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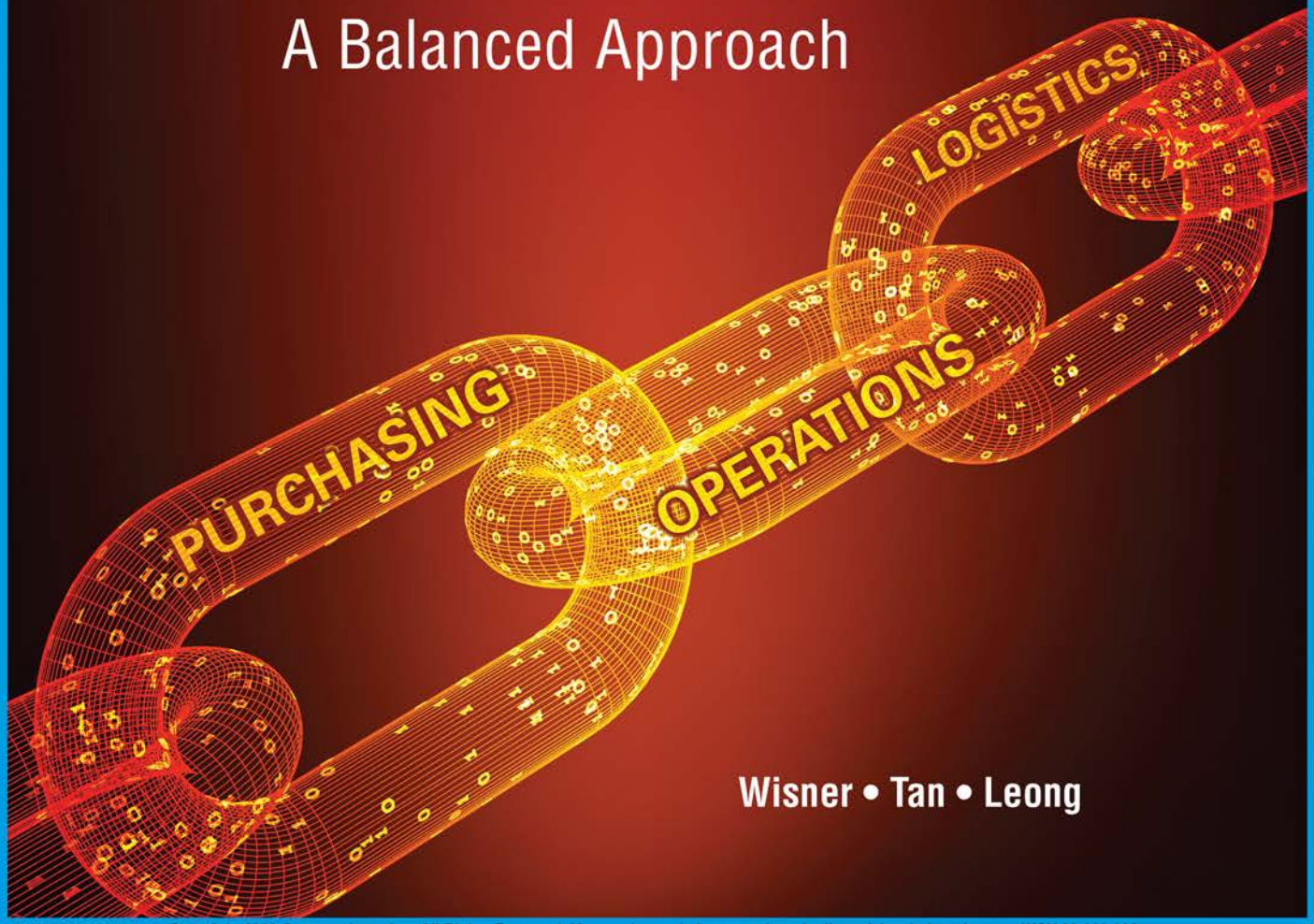
6th Edition

Principles of Supply Chain Management

A Balanced Approach



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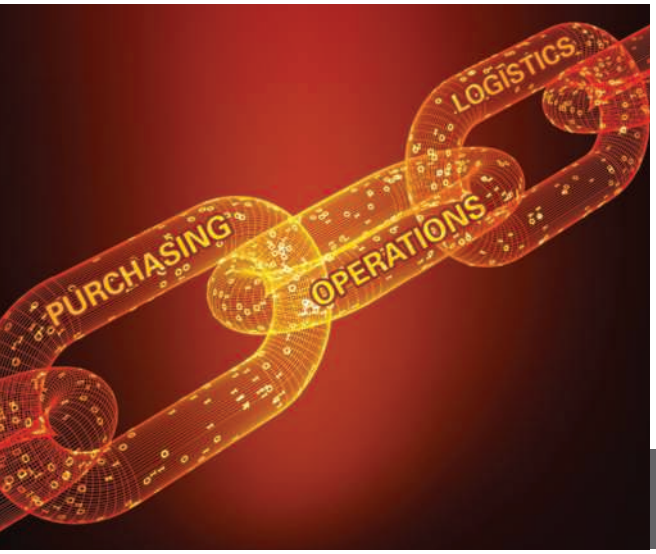

Principles of Supply Chain Management

A Balanced Approach | 6e

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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

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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 Profile

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 Cognero. 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 comptroller 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:

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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 Eagle[1]

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, Wayfair[2]

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

SCM Profile — The Top Five Supply Chains of 2020

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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

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.

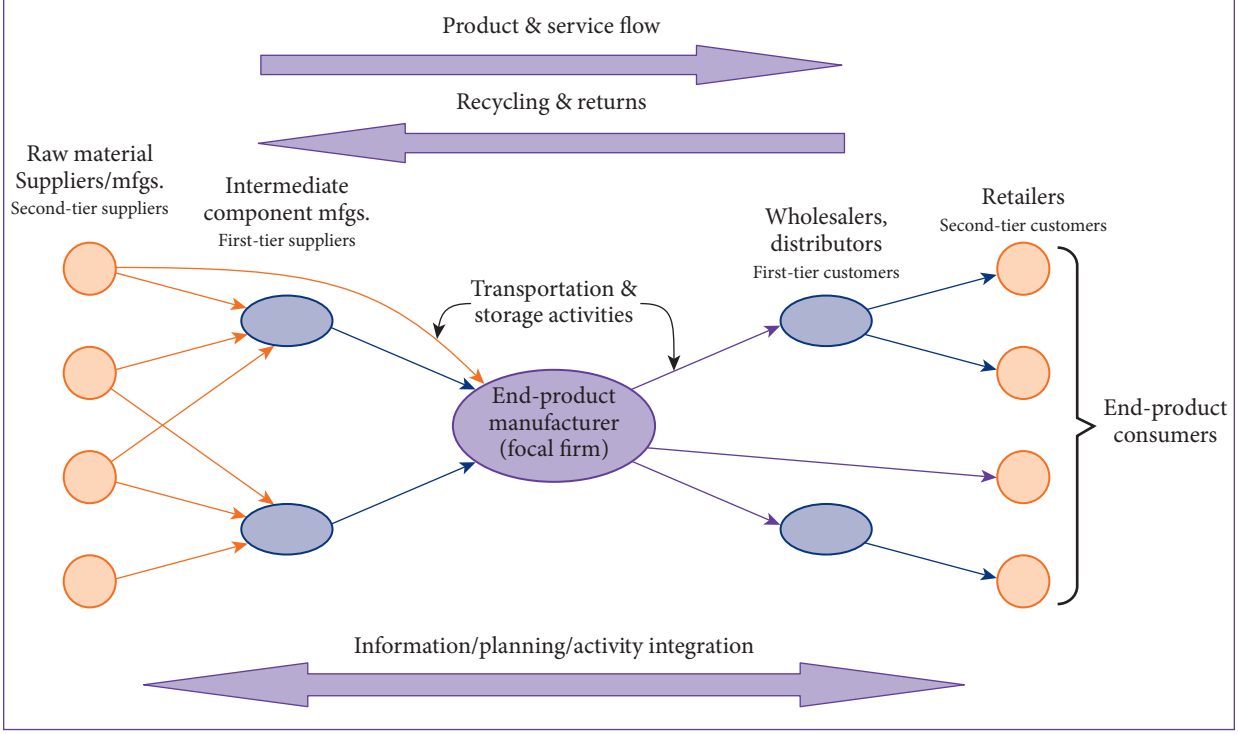
As you read this textbook, you will be introduced to the many concepts of supply chain management and how to use these concepts to become better managers in today's global economy. Examples are used throughout the text to illustrate the topics discussed, and cases at the end of each chapter are provided 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

Figure 1.1 A Generic Supply Chain



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

beyond a few of their most important first-tier suppliers and customers. However, with time and successful initial results, many firms are extending the boundaries of their managed supply chains to include their second-tier suppliers, second-tier customers, as well as their logistics service (transportation and warehousing) providers. Some of the firms considered to be the best at managing their supply chains have very recognizable names. Each year, for example, the business advisory company Gartner, Inc., announces the twenty-five companies that exhibit the best supply chain management business performance and leadership. The chapter-opening SCM Profile summarizes the five best from this list.

The Importance of Supply Chain Management

While all firms are part of a chain of organizations bringing goods and services to customers (and most firms operate within a number of supply chains), certainly not all supply chains are managed in a coordinated fashion. Firms continue to operate independently in many industries (particularly small firms). It is often easy for managers to be focused solely on their immediate customers, their daily internal operations, their sales, and their costs. After all, with customers complaining, employees to train, late supplier deliveries, creditors to pay, and equipment to repair, who has time for relationship building and other supply chain coordination efforts? Particularly during times like the economic downturn of 2009 and the global pandemic starting in 2020, firms were struggling to just keep their doors open, and many supply chain management efforts stalled.

In 2020 and 2021, as companies coped with tremendous changes brought about by COVID-19, they all faced the need to adapt to remote work, reconfigured physical workspaces, and revised supply chain networks. Arvind Krishna, CEO of IBM, says that "resiliency is about adaptability in this environment, as well as having a sustainable business for ourselves and for our clients. That's why, within 48 hours, we were able to move more than 95 percent of our employees to work from home. When you're critically dependent upon the cyber technologies, you need to up the level of resilience, and design your applications and your infrastructure in a way that never goes down." At Walmart, Kathleen McLaughlin, chief sustainability officer, said the company redoubled its resolve during the pandemic to bolster the sustainability of its supply chains. Walmart's Project Gigaton initiative, launched in 2017, for example, aims to reduce 1 billion metric tons of greenhouse gas emissions from the company's supply chains by 2030.[12]

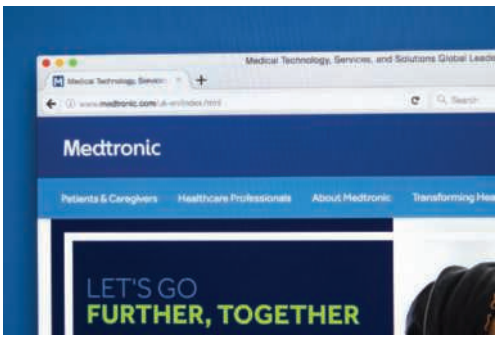
Aside from the recent trends in supply chain resiliency and sustainability, firms with large system inventories, many suppliers, complex product assemblies, and highly valued customers with large purchasing budgets have much to gain from the practice of supply chain management. For these firms, even moderate supply chain management success can mean lower purchasing and inventory carrying costs, better product quality, and higher levels of customer service—all leading to more sales and better profits. According to the U.S. Census Bureau's Annual Survey of Manufactures, the total cost of all materials purchased in 2018 exceeded $3.3 trillion among U.S. manufacturers, up $500 billion from 2017. The total 2018 end-of-year inventory value for all U.S. manufacturers was almost $680 billion, up from $643 billion in 2017.[13] Thus, it can be seen that purchasing and inventory costs can be quite sizable for firms and represent areas where significant cost savings can be realized when using effective supply chain management strategies.

Most recently, enVista, a global software and consulting services provider, conducted a 2020 Supply Chain Survey of retailers, and found that 34 percent said that handling the growth of online business was the top challenge they faced, while demand

planning and forecasting (33 percent), improving efficiencies (30 percent) and reducing supply chain costs (26 percent), were the next most important supply chain issues.[14] Seven years earlier, a similar survey found that over 70 percent of the respondents said that controlling costs was the number one focus area for supply chains. Obviously, the recent pandemic events have changed supply chain planning. The nearby SCM Profile describes Medtronic's use of a digital supply chain model to respond to supply disruptions caused by the pandemic.

Supply chain management efforts can start small—for instance, integrating processes with just one key supplier—and gather momentum over time to include more supply chain participants such as other important suppliers, key customers, and logistics or third-party services. Obviously, other behind-the-scenes activities must also be included such as getting stakeholder buy-in and use of an in-house or cloud IT solution. Finally, supply chain management efforts can include second-tier suppliers and customers. So why are these integration activities so important? As alluded to earlier, when a firm, its customers, and its

SCM Profile: Medtronic's Digital Supply Chain Model



christsdorney/Shutterstock.com

Medtronic, a large U.S. medical device manufacturer, created a digital model of its supply chain to assist in faster and better decision-making. Medtronic's supply chain includes hundreds of manufacturing and contract manufacturing sites, dozens of sterilization sites, over a thousand suppliers, and over 250,000 products. These products are distributed to hospitals, other distributors, and government health care programs. Over 60,000 daily shipments flow through a network of distribution centers, using various modes of transportation, to over 150 countries.

Medtronic's focus has been on analyzing how its products flow through its distribution network to customers. For example, using a slower mode of transportation means holding more inventory to attain desired service levels. Faster transportation means higher costs but requires less inventory. The company can also see the cost and service impacts of adding or subtracting a warehouse.

In a global pandemic environment, the supply chain impacts have been tremendous. Medtronic's supply chain has been heavily impacted by unexpected demand surges and crashes and countries shutting down their ports. As airlines stopped flying, air capacity vanished. When COVID-19 truly became a global problem, Medtronic was able to respond by placing inventories in countries before inbound shipments became impossible.

While demand has dropped off for many of its products, at some point demand will return. The company can place inventory in warehouses, it can slow down manufacturing, it can change where some products are manufactured, or it can slow down shipments by using ocean carriers. The total costs of all these options can be analyzed. Medtronic's digital model will always be on and constantly updated, improving the company's daily operations and business continuity capabilities.[15]

suppliers all know each other's future plans, and are willing to work together, the planning process is easier and much more productive in terms of decision-making, cost savings, quality improvements, and service enhancements.

On the other hand, lack of effective supply chain management can cause problems for organizations. Using a fictitious setting, Example 1.1 illustrates some of the costs associated with independent planning and lack of supply chain information sharing and coordination.

Example 1.1 Grebson Manufacturing's Supply Chain

The Pearson Bearings Co. makes roller bearings for Grebson Manufacturing on an as-needed basis. For the upcoming quarter, Pearson has forecasted Grebson's roller bearing demand to be 25,000 units. Since Grebson's demand for bearings from Pearson has been somewhat erratic in the past due to the number of bearing companies competing with Pearson and also the fluctuation of demand from Grebson's customers, Pearson's roller bearing forecast Includes 5,000 units of safety stock. The steel used in Pearson Bearings' manufacturing process is usually purchased from CJ Steels, Inc. CJ Steels has, in turn, forecasted Pearson's quarterly demand for the high-carbon steel it typically purchases for roller bearings. Their forecast also includes safety stock of about 20 percent over what CJ Steels actually expects Pearson to buy over the next three months.

Since Pearson Bearings does not know with full confidence what Grebson's roller bearing demand will be for the upcoming quarter (it could be zero or it could exceed 25,000 units), Pearson will incur the extra costs of producing and holding 5,000 units of safety stock. Additionally, Pearson Bearings risks having to either scrap, sell, or hold onto any units not sold to Grebson, as well as losing current and future sales to Grebson if their demand exceeds 30,000 units over the next quarter. CJ Steels faces the same dilemma—extra materials, labor costs, and warehouse space for safety stock along with the potential stockout costs of lost present and future sales. Additionally, Grebson's historic demand pattern for roller bearings from its suppliers already includes some safety stock, since it uses roller bearings in other products it makes for a primary customer.

Grebson's safety stock, which they have built into their roller bearing purchase orders, has resulted in still additional safety stock production levels at the Pearson plant. In fact, some of the erratic purchasing patterns of Grebson are probably due to their leftover safety stocks causing lower purchase quantities during subsequent production cycles. This, in turn, creates greater demand variability, leading to a decision at Pearson to produce even higher levels of safety stock. This same scenario plays out between Pearson and CJ Steels, with erratic buying patterns by Pearson and further safety stock production by CJ. This magnification of safety stock, based on erratic demand patterns and forecasts derived from demand already containing safety stock, and from a lack of sharing information, continues to grow as orders pass to more distant suppliers up the supply chain.

The continuing cycle of erratic demand, causing forecasts to include safety stock which in turn magnify supplier forecasts and cause production planning problems is known as the **bullwhip effect**. If Grebson Manufacturing *knew* its customers' purchase plans for the coming quarter along with how their purchase plans were derived, it would be much more confident about what the upcoming demand was going to be, resulting in little, if any, safety stock requirement, and consequently it would be able to communicate its own purchase plans for roller bearings to Pearson. If Grebson purchased its roller bearings from only Pearson and, further, told Pearson what its quarterly purchase plans were, and if Pearson did likewise with CJ Steels, safety stocks throughout the supply chain would be reduced considerably, driving down the costs of purchasing, producing, and carrying roller bearings at each stage. Trade estimates suggest that the bullwhip effect results in excess costs on the order of 12 to 25 percent for each firm in a supply chain, which can be a tremendous competitive disadvantage. This discussion also sets the stage for a supply chain management concept called collaborative planning, forecasting, and replenishment, discussed further in Chapter 5.

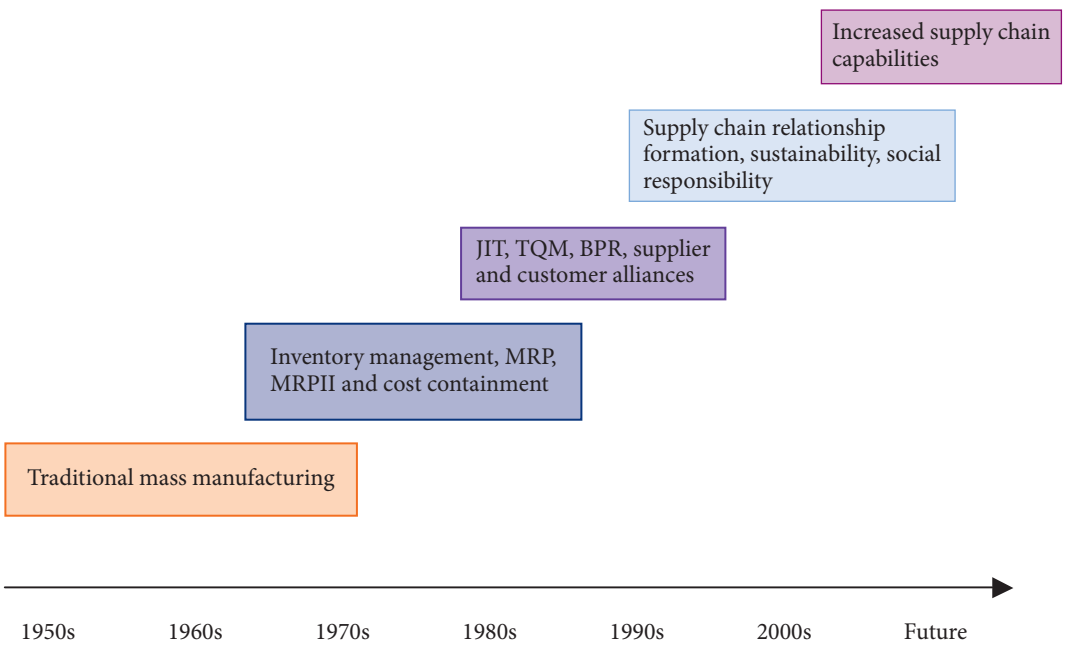
As working relationships throughout the supply chain mature, key trading partners will feel more comfortable investing capital in better facilities, better products, and better services for their customers. With time, customers will share more information with suppliers, and suppliers will be more likely to participate in their key customers' new product design efforts, for instance. These, then, become some of the more important benefits of a well-integrated supply chain. In the following chapters of the text, other associated benefits will also become apparent.

The Origins of Supply Chain Management in the United States

During the 1950s and 1960s, U.S. manufacturers were employing mass production techniques to reduce costs and improve productivity, while little attention was typically paid to creating supplier partnerships, improving process design and flexibility, or improving product quality (see Figure 1.2). New product design and development was slow and relied exclusively on in-house resources, technologies, and capacity. Sharing technology and expertise through strategic buyer–supplier partnerships was essentially unheard of back then. Processes on the factory floor were cushioned with work-in-process inventories to keep machines running and maintain balanced material flows, products moving through the facility even when equipment broke down, resulting in large inventory carrying cost investments.

In the 1960s and 70s, computer technologies began to flourish and material requirements planning (MRP) and manufacturing resource planning (MRPII) software

Figure 1.2 Historic Supply Chain Management Events in the United States



Note: MRP = material requirements planning, MRPII = manufacturing resource planning, JIT = just-in-time, TQM = total quality management, BPR = business process reengineering.

applications were developed. These systems allowed companies to see the importance of effective materials management—they could now recognize and quantify the impact of high levels of inventories on manufacturing, storage, and transportation costs. As computer capabilities grew, the sophistication of inventory tracking software also grew, making it possible to further reduce inventory costs while improving internal communication of the need for purchased parts and supplies.

The 1980s were the breakout years for supply chain management. One of the first widely recorded uses of the term *supply chain management* came about in a paper published in 1982.[17] Intense global competition beginning in the 1980s (and continuing today) provided an incentive for U.S. manufacturers to make low-cost, high-quality products while offering high levels of customer service. Manufacturers utilized just-in-time (JIT) and total quality management (TQM) strategies to improve quality, manufacturing efficiencies, and delivery times. In a JIT manufacturing environment with little inventory to cushion scheduling and/or production problems, firms began to realize the potential benefits and importance of strategic and cooperative supplier–buyer–customer relationships, which are the foundations of SCM. The concept of these partnerships or alliances emerged as manufacturers experimented with JIT and TQM.

As competition in the United States intensified further in the 1990s accompanied by increasing logistics costs and the trend toward market globalization, the challenges associated with improving quality, cost, customer service, and product design also increased. To deal with these challenges, manufacturers began purchasing from a select number of certified, high-quality suppliers with excellent service reputations and involved these suppliers in their new product design activities as well as in cost, quality, and service improvement initiatives. In other words, companies realized that if they started giving only their best suppliers most of their business, then they, in return, could expect these suppliers to provide continued benefits in the form of on-time deliveries; high-quality, low-cost products; and help with new product design efforts.

Interestingly, the general idea of supply chain management had been discussed for many years prior to the chain of events shown in Figure 1.2. In 1915, Arch W. Shaw of the Harvard Business School wrote the textbook *Some Problems in Market Distribution,* considered by many to be the first on the topic of what we now refer to as supply chain management (Shaw never used this term). The text included discussions of how best to purchase raw materials, transport products, locate facilities, and analyze productivity and waste. He recommended a "laboratory point of view" or what could now be termed a systematic study of supply chain issues.[18]

Business process reengineering (BPR), or just **reengineering**, described as the radical rethinking and redesigning of business processes to reduce waste and increase performance, was introduced in the early 1990s and was the result of a growing interest during this time in the need for cost reductions and a return to an emphasis on the key competencies of the firm to enhance long-term competitive advantage. Michael Hammer and James Champy's very popular book, *Reengineering the Corporation: A Manifesto for Business Revolution* combined with the many statements from notable business experts like Peter Drucker along the lines of "Reengineering is vital to success and it has to be done," created a fervor at the time among managers seeking some sort of magic pill or easy method for making their businesses successful.[19] As this fad died down in the late 1990s (reengineering became synonymous with downsizing and thus fell out of favor), the practice of supply chain management rapidly increased in popularity as a source of competitive advantage.

Also during this time, managers, consultants, and academics began developing an understanding of the differences between logistics and supply chain management. Up until then, supply chain management was simply viewed as logistics outside the firm. As companies began implementing supply chain management initiatives, they began to understand the need to integrate key business processes among the supply chain participants, enabling the supply chain to act and react as one entity. Today, logistics is viewed as one important element of the much broader supply chain management concept.

At the same time, companies also saw benefits in the creation of alliances or partnerships with their customers. Developing these long-term, close relationships with customers (referred to as **customer relationship management** or CRM) meant the need for less finished product safety stock (as discussed earlier in the bullwhip effect example) and allowed firms to focus their resources on providing better goods and services to their best customers. In time, when market share improved for its customers' products, the result was more business for the firm.

Thus, supply chain management has evolved along two parallel paths: (1) the inbound purchasing and supply management emphasis from industrial buyers at the focal firm, and (2) the outbound logistics and customer service emphasis from logistics personnel at the focal firm. The increasing popularity of alliances with suppliers and customers (and eventually suppliers' suppliers and customers' customers) has also meant a greater reliance on the inbound and outbound shipping, warehousing, and logistics services that provide transportation, storage, documentation, and customs clearing services to trading partners within a typical supply chain. Relationship building has also occurred increasingly with many of these **third-party logistics providers** (3PLs) to ensure a continuous, uninterrupted supply of goods. The need to periodically assess the performance of these relationships has also accompanied the growth of supply chain management. One of the challenges faced today by many firms involved in supply chain management is how to adequately assess overall end-to-end performance in often extremely complex, global supply chains. This idea of evaluating supply chain performance from numerous perspectives including financial, sustainability, speed, and risk is explored in Chapter 14.

For the wholesaling and retailing industries, the supply chain management focus is on location, logistics, and customer service issues more often compared to manufacturing. Supply chain management in these industries has often been referred to as quick response, service response logistics, or integrated logistics. The advancement of electronic data interchange (EDI) systems, bar coding, Internet systems, logistics software applications, and radio frequency identification (RFID) technologies over the past two decades has greatly aided the evolution of the integrated supply chain concept. Retailers utilize supply chain management to help quickly meet changing demands in the marketplace and to reduce inventories throughout their supply chains.

Most recently, the rapid development of client/server supply chain management software that typically includes integrated supply chain management and e-commerce components has aided in the evolution and adoption of supply chain management. These software applications are commonly referred to as **enterprise resource planning** (ERP) systems, and for years, the top two ERP providers worldwide have been SAP and Oracle. Total worldwide ERP product sales in 2019 were over $38 billion, and sales growth was expected to average about 8.2 percent per year for the following five years.[20] Sharing information with supply chain partners through the Internet using compatible ERP systems has enabled firms to integrate stocking, logistics, materials acquisition, shipping, and other functions to create a more proactive and effective style of business management and customer responsiveness.

Today, an emphasis is being placed on the resilience and the environmental and social impacts of supply chains. Customers are demanding that companies and their supply chains make buying easy in a pandemic environment, and also act in an ethically and socially responsible manner. This includes an attention on how suppliers utilize the Internet, hire and train employees, how they grow and harvest plants, how they manufacture parts, how their activities impact the environment, and what sorts of sustainability policies are being utilized. The term **sustainability** as applied to supply chains is a broad term that includes protecting the environment, some aspects of social responsibility, as well as financial performance (hence the linking of sustainability to what is termed the **triple bottom line**, or people, planet, and profits). Sustainability can be defined as the ability to meet the needs of current supply chain members without hindering the ability to meet the needs of future generations in terms of economic, environmental, and social challenges. Simply put, sustainability is doing the right things in ways that make economic sense. These topics are discussed further in Chapter 4. With these practices in mind, supply chain managers today must also cope with maintaining the most flexible supply chain possible to serve customers in chaotic marketplaces, and to take advantage of new markets, new sources of supply, and new customer demands.

The Foundations of Supply Chain Management

The foundation elements of supply chain management are introduced in this section. These elements essentially make up the table of contents for this textbook and are shown in Table 1.1 along with the chapters where they are discussed.

Supply Elements

Traditional purchasing strategies typically emphasized the use of many suppliers, hard bargaining, competitive bidding, and short-term contracts. This typically created adversarial buyer–supplier relationships with a focus primarily on the product's purchase price instead of the capabilities of the suppliers and how they could contribute to the long-term competitiveness of the buying organization. In many cases, purchasing was performed by a clerk, with little training. Over the past thirty years, there has been a shift toward a more strategic approach to purchasing, and this broader approach is more commonly referred to as **supply management**. Supply management professionals holding business degrees now most often perform the purchasing function. Effective supply management has resulted

Table 1.1 The Foundations of Supply Chain Management

FOUNDATION ELEMENTS	IMPORTANT ISSUES	CHAPTERS
Supply	Supplier base reduction, supplier alliances, SRM, global sourcing, ethical and sustainable sourcing	2, 3, 4
Operations	Demand management, CPFR, inventory management, MRP, ERP, lean systems, Six Sigma quality	5, 6, 7, 8
Logistics	Logistics management, CRM, network design, RFID, global supply chains, sustainability, service response logistics	9, 10, 11, 12
Integration	Barriers to integration, risk and security management, performance measurement, green supply chains	13, 14

generally in smaller supplier bases and the development of more long-term, trusting, mutually beneficial supplier relationships (termed **supplier relationship management** or SRM) to achieve the competitive benefits described earlier.

Purchasing and the strategic concepts of supply management are one of the foundations of supply chain management, since incoming material quality, delivery timing, purchase price, product safety, and the impact of purchasing on the environment are all affected by the buyer–supplier relationship and the capabilities of suppliers. A recent survey conducted by the American Productivity and Quality Center (APQC) and Supply Chain Management Review revealed that most organizations are familiar with the principles of SRM, and that nearly 40% of organizations are using SRM with their suppliers to some degree. Many organizations that do not use SRM intend to implement it in the near future. Clearly organizations consider this way of managing suppliers worth adopting. For suppliers that are more integral to an organization's success, or have potential to develop innovations that can benefit both parties, APQC recommends the development of a more strategic and collaborative relationship business model.[21] Chapters 2 through 4 cover the topics associated with supply management.

The global pandemic beginning in 2020 added another problem to the supply side of businesses, namely how the focal firm can continue producing successfully, when several key suppliers go out of business or are unable to export product when ports close down. Supply chain managers today must build better visibility and security into their supply chains using software applications and frequent communications to spot these problems before they become unmanageable.

One of the more crucial issues within the topic of supply management is **supplier management**. Simply put, this means encouraging or helping the firm's suppliers to perform in some desired fashion, and there are a number of ways this is done. It involves assessing the suppliers' current capabilities and then deciding if and how they need to improve. Thus, one of the key activities in supplier management is **supplier evaluation**, or determining the current capabilities of suppliers. This occurs both when potential suppliers are being evaluated for a future purchase and when existing suppliers are periodically evaluated for ongoing performance purposes. A closely related activity is **supplier certification**. Supplier certification allows buyers to assume the supplier will meet certain product quality and service requirements covered by the certification, thus reducing duplicate testing and inspections and the need for extensive supplier evaluations. Farm implement manufacturer Deere & Company, for example, has its Achieving Excellence Program wherein suppliers are evaluated annually across several performance categories. The idea is to reward high performers and provide feedback to promote continuous improvement. EgeTrans Internationale earned recognition as a Partner-level supplier for fiscal year 2019 in the John Deere Achieving Excellence Program. The Partner-level status is Deere & Company's highest supplier rating. Due to the dedication in providing logistics services of outstanding quality as well as the commitment to continuous improvement, EgeTrans was selected for this recognition. EgeTrans holds the record for receiving thirteen consecutive Partner-level awards.[22]

Over time, supplier management efforts allow firms to selectively screen out poor-performing suppliers and build successful, long-term, trusting relationships with top-performing suppliers. These suppliers can provide tremendous benefits to the buying firm and the entire supply chain. As discussed in greater detail in Chapter 2, greater purchase volumes, using fewer suppliers, typically means lower per-unit purchase costs (causing a much greater impact on profits than a corresponding increase in sales) and in many cases higher quality and better delivery service. These characteristics are viewed as strategically

important to the firm because of their impact on the firm's competitiveness. "Our suppliers play a key role in delivering the products, services and experiences our customers deserve, and these award-winning suppliers went above and beyond our expectations," said Shilpan Amin, GM's vice president, Global Purchasing and Supply Chain, when speaking of their top-performing suppliers. "We also believe it's important at this point in time to thank our entire supply base for their efforts the last few months to mitigate the impacts of COVID-19."[23]

Suppliers also see significant benefits from the creation of closer working relationships with customers in terms of long-term, higher-volume sales. These trading partner relationships have come to be termed **strategic partnerships** and are emphasized throughout this text as one of the more important aspects of supply chain management. Diageo, a U.K.-based beverage leader with one of the world's best supply chains, has made a considerable investment in transforming its procurement organization with a focus on supplier partnerships. A robust supplier relationship management framework is enabling end-to-end supply chain engagement on sustainability and collaboration across the business for long-term, strategic-value creation.[24] Chapter 3 explores strategic partnerships and other topics associated with supplier relationship management.

Recently, the supply management discipline has come to include a closer emphasis on **ethical and sustainable sourcing**, or purchasing from suppliers that are governed by environmental sustainability and social and ethical practices. Companies are realizing that suppliers can have a significant impact on a firm's reputation and carbon footprint, as well as their costs and profits. Supply chain managers must therefore learn how to develop socially responsible and environmentally friendly sourcing strategies that also create a competitive advantage for the company. Delaware-based Ashland Global Holdings for example, has required all suppliers to sign a Supplier Code of Conduct since 2014. The code holds suppliers to the same high standards as Ashland with respect to labor and employment rights, environmental health and safety, business ethics and social responsibility, and global trade practices. Additionally, Ashland partners with farmers in Mexico to ensure Ashland's aloe is harvested in an ecologically sustainable way and to maintain the Fair for Life certification. Funds are used as directed by the local farmers to also improve conditions within the communities where Ashland's aloe is grown.[25] These topics along with other supply management topics are discussed in detail in Chapter 4.

Operations Elements

Once materials, components, and other purchased items are delivered to the buying organization, a number of internal operations elements become important in assembling or processing the items into finished products, ensuring that the right amount of product is produced and that finished goods and services meet specific quality, cost, and customer service requirements. Along with supply management, **operations management** is also considered a foundation of supply chain management and is covered in Chapters 5 through 8.

During a calendar year, seasonal demand variations commonly occur. Firms can predict when these variations will occur based on historic demand patterns, through use of forecasting techniques that guide weekly or monthly production plans. If demand does not occur as forecasted, then the focal firm is left with either too much or too little inventory (or service capacity). Both situations are cost burdens to the firm (inventory carrying costs and stockout costs). As a matter of fact, in one survey, 63 percent of Americans admitted they would be somewhat to highly likely to look for an alternative brand if a product shortage affected their favorite electronics brand. Only 14 percent said they would stay loyal to their favorite brand in the event of a shortage.[26] To minimize lost sales and other

costs, firms often rely on **demand management** strategies and systems, with the objective of matching available capacity to demand, either by improving production scheduling, curtailing demand, using a back-order system, or increasing capacity.

Managing inventories is one of the most important aspects of operations and is certainly value enhancing for the firm. Firms typically have some sort of **material requirements planning** (MRP) software system for managing their inventories, purchases, and production schedules. These systems can be linked throughout the organization and its supply chain partners using **enterprise resource planning** (ERP) systems, providing real-time purchase and sales data, inventory, and production information to all business units and to key supply chain participants. These system configurations vary considerably, based on the number and complexity of products, size of the firm, and design of the supply chain. Retailers like Walmart, for example, scan the bar codes of items when consumers make purchases, causing the local store's MRP system to deduct units from inventory until a preset reorder point is reached. When this occurs, the local computer system automatically contacts Walmart's regional distribution center's MRP system and generates an order. At the distribution center, the order is filled and sent along with other orders to that particular Walmart. Eventually, the inventory at the distribution center needs replenishing, and at that time, the distribution center's MRP system automatically generates an order to the manufacturer which sells and then delivers the product to the Walmart distribution center. This type of order communication creates **inventory visibility** to the supply chain members and may also extend farther up the supply chain, reducing the likelihood of stockouts, excess inventories, and long lead times. Third-party logistics providers (3PLs) play a critical role in helping shippers with inventory visibility and real-time order monitoring. For example, a 3PL can help identify ports that are congested or even closed due to the pandemic or other natural disaster and quickly help shippers divert trade to different ports. Additionally, U.S. retailers can have in-store inventory visibility through the use of MRP and **radio frequency identification** (RFID) systems, which can scan incoming cartons and pallets for RFID tags, which describe the contents of the packages to the MRP.

Another common form of inventory management is through use of a **lean production system** (lean production may also be referred to as just-in-time or the Toyota production system). Lean within a production system refers to operating with low inventory levels. Implementing a lean system takes time but usually results in faster delivery times, lower system inventory levels, fewer stockouts, and better quality. An important aspect of a lean production system is the quality of the incoming purchased items and the quality of the assemblies as they move through the various production processes. Higher quality means less need for safety stock.

Firms employing lean production concepts usually have a **Six Sigma quality management** strategy in place to ensure continued quality compliance among suppliers and with internal production facilities. Six Sigma was originally created at Motorola in the 1980s, and Motorola proved the program's value when it won the Baldrige Quality Award in 1988. Many organizations have reported large savings with use of Six Sigma including $1.7 billion at Ford, $17 billion at Motorola, $1.2 billion at 3M, and $8 billion at General Electric.[27] Lean and Six Sigma are discussed in detail in Chapter 8.

Logistics Elements

When goods are produced, they can be delivered to customers through a number of different modes of transportation. Delivering products to customers at the right time, right quality, and right volume requires a high level of planning and cooperation between

the firm, its customers, and the various logistics elements or services employed (such as transportation, warehousing, and break-bulk or repackaging services). In contrast, services are produced and delivered to the customer simultaneously in most cases, so services are extremely dependent upon server capacity and successful service delivery to meet customer requirements. **Logistics** is the third foundation of supply chain management, and these topics are presented in Chapters 9 through 12.

Logistics decisions typically involve trade-offs between cost and delivery timing or customer service. Considering the five modes of transportation, motor carriers (trucks) are more expensive to use than rail carriers but offer more flexibility and speed, particularly for short routes. Air carriers are even more expensive but much faster than any other transportation mode. Water carriers are the slowest but are also the least expensive. Finally, pipelines are used to transport oil, water, natural gas, and coal slurry. Many transportation services offer various modal combinations, as well as warehousing and customs-clearing services.

In a typical integrated supply chain environment where JIT deliveries are the norm, **third-party logistics services** or 3PLs are critical to the overall success of supply chains. In many cases, these services are considered supply chain partners and are viewed as key value enhancers for supply chains. From pandemics to earthquakes, to tornadoes, floods, and other risk-prone environments, companies are teaming up with 3PLs to improve visibility, flexibility, and delivery performance while reducing risk in their supply chains. "Globally, manufacturers and retailers are taking a renewed interest in redesigning and reengineering their supply chains in the wake of these events," says Jim McAdam, president of 3PL provider APL Logistics.[28]

The desired goal of logistics is an appropriate level of customer service at a reasonable price. In order to provide the desired level of customer service, firms must identify customer requirements and then provide the right combination of transportation, warehousing, packaging, and information services to successfully satisfy those requirements. Through frequent contact with customers, firms develop customer relationship management strategies for meeting delivery due dates, resolving customer complaints, communicating with customers, and determining other logistics services required. From a supply chain management perspective, these customer activities take on added importance because second-tier, third-tier, and end-product customers are ultimately dependent on the logistics performance at each stage within a supply chain.

Today, supply chains are facing continuing disruption on a global scale. The pandemic shifted consumer demand to e-commerce and faster delivery options, adding to the pressure on shippers and logistics providers. A recent survey by Accenture and GEODIS of 200 large retailers found that companies expect the shift to online sales to continue. However, 52 percent thought their logistics capabilities were not scaled to absorb the quickly growing e-commerce volumes. Shippers need to build greater levels of agility, resiliency and sustainability, while managing costs. New innovative capabilities for delivery, product returns, and warehousing will be increasingly important. Thus, investing in new capabilities and finding the right 3PL providers is more essential than ever.[29] The nearby SCM Profile describes the impact the pandemic had on Whirlpool's global supply chain.

Designing and building an effective **distribution network** is one method of ensuring successful product delivery. Again, there is typically a trade-off between the cost of the distribution network and the level of customer service provided. For example, a firm may utilize a large number of regional or local warehouses in order to deliver products quickly to customers. In this case, the transportation cost from factory to warehouse, the inventory holding cost, and the cost to build and operate multiple warehouses would be quite

SCM Profile: Whirlpool's Global Supply Chain Produces PPE and Ventilators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Whirlpool Corp., the world's largest home appliance company, has $20 billion in annual sales and 59 manufacturing centers around the world. Its brands are sold in nearly every country on earth. When the COVID pandemic hit their Benton Harbor, MI headquarters hard in March, 2020, Whirlpool quickly focused on meeting the demand for supplies at Spectrum Health Lakeland, a health system in St. Joseph that serves the greater southwest Michigan and northern Indiana region. Over the following month, using its global supply chain and its China manufacturing unit, the company delivered at no cost many thousands of masks, gloves, thermometers and hospital gowns.

By May, as it became clear there would be a shortage of ventilators, Whirlpool partnered with Dow and Reynolds Consumer Products to make and distribute ventilators. Whirlpool built and distributed them through WIN Health Labs LLC, a subsidiary Whirlpool formed to make supplies needed to fight the pandemic. Dow provided the clear plastic face shields for the ventilators and Reynolds Consumer Products designed and made the units' disposable hoods. Over 4,000 ventilators were distributed free of charge to hospitals across Michigan, Texas, and Louisiana.

Whirlpool also experienced disruptions as their global supply chains experienced parts shortages, and social distancing slowed down manufacturing lines worldwide. Consumers trying to replace their overworked dishwashers and washing machines sometimes faced weeks of shipping delays. According to a Whirlpool statement: "Our 15,000 plant employees in our nine plants across the UNITED STATES have been working tirelessly as we have managed through COVID-19 and our factories are doing everything they can to meet consumer needs. Our plants have experienced a few brief interruptions in production related to the pandemic, including component shortages, but as a whole have remained up and running throughout this challenging time."[30]

high, but the payoff would be excellent customer service. On the other hand, a firm may choose to operate only a few large centralized warehouses, saving money on the inbound transportation costs from factories (since they would be delivering larger quantities to fewer locations) and the warehouse construction and operating costs, but then have to be content with limited customer service capabilities since the warehouses would be located farther from most customers. Today, the use of massive, efficient warehouses to serve large market areas is growing. For example, the Browning Investments/Duke Realty partnership constructed a 900,000-square-foot warehouse at All Points Midwest industrial park in Plainfield, Indiana, and Missouri-based North Point Development built a 741,000-square-foot warehouse near Lebanon Business Park in Indiana. Much of this building surge is driven by retailers opening e-commerce facilities at a dizzying pace as online shopping becomes more prevalent.[31]

When firms operate globally, their supply chains are more complex, making global location decisions (the topic of Chapter 11) a necessary aspect of supply chain

management. The increasing demand for products in emerging global markets like Russia, the Philippines, Thailand, and China combined with growing foreign competition in domestic markets, along with comparatively low labor costs in many Asian countries, have made international business commonplace for many companies. Firms must understand both the risks and advantages of operating in foreign locations and the impact this may have on their **global supply chains**. Some of the advantages include a larger market for products, economies of scale in purchasing and production, lower labor costs, a supplier base of potentially cheaper, higher-quality suppliers, and the generation of new product ideas from foreign suppliers and employees. Some of the risks include fluctuating exchange rates affecting production, warehousing, and purchasing and selling prices; government intervention or political instabilities causing supply disruptions; security concerns; and potential changes in subsidies, tariffs, and taxes.

Companies react to these problems by building flexibility into their global supply chains. This is accomplished by using a number of secondary suppliers as well as manufacturing and storage facilities in various foreign locations. As product demand and economic conditions change, the supply chain can react to take advantage of opportunities or cost changes to maximize profits. "Obviously, those with production capability in multiple regions and/or countries present a lower risk than a single location or a cluster of facilities in a single region or country," says Mark Taylor, vice president at North Carolina-based Risk International Services. "Even if you source 90 percent from the primary, by maintaining a second or third qualified (supplier), you've substantially shortened your lead time in making a change."[32]

For service products, the physical distribution issue is typically much less complex. Making sure services are delivered in a timely fashion is a primary topic of Chapter 12. Services are, for the most part, delivered by a server when customers request service. For instance, consider an example in which a customer walks into an auto repair facility in search of service for their automobile. They may talk to two or three facility employees during this service but eventually will complete a repair form, wait for the service to be completed, and then receive the repaired automobile. They will leave, satisfied with the service they received, as long as a number of things occurred: they got what they came for (the repair job), got the type of service they expected (a reasonable waiting period, knowledgeable servers, and a properly repaired auto), and got the service at a reasonable price. Otherwise, the customer will most likely be dissatisfied.

Successful service delivery depends on service location (service providers must be close to the customers they are trying to serve), service capacity (customers will leave if the wait is too long), and service capability (customers must be able to trust what servers are saying or doing for them). The final requirement of successful service is knowing what customers want. "I think we are very quickly moving toward that world of instant commerce where you'll be able to buy anything you like at any time anywhere, particularly in the United States, and be able to get it in a matter of hours," says AI-based logistics network company Ohi's CEO Ben Jones. "That's the kind of vision fulfillment companies are working toward and I think the COVID situation has accelerated that move, not necessarily by the end of 2020, but definitely by the end of 2021, that will be the new normal."[33]

Integration Elements

Thus far, three of the four foundations of supply chain management have been discussed: supply, operations, and logistics activities occurring among the firm and its tiers

of customers and suppliers. The final foundation topic—and certainly the most difficult one—is to integrate these processes among the focal firm and its key supply chain trading partners. **Supply chain process integration** is discussed in detail in the final two chapters of the text.

Processes in a supply chain are said to be integrated when trading partners in the supply chain work together to make purchasing, inventory, production, quality, and logistics decisions that impact the overall costs and profits of the supply chain. If one key process activity fails or is performed poorly, then the flow of goods moving along the supply chain is disrupted, jeopardizing the effectiveness of the entire supply chain. Successful supply chain process integration occurs when the participants realize that effective supply chain management must become part of each member's strategic planning process, where objectives and policies are jointly determined based on the end consumers' needs and what the supply chain as a whole can do for them.

Ultimately, trading partners act together to maximize total supply chain profits by determining optimal purchase quantities, product availabilities, service levels, lead times, production quantities, use of technology, and product support at each tier within the supply chain. These integration activities also require high levels of *internal* functional integration of activities within each of the participating firms, such that the supply chain acts as one entity. This idea of supply chain integration can run contrary to some potential supply chain participants' independent profit-maximizing objectives, making supply chain process integration a tough sell in many supplier–buyer–customer situations. Thus, continued efforts are required to break down obstacles, change cultural norms and adversarial relationships, knock down corporate silos, reduce conflicts, and bridge functional barriers within and between companies if supply chain integration is to become a reality.

The need for and value of process integration has impacted the auto industry in particular. Michigan governor Rick Snyder and Ontario, Canada premier Kathleen Wynne went on the offensive in August 2016, by signing a memorandum of understanding to increase the region's competitiveness in the automotive industry. The agreement covers best practices, improved supply chain integration, and technology transfer agreements. Ontario and Michigan account for more than 26 percent of vehicle production in the Great Lakes region. "Collaborating to improve the auto sector is a great use of resources that will lead to continued growth and job creation in both economies. Sharing best practices and integrating our supply chains will advance Michigan's and Ontario's positions as leaders in the auto industry," said Snyder.[34]

One additional integration topic is the use of a **supply chain performance measurement** system. Performance measurements must be utilized along supply chains to help firms keep track of their process integration and supply chain management efforts. It is crucial for firms to know whether certain strategies are working as expected—or not—before they become financial and customer drains on the organizations. Firms work together to develop long-term supply chain management strategies and then devise tactics to implement these strategies. Performance measurements help firms decide the value of these tactics and should be developed to highlight performances within the areas of purchasing, operations, logistics, and integration.

Performance measures should be designed around each important supply chain activity and should be detailed performance descriptors instead of merely sales or cost figures. High levels of supply chain performance occur when the strategies at each of

the firms fit well with overall supply chain strategies. Thus, each firm must understand its role in the supply chain, the needs of the supply chain's end customers, the needs of each firm's immediate customers, and how these needs translate into internal operations requirements and the requirements being placed on suppliers. Once these needs and the goods and services themselves can be communicated and transported through the supply chain effectively, successful supply chain management and its associated benefits can be realized.

Current Trends in Supply Chain Management

The practice of supply chain management is a fairly recent phenomenon, and many organizations are beginning to realize both the benefits and problems accompanying integrated supply chains. Supply chain management is a complex and time-consuming undertaking, involving cultural change among most or all of the participants, investment and training in new software and communication systems, the building of trust between supply chain members, and a change or realignment of the competitive strategies employed among at least some of the participating firms. Further, as competitors, products, technologies, economic conditions, and customers change, the priorities for supply chain trading partners also change. A look at industry surveys of executives reveals a number of supply chain issues that companies are addressing today, including the use of supply chain analytics, improving supply chain sustainability, and increasing supply chain visibility.[35] While these and other supply chain management issues are discussed in numerous places in this text, these newest trends are discussed below to give the reader a better sense of some of the issues facing executives and their companies' supply chains today.

Use of Supply Chain Analytics

Supply chain analytics refers to examining raw supply chain data and then reaching conclusions or making predictions with the information. It is used in many industries to allow supply chain managers to make better business decisions. The market for supply chain analytics solutions is growing at about 15 percent per year, with the 2018 global revenues exceeding $4.8 billion. The solutions include supply chain planning and procurement, sales and operations planning, forecasting, manufacturing analytics, transportation and logistics analytics, and visualization and reporting tools. The growth is being pushed by the enormous rise in computing capabilities and the huge volumes of data generated (hence the term **big data**) in business organizations including retail, healthcare, manufacturing, and electronics, and the rising awareness levels among executives regarding the benefits of these analytics solutions.[36]

Analytics can be used along the supply chain, for example, to schedule production according to expected supplier deliveries, to route delivery trucks through a distribution network, or to determine when and how much PPE to order at a hospital. At Vanderbilt University Medical Center in Nashville, TN, for example, Teresa Dail, chief supply chain officer, and her team developed a customized PPE model. Clinical feedback helped with time studies and mappings of PPE utilization for COVID-19 patients in the ICU, the emergency room, the operating room, and at the organization's COVID-19 testing and assessment sites. Those standards are built into the model, along with the number of potential encounters per day for an inpatient stay. The supply chain team

can input patient volumes based on either the current census or a projected number and compute how much PPE will be needed for each product category during thirty-day intervals. "We've based our entire plan on buying PPE over the next six months just around that modeling," Dail says.[37] Analytics solution provider Blue Yonder has developed forecasting methods for retailers, where 130,000 SKUs and 200 influencing variables generate 150,000,000 probability distributions every day to ensure the right products are replenished at each store. Increased forecast accuracy generates savings on inventory and other supply chain costs. In a transportation application, UPS has spent 10 years developing its On-Road Integrated Optimization and Navigation system to optimize routes in real time according to traffic. While cost reduction is often the trigger of analytics initiatives, customers benefit from reduced stock-outs and more accurate delivery slots.[38]

Improving Supply Chain Sustainability

As mentioned earlier in this chapter, supply chain sustainability refers to meeting the needs of current supply chain members without hindering the ability to meet the needs of future generations in terms of economic, environmental, and social challenges. Even retailer JCPenney is getting into the act. They are partnering with the Apparel Impact Institute (AII) to improve its supply chain sustainability performance.

Working with AII will help improve performance related to energy, water and chemicals. "We are pleased to see JCPenney take this leadership position by recognizing the serious environmental impacts of wet processing activities in Tier 2 production by joining our Clean by Design program," Lewis Perkins, AII's president, said. "As the world seeks to build back with better solutions, JCPenney is 'leaning in' to this opportunity to improve existing facilities in the ways that will have the most positive impact for both sustainability and production cost."[39]

According to a Gartner survey of 528 supply chain professionals across the high-tech, industrial and food and beverage industries conducted in 2020, 51 percent of respondents expected their focus on "circular economy strategies" to increase. Additionally, accessing and reprocessing end-of-life products are the biggest challenges organizations face when transitioning from a linear to circular supply model, according to Gartner. (**Circular economy** refers to an economic system aimed at eliminating waste and the continual use of resources). Finally, based on the survey, companies are committed to integrating sustainability practices into their supply chain strategies, as consumer, shareholder, and governmental pressures to reduce the environmental impacts of industrial operations continue. Chief supply chain officers believe that a circular economy remains the road forward.[40]

In 2016, Ford Motor Co. announced an effort to expand its environmental and resource conservation goals along its supply chains, unveiling what it calls its Partnership for a Cleaner Environment. Working with 25 suppliers representing 800 manufacturing plants in 40 countries, Ford's Partnership shared with these suppliers what it considers best practices around reducing water, energy, and carbon dioxide as well as materials reuse. Ms. Mary Wroten, Ford's senior manager of supply chain sustainability, said that by sharing what works in-house with its suppliers, Ford is able to multiply the reductions in water, energy use, and GHG emissions. "Climate is not a competitive space, and more that we can talk about this and share what we are doing, a stronger planet we can create," said Wroten.[41]

Increasing Supply Chain Visibility

Supply chain visibility is defined as the ability of suppliers, manufacturers, business partners, and customers to know exactly where products are, at any point in the supply chain. This inventory visibility is obviously made easier by technology and can prove very advantageous when dealing with disruptive events such as pandemics, floods, hurricanes, and political upheavals. UPS and Fedex tracking methods are good examples of visibility—shipments are tracked and monitored using technology, and alerts are sent to shippers as the item is in transit and then delivered. Today, more sophisticated software applications are being developed and offered to organizations for tracking orders, inventories, deliveries, returned goods, and even employee attendance.[42]

Centauro, Brazil's largest sporting goods retailer with 211 stores, has adopted the RFID-based Mojix Ytem solution to enable, real-time, item-level visibility across all of their supply chains. Mojix claims Centauro can achieve 99.9 percent inventory accuracy, improve supply chain efficiency, reduce safety stock, and improve the customer experience. On average, Centauro manages more than 40 million items per year across all aspects of operations. Using the Mojix solution, Centauro aims to streamline the logistics process, consistently reach its operational goals, and strengthen its customer-focused strategy. "Knowing what I have in stock and what I receive in the store, I control practically my entire supply chain," says Sérgio Silva Jardim Filho, executive manager at Grupo SBF, the operator of Centauro. "We no longer see ourselves as two channels: physical and digital. Omnichannel is already part of the Centauro culture. We are a single company and we want the customers to see that. The Mojix solution has been a key enabler to our omnichannel execution."[43] In another example, Colorado-based transportation management systems provider 10-4 Systems partnered with Anheuser-Busch to add visibility to all of its brewery shipments. "AB recognized an opportunity to improve their customer's product and shipment visibility experience. Our technology was able to help them achieve this goal through centralizing carrier visibility and modernizing the methods in which those events were communicated to their end-users," says 10-4's CEO, Travis Rhyan. According to James Sembrot, Anheuser-Busch's Sr. Director of Logistics Strategy, "We're committed to using technology to enhance our supply chain processes. Using 10-4's platform, we are now tracking all shipments from our U.S. breweries through customer delivery, enabling our logistics operations team to proactively address any transportation issues."[44]

Summary

Supply chain management is the integration of key business processes from initial raw material extraction to the final or end customer, including all intermediate processing, transportation, and storage activities, along with the final sale to the end-product customer and eventually product returns. It requires supply chain members to work together to provide benefits to all stakeholders. Today, the practice of supply chain management is becoming extremely important to reduce costs and improve quality and customer service, with the end objective of improving competitiveness. Many firms are today becoming adept at managing at least some part of their supply chains. Supply chain management is an outgrowth and expansion of lean and Six Sigma activities and has grown in popularity since the 1980s. The foundations of supply chain management can be found in the areas of purchasing, production, logistics, and collaboration between trading partners. Finally, as markets, political forces, technology, and economic conditions change around the world, the practice of supply chain management must also change and grow. This chapter serves as an opening discussion of the topic of supply chain management and describes what the remaining chapters will cover.

Key Terms

big data, 24
bullwhip effect, 12
business process reengineering, 14
cold chain, 08
customer relationship management, 15
demand management, 19
distribution network, 20
enterprise resource planning, 15
enterprise resource planning, 19
ethical and sustainable sourcing, 18
first-tier customers, 07
first-tier suppliers, 07
global supply chains, 22
inventory visibility, 19
lean production system, 19
logistics, 20
material requirements planning, 19
multi-channel fulfillment, 09
operations management, 18
radio frequency identification, 19
reengineering, 14
second-tier customers, 07
second-tier suppliers, 07
Six Sigma quality management, 19
starting conditions, 32
strategic partnerships, 18
supplier certification, 17
supplier evaluation, 17
supplier management, 17
supplier relationship management, 17
supply chain, 06
supply chain analytics, 09
supply chain management, 08
supply chain performance measurement, 23
supply chain process integration, 23
supply chain visibility, 26
supply management, 16
sustainability, 16
third-party logistics providers, 15
third-party logistics services, 20
triple bottom line, 16

Discussion Questions

1. Define the term *supply chain management* in your own words, and list its most important activities.
2. Can a small business like a local sandwich or bicycle shop benefit from practicing supply chain management? What aspects would they most likely concentrate on?
3. Describe and draw a supply chain for a bicycle repair shop, and list the important supply chain members.
4. Can a bicycle repair shop have more than one supply chain? Explain.

5. What is a cold chain? Why did it become so important in 2020?
6. How has the recent global pandemic impacted supply chain management?
7. What roles do collaboration and trust play in the practice of supply chain management?
8. Why don't firms just become more vertically integrated (e.g., buy out suppliers and customers), instead of trying to manage their supply chains?
9. What types of organizations would benefit the most from practicing supply chain management? What sorts of improvements could be expected?
10. What are the benefits of supply chain management?
11. Can nonprofit, educational, or government organizations benefit from supply chain management? How?
12. What does the term, third-tier supplier mean? What about third-tier customer? What about the focal firm? Provide examples.
13. What is the bullwhip effect and what causes it? How would you try to reduce the bullwhip effect?
14. When did the idea and term, supply chain management, first begin to be thought about and discussed? Which two operations management practices became the origin of supply chain management?
15. Do you think supply chain management is simply the latest trend in management thinking and will likely die out in a few years? Why or why not?
16. How has technology impacted supply chain management?
17. What are the four foundation elements of supply chain management? Describe some activities within each element.
18. Is the use of a large number of suppliers a good idea? Why?
19. Do you think the proper way to choose a supplier is to always find the one that will give you the lowest price? When might this not be a good idea?
20. What is supplier management? What are some of the activities of supplier management?
21. What is the difference between supply chain management and logistics?
22. What is demand management, and why is this an important part of supply chain management?
23. What is the difference between and MRP system and an ERP system?
24. What role do information systems play in supply chain management? Give some examples.
25. Briefly describe the terms, lean production, and, Six Sigma systems.
26. What are 3PLs, and what role do they play in SCM?
27. What is logistics? What is the objective of logistics?
28. What is the triple bottom line and how would you describe it for Walmart?
29. What trade-offs must be considered in designing a distribution system?

30. What are the advantages and risks involved with global supply chains?
31. What does process integration mean? Can supply chain management succeed without it? Why, or why not?
32. Should companies require their suppliers to get certified if they are performing well?
33. At what point should a supplier be considered to have a strategic partnership with the buying firm?
34. Why are performance measurement systems important when trying to manage supply chains?
35. Does a global supply chain have more risk than a domestic supply chain? Why?
36. What are big data and data analytics? How might they be used in supply chains?
37. What are some things supply chain members could do to improve sustainability?
38. Describe supply chain visibility, and why supply chain managers like it.

Essay/Project Questions

1. Visit the websites of companies like Walmart, Target, and Home Depot and see if you can find discussions of their supply chain management activities. List information you can find on purchasing/supplier, logistics, information system, inventory management, quality, and customer service issues.
2. Search on the term *supply chain management.* How many hits did you get? Describe five of the websites found in your search.
3. Search the term *bullwhip effect,* and write a paper on the impacts of the bullwhip effect and the companies profiled in the papers you find.
4. Search on the term *supply chain management software applications*, and write a paper about how companies use these to improve their financial performance.
5. Search on the term *green supply chains*, and write a paper regarding the global regulatory status of environmental legislation and how it is impacting supply chain management.

Cases

Supply Chain Management: The Big Picture*

Cyber Logic Systems is a successful regional company in the United States that specializes in cyber security. Because of the dramatic increase in the hacking of business and government databases, Cyber Logic Systems believes this is the moment to expand its operations. Elmer Armstrong, chief executive officer, met with the board of directors and explained his vision for the company. Mr. Armstrong planned to aggressively expand into Europe and South America. The board of directors gave Elmer the go ahead.

Elmer called a meeting of his senior staff and explained his vision to them. He asked what major issues they saw that required immediate resolution before Cyber Logic Systems could

*Written by Rick Bonsall, D. Mgt., McKendree University, Lebanon, IL. The people and institution are fictional and any resemblance to any person or institution is coincidental. This case was prepared solely to provide material for class discussion. The author does not intend to illustrate either effective or ineffective handling of a managerial situation.

proceed with such an aggressive expansion. Rhonda Mendoza, director of operations, said that their current supply chain structure would not be able to support such an expansion. She further stated that the supply chain structure would collapse under the strain, thus endangering their regional business, as well as the expansion. Elmer tasked Rhonda with developing a plan on how to get the supply chain structure robust enough to move forward with the expansion.

Rhonda began analyzing their supply chain management needs by reviewing the four foundation elements—supply, operations, logistics, and integration. As she performed her analysis, Rhonda realized that not all their current suppliers had the capabilities to support Cyber Logic Systems' operations in Europe and South America. Ms. Mendoza decided to perform a detailed supplier evaluation on each supplier. Through this evaluation she determined that some suppliers could easily support European operations, while others were better suited for the South American operations. Furthermore, some suppliers, who were a tremendous asset to Cyber Logic Systems, would only be capable of supporting their current regional business.

Each market area, United States, Europe, and South America, had regulations with differing standards for cyber security. The technical specifications for the systems Cyber Logic Systems would install varied significantly between the three marketplaces. Rhonda decided this could be a considerable problem. Her solution was simple yet elegant, supplier certification. Supplier certification would ensure that the suppliers supporting the specific operational markets would be qualified to meet the particular regulatory requirements.

Although the systems Cyber Logic Systems installed were primarily software, often new hardware was required to support the software. Ms. Mendoza understood that their current distribution network was insufficient. They needed to redesign and build a more self-sustaining distribution network in order to ensure timely product delivery. They truly needed to move from the mindset of a regional distribution system to a global supply chain. This requirement would mean sourcing from suppliers who were close to the customers. When a customer has a cyber security issue, time is the enemy. The new systems must be in place as quickly as possible to avoid further damage to the customer's databases and to enable them to continue operating.

Rhonda believed she had identified the key elements that must be improved before they could move forward with the expansion. The last hurdle was how to guarantee that the three foundation elements, supply, operations, and logistics, worked as one smooth global supply chain and not as disjointed parts. This was the biggest challenge of all. If Cyber Logic Systems didn't solve this issue, the chance of failure was high.

Ms. Mendoza reflected on her studies in operations and supply chain management. The answer to the issue was process integration. She knew that they had a challenge ahead. They must convince each supply chain partner that this supply chain management structure must be part of everyone's strategic planning process. Only then could they ensure that the individual pieces, purchasing, inventory, operations, logistics, quality, etc. would work together as a single well-oiled machine. Ms. Mendoza was ready to outline her plan to Mr. Armstrong and the other members of his senior staff.

Discussion Questions

1. When analyzing the supply chain management foundation element "supply," what are some of the specific issues Cyber Logic Systems must address?
2. When analyzing the supply chain management foundation element "operations," what are some of the specific issues Cyber Logic Systems must address?
3. When analyzing the supply chain management foundation element "logistics," what are some of the specific issues Cyber Logic Systems must address?
4. When working on process integration, what type of issues must a company overcome for true integration to be achieved?

APPENDIX 1.1

The Beer Game

The Beer Game is a popular game played in operations management and supply chain management courses and was developed by MIT in the 1960s.[45] The game simulates the flow of product and information in a simple supply chain consisting of a retailer, a wholesaler, a distributor, and a manufacturer. One person takes the role of each organization in a typical game. The objective is to minimize total supply chain inventory and back-order costs. In this way, a class can be separated into any number of four-person supply chains—each supply chain competing against the others. The game is used to illustrate the bullwhip effect and the importance of timely and accurate communications and information with respect to purchases along the supply chain (in this game, no one is allowed to share any information other than current order quantities, as might be found in unmanaged or unlinked supply chains).

Each supply chain participant follows the same set of activities:

1. The participant fills customer orders from current inventory and creates back orders if demand cannot be met.
2. The participant forecasts customer demand and then orders beer from the supplier (or schedules beer production if the participant is the manufacturer), which then takes several weeks to be delivered.
3. The participant attempts to manage inventories in order to minimize back-order costs (stockouts) and inventory carrying costs.

Figure A1.1 illustrates the beer supply chain, showing the transportation and information delays. There is no product transportation or order delay between the retailer and the end customers. For the other supply chain members, there is a one-week delay between

Figure A1.1 The Beer Game Supply Chain