SIXTH EDITION

SUPPLY CHAIN MANAGEMENT

STRATEGY, PLANNING, AND OPERATION

Sunil Chopra | Peter Meindl
Dharam Vir Kalra

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Sixth Edition

Supply Chain Management

Strategy, Planning, and Operation

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PEARSON
Delhi • Chennai

ISBN: 978-93-325-4823-7
eISBN: 978-93-325-8267-5

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Dedication

I would like to thank my colleagues at Kellogg for all I have learned from them about logistics and supply chain management. I am grateful for the love and encouragement that my parents, Krishan and Pushpa, and sisters, Sudha and Swati, have always provided during every endeavor in my life. I thank my children, Ravi and Rajiv, for the joy they have brought me. Finally, none of this would have been possible without the constant love, caring, and support of my wife, Maria Cristina.

—Sunil Chopra

I would like to thank three mentors—Sunil Chopra, Hau Lee, and Gerry Lieberman—who have taught me a great deal. Thank you also to my parents and sister for their love, and to my sons, Jamie and Eric, for making me smile and teaching me what life is truly all about. Most important, I thank my wife, Sarah, who makes life wonderful and whom I love with all my heart.

—Peter Meindl

I would like to dedicate this work to my dear wife Sunil and my adorable daughters, Ruma and Anju, who have been a constant source of support and encouragement. I love them dearly.

—Dharam Vir Kalra

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ABOUT THE AUTHORS

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Sunil Chopra is the IBM Distinguished Professor of Operations Management and Information Systems at the Kellogg School of Management. He has served as the interim dean and senior associate dean for curriculum and teaching, and the codirector of the MMM program, a joint dual-degree program between the Kellogg School of Management and the McCormick School of Engineering at Northwestern University. He has a PhD in operations research from SUNY at Stony Brook. Prior to joining Kellogg, he taught at New York University and spent a year at IBM Research.

Professor Chopra's research and teaching interests are in supply chain and logistics management, operations management, and the design of telecommunication networks. He has won several teaching awards at the MBA and Executive programs of Kellogg. He has authored more than 40 papers and two books.

He has been a department editor for *Management Science* and an associate editor for *Manufacturing & Service Operations Management*, *Operations Research,* and *Decision Sciences Journal*. His recent research has focused on understanding supply chain risk and devising effective risk mitigation strategies. He has also consulted for several firms in the area of supply chain and operations management.

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Peter Meindl is a portfolio manager with Kepos Capital in New York. Previously, he was a research officer with Barclays Global Investors, a consultant with the Boston Consulting Group and Mercer Management Consulting, and the director of strategy with i2 Technologies. He holds PhD, MS, BS, and BA degrees from Stanford, and an MBA from the Kellogg School of Management at Northwestern.

DHARAM VIR KALRA

Dharam Vir Kalra retired from the Indian Army as Lieutenant General in 1993. During his service, he held various prestigious positions in the field of logistics. He was Major General Operational Logistics, and Commandant and Principal in College of Materials Management, Jabalpur. He then rose to become Director General Ordnance Services.

General Kalra obtained his M.Sc. in Defence Studies from Madras University. He also obtained Master's degrees in Political Science and Business Administration (Materials) from Jabalpur University. A graduate of the Defence Services Staff College, he also attended the Long Defence Management Course and the National Defence College Course. He completed a specialist course at the Royal Military College of Science, Shrivenham (UK). He has recently obtained an M.Phil Degree from the University of Madras.

Apart from his military service, General Kalra has been Dean, Faculty of Management, Jabalpur University; Consultant, Ministry of Defence, Government of India; Consultant, Comptroller and Auditor General of India; and Member, National Audit Advisory Board. He is a fellow of the Chartered Institute of Logistics and Transport (UK) and Indian Management Association, and also a Member Board of Studies of Indian Institute of Materials Management.

Currently, he is a guest faculty for Supply Chain Management and International Logistics at the Indian Institute of Management Rohtak.

General Kalra was decorated with an Ati Vishisht Seva Medal by the President of India in 1988 and with Param Vishisht Seva Medal in 1992 for services of an exceptional order.

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Part III Planning and Coordinating Demand and Supply in a Supply Chain

Part VII Online Chapter

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PREFACE

This book is targeted toward an academic as well as a practitioner audience. On the academic side, it should be appropriate for MBA students, engineering master's students, and senior undergraduate students interested in supply chain management and logistics. It should also serve as a suitable reference for both concepts as well as providing a methodology for practitioners in consulting and industry.

NEW TO THIS EDITION

The sixth edition has focused on allowing students to learn more as they study with the book. We have tightened the link between examples in the book and associated spreadsheets and have added exercises and cases in several chapters. We have also added changes based on specific reviewer feedback that we believe significantly improve the book and its use by faculty and students.

- We have added several new mini-cases throughout the book. New cases appear in Chapters 2, 8, 9, 11, 13, 14, and 16. Information in other cases has been updated to be current.
- In Chapter 11, we have added several new exercises as well as a mini-case.
- In Chapter 12, we have added several new exercises.
- In Chapter 13, we have tried to make the flow of material easier to follow. Given the more advanced concepts, we have tightened the linkage to the associated spreadsheets. We have also added a mini-case.
- In Chapter 14, we have added discussion of the Mumbai *dabbawalas*, a responsive distribution network. We have tightened the linkage of examples to associated spreadsheets and added a couple of mini-cases.
- Chapter 15 has had a very significant revision, with an enhanced discussion of successful third parties as well as the impact of incentives and the sharing of risk and reward in the supply chain.
- Chapter 16 has a new mini-case.
- Information Technology in a Supply Chain has been updated and placed online at www.pearsoned.co.in/SunilChopra.
- Chapter 17, on sustainability, has been further developed, with a new section related to the pricing of sustainability.
- We have continued to add current examples throughout the book, with a particular focus on bringing in more global examples.

The goal of this class was not only to cover high-level supply chain strategy and concepts, but also to give students a solid understanding of the analytical tools necessary to solve supply chain problems. With this class goal in mind, our objective was to create a book that would develop an understanding of the following key areas and their interrelationships:

- The strategic role of a supply chain
- The key strategic drivers of supply chain performance
- Analytic methodologies for supply chain analysis

Our first objective in this book is for the reader to learn the strategic importance of good supply chain design, planning, and operation for every firm. The reader will be able to understand how good supply chain management can be a competitive advantage, whereas weaknesses in the supply chain can hurt the performance of a firm. We use many examples to illustrate this idea and develop a framework for supply chain strategy.

Within the strategic framework, we identify facilities, inventory, transportation, information, sourcing, and pricing as the key drivers of supply chain performance. Our second goal in the book is to convey how these drivers may be used on conceptual and practical levels during supply chain design, planning, and operation to improve performance. We have presented a variety of cases that can be used to illustrate how a company uses various drivers to improve supply chain performance. For each driver of supply chain performance, our goal is to provide readers with practical managerial levers and concepts that may be used to improve supply chain performance.

Using these managerial levers requires knowledge of analytic methodologies for supply chain analysis. Our third goal is to give the reader an understanding of these methodologies. Every methodological discussion is illustrated with its application in Excel. In this discussion, we also stress the managerial context in which the methodology is used and the managerial levers for improvement that it supports.

The strategic frameworks and concepts discussed in the book are tied together through a variety of examples that show how a combination of concepts is needed to achieve significant increases in performance.

ONLINE SUPPLEMENTS

Instructors can easily register to gain access to a variety of instructor resources available with this text in downloadable format.

The following supplements are available with this text:

- Instructor's Solutions Manual
- Test Bank
- TestGen® Computerized Test Bank
- PowerPoint Presentations

Chapter A: Information Technology in a Supply Chain is available online for students.

Sunil Chopra
Kellogg School of Management, Northwestern University

Peter Meindl
Kepos Capital

This edition of the book, retains as its principal focus , the linking of general theory of supply chain management and the practical experiences of businesses in the developed world with the ground realities in India, one of the world's fastest growing economies. This has helped produce a text with lessons of equal value for students of the subject across the globe.

The march of international trade towards ever-increasing spatial dispersion at both the supply and the demand ends has been inexorable. In the process, it has embraced not only economies at different levels of development but also diverse sociopolitical environments. This makes it imperative for the study of supply chain management to take a note of the challenges that such diversities throw up, and also the solutions that are emerging under the relentless competitive pressures to which present-day businesses are exposed.

The digital revolution is perhaps the most challenging and game-changing development affecting the business world. It has dawned on India at a time when its traditional supply chains are in a flux. This has added a new dimension to the transformation process, making it a fit case for lessons in the ongoing evolutionary process. An attempt has been made in this edition of the book to document the impact of this revolution as it unfolds.

Rooted in the Indian ethos, the case studies and examples added to this book present a different perspective, thus making the text multidimensional and enhancing its practical utility for a wider readership.

Dharam Vir Kalra
Guest Faculty
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ACKNOWLEDGMENTS

We would like to thank the many people who helped us throughout this process. We thank the reviewers whose suggestions significantly improved the book, including: Steven Brown, Arizona State University; Ming Chen, California State University, Long Beach; Sameer Kumar, University of Saint Thomas; Frank Montabon, Iowa State University; Brian Sauser, University of North Texas; and Paul Venderspek, Colorado State University.

We are grateful to the students at the Kellogg School of Management who suffered through typo-ridden drafts of earlier versions of the book. We would also like to thank our editor, Dan Tylman, and the staff at Pearson, including Liz Napolitano, senior production project manager; Anne Fahlgren, executive product marketing manager; Claudia Fernandes, program manager; and Linda Albelli, editorial assistant, for their efforts with the book. Finally, we would like to thank you, our readers, for reading and using this book. We hope it contributes to all your efforts to improve the performance of companies and supply chains throughout the world. We would be pleased to hear your comments and suggestions for future editions of this text.

Sunil Chopra
Kellogg School of Management, Northwestern University

Peter Meindl
Kepos Capital

I am grateful to all the companies that have permitted me to draw upon and quote their experiences. Some of the notable contributions have come from M/S Mercurio Pallia, M/S Fresh and Healthy, and M/S Kale Logistics. I would like to thank the authors who have graciously allowed me to incorporate their case studies and research papers in my adaptation. I also gratefully acknowledge the useful inputs provided to me by Mr. Enamul Haque and Naveen Kumar. I extend my gratitude to Professor Vivek Kumar for his encouragement and support throughout the production of this work and Dr. Hema Yadav for her original contribution My special thanks are due to Mr. N K Chaudhary of Jaipur Rugs who has built a remarkable business model that reflects the Indian socio-economic realities. I also want to acknowledge the contribution of Pricewaterhouse Coopers for allowing me to reproduce the Executive Summary of their very well-researched report which provides a fitting finale to this edition of the book.

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CHAPTER

1

Understanding the Supply Chain

LEARNING OBJECTIVES

After reading this chapter, you will be able to

1. Understand the nature of supply chains and trace the historical perspectives leading to their development and growth.
2. Discuss the goal of a supply chain and explain the impact of supply chain decisions on the success of a firm.
3. Identify the three key supply chain decision phases and explain the significance of each one.
4. Describe the cycle and push/pull views of a supply chain.
5. Classify the supply chain macro processes in a firm.

In this chapter, we provide a conceptual understanding of what a supply chain is and the various issues that need to be considered when designing, planning, or operating a supply chain besides tracing its historical background. We discuss the significance of supply chain decisions and supply chain performances for the success of a firm. We also provide several examples from different industries to emphasize the variety of supply chain issues that companies need to consider at the strategic, planning, and operational levels.

1.1 WHAT IS A SUPPLY CHAIN?

A *supply chain* consists of all parties involved, directly or indirectly, in fulfilling a customer request. The supply chain includes not only the manufacturer and suppliers, but also transporters, warehouses, retailers, and even customers themselves. Within each organization, such as a manufacturer, the supply chain includes all functions involved in receiving and filling a customer request. These functions include, but are not limited to, new product development, marketing, operations, distribution, finance, and customer service.

Consider a customer walking into a Walmart store to purchase detergent. The supply chain begins with the customer and his or her need for detergent. The next stage of this supply chain is the Walmart retail store that the customer visits. Walmart stocks its shelves using inventory that

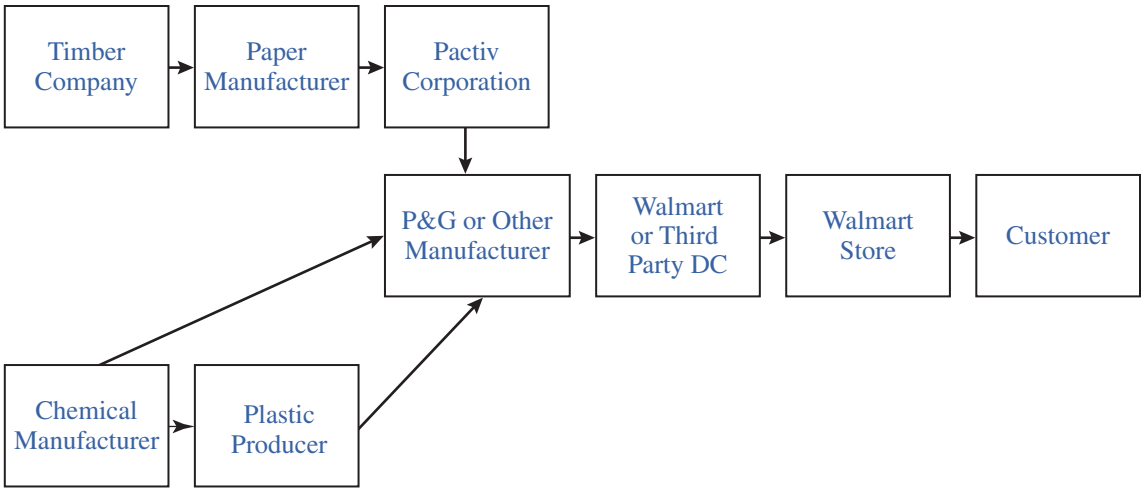

FIGURE 1-1 Stages of a Detergent Supply Chain

may have been supplied from a finished-goods warehouse or a distributor using trucks supplied by a third party. The distributor, in turn, is stocked by the manufacturer (say, Procter & Gamble [P&G] in this case). The P&G manufacturing plant receives raw material from a variety of suppliers, which may themselves have been supplied by lower-tier suppliers. For example, packaging material may come from Pactiv Corporation, whereas Pactiv receives raw materials to manufacture the packaging from other suppliers. This supply chain is illustrated in Figure 1-1, with the arrows corresponding to the direction of physical product flow.

A supply chain is dynamic and involves the constant flow of information, product, and funds among different stages. In our example, Walmart provides the product, as well as pricing and availability information, to the customer. The customer transfers funds to Walmart. Walmart conveys point-of-sales data and replenishment orders to the warehouse or distributor, which transfers the replenishment order via trucks back to the store. Walmart transfers funds to the distributor after the replenishment. The distributor also provides pricing information and sends delivery schedules to Walmart. Walmart may send back packaging material to be recycled. Similar information, material, and fund flows take place across the entire supply chain.

In another example, when a customer makes a purchase online from Amazon, the supply chain includes, among others, the customer, Amazon's website, the Amazon warehouse, and all of Amazon's suppliers and their suppliers. The website provides the customer with information regarding pricing, product variety, and product availability. After making a product choice, the customer enters the order information and pays for the product. The customer may later return to the website to check the status of the order. Stages further up the supply chain use customer order information to fill the request. That process involves an additional flow of information, product, and funds among various stages of the supply chain.

These examples illustrate that the customer is an integral part of the supply chain. In fact, the primary purpose of any supply chain is to satisfy customer needs and, in the process, generate profit for itself. The term *supply chain* conjures up images of product or supply moving from suppliers to manufacturers to distributors to retailers to customers along a chain. This is certainly part of the supply chain, but it is also important to visualize information, funds, and product flows along both directions of this chain. The term *supply chain* may also imply that only one player is involved at each stage. In reality, a manufacturer may receive material from several suppliers and then supply several distributors. Thus, most *supply chains* are actually networks. It may be more accurate to use the term *supply network* or *supply web* to describe the structure of most supply chains, as shown in Figure 1-2.

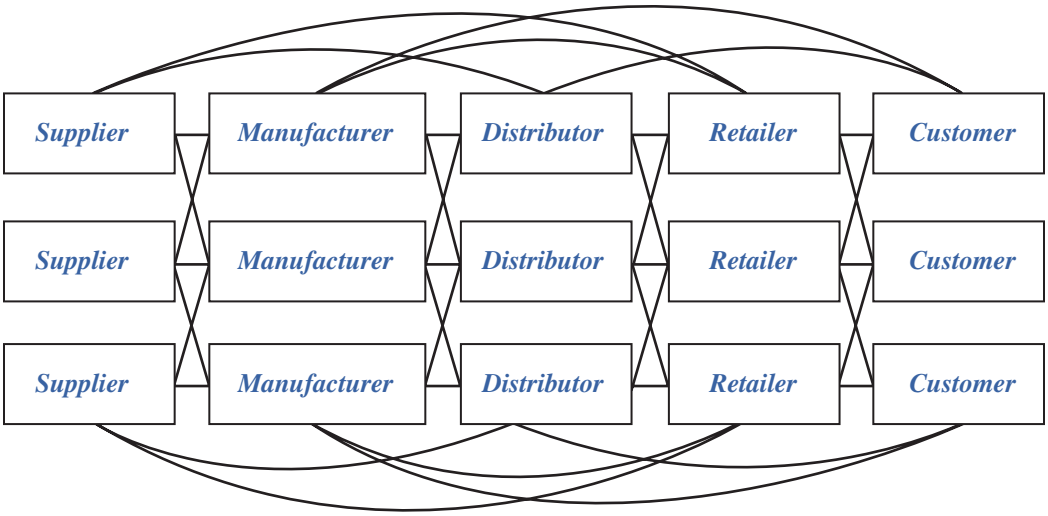

FIGURE 1-2 Supply Chain Stages

A typical supply chain may involve a variety of stages, including the following:

- Customers
- Retailers
- Wholesalers/distributors
- Manufacturers
- Component/raw material suppliers

Each stage in a supply chain is connected through the flow of products, information, and funds. These flows often occur in both directions and may be managed by one of the stages or an intermediary. Each stage in Figure 1-2 need not be present in a supply chain. As discussed in Chapter 4, the appropriate design of the supply chain depends on both the customer's needs and the roles played by the stages involved. For example, Dell has two supply chain structures that it uses to serve its customers. For its server business, Dell builds to order; that is, a customer order initiates manufacturing at Dell. For the sale of servers, Dell does not have a separate retailer, distributor, or wholesaler in the supply chain. Dell also sells consumer products such as PCs and tablets through retailers such as Walmart, which carry Dell products in inventory. This supply chain thus contains an extra stage (the retailer), compared with the direct sales model used by Dell for servers. In the case of other retail stores, the supply chain may also contain a wholesaler or distributor between the store and the manufacturer.

1.2 HISTORICAL PERSPECTIVE

Supply chain management, as we understand it today, represents the confluence of at least three main streams of knowledge and practical experience of the business world, spanning almost 60 years. The fusion of these streams into one powerful movement, *supply chain management*, that is sweeping across the present-day industrial world has been brought about by intense competition characteristic of contemporary markets. It is, therefore, appropriate that a discussion on supply chain management is preceded by a brief understanding of contributing disciplines.

These streams include business processes and managerial practices, which have evolved somewhat unconnectedly, if not entirely independently, in the fields of operations management,

industrial engineering, and physical distribution. In the course of their development, these processes and practices have absorbed several allied and subsidiary functions as well as activities, and adopted various successful business innovations.

The three principal streams are:

- Sourcing, procurement, and supply management
- Materials management
- Logistics and distribution

Sourcing, Procurement, and Supply Management

Commonly, though quite mistakenly referred to as *supply chain management*, these functions arose in the area of purchasing which came to occupy a predominant position in businesses because of their impact on cash flow and contribution towards the company profitability. Businesses realized that efforts required to increase profits through increasing sales were far greater than those involved in generating equivalent returns through reduction in procurement prices.[1] Major purchases came to be handled by the top management who in turn depended on purchase specialists for advice. Economic buying was seen to be a strategic function, with major contribution to bottom-line. The responsibilities of the purchase function, however, ended with the procurement and a more mundane function of materials management took over. We may, thus, regard it as the set of activities, functions, and processes concerned with economic procurement and inflow of inputs[2] into the enterprise and an efficient control over flow of funds out of the company.

In the context of supply chain management, these processes fall under *sourcing, supply side management, inbound logistics*, and *supplier relationship management* together with materials, information, and cash flows interconnected with each other.

Materials Management

Classic materials management included the functions of *forecasting, inventory management, stores management, warehousing, stock keeping*, and *scheduling* till it came to include *production planning* and *production control*, to evolve into *extended materials management*. With subsequent inclusion of *order processing* in its fold, it came to be known as *integrated materials management*. Since materials constitute almost 60 per cent of the cost of most manufactured products,[3] at least in the Indian context, the importance of efficient management of materials came to be recognized by businesses during the 1970s as the route to cost reduction and thereby to profitability. The merger of purchasing, which presented opportunities for reduction in the cost of material inputs, with materials management, thus became an obvious business compulsion. Some of the most innovative techniques focusing on reducing total cost of inventories to the lowest possible levels without compromising on service levels, owe their origin and growth to this stream of knowledge and experience. In relation to supply chain management, it may be regarded as the management of flow of material into, through, and out of an enterprise, adding in the process, value for the customers both internal and external to the organization.

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[1] In food industry, for instance, where logistics costs are of the order of 60 percent, a company would need to generate additional sales to the tune of ₹4 to derive the same profits as it would, if it manages to reduce the procurement price by Re. 1, presuming that it is working on a net profit margin of 10 percent.

[2] In its classic interpretation, purchasing function does not cover procurement of capital, personnel, data, and proprietary rights such as licenses and patents. Integrated Materials Management: Definitions, Functions, and Activities. Robert Fieten. Published by German Federal Association of Materials Management.

[3] With possible exception of some electronic goods incorporating innovative frontier technologies.

Logistics and Distribution

Derived from military parlance,[4] wherein it covered all functions related to movement and maintenance of armies, the logistics function in its business application came to be recognized as time- and space-related placement of goods to provide improved customer service. According to the Council of Logistics Management, it is that part of the supply chain management process that plans, implements, and controls the efficient, effective, forward, and reverse flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet customers' requirements. The distribution function, which Peter Drucker identified as the "Today's Frontier",[5] is, in that sense, synonymous with Logistics.

Since transportation, which is the backbone of logistics, accounts for up to 50 per cent of total logistics costs, the efficient management of this function became an important preoccupation of management leading to the development of transportation-related practices involving all modes, in general and multimodal transport, in particular as evidenced by revolutionary development and exponential growth of containerized cargo handling and movement worldwide. Realization, on the part of businesses, that there was an obvious trade-off between transportation choices and inventory policies led to integration, and *logistics* emerged as a cross-functional approach that integrates all materials, functions of purchasing, inventory management, production control, inbound traffic, warehousing, and store keeping as well as incoming quality control with the objective of ensuring efficient operations. In this shape, business logistics may be regarded as the early *avatar* of supply chain management.

In the context of supply chain management, logistics would fall at both ends, that is, inbound logistics and outbound logistics. Interestingly, the intracompany flow of materials is sometimes referred to as manufacturing logistics, giving this discipline a breadth of reach over end-to-end movement of materials at all stages of industrial and business endeavor in delivering value to customer. Supply chain management has thus emerged as an integrative philosophy and a strategic-level business practice which encompasses flow of materials, funds, and information throughout the network that ultimately delivers value to the customer.

1.3 THE OBJECTIVE OF A SUPPLY CHAIN

The objective of every supply chain should be to maximize the overall *value* generated. The value (also known as *supply chain surplus*) a supply chain generates is the difference between what the value of the final product is to the customer and the costs the supply chain incurs in filling the customer's request.

$$\textit{Supply Chain Surplus} = \textit{Customer Value} - \textit{Supply Chain Cost}$$

The value of the final product may vary for each customer and can be estimated by the maximum amount the customer is willing to pay for it. The difference between the value of the product and its price remains with the customer as *consumer surplus*. The amount of consumer surplus, a concept expounded in welfare economics, has always been difficult to determine precisely in monetary terms as it is not clearly measurable as to how much a customer was eventually willing to pay for a product or service vis-a-vis what he actually paid. The estimates are subjective and would vary from person to person and situation to situation. A person in dire need of a product or service in an extreme situation may be willing to pay any price if he has no other alternative. A man stranded in a desert without water may be willing to give away his entire estate for a glass of water.

However, there is one area in which this figure does become measurable and that is through the difference in prices between branded and generic drugs which provide equal relief or deliver

[4] First used by Henri Jomini during mid 19th Century to cover the art of moving and marinating armies.

[5] "Physical distribution is today's frontier in business. It is one area where managerial results of great magnitude can be achieved and is still largely unexplored." Peter Drucker.

equal value to the patient. As the price differential between the patented drugs and their generic versions is substantial, and as both ostensibly provide equal value to the patient, we can measure, fairly precisely, the difference in costs of the two and regard it as consumer surplus.

Naturally, the higher the consumer surplus the more attractive the product or service. This is what is accounting for the exponential growth in Indian Generic Drugs industry.

We will cover this phenomenon through as case study at the end of the chapter.

The rest of the supply chain surplus becomes *supply chain profitability*, the difference between the revenue generated from the customer and the overall cost across the supply chain. For example, a customer purchasing a wireless router from Best Buy pays $60, which represents the revenue the supply chain receives. Customers who purchase the router clearly value it at or above $60. Thus, part of the supply chain surplus is left with the customer as consumer surplus. The rest stays with the supply chain as profit. Best Buy and other stages of the supply chain incur costs to convey information, produce components, store them, transport them, transfer funds, and so on. The difference between the $60 that the customer paid and the sum of all costs incurred by the supply chain to produce and distribute the router represents the supply chain profitability. Supply chain profitability is the total profit to be shared across all supply chain stages and intermediaries. The higher the supply chain profitability, the more successful is the supply chain. For most profit-making supply chains, the supply chain surplus will be strongly correlated with profits. Supply chain success should be measured in terms of supply chain profitability and not in terms of the profits at an individual stage. (In subsequent chapters, we see that a focus on profitability at individual stages may lead to a reduction in overall supply chain profits.) A focus on growing the supply chain surplus pushes all members of the supply chain toward growing the size of the overall pie.

Having defined the success of a supply chain in terms of supply chain profitability, the next logical step is to look for sources of value, revenue, and cost. For any supply chain, there is only one source of revenue: the customer. The value obtained by a customer purchasing detergent at Wal-Mart depends upon several factors, including the functionality of the detergent, how far the customer has to travel to Wal-Mart, and the likelihood of finding the detergent in stock. The customer is the only one providing positive cash flow for the Wal-Mart supply chain. All other cash flows are simply fund exchanges that occur within the supply chain, given that different stages have different owners. When Wal-Mart pays its supplier, it is taking a portion of the funds the customer provides and passing that money on to the supplier. All flows of information, product, or funds generate costs within the supply chain. Thus, the appropriate management of these flows is a key to supply chain success. Effective *supply chain management* involves the management of supply chain assets and product, information, and fund flows to maximize total supply chain surplus. A growth in supply chain surplus increases the size of the total pie, allowing contributing members of the supply chain to benefit.

In this book, we have a strong focus on analyzing all supply chain decisions in terms of their impact on the supply chain surplus. These decisions and their impact can vary for a wide variety of reasons. For instance, consider the difference in the supply chain structure for fastmoving consumer goods observed in the United States and India. U.S. distributors play a much smaller role in this supply chain compared to their Indian counterparts. We argue that the difference in supply chain structure can be explained by the impact a distributor has on the supply chain surplus in the two countries.

Retailing in the United States is largely consolidated, with large chains buying consumer goods from most manufacturers. This consolidation gives retailers sufficient scale that the introduction of an intermediary such as a distributor does little to reduce costs and may actually increase costs because of an additional transaction.

In contrast, India has millions of small retail outlets. The small size of Indian retail outlets limits the amount of inventory they can hold, thus requiring frequent replenishment—an order

can be compared with the weekly grocery shopping for a family in the United States. The only way for a manufacturer to keep transportation costs low is to bring full truckloads of product close to the market and then distribute locally using "milk runs" with smaller vehicles. The presence of an intermediary who can receive a full truckload shipment, break bulk, and then make smaller deliveries to the retailers is crucial if transportation costs are to be kept low. Most Indian distributors are one-stop shops, stocking everything from cooking oil to soaps and detergents made by a variety of manufacturers. Besides the convenience provided by one-stop shopping, distributors in India are also able to reduce transportation costs for outbound delivery to the retailer by aggregating products across multiple manufacturers during the delivery runs. Distributors in India also handle collections, because their cost of collection is significantly lower than that of each manufacturer collecting from retailers on its own would be. Thus, the important role of distributors in India can be explained by the growth in supply chain surplus that results from their presence.

Most traditional supply chains presently existing in India, operate what approximates to a multi echelon distribution model in which supplies move from the suppliers and manufacturers through a series of large and small stockholders and intermediaries to reach the customers right down to remote villages in which most of the Indian population resides and which are not always well connected. National-, regional-, state-, district-, and local-level stockiest constitute links in the chain replenishing and getting replenished, normally through a wide variety of surface transportation in an interconnected network, creating in the process inventories at each stage. The dynamics of such supply chains differ quite considerably from the IT-enabled supply chains serving well-developed and well-connected urban markets through organized retailing. The supply chain surplus argument implies that as retailing in India begins to consolidate, the role of distributors will diminish.

1.4 THE IMPORTANCE OF SUPPLY CHAIN DECISIONS

There is a close connection between the design and management of supply chain flows (product, information, and funds) and the success of a supply chain. Walmart, Amazon, and Seven-Eleven Japan are examples of companies that have built their success on superior design, planning, and operation of their supply chain. In contrast, the failure of many online businesses, such as Webvan, can be attributed to weaknesses in their supply chain design and planning. The rise and subsequent fall of the bookstore chain Borders illustrates how a failure to adapt its supply chain to a changing environment and customer expectations hurt its performance. Dell Computer is another example of a company that had to revise its supply chain design in response to changing technology and customer needs. We discuss these examples later in this section.

Walmart has been a leader at using supply chain design, planning, and operation to achieve success. From its beginning, the company invested heavily in transportation and information infrastructure to facilitate the effective flow of goods and information. Walmart designed its supply chain with clusters of stores around distribution centers to facilitate frequent replenishment at its retail stores in a cost-effective manner. Frequent replenishment allows stores to match supply and demand more effectively than the competition. Walmart has been a leader in sharing information and collaborating with suppliers to bring down costs and improve product availability. The results are impressive. In its 2013 annual report, the company reported a net income of about $17 billion on revenues of about $469 billion. These are dramatic results for a company that reached annual sales of only $1 billion in 1980. The growth in sales represents an annual compounded growth rate of more than 20 percent.

Seven-Eleven Japan is another example of a company that has used excellent supply chain design, planning, and operation to drive growth and profitability. It has used a very responsive

replenishment system along with an outstanding information system to ensure that products are available when and where customers need them. Its responsiveness allows it to change the merchandising mix at each store by time of day to precisely match customer demand. As a result, the company has grown from sales of 1 billion yen in 1974 to almost 1.9 trillion yen in 2013, with profits in 2013 totaling 222 billion yen.

The failure of many online businesses, such as Webvan and Kozmo, can be attributed to their inability to design appropriate supply chains or manage supply chain flows effectively. Webvan designed a supply chain with large warehouses in several major cities in the United States, from which groceries were delivered to customers' homes. This supply chain design could not compete with traditional supermarket supply chains in terms of cost. Traditional supermarket chains bring product to a supermarket close to the consumer using full truckloads, resulting in very low transportation costs. They turn their inventory relatively quickly and let the customer perform most of the picking activity in the store. In contrast, Webvan turned its inventory marginally faster than supermarkets but incurred much higher transportation costs for home delivery, as well as high labor costs to pick customer orders. The result was a company that folded in 2001, within two years of a very successful initial public offering.

As the experience of Borders illustrates, a failure to adapt supply chains to a changing environment can significantly hurt performance. Borders, along with Barnes & Noble, dominated the selling of books and music in the 1990s by implementing the superstore concept. Compared with small local bookstores that dominated the industry prior to that, Borders was able to offer greater variety (about 100,000 titles at superstores, relative to fewer than 10,000 titles at a local bookstore) to customers at a lower cost by aggregating operations in large stores. This allowed the company to achieve higher inventory turns than local bookstores with lower operating costs per dollar of sales. In 2004, Borders achieved sales of almost $4 billion, with profits of $132 million. Its model, however, was already under attack with the growth of Amazon, which offered much greater variety than Borders at lower cost by selling online and stocking its inventories in a few distribution centers. Borders' inability to adapt its supply chain to compete with Amazon led to a rapid decline. By 2009, sales had dropped to $2.8 billion; the company lost $109 million that year.

Dell is another example of a company that enjoyed tremendous success based on its supply chain design, planning, and operation but then had to adapt its supply chain in response to shifts in technology and customer expectations. Between 1993 and 2006, Dell experienced unprecedented growth of both revenue and profits by structuring a supply chain that provided customers with customized PCs quickly and at reasonable cost. By 2006, Dell had a net income of more than $3.5 billion on revenues of just over $56 billion. This success was based on two key supply chain features that supported rapid, low-cost customization. The first was Dell's decision to sell directly to the end customer, bypassing distributors and retailers. The second key aspect of Dell's supply chain was the centralization of manufacturing and inventories in a few locations where final assembly was postponed until the customer order arrived. As a result, Dell was able to provide a large variety of PC configurations while keeping low levels of component inventories

Key Point

Supply chain design, planning, and operation decisions play a significant role in the success or failure of a firm. To stay competitive, supply chains must adapt to changing technology and customer expectations.

In spite of this tremendous success, the changing marketplace presented some new challenges for Dell. Whereas Dell's supply chain was well suited for highly customized PCs, the market shifted to lower levels of customization. Given the growing power of hardware,

customers were satisfied with a few model types. Dell reacted by adjusting its supply chain with regard to both direct selling and building to order. The company started selling its PCs through retail chains such as Walmart in the United States and GOME in China. It also outsourced a large fraction of its assembly to low-cost locations, effectively building to stock rather than to customer order. Unlike Borders, Dell is making a significant effort to adapt its supply chain to changing times. It remains to be seen whether these changes will improve Dell's performance.

In the next section, we categorize supply chain decision phases based on the frequency with which they are made and the time frame they take into account.

1.5 DECISION PHASES IN A SUPPLY CHAIN

Successful supply chain management requires many decisions relating to the flow of information, product, and funds. Each decision should be made to raise the supply chain surplus. These decisions fall into three categories or phases, depending on the frequency of each decision and the time frame during which a decision phase has an impact. As a result, each category of decisions must consider uncertainty over the decision horizon.

1. ***Supply chain strategy or design:*** During this phase, a company decides how to structure the supply chain over the next several years. It decides what the chain's configuration will be, how resources will be allocated, and what processes each stage will perform. Strategic decisions made by companies include whether to outsource or perform a supply chain function in-house, the location and capacities of production and warehousing facilities, the products to be manufactured or stored at various locations, the modes of transportation to be made available along different shipping legs, and the type of information system to be used. PepsiCo Inc.'s decision in 2009 to purchase two of its largest bottlers is a supply chain design or strategic decision. A firm must ensure that the supply chain configuration supports its strategic objectives and increases the supply chain surplus during this phase. As the PepsiCo CEO announced in a news release on August 4, "while the existing model has served the system very well, the fully integrated beverage business will enable us to bring innovative products and packages to market faster, streamline our manufacturing and distribution systems and react more quickly to changes in the marketplace." Supply chain design decisions are typically made for the long term (a matter of years) and are expensive to alter on short notice. Consequently, when companies make these decisions, they must take into account uncertainty in anticipated market conditions over the following few years.

It is nevertheless important that companies continually revisit their supply chain strategies and make necessary mid-course corrections to realign themselves with the changing market conditions, technological development, and consumer preferences. This is particularly important in case of countries where the adoption of IT tools and emergence of e-commerce are impacting the traditional supply chains, and those that are in the process of moving into the organised sector, equally. In this context, developments in the Indian Retail industry where both *kiranas* (traditional grocery stores) and shopping malls are being impacted by the growing consumer preference for online shopping, hold some useful lessons. Shopping malls, which were threatening the traditional kiranas are now themselves being threatened by the 'e-tailers' as seen from the fact that the footfalls in the brick and mortar malls have dropped considerably. This has resulted in a large number of malls in metropolitan cities to close down and many others to reshape themselves into office spaces for alternative uses. Reliance Retail and Reliance Fresh Direct are both aggressively promoting 'e-tailing' and launching their own E commerce portals to create both an online and offline presence. *Kiranas* too are adopting IT tools to provide more responsive customer service. Some of the larger 'e-tailers' are considering taking the local *kiranas* under their wings and use them for better performance and last