models
Ch. 15: Developing Products and Services	Addresses the product and service development process, with an emphasis on how these decisions directly affect choices in operations and supply chain management

INSTRUCTOR TEACHING RESOURCES

This program comes with the following teaching resources.

SUPPLEMENTS AVAILABLE TO INSTRUCTORS AT WWW.PEARSONHIGHERED.COM/BOZARTH	FEATURES OF THE SUPPLEMENT
Instructor's Solutions Manual, authored by Geoff Willis from UCO College of Business	<ul style="list-style-type: none"> Detailed solutions for all end-of-chapter Discussion Questions, Problems, and Case Study questions Solutions of the Excel problems available on the Data Download page
Test Bank, authored by Geoff Willis from UCO College of Business	<p>More than 1,500 multiple-choice, true/false, short-answer, and graphing questions with these annotations:</p> <ul style="list-style-type: none"> Difficulty level (1 for straight recall, 2 for some analysis, 3 for complex analysis) Type (Multiple-choice, true/false, short-answer, essay) Keywords (The term or concept the question supports) Learning outcome 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)

(Continued)

SUPPLEMENTS AVAILABLE TO INSTRUCTORS AT WWW.PEARSONHIGHERED.COM/BOZARTH	FEATURES OF THE SUPPLEMENT
Computerized TestGen	TestGen allows instructors to: <ul style="list-style-type: none"> • Customize, save, and generate classroom tests • Edit, add, or delete questions from the Test Item Files • Analyze test results • Organize a database of tests and student results
PowerPoints, authored by Dr. Kathryn A. Marley from Duquesne University	Slides include key Excel figures, graphs, tables, and equations in the textbook. PowerPoints meet accessibility standards for students with disabilities. Features include, but not limited to: <ul style="list-style-type: none"> • Keyboard and Screen Reader access • Alternative text for images • High color contrast between background and foreground colors
Excel Problems	Instructors can create different homework problems for different class sections and even different students. This feature is ideal for instructors teaching large sections of an introductory operations/supply chain course. With these homework problems, professors have an extra measure to guard against plagiarism in homework assignments. Here's how it works: <ol style="list-style-type: none"> 1. Students go to the Multimedia Library in MyLab Operations Management or to the Data Download page at www.pearsonhighered.com/bozarth and open an Excel spreadsheet listed under the chapter of interest. 2. Students type their name and a four-digit number chosen by the instructor into the spreadsheet. The four-digit number creates new parameters for the problem. 3. Students print out their customized homework sets and solve the problems. 4. The instructor uses an Excel-based key that uses the same four-digit number to generate the correct answers.

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.

ACKNOWLEDGMENTS

We would like to thank the following reviewers of the previous editions:

- R. C. Baker, University of Texas at Arlington
- David L. Bakuli, Westfield State College
- Gregory L. Bier, University of Missouri
- Terrence M. Boardman, East Carolina University
- Kimball Bullington, Middle Tennessee State University
- David T. Cadden, Quinnipiac University
- Cem Canel, University of North Carolina at Wilmington
- Sohail Chaudhry, Villanova University
- Christopher W. Craighead, University of North Carolina at Charlotte
- Richard E. Crandall, Appalachian State University
- Barry A. Cumbie, University of Southern Mississippi
- Sime Curkovic, Western Michigan University
- Eduardo C. Davila, Arizona State University
- Kenneth H. Doerr, University of Miami
- Matthew J. Drake, Duquesne University
- Ike C. Ehie, Kansas State University
- Lawrence P. Etkin, University of Tennessee at Chattanooga
- Jared Everett, Boise State University

Kamvar Farahbod, California State University, San Bernardino
Donavon Favre, North Carolina State University
Geraldo Ferrar, University of North Carolina at Chapel Hill
Bruce G. Ferrin, Western Michigan University
Gene Fliedner, Oakland University
Tom Foster, Brigham Young University
Ram Ganeshan, University of Cincinnati
Janet L. Hartley, Bowling Green State University
Ray M. Haynes, California Polytechnic State University, San Luis Obispo
Lesley Gail Scamacca Holmer, The Pennsylvania State University
Seung-Lae Kim, Drexel University
Timothy J. Kloppenborg, Xavier University
Terry Nels Lee, Brigham Young University
Binshan Lin, Louisiana State University in Shreveport
Rhonda R. Lummus, Iowa State University
Daniel S. Marrone, State University of New York Farmingdale
Mark McKay, University of Washington
Mohammad Meybodi, Indiana University Kokomo
Philip F. Musa, Texas Tech University
Joao S. Neves, The College of New Jersey
Barbara Osyk, The University of Akron
Fariborz Y. Partovi, Drexel University
Charles Petersen, Northern Illinois University
Carl J. Poch, Northern Illinois University
Robert F. Reck, Western Michigan University
Richard A. Reid, University of New Mexico
Shane J. Schvaneveldt, Weber State University
V. Sridharan, Clemson University
Mahesh Srinivasan, The University of Akron
Harm-Jan Steenhuis, Eastern Washington University
Joaquin Tadeo, University of Texas at El Paso
V. M. Rao Tummala, Eastern Michigan University
Elisabeth Umble, Baylor University
Enrique R. Venta, Loyola University Chicago
Y. Helio Yang, San Diego State University

This page intentionally left blank



Ib0007/Shutterstock

CHAPTER one

CHAPTER OUTLINE

Introduction

1.1 Why Study Operations and Supply Chain Management?

1.2 Important Trends

1.3 Operations and Supply Chain Management and You

1.4 Employability Skills

1.5 Purpose and Organization of This Book

Chapter Summary

Introduction to Operations and Supply Chain Management

CHAPTER OBJECTIVES

By the end of this chapter, you will be able to:

- Describe what the operations function is and why it is critical to an organization's survival.
- Describe what a supply chain is and how it relates to a particular organization's operations function.
- Discuss what is meant by operations management and supply chain management.
- Identify some of the major operations and supply chain activities, as well as career opportunities in these areas.
- Make a case for studying *both* operations management and supply chain management.

INTRODUCTION

Let's start with a question: What do the following organizations have in common?

- **Walmart**, which not only is a leading retailer in the United States but also has built a network of world-class suppliers, such as GlaxoSmithKline, Sony, and Mattel
- **FedEx**, a service firm that provides supply chain solutions and transportation services
- **Flex Ltd.**, a contract manufacturer that assembles everything from plug-in electric motorcycles to LCD and touch displays
- **SAP**, the world's largest provider of enterprise resource planning (ERP) software

While these firms may appear to be very different from one another, they have at least one thing in common: a strong commitment to superior operations and supply chain management.

In this chapter, we kick off our study of operations and supply chain management. We begin by examining what operations is all about and how the operations of an individual organization fit within a larger supply chain. We then talk about what it means to *manage* operations and supply chains. As part of this discussion, we will introduce you to the Supply Chain Operations Reference (SCOR) model, which many businesses use to understand and structure their supply chains.

In the second half of the chapter, we discuss several trends in business that have brought operations and supply chain management to the forefront of managerial thinking. We also devote a section to what this all means to you. We discuss career opportunities in the field, highlight some of the major professional organizations that serve operations and supply chain professionals, and look at some of the major activities that operations and supply chain professionals are involved in on a regular basis. We end the chapter by providing a roadmap of this book.



James Lauritz/AGE Fotostock



Sudok1/Fotolia



George Doyle/Stockbyte/Getty Images



Monkey Business Images/Shutterstock

Operations management and supply chain management cover a wide range of activities, including transportation services, manufacturing operations, retailing, and consulting.

1.1 WHY STUDY OPERATIONS AND SUPPLY CHAIN MANAGEMENT?

So, why should you be interested in operations and supply chain management? There are three simple reasons.

1. Every organization must make a product or provide a service that someone values.

Otherwise, why would the organization exist? Think about it. Manufacturers produce physical goods that are used directly by consumers or other businesses. Transportation companies provide valuable services by moving and storing these goods. Design firms use their expertise to create products or even corporate images for customers. Software firms develop apps that consumers use on their smartphones. The need to provide a valuable product or service holds true for not-for-profit organizations as well. Consider the variety of needs met by government agencies, charities, and religious groups, for example.

The common thread is that each organization has an operations function, or *operations*, for short. The **operations function** is the collection of people, technology, and systems within an organization that has primary responsibility for providing the organization's products or services. Regardless of what career path you might choose, you will need to know something about your organization's operations function.

As important as the operations function is to a firm, few organizations can—or even want to—do everything themselves. This leads to our second reason for studying operations and supply chain management.

2. Most organizations function as part of larger supply chains.

A **supply chain** is a network of manufacturers and service providers that work together to create products or services needed by end users. These manufacturers and service providers are linked together through physical flows, information flows, and monetary flows. When the primary focus is on physical goods, much of the supply chain activity will revolve around the conversion, storage, and movement of materials and products. In other cases, the focus might be on providing an intangible service. For example, automobile insurance companies like Progressive Insurance depend on cellular phone networks and Internet service providers (ISPs) to support the data flows that allow customers to upload photos of accident damage and receive settlement checks electronically.

Supply chains link together the operations functions of many different organizations to provide real value to customers. Consider a sporting goods store that sells athletic shoes. Although the store doesn't actually make the shoes, it provides valuable services for its customers—a convenient location and a wide selection of products. Yet, the store is only one link in a much larger supply chain that includes:

- Plastic and rubber producers that provide raw materials for the shoes.
- Manufacturers that mold and assemble the shoes.
- Wholesalers that decide what shoes to buy and when.
- Transportation firms that move the materials and finished shoes to all parts of the world.
- Software firms and ISPs that support the information systems that coordinate these physical flows.
- Financial firms that help distribute funds throughout the supply chain, ensuring that the manufacturers and service firms are rewarded for their efforts.

So where does this lead us? To our third reason for studying operations and supply chain management—and the premise for this book.

3. Organizations must carefully manage their operations and supply chains in order to prosper and, indeed, survive.

Returning to our example, think about the types of decisions facing a shoe manufacturer. Some fundamental operations decisions that it must make include the following: “How many shoes should we make, and in what styles and sizes?” “What kind of people skills and equipment do we need?” “Should we locate our

Operations function

Also called *operations*. The collection of people, technology, and systems within an organization that has primary responsibility for providing the organization's products or services.

Supply chain

A network of manufacturers and service providers that work together to create products or services needed by end users. These manufacturers and service providers are linked together through physical flows, information flows, and monetary flows.



Dmitri Ma/Shutterstock

Athletic shoes at a retailer represent the last stage in a supply chain that crosses the globe and involves many different companies.

plants to take advantage of low-cost labor or to minimize shipping cost and time for the finished shoes?”

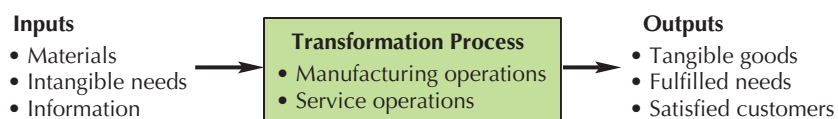
In addition to these operations issues, the shoe manufacturer faces many decisions with regard to its role in the supply chain: “From whom should we buy our materials—the lower-cost supplier or the higher-quality one?” “Which transportation carriers will we use to ship our shoes?” The right choices can lead to higher profitability and increased market share, while the wrong choices can cost the company dearly—or even put it out of business.

Operations Management

Let’s begin our detailed discussion of operations and supply chain management by describing operations a little more fully and explaining what we mean by operations management. As we noted earlier, all organizations must make products or provide services that someone values, and the operations function has the primary responsibility for making sure this happens.

One way to think about operations is as a *transformation process* that takes a set of inputs and transforms them in some way to create outputs—either goods or services—that a customer values (Figure 1.1). Consider a plant that makes wood furniture. Even for a product as simple as a chair, the range of activities that must occur to transform raw lumber into a finished chair can be overwhelming at first. Raw lumber arrives as an input to the plant, perhaps by truck or even train car. The wood is then unloaded and moved onto the plant floor. Planing machines cut the

FIGURE 1.1
Viewing Operations
as a Transformation
Process





Goodluz/Shutterstock

Health care services use highly skilled individuals as well as specialized equipment to provide physiological transformation processes for their patients.

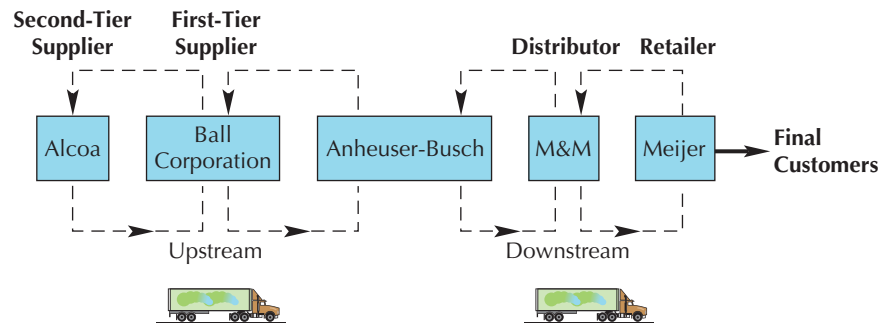
lumber to the right thickness. Lathes shape pieces of wood into legs and back spindles for the chairs. Other machines fabricate wood blanks, shaping them into seats and boring holes for the legs and back spindles.

In addition to the equipment, there are people who run and load the machines, conveyors, and forklifts that move materials around the plant, and there are other people who assemble the chairs. Once the chairs are finished, still more people pack and move the chairs into a finished goods warehouse or onto trucks to be delivered to customers. In the background, supervisors and managers use information systems to plan what activities will take place next.

The operations function can also provide intangible services, as in the case of a law firm. A major input, for example, might be the need for legal advice—hardly something you can put your hands around. The law firm, through the skill and knowledge of its lawyers and other personnel, transforms this input into valuable legal advice, thereby fulfilling the customer's needs. How well the law firm accomplishes this transformation goes a long way in determining its success.

Figure 1.1 makes several other points. First, inputs to operations can come from many places and take many different forms. They can include raw materials, intangible needs, and even information, such as demand forecasts. Also, operations are often highly dependent on the quality and availability of inputs. Consider our furniture plant again. If the lumber delivered to it is of poor quality or arrives late, management might have to shut down production. In contrast, a steady stream of good-quality lumber can ensure high production levels and superior products. Second, nearly all operations activities require coordination with other business functions, including engineering, marketing, and human resources. We will revisit the importance of cross-functional decision making in operations throughout the book. Third, operations management activities are information and decision intensive. You do not have to be able to assemble a product or treat a patient yourself to be a successful operations manager—but you *do* have to make sure the right people and equipment are available to do the job, the right materials arrive when needed, and the product or service is completed on time, at cost, and to specifications!

FIGURE 1.2
A Simplified View of
Anheuser-Busch's
Supply Chain



Operations management

"The planning, scheduling, and control of the activities that transform inputs into finished goods and services."

Operations management, then, is "the planning, scheduling, and control of the activities that transform inputs into finished goods and services."¹ Operations management decisions can range from long-term, fundamental decisions about what products or services will be offered and what the transformation process will look like to more immediate issues, such as determining the best way to fill a current customer request. Through sound operations management, organizations hope to provide the best value to their customers while making the best use of resources.

Supply Chain Management

The traditional view of operations management illustrated in Figure 1.1 still puts most of the emphasis on the activities a particular organization must perform when managing its own operations. But, as important as a company's operations function is, it is not enough for a company to focus on doing the right things within its own four walls. Managers must also understand how the company is linked in with the operations of its suppliers, distributors, and customers—what we refer to as the supply chain.

As we noted earlier, organizations in the supply chain are linked together through physical flows, information flows, and monetary flows. These flows go both up and down the chain. Let's extend our discussion and vocabulary using a product many people are familiar with: a six-pack of beer. Figure 1.2 shows a simplified supply chain for Anheuser-Busch. From Anheuser-Busch's perspective, the firms whose inputs feed into its operations are positioned **upstream**, while those firms who take Anheuser-Busch's products and move them along to the final consumer are positioned **downstream**.

When the typical customer goes to the store to buy a six-pack, he or she probably does not consider all of the steps that must occur beforehand. Take cans, for example. Alcoa extracts the aluminum from the ground and ships it to Ball Corporation, which converts the aluminum into cans for Anheuser-Busch. In the supply chain lexicon, Ball Corporation is a **first-tier supplier** to Anheuser-Busch because it supplies materials directly to the brewer. By the same logic, Alcoa is a **second-tier supplier**; it provides goods to the first-tier supplier.

The cans from Ball Corporation are combined with other raw materials, such as cartons, grain, hops, yeast, and water, to produce the packaged beverage. Anheuser-Busch then sells the packaged beverage to M&M, a wholesaler that, in turn, distributes the finished good to Meijer, the retailer. Of course, we cannot forget the role of transportation carriers, which carry the inputs and outputs from one place to the next along the supply chain.

As Figure 1.2 suggests, the flow of goods and information goes both ways. For instance, Ball Corporation might place an order (information) with Alcoa, which, in turn, ships aluminum (product) to Ball. Anheuser-Busch might even return empty pallets or containers to its first-tier suppliers, resulting in a flow of physical goods back up the supply chain.

Of course, there are many more participants in the supply chain than the ones shown here; Anheuser-Busch has hundreds of suppliers, and the number of retailers is even higher. We could also diagram the supply chain from the perspective of Alcoa, M&M, or any of the other

Upstream

A term used to describe activities or firms that are positioned *earlier* in the supply chain relative to some other activity or firm of interest. For example, corn harvesting takes place upstream of cereal processing, and cereal processing takes place upstream of cereal packaging.

Downstream

A term used to describe activities or firms that are positioned *later* in the supply chain relative to some other activity or firm of interest. For example, sewing a shirt takes place downstream of weaving the fabric, and weaving the fabric takes place downstream of harvesting the cotton.

First-tier supplier

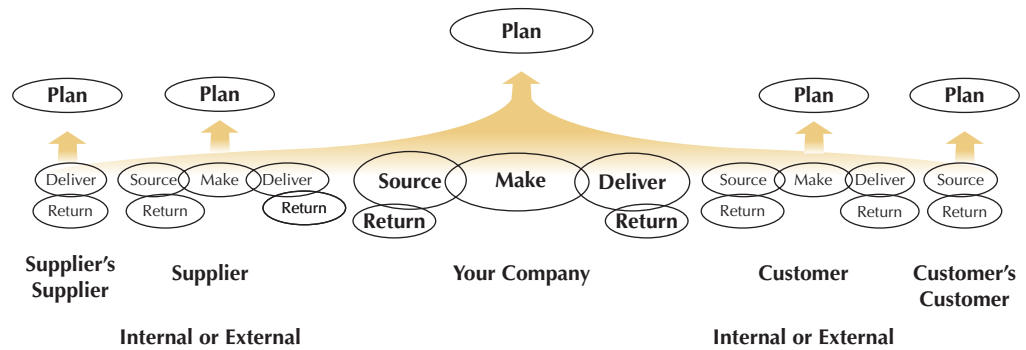
A supplier that provides products or services directly to a firm.

Second-tier supplier

A supplier that provides products or services to a firm's first-tier supplier.

¹J. H. Blackstone, ed., *APICS Dictionary*, 15th ed. (Chicago, IL: APICS, 2016).

FIGURE 1.3
The Supply Chain
Operations Reference
(SCOR) Model



participants. The point is that most of the participants in a supply chain are both customers and suppliers. Finally, the supply chain must be very efficient, as the final price of the good must cover all of the costs involved plus a profit for each participant in the chain.

While you were reading through the above example, you might have thought to yourself, “Supply chains aren’t new”—and you’d be right. Yet most organizations historically performed their activities independently of other firms in the chain, which made for disjointed and often inefficient supply chains. In contrast, **supply chain management** is the *active* management of supply chain activities and relationships in order to maximize customer value and achieve a sustainable competitive advantage. It represents a conscious effort by a firm or group of firms to develop and run supply chains in the most effective and efficient ways possible.

But what exactly *are* these supply chain activities? To answer this, we turn to the **Supply Chain Operations Reference (SCOR) model**. The SCOR model is a framework that seeks to provide standard descriptions of the processes, relationships, and metrics that define supply chain management.² We will explore the SCOR model in more detail in Chapter 4, but for now, Figure 1.3 provides a high-level view of the framework. According to the SCOR model, supply chain management covers five broad areas:

1. *Planning activities*, which seek to balance demand requirements against resources and communicate these plans to the various participants.
2. *Sourcing activities*, which include identifying, developing, and contracting with suppliers and scheduling the delivery of incoming goods and services.
3. *“Make,” or production, activities*, which cover the actual production of a good or service.
4. *Delivery activities*, which include everything from entering customer orders and determining delivery dates to storing and moving goods to their final destination.
5. *Return activities*, which include the activities necessary to return and process defective or excess products or materials.

Finally, notice that Figure 1.3 shows the supply chain management task extending from the company’s suppliers’ suppliers, all the way to the customers’ customers. As you can imagine, coordinating the activities of all these parties is challenging.

To illustrate, let’s consider Walmart, one of the earliest proponents of supply chain management.³ What Walmart was doing in the late 1980s and early 1990s was nothing short of revolutionary. Individual stores sent daily sales information to Walmart’s suppliers via satellite. These suppliers then used the information to plan production and ship orders to Walmart’s warehouses. Walmart used a dedicated fleet of trucks to ship goods from warehouses to stores in less than 48 hours and to replenish store inventories about twice a week. The result was better customer service (because products were nearly always available), lower production and transportation costs (because suppliers made and shipped only what was

Supply chain management
The *active* management of supply chain activities and relationships in order to maximize customer value and achieve a sustainable competitive advantage. It represents a conscious effort by a firm or group of firms to develop and run supply chains in the most effective and efficient ways possible.

Supply Chain Operations Reference (SCOR) model
A framework developed and supported by the Supply Chain Council that seeks to provide standard descriptions of the processes, relationships, and metrics that define supply chain management.

²SCOR Framework, www.apics.org/apics-for-business/products-and-services/apics-scc-frameworks/scor.

³G. Stalk, P. Evans, and L. E. Shulman, “Competing on Capabilities: The New Rules of Corporate Strategy,” *Harvard Business Review* 70, no. 2 (March–April 1992): 57–69.



JG Photography/Alamy Stock Photo

Walmart was an early proponent of superior supply chain performance. Other companies have now adopted many of the practices Walmart pioneered in the 1980s.

needed), and better use of retail store space (because stores did not have to hold an excessive amount of inventory).

Walmart has continued to succeed through superior sourcing and delivery, and many of the practices it helped pioneer have taken root throughout the business world. In fact, many retailers now make *multiple* shipments to stores each day, based on *continuous* sales updates. To illustrate how widespread supply chain management thinking has become, consider the example of Panera Bread in the *Supply Chain Connections* feature.

Supply chain management efforts can range from an individual firm taking steps to improve the flow of information between itself and its supply chain partners to a large trade organization looking for ways to standardize transportation and billing practices. In the case of Walmart, a single, very powerful firm took primary responsibility for improving performance across its own supply chain. As an alternative, companies within an industry often form councils or groups to identify and adopt supply chain practices that will benefit all firms in the industry. One such group is the Automotive Industry Action Group (AIAG, www.aiag.org), whose members “work collaboratively to streamline industry processes via global standards development & harmonized business practices.”⁴ The Grocery Manufacturers of America (GMA, www.gmaonline.org) serves a similar function. Other organizations, such as APICS (www.apics.org/apics-for-business), seek to improve supply chain performance across many industries.

⁴Automotive Industry Action Group (AIAG), www.aiag.org/about.

SUPPLY CHAIN CONNECTIONS

PANERA BREAD: “A LOAF OF BREAD IN EVERY ARM”

If you live in the United States or Canada, there is a good chance that you have either heard of or visited a Panera Bread bakery-cafe. Panera Bread is a specialty food retailer that has built its business on providing consumers with fresh artisan bread products served at strategically located, distinctive bakery-cafes. As of December 2016, Panera Bread had over 2,100 company- and franchise-operated bakery-cafes.⁵ Financial results have been equally impressive: for 2015, revenues from \$2.68 billion, with an operating profit of over \$240 million.⁶

But consider for a moment the upstream supply chain activities that must take place to ensure that these bakery-cafes receive the fresh dough needed to fulfill the company’s mission statement, “A loaf of bread

in every arm.” In the case of Panera Bread, the operations and supply chain team has responded by putting in place a network of 24 fresh dough manufacturing facilities that produce more than 300 million pounds of dough annually. To ensure the freshest product possible, this dough is delivered 7 days a week, 365 days a year, to the bakery-cafes. Panera’s operations and supply chain team also controls the distribution system for the retail bakery-cafes and supports the company’s baking activities. In effect, the team is responsible for everything that comes through the back doors of Panera Bread bakery-cafes.

Even in this short description, we can see how Panera Bread’s supply chain activities cover everything from sourcing to production to delivery. It’s a safe bet that Panera Bread’s interest in effective supply chain management will continue to “rise” along with its products.



Judith Collins/Alamy Stock Photo

⁵Reuters, Profile: Panera Bread (PNRA.O), www.reuters.com/finance/stocks/companyProfile?symbol=PNRA.O, April 6, 2017.

⁶Panera Bread Company, 2015 Annual Report to Stockholders, www.panerabread.com/content/dam/panerabread/documents/financial/2016/pbc-annual-report-2015.pdf.

1.2 IMPORTANT TRENDS

As we shall see, operations management and supply chain management are as much philosophical approaches to business as they are bodies of tools and techniques, and thus they require a great deal of interaction and trust between companies. For right now, however, let’s talk about three enduring trends that will continue to attract the attention of operations and