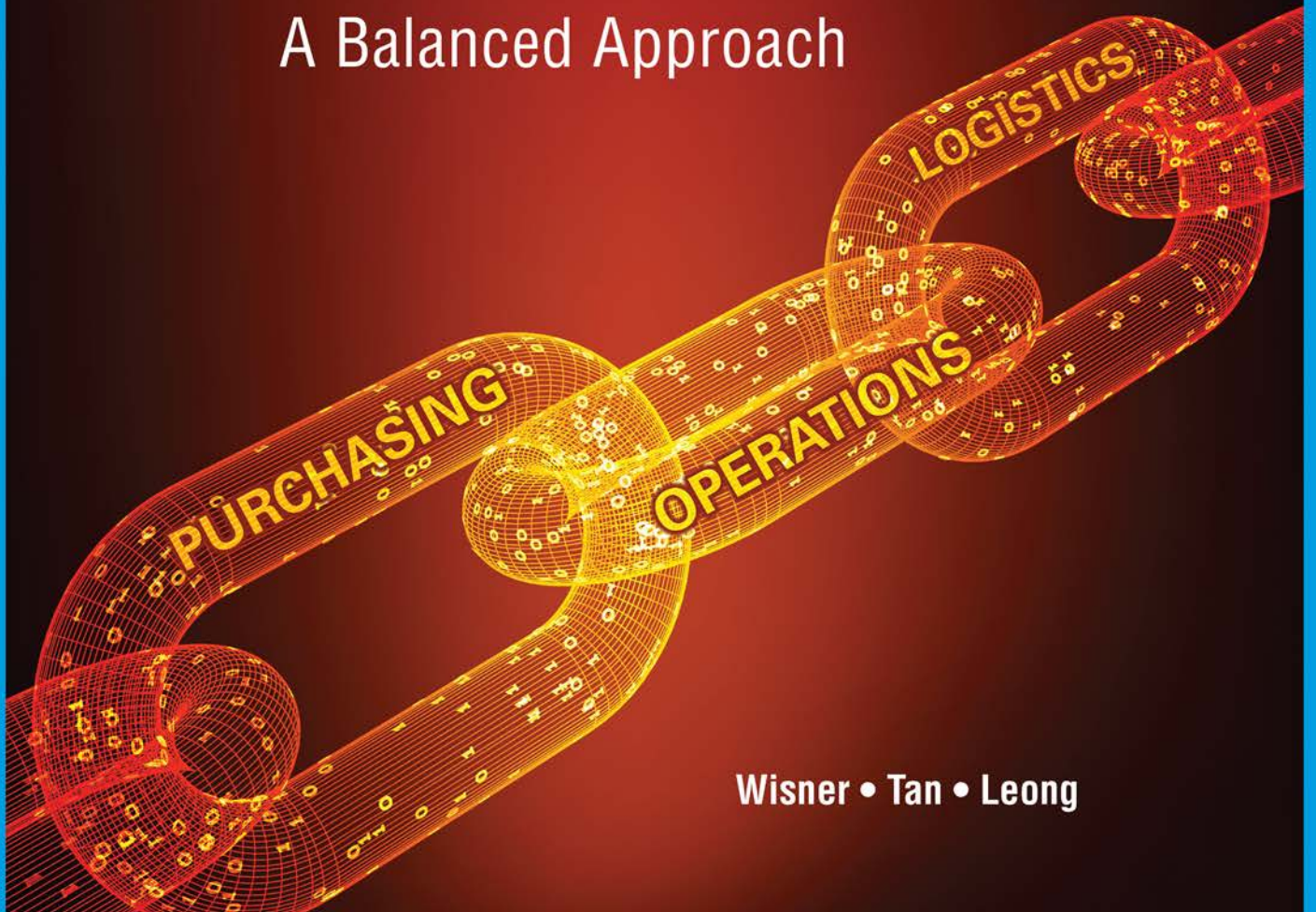


 CENGAGE

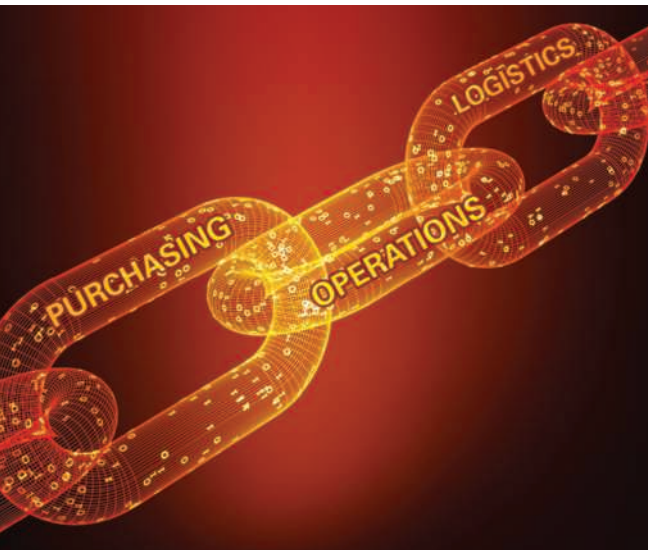
6th Edition

Principles of Supply Chain Management

A Balanced Approach



Wisner • Tan • Leong



Principles of Supply Chain Management

A Balanced Approach | 6e

JOEL D. WISNER, PhD

University of Nevada, Las Vegas

KEAH-CHOON TAN, PhD

University of Nevada, Las Vegas

G. KEONG LEONG, PhD

*California State University,
Dominguez Hills*



Australia • Brazil • Canada • Mexico • Singapore • United Kingdom • United States

This is an electronic version of the print textbook. Due to electronic rights restrictions, some third party content may be suppressed. Editorial review has deemed that any suppressed content does not materially affect the overall learning experience. The publisher reserves the right to remove content from this title at any time if subsequent rights restrictions require it. For valuable information on pricing, previous editions, changes to current editions, and alternate formats, please visit www.cengage.com/highered to search by ISBN#, author, title, or keyword for materials in your areas of interest.

Important Notice: Media content referenced within the product description or the product text may not be available in the eBook version.

Principles of Supply Chain Management,
6th edition

Joel Wisner, Keah-Choon Tan,
G. Keong Leong

SVP, Higher Education Product Management:
Erin Joyner

VP, Product Management, Learning
Experiences: Thais Alencar

Product Director: Joe Sabatino

Sr. Product Manager: Aaron Arnsperger

Product Assistant: Livia Weingarten

Sr. Learning Designer: Brandon Foltz

Content Manager: Justin Traister

Digital Delivery Quality Partner:
Steven McMillian

Director, Product Marketing: Danae April

Product Marketing Manager: Nate Anderson

IP Analyst: Ashley Maynard

IP Project Manager: Arul Kumaran

Production Service: Lumina Datamatics, Ltd.

Designer: Chris Doughman

Cover Image Source: Iurii Motov
/Shutterstock.com

Interior image Source: Shutterstock

© 2023, 2012, 2009 Cengage Learning, Inc. ALL RIGHTS RESERVED.

WCN: 02-300

No part of this work covered by the copyright herein may be reproduced or distributed in any form or by any means, except as permitted by U.S. copyright law, without the prior written permission of the copyright owner.

For product information and technology assistance, contact us at
Cengage Customer & Sales Support, 1-800-354-9706
or **support.cengage.com**.

For permission to use material from this text or product, submit all
requests online at **www.copyright.com**.

Library of Congress Control Number: 2021924152

ISBN: 978-0-357-71560-4

Cengage

200 Pier 4 Boulevard
Boston, MA 02210
USA.

Cengage is a leading provider of customized learning solutions with employees residing in nearly 40 different countries and sales in more than 125 countries around the world. Find your local representative at **www.cengage.com**.

To learn more about Cengage platforms and services, register or access your online learning solution, or purchase materials for your course, visit **www.cengage.com**.

To CJ, Hayley, Blake, Mary Jane, Phyllis, Bob, and Sally.

—JOEL WISNER

To Shaw Yun, Wen Hui, Wen Jay, and Kevin.

—KEAH-CHOON TAN

To Lin and Michelle.

—G. KEONG LEONG

Brief Contents

Preface xvi
Acknowledgments xix
About the Authors xx

Part 1 Supply Chain Management: An Overview 1

Chapter 1 Introduction to Supply Chain Management 3

Part 2 Supply Issues in Supply Chain Management 39

Chapter 2 Purchasing Management 41
Chapter 3 Creating and Managing Supplier Relationships 95
Chapter 4 Ethical and Sustainable Sourcing 133

Part 3 Operations Issues in Supply Chain Management 171

Chapter 5 Demand Forecasting 173
Chapter 6 Resource Planning Systems 213
Chapter 7 Inventory Management 271
Chapter 8 Process Management—Lean and Six Sigma
in the Supply Chain 321

Part 4 Distribution Issues in Supply Chain Management 379

Chapter 9 Domestic U.S. and Global Logistics 381
Chapter 10 Customer Relationship Management 437
Chapter 11 Global Location Decisions 467
Chapter 12 Service Response Logistics 507

Part 5 Integration Issues in Supply Chain Management 557

Chapter 13 Supply Chain Process Integration 559
Chapter 14 Performance Measurement Along Supply Chains 601

Appendix 1 Areas Under the Normal Curve 635
Appendix 2 Answers to Selected End-of-Chapter Problems 636

On the Companion Website

Student and Instructor Materials

Contents

Preface	xvi
Acknowledgments	xix
About the Authors	xx

Part 1 **Supply Chain Management: An Overview** **1**

Chapter 1	Introduction to Supply Chain Management	3
	Introduction	5
	Supply Chain Management Defined	6
	The Importance of Supply Chain Management	10
	The Origins of Supply Chain Management in the United States	13
	The Foundations of Supply Chain Management	16
	<i>Supply Elements</i>	16
	<i>Operations Elements</i>	18
	<i>Logistics Elements</i>	19
	<i>Integration Elements</i>	22
	Current Trends in Supply Chain Management	24
	<i>Use of Supply Chain Analytics</i>	24
	<i>Improving Supply Chain Sustainability</i>	25
	<i>Increasing Supply Chain Visibility</i>	26
	Summary	27
	Key Terms	27
	Discussion Questions	27
	Essay/Project Questions	29
	Cases	29
Appendix 1.1		
	The Beer Game	31
	Additional Resources	35
	Endnotes	35

Part 2 **Supply Issues in Supply Chain Management** **39**

Chapter 2	Purchasing Management	41
	Introduction	44
	A Brief History of Purchasing Terms	44
	The Role of Supply Management in an Organization	45

<i>The Financial Significance of Supply Management</i>	47
The Purchasing Process	50
<i>The Manual Purchasing System</i>	50
<i>Electronic Procurement Systems (e-Procurement)</i>	53
<i>Small-Value Purchase Orders</i>	56
Sourcing Decisions: The Make-or-Buy Decision	59
<i>Reasons for Buying or Outsourcing</i>	61
<i>Reasons for Making</i>	62
<i>Make-or-Buy Break-Even Analysis</i>	63
Roles of the Supply Base	64
Supplier Selection	65
<i>Supplier Diversity</i>	66
<i>The Total Cost of Ownership Concept</i>	67
How Many Suppliers to Use	69
<i>Reasons Favoring a Single Supplier</i>	69
<i>Reasons Favoring Multiple Suppliers</i>	70
Purchasing Organization	71
<i>Advantages of Centralization</i>	71
<i>Advantages of Decentralization</i>	72
Global Sourcing	72
<i>Reasons for Global Sourcing</i>	73
<i>Potential Challenges for Global Sourcing</i>	74
<i>International Trade Law and Commercial Terms</i>	75
Procurement in Government and Nonprofit Agencies	79
<i>Characteristics of Public Procurement</i>	79
Summary	81
Key Terms	81
Discussion Questions	82
Essay/Project Questions	83
Spreadsheet Problems	83
Cases	87
Additional Resources	91
Endnotes	92
Chapter 3 Creating and Managing Supplier Relationships	95
Introduction	97
Developing Supplier Relationships	100
<i>Building Trust</i>	101
<i>Shared Vision and Objectives</i>	101
<i>Personal Relationships</i>	102
<i>Mutual Benefits and Needs</i>	102
<i>Commitment and Top Management Support</i>	102

	<i>Change Management</i>	102
	<i>Information Sharing and Transparent Communications</i>	103
	<i>Relationship Capabilities</i>	103
	<i>Performance Metrics</i>	104
	<i>Continuous Improvement</i>	106
	<i>Monitoring Supplier Relationships</i>	107
	<i>Key Takeaways</i>	108
	Managing Supplier Relationships During the COVID-19 Pandemic	108
	Supplier Evaluation and Certification	110
	<i>The Weighted Criteria Evaluation System</i>	111
	<i>External Certifications</i>	112
	<i>ISO 9000</i>	112
	<i>ISO 14000</i>	113
	Supplier Development	114
	Supplier Recognition Programs	115
	Supplier Relationship Management	116
	Summary	119
	Key Terms	119
	Discussion Questions	119
	Problems	120
	Essay/Project Questions	121
	Cases	122
	Endnotes	128
Chapter 4	Ethical and Sustainable Sourcing	133
	Introduction	135
	Ethical and Sustainable Sourcing Defined	136
	<i>Ethical Sourcing</i>	136
	<i>Sustainable Sourcing</i>	141
	Developing Ethical and Sustainable Sourcing Strategies	143
	Ethical and Sustainable Sourcing Initiatives	147
	<i>Ethical and Sustainable Supplier Certification Programs</i>	147
	<i>Supply Base Rationalization Programs</i>	148
	<i>Outsourcing Products and Services</i>	149
	Early Supplier Involvement	149
	<i>Vendor Managed Inventories</i>	150
	Strategic Alliance Development	151
	<i>Negotiating Win–Win Strategic Alliance Agreements</i>	153
	Rewarding Supplier Performance	154
	Benchmarking Successful Sourcing Practices	156
	Assessing and Improving the Firm’s Sourcing Function	158

Summary	159
Key Terms	159
Discussion Questions	159
Essay/Project Questions	161
Cases	161
Additional Resources	166
Endnotes	166

Part 3 **Operations Issues in Supply Chain Management** **171**

Chapter 5	Demand Forecasting	173
	Introduction	175
	The Importance of Demand Forecasting	176
	Demand Forecasting Techniques	178
	<i>Qualitative Methods</i>	178
	<i>Quantitative Methods</i>	179
	<i>Cause-and-Effect Models</i>	186
	Forecast Performance	188
	Demand Sensing	190
	Demand Planning During the COVID-19 Pandemic and Beyond	192
	Useful Forecasting Websites	193
	Forecasting Software	194
	Artificial Intelligence and Machine Learning in Demand Forecasting	197
	Cloud-Based Forecasting	198
	Summary	200
	Key Terms	200
	Discussion Questions	200
	Problems	201
	Essay/Project Questions	204
	Cases	204
	Endnotes	210
Chapter 6	Resource Planning Systems	213
	Introduction	216
	Operations Planning	216
	The Aggregate Production Plan	218
	<i>The Chase Production Strategy</i>	219
	<i>The Level Production Strategy</i>	221
	<i>The Mixed Production Strategy</i>	222

The Master Production Schedule	222
<i>Master Production Schedule Time Fence</i>	223
<i>Available-to-Promise Quantities</i>	224
The Bill of Materials	227
The Material Requirements Plan	230
<i>Terms Used in Material Requirements Planning</i>	231
<i>An Example of MRP Computation without Net Requirements and Planned Order Receipts</i>	232
<i>An Example of MRP Computation with Net Requirements and Planned Order Receipts</i>	236
Capacity Planning	238
<i>Capacity Strategies</i>	239
The Distribution Requirements Plan	239
The Legacy Material Requirements Planning Systems	242
<i>Manufacturing Resource Planning</i>	242
The Development of Enterprise Resource Planning Systems	243
<i>The Rapid Growth of Enterprise Resource Planning Systems</i>	245
<i>Implementing Enterprise Resource Planning Systems</i>	246
Advantages and Disadvantages of Enterprise Resource Planning Systems	250
<i>Enterprise Resource Planning System Advantages</i>	250
<i>Enterprise Resource Planning System Disadvantages</i>	250
Enterprise Resource Planning Software Applications	251
Summary	253
Key Terms	253
Discussion Questions	254
Essay/Project Questions	255
Spreadsheet Problems	256
Cases	264
Additional Resources	269
Endnotes	269

Chapter 7	Inventory Management	271
	Introduction	273
	Dependent Demand and Independent Demand	275
	Concepts and Tools of Inventory Management	275
	<i>The Functions and Basic Types of Inventories</i>	276
	<i>Inventory Costs</i>	276
	<i>Inventory Investment</i>	277
	<i>The ABC Inventory Control System</i>	280
	<i>Radio Frequency Identification</i>	284
	Inventory Models	289

	<i>The Economic Order Quantity Model</i>	289
	<i>The Quantity Discount Model</i>	294
	<i>The Economic Manufacturing Quantity Model</i>	296
	<i>The Statistical Reorder Point</i>	301
	<i>The Continuous Review and the Periodic Review Inventory Systems</i>	304
	Summary	307
	Key Terms	307
	Discussion Questions	307
	Essay/Project Questions	308
	Computation/Spreadsheet Problems	309
	Cases	314
	Endnotes	319
Chapter 8	Process Management—Lean and Six Sigma in the Supply Chain	321
	Introduction	323
	Lean Production and the Toyota Production System	324
	Lean Thinking and Supply Chain Management	327
	The Elements of Lean	327
	<i>Waste Elimination</i>	328
	<i>Lean Supply Chain Relationships</i>	330
	<i>Lean Layouts</i>	331
	<i>Inventory and Setup Time Reduction</i>	333
	<i>Small Batch Production Scheduling</i>	335
	<i>Continuous Improvement</i>	338
	<i>Workforce Commitment</i>	338
	Lean Systems and the Environment	339
	The Origins of Six Sigma Quality	340
	Comparing Six Sigma and Lean	342
	<i>Lean Six Sigma</i>	343
	Six Sigma and Supply Chain Management	344
	The Elements of Six Sigma	344
	<i>Deming's Contributions</i>	345
	<i>Crosby's Contributions</i>	346
	<i>Juran's Contributions</i>	346
	<i>The Malcolm Baldrige National Quality Award</i>	347
	<i>The ISO 9000 and 14000 Families of Management Standards</i>	350
	<i>The DMAIC Improvement Cycle</i>	351
	<i>Six Sigma Training Levels</i>	352
	The Statistical Tools of Six Sigma	353
	<i>Flow Diagrams</i>	353

<i>Check Sheets</i>	353
<i>Pareto Charts</i>	354
<i>Cause-and-Effect Diagrams</i>	354
<i>Statistical Process Control</i>	356
Summary	364
Key Terms	364
Discussion Questions	364
Essay/Project Questions	366
Problems	367
Cases	369
Additional Resources	375
Endnotes	375

Part 4 **Distribution Issues in Supply Chain Management** 379

Chapter 9	Domestic U.S. and Global Logistics	381
	Introduction	384
	Transportation Fundamentals	385
	<i>The Objective of Transportation</i>	385
	<i>Legal Forms of Transportation</i>	386
	<i>The Five Modes of Transportation</i>	387
	<i>Intermodal Transportation</i>	392
	<i>Transportation Pricing</i>	393
	<i>Transportation Security</i>	395
	<i>Transportation Regulation and Deregulation in the United States</i>	396
	Warehousing and Distribution	401
	<i>The Importance and Types of Warehouses</i>	401
	<i>Risk Pooling and Warehouse Location</i>	404
	<i>Lean Warehousing</i>	407
	The Impacts of Logistics on Supply Chain Management	408
	<i>Third-Party Logistics (3PL) Services</i>	408
	<i>Other Transportation Intermediaries</i>	412
	Environmental Sustainability in Logistics	413
	Logistics Management Software Applications	415
	<i>Transportation Management Systems</i>	415
	<i>Warehouse Management Systems</i>	417
	<i>Global Trade Management Systems</i>	417
	Global Logistics	418
	<i>Global Freight Security</i>	418
	<i>Global Logistics Intermediaries</i>	418
	<i>Foreign-Trade Zones</i>	419
	<i>The United States–Mexico–Canada Agreement</i>	420
	Reverse Logistics	421

	<i>The Impact of Reverse Logistics on the Supply Chain</i>	422
	<i>Reverse Logistics and the Environment</i>	422
	Summary	422
	Key Terms	423
	Discussion Questions and Exercises	424
	Essay/Project Questions	425
	Problems	425
	Cases	426
	Additional Resources	429
	Endnotes	429
Chapter 10	Customer Relationship Management	437
	Introduction	439
	Customer Relationship Management Defined	440
	Key Tools and Components of CRM	443
	<i>Segmenting Customers</i>	443
	<i>Predicting Customer Behaviors</i>	445
	<i>Customer Value Determination</i>	446
	<i>Personalizing Customer Communications</i>	447
	<i>Automated Sales Force Tools</i>	447
	<i>Managing Customer Service Capabilities</i>	449
	Designing and Implementing A Successful CRM Program	452
	<i>Creating the CRM Plan</i>	453
	<i>Involving CRM Users from the Outset</i>	454
	<i>Selecting the Right Application and Provider</i>	454
	<i>Integrating Existing CRM Applications</i>	455
	<i>Establishing Performance Measures</i>	456
	<i>Training for CRM Users</i>	457
	Trends in CRM	457
	<i>The Customer Experience</i>	457
	<i>Artificial Intelligence</i>	458
	<i>Mobile CRM</i>	458
	<i>Use of Social Media</i>	458
	Summary	459
	Key Terms	459
	Discussion Questions and Exercises	459
	Essay and Project Questions	461
	Problems	461
	Cases	461
	Additional Resources	465
	Endnotes	465
Chapter 11	Global Location Decisions	467
	Introduction	469

Global Location Strategies	470
Critical Location Factors	471
<i>Regional Trade Agreements and the World Trade Organization</i>	472
<i>Competitiveness of Nations</i>	475
<i>The World Economic Forum's 12 Pillars of Competitiveness</i>	477
<i>Government Taxes and Incentives</i>	478
<i>Currency Stability</i>	479
<i>Environmental Issues</i>	479
<i>Access and Proximity to Markets</i>	481
<i>Labor Issues</i>	481
<i>Access to Suppliers</i>	482
<i>Logistics Issues</i>	482
<i>Utility Availability and Cost</i>	483
<i>Quality-of-Life Issues</i>	483
<i>Right-to-Work Laws</i>	484
<i>Land Availability and Cost</i>	484
Facility Location Techniques	485
<i>The Weighted-Factor Rating Model</i>	485
<i>The Break-Even Model</i>	486
Business Clusters	487
Sustainable Development and Facility Location	489
Additive Manufacturing and Its Impact on Facility Location	491
COVID-19 and Its Impact on Global Location Strategies	493
Summary	495
Key Terms	495
Discussion Questions	495
Essay/Project Questions	496
Problems	497
Cases	498
Endnotes	502
Chapter 12 Service Response Logistics	507
Introduction	509
An Overview of Service Operations	510
<i>Service Productivity</i>	511
<i>Global Service Issues</i>	513
<i>Service Strategy Development</i>	514
<i>The Service Delivery System</i>	515
<i>Service Location and Layout Strategies</i>	516
Supply Chain Management in Services	520
<i>Service Quality and Customers</i>	522
The Primary Concerns of Service Response Logistics	522
<i>Managing Service Capacity</i>	523

<i>Managing Queue Times</i>	527
<i>Managing Distribution Channels</i>	537
<i>Managing Service Quality</i>	542
Summary	545
Key Terms	545
Discussion Questions	545
Essay/Project Questions	547
Problems	548
Cases	550
Additional Resources	553
Endnotes	554

Part 5 Integration Issues in Supply Chain Management **557**

Chapter 13	Supply Chain Process Integration	559
	Introduction	561
	The Supply Chain Management Integration Model	562
	<i>Identify Critical Supply Chain Trading Partners</i>	562
	<i>Review and Establish Supply Chain Strategies</i>	564
	<i>Align Supply Chain Strategies with Key Supply Chain Process Objectives</i>	564
	<i>Develop Internal Performance Measures for Key Process Effectiveness</i>	569
	<i>Assess and Improve Internal Integration of Key Supply Chain Processes</i>	570
	<i>Develop Supply Chain Performance Measures for the Key Processes</i>	571
	<i>Assess and Improve External Process Integration and Supply Chain Performance</i>	571
	<i>Extend Process Integration to Second-Tier Supply Chain Partners</i>	572
	<i>Reevaluate the Integration Model Annually</i>	574
	Obstacles to Process Integration Along the Supply Chain	574
	<i>The Silo Mentality</i>	575
	<i>Lack of Supply Chain Visibility</i>	576
	<i>Lack of Trust</i>	577
	<i>Lack of Knowledge</i>	578
	<i>Activities Causing the Bullwhip Effect</i>	579
	Managing Supply Chain Risk and Security	581
	<i>Managing Supply Chain Risk</i>	582
	<i>Managing Supply Chain Security</i>	586
	Summary	589
	Key Terms	589
	Discussion Questions	590
	Essay/Project Questions	591

	Cases	592
	Endnotes	597
Chapter 14	Performance Measurement Along Supply Chains	601
	Introduction	603
	Viewing Supply Chains as a Competitive Force	605
	<i>Understanding End Customers</i>	605
	<i>Understanding Supply Chain Partner Requirements</i>	606
	<i>Adjusting Supply Chain Member Capabilities</i>	607
	Traditional Performance Measures	608
	<i>Use of Organization Costs, Revenue, and Profitability Measures</i>	608
	<i>Use of Performance Standards and Variances</i>	609
	<i>Productivity and Utilization Measures</i>	610
	World-Class Performance Measurement Systems	612
	<i>Developing World-Class Performance Measures</i>	612
	Supply Chain Performance Measurement Systems	614
	<i>Supply Chain Environmental Performance</i>	614
	<i>Triple Bottom Line Performance</i>	616
	The Balanced Scorecard	618
	<i>Web-Based Scorecards</i>	620
	The Scor Model	621
	Summary	623
	Key Terms	624
	Discussion Questions	624
	Problems	626
	Essay/Project Questions	626
	Cases	627
	Additional Resources	632
	Endnotes	632
Appendix 1	Areas Under the Normal Curve	635
Appendix 2	Answers to Selected End-of-Chapter Problems	636
Glossary		644
Author Index		654
Subject Index		655

On the Companion Website

Student and Instructor Materials

Preface

INTRODUCTION

Welcome to the sixth edition of *Principles of Supply Chain Management: A Balanced Approach*. The practice of supply chain management has become widespread in all industries around the globe today, and the benefits to firms of all sizes are being realized. We think this text is unique in that it uses a novel and logical approach to present discussions of this topic from four foundation perspectives: purchasing, operations, logistics, and process integration. We think this book is also somewhat different than the other supply chain management texts available, since we present a more balanced view of the topic—many of the texts available today concentrate primarily on just one of the three areas of purchasing, operations, or logistics.

The objective of the book is to make readers think about how supply chain management impacts all of the various areas and processes of the firm and its supply chain trading partners, and to show managers how to improve their firm's competitive position by employing the practices we describe throughout the text. Junior- or senior-level business students, beginning MBA students, as well as practicing managers can benefit from reading and using this text.

As with the fifth edition, the sixth edition has a tie-in to a wonderfully engaging global supply chain simulation game called SCM Globe. A separate page dedicated to SCM Globe follows this preface. We are very excited about the simulation and hope instructors will take it for a test drive and then use it in their classes.

The sixth edition continues to offer MindTap, the leading digital platform from Cengage. MindTap includes an interactive eBook, quizzes, chapter homework assignments, Excel online activities, and more. New to this edition, the continuing cases from the book are also available in MindTap as Excel-based assignments for students to apply what they have learned in computational, decision-making scenarios. For more information about MindTap and how students can access it with the text, please contact your Cengage representative.

In the Chapter 1 Appendix, there is a discussion of the Beer Game, with inventory tracking sheets to allow instructors to actually play the game with their students. There are also quantitative as well as qualitative problems and questions, essay/project exercises, and Excel problems spread throughout most of the chapters.

NEW TO THIS EDITION

There are several changes to this sixth edition that we hope you will find interesting and useful. Perhaps the biggest change are the three continuing cases in Parts 2, 3, and 4. (The continuing case for Part 4 is online only.) The teaching notes for all cases can be found in the Instructor's Manual. There is also an emphasis on the pandemic's impacts on the supply chain and a greater emphasis on technological advances and quantitative examples and problems throughout the text. Additionally, each chapter contains a number

of new SCM Profiles, beginning with a chapter-opening profile, and then other smaller company profiles throughout the chapters. The chapter references throughout the text have been updated, with new and interesting storylines, to keep readers engaged and informed. Additionally, new end-of-chapter discussions, essay and project questions, and exercises have been added. There are also cases at the end of each chapter and several extended cases encompassing the chapters in Parts 2, 3, and 4. Other ancillary materials are described below.

ORGANIZATION OF THE TEXT

Part 1 is the overview and introduction to the topic of supply chain management. This chapter introduces the basic understanding and concepts of supply chain management, and should help students realize the importance of this topic. Core concepts such as the bullwhip effect, supplier relationship management, forecasting and demand management, enterprise resource planning, transportation management, and customer relationship management are briefly discussed. There is also a closing section on current trends in supply chain management.

Part 2 presents supply issues in supply chain management. This very important topic is covered in three chapters, building from an introduction to purchasing management, to managing supplier relationships, and then finally to ethical and sustainable sourcing. Within these chapters can be found sections on government purchasing, global sourcing, e-procurement, software applications, supplier development, ethical purchasing, and green purchasing.

Part 3 includes four chapters regarding operations issues in supply chain management. This section progresses from forecasting, resource planning, and inventory management to lean production and Six Sigma in a supply chain setting. Topics in this section include the basics of forecasting; collaborative planning, forecasting, and replenishment; material requirements planning; enterprise resource planning; inventory models; lean thinking; Six Sigma concepts and tools; and statistical process control techniques.

Part 4 presents distribution issues in supply chain management and consists of four chapters. This section begins with a review of domestic U.S. and international logistics with sections on green transportation, international logistics security, and reverse logistics. This is followed by chapters on customer relationship management, global location decisions, and service response logistics. Content in these chapters includes new software application discussions, social media and cloud computing in customer relationship management, sustainability in logistics, new location trends in the global economy, and cloud computing in services.

The final section is Part 5, which presents discussions of the integration issues in supply chain management and performance measurements along the supply chain. While cooperation and integration are frequently referred to in the text, this section brings the entire text into focus, tying all of the parts together, first by discussing internal and external process integration in detail, followed by a discussion of traditional and world-class performance measurement systems. The topics of supply chain risk management and expanded coverage of performance measurement models are also included.



SCM Globe—Accurate and Easy Supply Chain Simulations

SCM Globe is a serious supply chain game. Students can design supply chains from scratch or use the supply chains provided by the case studies to understand how different designs produce different operating results. And students learn how to manage those results. As they work with the simulations, students get an intuitive and analytical understanding for how supply chains work.

SCM Globe is not just a toy or a game about a make-believe company. It enables a wide range of people to accurately model and simulate real supply chains or design new ones. Users can model and simulate any supply chain with just four types of entities: Products; Facilities; Vehicles; and Routes. Users can define supply chain facilities and see their icons pop up on the screen, then drag-and-drop their icons to place them on a smart map such as Google Maps; put them where they really are in existing supply chains, or where they could be in new supply chains; define products used at the facilities, and define vehicles to move the products between facilities; and finally, specify the routes (road, rail, air, water) to connect the facilities.

This creates a mathematically rigorous model of the supply chain, but students do not have to deal with the math, the software does it for them. Then SCM Globe simulates the operation of the supply chain. As the simulation runs it shows vehicles moving on their routes and displays daily operating and financial data. Simulations identify problem areas—facilities where too many units of products accumulate or where products run out. Students use what the simulations show them, to change their supply chain designs to fix problems and improve their operating results. Students do not need advanced math skills, nor do they need to deal with abstract network diagrams and flow charts.

SCM Globe is designed to be user friendly and works equally well online or in the classroom. Students work individually at first to learn the simulations, then they can work in teams or continue working individually. The simulations produce performance reports that show progress and provide an objective basis to compare different student supply chain designs. The simulations combined with the performance reports become a real-time strategy game where the goal is to create supply chains that meet customer demand for products, while also attaining the lowest operating costs and inventory levels.

A concise online user's guide and video tutorials are available to walk people through the basics of designing a supply chain and simulating its performance. The FAQ section and other in-depth information in the online guide provide additional help for students and instructors. There is also a library of case studies. There is a beginning case and progressively more challenging cases that illustrate different supply chain operating principles. Each case study has an introduction in the online guide to get students started, and there are step by step instructor study guides for some of the more popular cases.

SCM Globe is engaging for students and teaches real-world supply chain skills. What students learn in the simulations is directly applicable for use in real supply chains. SCM Globe costs \$64.95 per student per semester and is provided at no charge to instructors, with classes of five or more students. To learn more about SCM Globe, go to www.scmglobe.com. Click on the blue "Get Started Now!" button in the middle of the screen to see more about what SCM Globe can do.

For instructors using the new sixth edition of *Principles of Supply Chain Management*, a one-time 15 percent discount is available for schools purchasing semester-length student subscriptions. Instructors can request this discount by sending an email to Michael Hugos

at: mhugos@scmglobe.com. Tell us your school name. We will schedule a call at your convenience to set up your instructor account, and show you how to get started with the simulations. We'll also provide you with the number of student subscriptions you need at a 15 percent discount.

If you are an instructor and would like to do a short 2–4 week pilot project, we can train you and provide free demo accounts for you and your students. At the end of the pilot project, you will know if you and your students like using the simulations, and if they enhance your supply chain or logistics class. To inquire about a pilot project, please contact Michael Hugos at: mhugos@scmglobe.com.

ANCILLARY PACKAGE

Additional instructor resources for this product are available online. Instructor assets include Instructor's Manual, PowerPoint lecture slides, case teaching notes, answers to all of the end-of-chapter questions and problems, and a test bank powered by Cengage. Sign up or sign in at www.cengage.com to search for and access this product and its online resources.

ACKNOWLEDGMENTS

We greatly appreciate the efforts of a number of fine and hard-working people at Cengage Without their feedback and guidance, this text would not have been completed. The team members are: Aaron Arnsparger, Senior Product Manager; Justin Traister, Content Manager; and Brandon Foltz, Senior Learning Designer. A number of other people at Cengage also need to be thanked including Chris Doughman, Conor Allen, and Steven McMillian. We also would like to thank Sangeetha Vijay and the people at Lumina who put the manuscript into final copy form.

Additionally, we would like to thank all of the case writers who contributed their cases to this textbook, particularly Rick Bonsall and Brian Hoyt, who wrote most of the cases. The other case writers' names, along with their contact information, are printed following their cases in the textbook. Finally, we thank CJ Wisner for all her help in preparing the MindTap quizzes, PowerPoints, and test bank. As with any project of this size and time span, there are certain to be a number of people who gave their time and effort to this textbook, and yet their names remain unknown and so were inadvertently left out of these acknowledgments. We apologize for this and wish to thank you here.

About the Authors

Joel D. Wisner is Professor of Supply Chain Management in the Lee Business School at the University of Nevada, Las Vegas. He earned his BS in Mechanical Engineering from New Mexico State University in 1976 and his MBA from West Texas State University in 1986. During that time, Dr. Wisner worked as an engineer for Union Carbide at its Oak Ridge, Tennessee facility and then worked in the oil industry in the Louisiana Gulf Coast and West Texas areas. In 1991, he earned his PhD in Supply Chain Management from Arizona State University.

He is currently keeping busy teaching courses and writing textbooks in supply chain management and operations management at UNLV. His research and case writing interests are in process assessment and improvement strategies along the supply chain. His articles have appeared in numerous journals including *Journal of Business Logistics*, *Journal of Operations Management*, *Journal of Supply Chain Management*, *Journal of Transportation, Production and Operations Management Journal*, and *Business Case Journal*.

Keah-Choon Tan is Professor of Operations Management in the Lee Business School at the University of Nevada, Las Vegas. He received a BSc degree and an MBA from the University of South Alabama, and a PhD in Operations Management from Michigan State University. Prior to academia, Dr. Tan was a hospital administrator and an account controller of a manufacturing firm. Dr. Tan has served as the Department Chair of the Marketing Department and Associate Dean for Academic Affairs at the Lee Business School at UNLV.

Dr. Tan has published articles in the areas of supply chain management, quality, and operations scheduling, in academic journals and magazines including *Decision Sciences*, *Decision Support Systems*, *International Journal of Production Research*, *International Journal of Operations & Production Management*, *International Journal of Logistics Management*, *Journal of Supply Chain Management*, and *Omega*, among others. He has served as editor, co-guest editor, and on the editorial boards of several academic journals. Dr. Tan has received numerous research grants and teaching awards, including the UNLV Foundation Distinguished Teaching Award.

G. Keong Leong is an instructional faculty and professor emeritus in the Information Systems and Operations Management Department, in the College of Business Administration and Public Policy (CBAPP) at California State University, Dominguez Hills. He served as Associate Dean previously at CBAPP. He received an undergraduate degree in Mechanical Engineering from the University of Malaya and an MBA and PhD from the University of South Carolina. He is professor emeritus at the University of Nevada, Las Vegas and faculty at the Ohio State University, and a clinical faculty member at the Thunderbird School of Global Management.

His publications appear in academic journals such as *Journal of Operations Management*, *Decision Sciences*, *Interfaces*, *Journal of Management*, *European Journal of Operational Research*, and *International Journal of Production Research*, among others. He has coauthored three books including *Operations Strategy: Focusing Competitive Excellence*, and *Cases in International Management: A Focus on Emerging Markets* and received research, teaching, and service awards including an Educator of the Year award from the

Asian Chamber of Commerce in Las Vegas, Dennis E. Grawoig Distinguished Service award from Decision Sciences Institute, and OM Distinguished Scholar award from the Operations Management Division, Academy of Management. He has been active in the Decision Sciences Institute, serving as President, Editor of *Decision Line*, At-Large Vice-President, Associate Program Chair, Chair of the Innovative Education Committee, Chair of the Doctoral Student Affairs Committee, and Manufacturing Management Track Chair. In addition, he served as President of the Western Decision Sciences Institute and Chair of the Operations Management Division, Academy of Management.

We think we have compiled a very interesting set of supply chain management topics that will keep readers engaged and we hope you enjoy it. We welcome your comments and suggestions for improvement. Please direct all comments and questions to:

Joel D. Wisner: joel.wisner@unlv.edu (primary contact),

Keah-Choon Tan: kctan@unlv.edu, or

G. Keong Leong: gkleong@csudh.edu

PART 1

Supply Chain Management: An Overview

Chapter 1 Introduction to Supply Chain Management

Chapter 1

Introduction to Supply Chain Management



Giant Eagle is really committed to increasing the diversity amongst our supply chain. There's several reasons for that. The first one, if COVID taught us nothing, it taught us that we collectively need to build a more resilient supply chain. We need to have access to more and different kinds of suppliers who are more agile, more nimble.

—Laura Shapira Karet, CEO, Giant Eagle¹

Our proprietary logistics network, strong supplier partnerships, and nimble and dedicated team of more than 16,000 employees enabled Wayfair to consistently serve our customers at a time they needed us most, both in North America and Europe. The plans that we put in place in late 2019, combined with these factors, translated to a powerful profitability inflection, and we generated over \$1 billion in free cash flow in the quarter.

—Niraj Shah, CEO, Wayfair²

Learning Objectives

After completing this chapter, you should be able to

- LO 1** Describe a supply chain and define supply chain management.
- LO 2** Describe the objectives and elements of supply chain management.
- LO 3** Describe local, regional, and global supply chain management activities.
- LO 4** Describe a brief history and current trends in supply chain management.
- LO 5** Understand the bullwhip effect and how it impacts the supply chain.

Chapter Outline

Introduction

Supply Chain Management Defined

The Importance of Supply Chain Management

The Origins of Supply Chain Management in the United States

The Foundations of Supply Chain Management

Current Trends in Supply Chain Management

Summary

SCM Profile

The Top Five Supply Chains of 2020

Connecticut-based research company Gartner published its 16th annual ranking of the world's leading supply chains in 2020. During an ongoing global pandemic and economic uncertainty in 2020, some countries around the world were attempting to reopen their economies, while tremendous uncertainty remained about the safety involved in such endeavors. Companies were trying to predict how markets would recover in 2021 and beyond, while designing risk-mitigation strategies for future waves of the coronavirus and its variants. The top five companies and their supply chains are described below:

1. High-tech leader Cisco Systems exhibited strengths in revenue growth, and in environmental and social aspects. They were also recognized as a leader in the communities where they operate. Cisco's digital supply chain uses security as a foundation, and its improvements include monitoring and assessing partner IT security capabilities. Cisco has achieved significant performance in the areas of order lead-time, cost savings and inventory reduction, while launching many new products.
2. Colgate-Palmolive and its supply chains showed a commitment to reduce its environmental impact with its certification as a "TRUE Zero Waste" company by the U.S. Green



Travel mania/Shutterstock.com

Building Council (USGBC). Since 2017, 15 Colgate-Palmolive manufacturing sites had achieved TRUE Zero Waste certification, with 10 of the sites achieving the highest level of recognition. The company also received the 2019 Leadership Award from the USGBC “as an organization at the forefront of the green building movement.”

3. Johnson & Johnson’s commitment to supply chain innovation is evidenced by its Supply Chain Innovation Engine, located in New Brunswick, NJ. It creates collaborations among supply chain team members, key partners and external experts. People who work at Johnson & Johnson develop and prioritize ideas that improve healthcare. To support the early coronavirus control efforts, Johnson & Johnson used its 3D printing expertise to make manifolds for ventilators which allowed two patients to share the same ventilator.
4. Schneider Electric, the French energy management and automation specialist, created EcoStruxure, a suite of tools and services to help further develop the Internet of Things. EcoStruxure provides connectivity across a business, providing support for faster decision making in operations. Schneider Electric also willingly shares what it is doing with its peers, to promote improvements among all supply chains.
5. Nestlé has a strong focus on customers, emphasizing product availability both on the shelf and online. To improve its product availability, Nestlé created additional capacity in several manufacturing facilities. To increase agility, Nestlé is using demand-sensing technologies and integrating processes with key customers.³

Introduction

Successful organizations today must be heavily involved with their suppliers and customers. Creating goods and services that customers want, at a price they are willing to pay, requires firms to be good at a number of things. Managers must pay closer attention to where parts and materials come from; how suppliers’ goods are designed, produced, stored, and transported; how their own products are produced and then distributed to customers; and finally, what their direct customers and the end-product consumers really think of the firm’s goods and services. (Note that this textbook uses the term *products* to refer to both *goods* and *services*).

Thirty years ago, many large firms were vertically integrated, meaning they owned some of their suppliers and/or customers. Today, this practice is much less common due to the high cost and difficulty in managing such diverse business units. Instead, firms are focusing more of their resources on core capabilities, while trying to create alliances with suppliers, transportation and warehousing companies, and manufacturers. Thus, a collaborative approach to buying, making, and distributing goods and services has become the best way for firms to stay successful—and these are central to the practice of supply chain management (SCM).

Several factors enable firms to work together more effectively than ever before. Communication and information exchange using enterprise resource planning (ERP) system applications (discussed further in Chapter 6) has made global collaboration not only possible but necessary for firms to compete. Communication technologies continue to change rapidly, making partnerships and teamwork much easier than ever before. Competition is also expanding rapidly in all industries and in all markets around the world, bringing new materials, products, people, and resources together, making it more difficult for many of the local, individually owned shops to keep customers satisfied. Additionally, the 2020 global recession made customers more cost-conscious while seeking

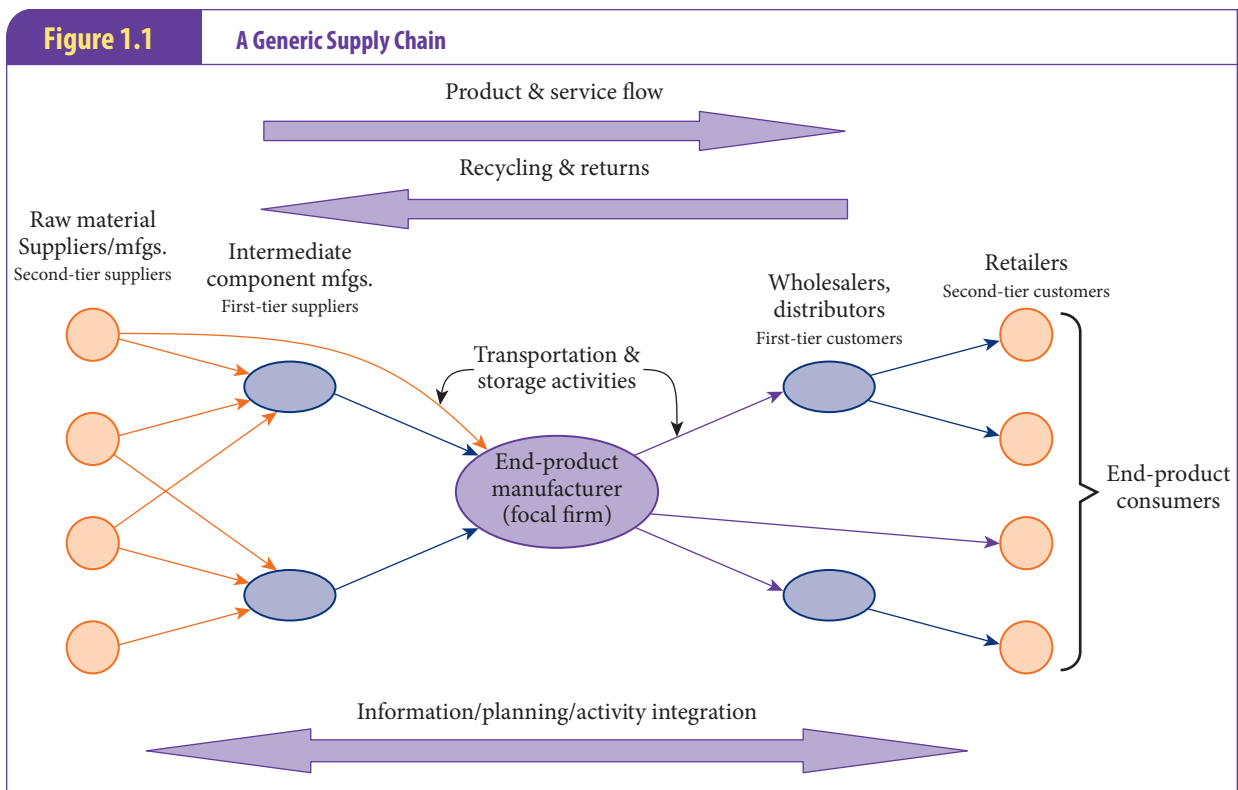
higher levels of quality and service, which forces organizations to find even better ways to compete. Customers are also demanding more socially responsible and environmentally friendly goods from organizations. Considering all of these changes to the environment, it is indeed a challenging time for companies to develop new products, find new suppliers and customers, and compete more successfully. Consequently, many job opportunities are opening up in the areas of purchasing, operations, logistics, and supply chain management.

As you read this textbook, you will be introduced to the many concepts of supply chain management and how to use these concepts to become better managers in today's global economy. Examples are used throughout the text to illustrate the topics discussed, and cases at the end of each chapter are provided to enable you to test your problem-solving and decision-making skills in supply chain management. It is hoped that by the end of the text you will have gained an appreciation of the value of supply chain management and will be able to apply what you have learned, both in your profession and in future courses in supply chain management.

In this chapter, the term *supply chain management* is defined, including a discussion of its importance, history, and developments to date. The chapter ends with a look at a few of the current trends in supply chain management.

Supply Chain Management Defined

To understand supply chain management, one must first begin with a discussion of a supply chain; a generic one is shown in Figure 1.1. The **supply chain** shown in the figure starts with firms extracting raw materials from the earth—such as iron ore, oil, wood, and food



items—and then selling these to raw material suppliers such as lumber companies, steel mills, and raw food distributors. These firms, acting on purchase orders and specifications they have received from component manufacturers, turn the raw materials into materials that are usable by their customers (materials such as sheet steel, aluminum, copper, lumber, and inspected foodstuffs). The component manufacturers, responding to orders and specifications from their customers (the final product manufacturers), make and sell intermediate components (electrical wire, fabrics, plumbing items, nuts and bolts, molded plastic components, component parts and assemblies, and processed foods). The final product manufacturers (companies such as Boeing, General Motors, and Kraft) assemble the finished products and sell them to wholesalers or distributors, who then resell these products to retailers as their product orders are received. Retailers in turn, sell these products to us, the end-product consumers.

Consumers purchase products based on a combination of cost, quality, customer service, availability, maintainability, and reputation factors, and then hope the purchased items satisfy their requirements and expectations. Companies, along with their supply chains, that can provide all of these desired things will ultimately be successful. Along the supply chain, intermediate and end customers may need to return products or obtain warranty repairs, or they may just throw products away or recycle them. These reverse logistics activities are also included in the supply chain and are discussed further in Chapter 9.

Referring again to Figure 1.1, the firm in the middle of the figure is referred to as the *focal firm* simply because it is the central firm being discussed; the direct suppliers and customers of the focal firm are **first-tier suppliers** and **first-tier customers**. The first-tier suppliers' suppliers are thus the focal firm's **second-tier suppliers**, and the first-tier customers' customers are the focal firm's **second-tier customers**. Not all supply chains look exactly like the one shown in Figure 1.1. Some raw material and end-product manufacturers, for example, may sell directly to end consumers. Some supply chains, such as an automobile supply chain, might have many tiers, while others such as a law office's supply chain might have only one tier of suppliers and customers.

Thus, the series of companies eventually making goods and services available to consumers, including all of the functions enabling the purchase, production, delivery, and recycling of materials, components, end products, and services, is called a supply chain. Companies with multiple products likely have multiple supply chains. All goods reach their customers via some type of supply chain—some much larger, longer, and more complex than others. Some may also involve foreign suppliers or markets.

With this idea of a supply chain in mind, there really is only one true source of income for all supply chain organizations—a supply chain's end customers. According to Manu Vora, the founder and president of Business Excellence Inc., a global management consulting services firm, high performing supply chains are not only essential to delivering goods on time, but global companies also depend on their supply chain processes to manage the divergent expectations of customers, to stay one step ahead of the competition.⁴ A **process** by the way, can be defined as a set of activities designed to produce a good or service for an internal or external customer. When companies make business decisions while ignoring the interests of the end customer and other chain members, these decisions create additional risks, costs, and waiting time along the supply chain, ultimately leading to higher end-product prices, lower supply chain service levels, and eventually lower end-customer demand.

A number of other companies are also indirectly involved in most supply chains, and they play a very important role in the delivery of goods to customers. These are the many service providers, such as trucking and airfreight shipping companies, information system providers, public warehousing firms, freight forwarders, agents, and supply chain

consultants. These service providers are extremely useful to the firms in most supply chains because: they can help to get goods where they need to be in a timely fashion, they allow buyers and sellers to communicate effectively, they allow firms to serve outlying markets, they enable firms to save money on domestic and global shipments, and in general they allow firms to adequately serve their customers at the lowest possible cost.

One form of supply chain that has been featured numerous times during the 2020 pandemic on TV and in newsprint is the cold chain. The **cold chain** refers to an alliance of companies that can monitor and protect the temperature of perishable products in order to maintain quality and safety from the point of origin through distribution to the final consumer. While cold chains have been around for many years to protect the temperatures of produce, fresh fish, and other foodstuffs as they travel from farm to retailer, cold chains became a popular news item in 2020 as COVID vaccines began to be distributed globally by Pfizer and Moderna. The two vaccines must be stored and transported at sub-zero temperatures. Satellite Internet of Things company Orbcomm, for example, offers transportation companies a cold chain telematics solution, which is used while transporting the vaccines. Orbcomm supplies hardware that connects to a refrigerated device, which passes information by satellite to Orbcomm's application. The application is integrated into customers' systems, and so managers, dispatchers, and drivers can monitor temperatures in real time and adjust the temperatures if needed.⁵

Now that a general description of a supply chain has been provided, what is **supply chain management** (SCM)? A number of definitions are available in the literature and among various professional associations. A few of these are provided here from various organizations connected to the practice of supply chain management:

- The Council of Supply Chain Management Professionals (CSCMP) defines supply chain management as:

*The planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers.*⁶

- The Institute for Supply Management (ISM) describes supply chain management as:

*The design and management of seamless, value-added processes across organizational boundaries to meet the real needs of the end customer.*⁷

- The Business Dictionary defines supply chain management as:

*Management of material and information flow in a supply chain to provide the highest degree of customer satisfaction at the lowest possible cost. Supply chain management requires the commitment of supply chain partners to work closely to coordinate order generation, order taking, and order fulfillment.*⁸

Consistent across these definitions is the idea of coordinating or integrating a number of goods-related activities among supply chain participants to improve operating efficiencies, quality, and customer service. Thus, for supply chain management to be successful, firms must work together by sharing information on things like demand forecasts, production plans, capacity changes, new marketing strategies, new product and service developments, new technologies employed, purchasing plans, delivery dates, and anything else impacting

the other supply chain members' purchasing, production, and distribution plans. In a supply chain innovation survey conducted by MHI, a material handling association, and Deloitte, the top two strategic priorities for supply chain executives are **supply chain analytics** (tools that harness data from internal and external sources to produce breakthrough insights that can help supply chains reduce costs and risk) and **multi-channel fulfillment** (allowing consumers to shop for what they want, where they want, and when they want, and then have their purchases delivered quickly and consistently).⁹

In theory, companies in a supply chain work as a cohesive, singularly competitive unit, accomplishing what many large, vertically integrated firms tried and failed to accomplish in years past. The difference is that independent firms in a supply chain are relatively free to enter and leave supply chain relationships if these relationships are no longer proving to be beneficial; it is this free market alliance-building that allows supply chains to operate more effectively than vertically integrated conglomerates.

For example, when a particular item is in short supply accompanied by rising prices, a firm might find it beneficial to align itself with one of these suppliers to ensure a continued supply of the scarce item. This alignment may become beneficial to both parties—new markets for the supplier leading to new, future product opportunities, and long-term continuity of supply and stable prices for the buyer. Later, when new competitors start producing the scarce product or when demand declines, the supplier may no longer be valued by the buying firm; instead, the firm may see more value in negotiating with other potential suppliers for its purchase requirements and may then decide to dissolve the original buyer-supplier alignment. Unforeseen weather events and accidents can also create supply chain management problems.

For example, Indiana-based Zimmer Biomet, which makes artificial joints and dental devices, blamed its 2016 declining stock price on supply chain disruption problems. “Our current supply chain, not being fully integrated, did hamper our ability to respond effectively to this shifting product mix,” said Daniel Florin, Zimmer Biomet’s chief financial officer.¹⁰ In China, in 2015, two blasts tore through a chemical warehouse containing 3,000 tons of hazardous chemicals, including sodium cyanide and explosive ammonium nitrate. Along with destroying buildings and infrastructure within a 1.2-mile radius, the blasts incinerated more than 10,000 new cars. Jaguar Land Rover, Volkswagen, Fiat Chrysler, Hyundai, and Renault all reported significant vehicle losses, which hampered their supply chain effectiveness.¹¹ As can be seen from these examples, supply chains are often very dynamic, which can create problems in effectively managing them.

While supply chain management may allow organizations to realize the advantages of vertical integration, certain conditions must be present for successful supply chain management to occur. One important prerequisite is a melding of the corporate cultures of the supply chain participants so all parties are receptive to the requirements of successful supply chain management, such as sharing process information. More traditional organizational cultures that emphasize short-term, company-focused performance can conflict with the objectives of supply chain management. Supply chain management focuses on positioning organizations in such a way that all participants benefit. Successful supply chain management requires high levels of trust, cooperation, collaboration, and honest, accurate communications.

The boundaries of supply chains are also dynamic. It has often been said that supply chain boundaries for the focal firm extend from “the suppliers’ suppliers to the customers’ customers.” Today, most supply chain collaboration efforts do not extend beyond these boundaries. In fact, in many cases, firms find it very difficult to extend coordination efforts