




SECOND EDITION

# SUPPLY CHAIN MANAGEMENT

## TEXT AND CASES



JANAT SHAH




ALWAYS LEARNING

PEARSON

# Supply Chain Management

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## TEXT AND CASES

SECOND EDITION

**Janat Shah**

*Indian Institute of Management Udaipur*

PEARSON

Delhi • Chennai

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*To*
*my parents,*
*Ghanshyambhai and Padmaben,*
*my wife,*
*Seema,*
*my daughter,*
*Riddhi,*
*and*
*her cousins,*
*Medha, Stuti, Niket, Rishwa and Yashwi*

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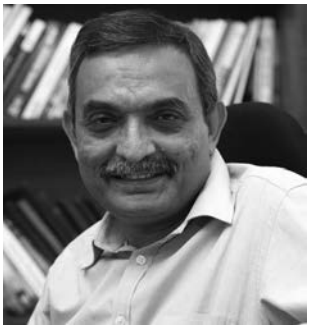
# ABOUT THE AUTHOR



Janat Shah, a mechanical engineer from the Indian Institute of Technology Mumbai, held several middle- and senior-management positions before returning to academia in 1989. A Fellow in Management from the Indian Institute of Management Ahmedabad, Professor Shah has worked for a short duration at the Institute of Rural Management, Anand, before moving to the Indian Institute of Management Bangalore as Assistant Professor in 1991. As visiting scholar at the Sloan School of Management, MIT, in 1997, he has worked on areas related to supply chain management. He was also a visiting faculty at the Logistics Institute, National University of Singapore in 2001.

Currently, Janat Shah is a professor of operations management at the Indian Institute of Management Udaipur, and holds the position of Honorary Professor at the Nottingham University Business School in the operations management division.

Professor Shah conducts management education programmes for executives in a number of companies, and offers consultancy services in the area of design and development of decision-support systems for supply chain management. He is a consultant to companies such as Tata Chemicals Limited, Mahindra & Mahindra, Infosys, Marico, Tata Teleservices, IBM, Aditya Birla Group, Yokogawa Blue Star Limited, and Ingersoll Rand. He has edited two volumes, *Logistics and Global Outsourcing* (2004) and *Operational Research in the Indian Steel Industry* (1993), besides contributing chapters to numerous books on supply chain management. In addition, he is also on the editorial board of international journals such as *International Journal of Procurement Management*, *International Journal of Product Lifecycle Management* and *International Journal of Logistics: Research and Applications*, and has refereed diverse journal articles and proceedings.

Professor Shah, voted the best teacher by the MBA class of 1999, has won numerous teaching awards. Significant among them is the IBM faculty award that was awarded to Professor Shah and his team for two successive years, 2005 and 2006, for their work on human resource supply chain management.

His research interests lie in the fields of supply chain management, and design of manufacturing systems.

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# PREFACE

I have benefited from many suggestions from students, colleagues, and senior supply chain executives from industry on my first edition. Based on the received comments as well as from my experience in using my text, I have made several changes in this edition.

The most significant change from the previous edition is the addition of two chapters. Chapter 11 is about supply chain contracts. Supply chain contract is emerging as a valuable instrument to coordinate various supply chains. Few popular contracts such as buyback contracts and revenue sharing contracts are discussed in depth. The other new chapter is Chapter 14. It deals with emerging field of sustainable supply chain management. Sustainable supply chain encompasses economic development, environment performance, and social betterment. Apart from focusing on managing relevant trade-offs, the chapter also deals with issues related to reverse supply chains.

Significant changes have been made in Chapter 1 while dealing supply chain evolution. Discussion about third revolution has been strengthened using recent examples from Apple and Airtel. Chapter 4 has been reorganized and discussion on periodic review model has been moved from appendix to main chapter. Section on e-retailing has been focussed in detail in Chapter 6. Chapter 8 dealing with IT has been updated with recent advances in technologies.

A few new cases have been added in Part V, and for two cases Kurlon and Subhiksha, recent updates have been captured as Case (b).

# PREFACE FOR 1ST EDITION

Supply Chain Management: Text and Cases presents a comprehensive, yet structured, view of logistics and supply chain management, with a focus on supply chain innovations for firms operating in competitive markets.

This book evolved from a supply chain management course that I have been teaching at the Indian Institute of Management Bangalore since 1998. When I first offered this course, the discipline of supply chain management was still in its infancy, leaving me to draw on my experiences with various Indian industries. Between then and now, however, many good books on supply chain management have been published, which brings us to an important question.

## Why Another Book on Supply Chain Management?

As globalization and technological innovation continue to etch new contours on the landscape of business, supply chain management continues to evolve. In such a dynamic scenario, this

book places equal weight on state-of-the-art know-how in supply chain management as it does on the fundamentals.

Moreover, while it is important for Indian companies to learn from the West, even tried-and-tested solutions may not always be applicable to Indian firms. Issues such as poor infrastructure, large numbers of customers at the base of the economic pyramid and complex distribution and taxation structures require solutions specific to the Indian context. This book addresses these issues by blending the best global supply chain practices with an in-depth knowledge of the Indian environment, encouraging practitioners and readers to innovate. Numerous real-life examples of firms that have successfully evolved their supply chain management strategies help the reader relate to the theory presented and make learning easier.

Throughout the book, while presenting mathematical models, every possible attempt has been made to foster in the reader an intuitive feel for the concepts described. This approach is intended to benefit those students who are intimidated by the use of mathematics. The final material presented in the book has been thoroughly tested at executive MBA programmes as well as several in-company programmes.

## The Structure of the Book

The book is divided into five parts. The first four parts of the book equip readers with the necessary concepts, frameworks, tools and techniques for understanding, analysing and enhancing supply chain performance. In Part V, the focus is on applying these concepts to real-life business situations.

### *Part I: Introduction and a Strategic View of Supply Chains*

Part I lays the foundation for understanding and analysing supply chains from a strategic perspective. For this, the framework for aligning the supply chain strategy with the business strategy is presented. The key strategic supply chain decisions regarding the boundary of the firm, reflected in the make versus buy decisions faced by a firm, are extensively discussed. Part I also establishes several leads for the three remaining parts of the book.

### *Part II: Managing Material Flow in Supply Chains*

Part II focuses on issues related to material flow: network design, transportation and inventory. Furthermore, the idea of supply chain optimization is introduced here. Using analytical models based on this approach, a firm can design and operate material flow in an efficient and effective manner.

### *Part III: Managing Information Flow in Supply Chains*

For several key decisions related to material flow discussed in Part II, access to real-time, undistorted data is essential. This information, rather than customer orders, is the basis of demand forecasting in most global supply chains. This part examines the various methods of demand forecasting and the related implementation issues. The contribution of information technology in facilitating the availability of these data is also discussed.

### *Part IV: Supply Chain Innovations*

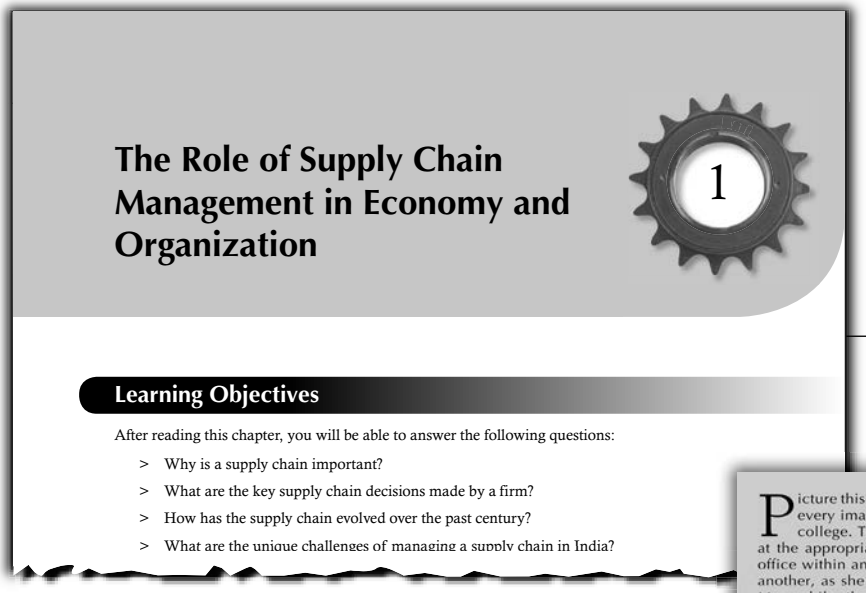
In Part IV, innovative supply chain strategies that enhance supply chain performance are highlighted. The three strategies discussed are integration, reconfiguration and optimization of

supply chains. Within supply chain design and operations decisions, specific issues, decisions and models involved in network design, inventory and transportation are scrutinized.

### *Part V: Supply Chain Cases*

Ten case studies, designed to bring real-life supply chain environments within the classroom, are presented in this part. Collectively, these 10 cases cover all aspects of the rich landscape of issues that managers confront in the Indian supply chain context. Some of these cases are sharply focused on specific dimensions of supply chains whereas others are quite comprehensive, dealing with the whole gamut of supply chain issues that affect a business. Under the skilful guidance of a faculty member, the readers are expected to analyse and synthesize conflicting data and points of view to define and prioritize goals, to persuade and inspire others who think differently and to make tough decisions with uncertain information.

## Features


The Role of Supply Chain Management in Economy and Organization

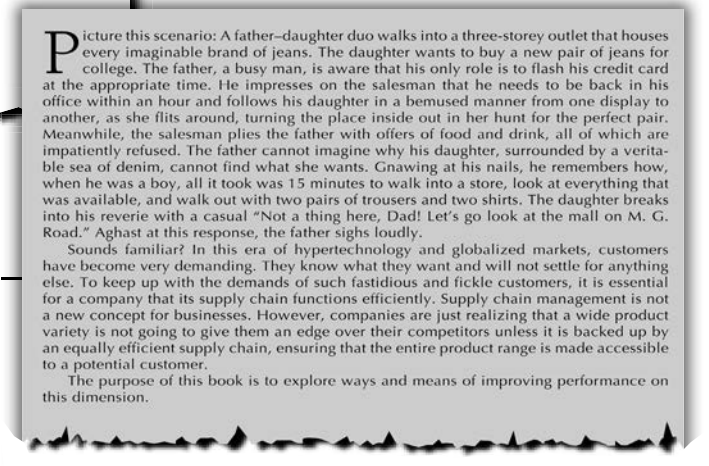
1

Learning Objectives

After reading this chapter, you will be able to answer the following questions:

- Why is a supply chain important?
- What are the key supply chain decisions made by a firm?
- How has the supply chain evolved over the past century?
- What are the unique challenges of managing a supply chain in India?

**The learning objectives** define the salient points in each chapter that the student needs to focus on while reading the chapter. Their purpose is to minimize the need for repeatedly reading the chapter.


Picture this scenario: A father–daughter duo walks into a three-storey outlet that houses every imaginable brand of jeans. The daughter wants to buy a new pair of jeans for college. The father, a busy man, is aware that his only role is to flash his credit card at the appropriate time. He impresses on the salesman that he needs to be back in his office within an hour and follows his daughter in a bemused manner from one display to another, as she flits around, turning the place inside out in her hunt for the perfect pair. Meanwhile, the salesman plies the father with offers of food and drink, all of which are impatiently refused. The father cannot imagine why his daughter, surrounded by a veritable sea of denim, cannot find what she wants. Gnawing at his nails, he remembers how, when he was a boy, all it took was 15 minutes to walk into a store, look at everything that was available, and walk out with two pairs of trousers and two shirts. The daughter breaks into his reverie with a casual "Not a thing here, Dad! Let's go look at the mall on M. G. Road." Aghast at this response, the father sighs loudly.

Sounds familiar? In this era of hypertechnology and globalized markets, customers have become very demanding. They know what they want and will not settle for anything else. To keep up with the demands of such fastidious and fickle customers, it is essential for a company that its supply chain functions efficiently. Supply chain management is not a new concept for businesses. However, companies are just realizing that a wide product variety is not going to give them an edge over their competitors unless it is backed up by an equally efficient supply chain, ensuring that the entire product range is made accessible to a potential customer.

The purpose of this book is to explore ways and means of improving performance on this dimension.

**Opening vignettes** capture incidents from the real world. These lay the foundation for the theory covered in the chapter and exemplify the consequences of the application of theory to real-world situations.

Each chapter carries an **interview** of a senior management executive/CEO of a firm that is a supply chain leader within the industry. The interviews highlight the supply chain challenges that real companies face and the innovative supply chain practices that companies have adopted to establish themselves as the market leaders.

**INTERVIEW WITH**

**SABYASACHI PATNAIK**

*Asian Paints is India's largest paint company and the third-largest paint company in Asia today, with a turnover of Rs 36.7 billion. Sabyasachi Patnaik is the General Manager, Manufacturing, for the Decorative Paint Business Unit (DBU) at Asian Paints.*

*What is the level of complexity of the supply chain at Asian Paints?*

**Sabyasachi Patnaik:** At DBU, we manage around 500-odd vendors, 5 main manufacturing plants, 13 processing centres, 7 regional distribution centres and 76 depots. We serve about 19,000 dealers who are spread all over the country. On the variety front, we have to manage 750 raw materials and packing materials and 1,500-odd inventoried SKUs at the FG level.

*What are the supply chain challenges that you face?*

**Sabyasachi Patnaik:** Increasingly our customers have become more demanding and as a result we are constantly expected to improve service levels. Further, we add 80–100 new SKUs every year. These new SKUs are more complex products requiring new materials and complex manufacturing processes but usually have lower volumes compared to our existing product lines. It is expected that our business should not only service a larger number of SKUs at higher service levels but also reduce costs related to the supply chain. So, unlike most other businesses, where chains have to be either efficient or responsive, we are expected to be responsive as well as efficient. How to manage this stretch is the most important challenge for supply chain managers at Asian Paints.

we could offer a large variety to customers without increasing the number of SKUs at the factory. Way back in 1998 we restructured ourselves and created different business units. In the business of decorative paints, we created a position of Vice President supply chain that is responsible for the end-to-end supply chain. We have been early users of information technology in India and we make sure that our information technology initiatives are driven by our business people. Our early investments in information technology has helped us in reducing forecast errors, reduced safety stocks and lowered the freight costs. In past few years, we have focused on improving our capabilities in manufacturing. We have implemented Six Sigma and other lean methodologies to improve quality, reduce cycle times and reduce rework.

To reduce our material costs we have focused on sourcing efficiency as well as on improving formulation efficiency. Hence, our material costs are probably the lowest in the industry. We also have reduced our working capital requirement by exploring ways in which we can get higher credit from suppliers and by reducing the FG and RM inventory levels. Optimal balancing has been done between higher creditors and material costs. I guess our main strength is quality of our execution.

*What are the future supply chain initiatives that the firm is working on?*

**Sabyasachi Patnaik:** With increased variety, we realize that holding stocks close to customers may not be the best option. We are exploring the idea of keeping stocks at central distribution centres (CDC) located close to the plant so that

### *LAUNCH OF THE SEVENTH HARRY POTTER BOOK*

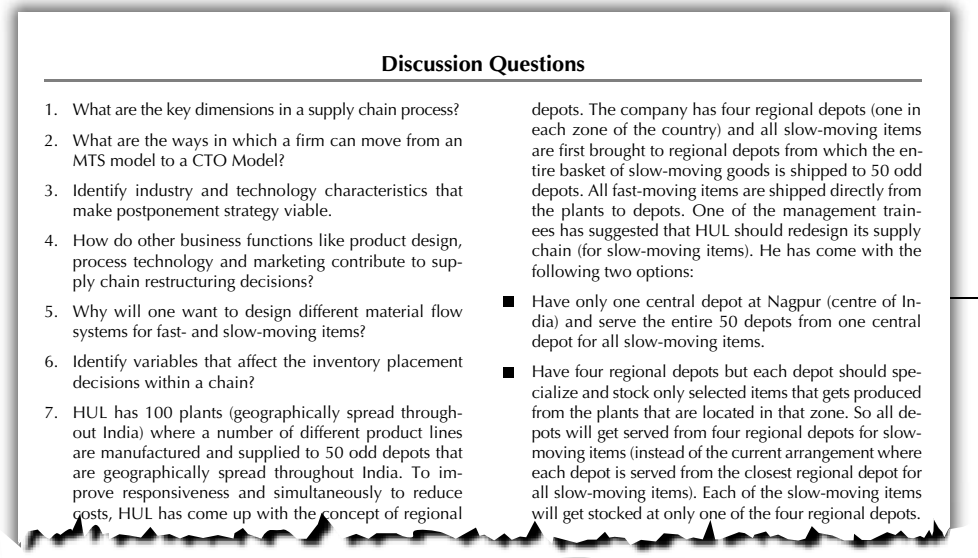
*Harry Potter and the Deathly Hallows*, the much-awaited seventh and final book in the Harry Potter series of novels, was released in 93 countries simultaneously on 21 July 2007. Managing a launch of this magnitude is a supply chain nightmare. Ensuring that the book is available in sufficient quantity at tens of thousands of outlets across 93 countries across the globe poses substantial challenges to supply chain managers, who have also to ensure that the content of books is not leaked out before the launch date. The books had to reach the stores just in time for the launch, neither too early nor too late. Penguin India, the distributor of Harry Potter books in India, had to manage the seemingly impossible task of delivering the books simultaneously to 300 destinations just a few hours prior to the launch time of 6:30 a.m.

The **caselets** are snippets that present actual industrial practices or unique solutions adopted by companies.

A **summary** at the end of the chapter recapitulates the important concepts and definitions from the chapter.
It allows the students to concentrate on the salient points in the chapter.

**Summary**

- Supply chain restructuring focuses on questioning the existing processes and architecture of the chain.
- Supply chains can be characterized using the following three dimensions: shape of the value-addition curve, point of differentiation and customer entry point. Restructuring of the supply chain process involves altering the supply chain process on at least one of the three dimensions.
- Supply chain restructuring involves supply chain innovations involving either product redesign or process redesign or value offering to customers so as to improve customer service and reduce cost. Using supply chain restructuring firms like Dell Computers and National Panasonic have managed to move from the MTS to the CTO business model.
- Restructuring supply chain architecture involves either altering the way in which material flow takes play in a chain or alteration in inventory placement in a chain.
- Unlike supply chain integration and supply chain optimization, supply chain restructuring goes beyond supply chain function and will require integrating product and process engineering with supply chain function. Similarly, it may also involve closer integration between marketing and supply chain function.
- Business benefits of supply chain restructuring can be quantified with the help of analytical inventory models.

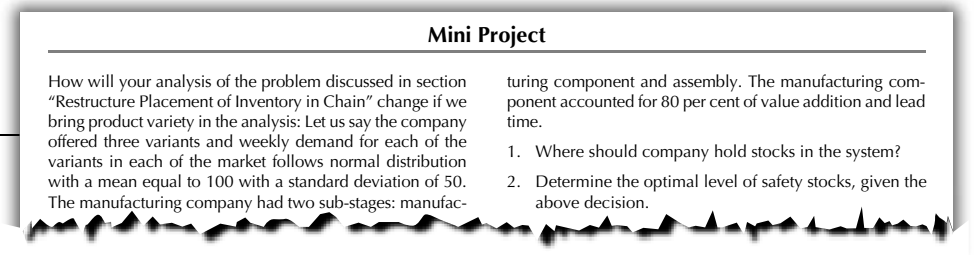


**Discussion Questions**

1. What are the key dimensions in a supply chain process?
2. What are the ways in which a firm can move from an MTS model to a CTO Model?
3. Identify industry and technology characteristics that make postponement strategy viable.
4. How do other business functions like product design, process technology and marketing contribute to supply chain restructuring decisions?
5. Why will one want to design different material flow systems for fast- and slow-moving items?
6. Identify variables that affect the inventory placement decisions within a chain?
7. HUL has 100 plants (geographically spread throughout India) where a number of different product lines are manufactured and supplied to 50 odd depots that are geographically spread throughout India. To improve responsiveness and simultaneously to reduce costs, HUL has come up with the concept of regional depots. The company has four regional depots (one in each zone of the country) and all slow-moving items are first brought to regional depots from which the entire basket of slow-moving goods is shipped to 50 odd depots. All fast-moving items are shipped directly from the plants to depots. One of the management trainees has suggested that HUL should redesign its supply chain (for slow-moving items). He has come with the following two options:
   - Have only one central depot at Nagpur (centre of India) and serve the entire 50 depots from one central depot for all slow-moving items.
   - Have four regional depots but each depot should specialize and stock only selected items that gets produced from the plants that are located in that zone. So all depots will get served from four regional depots for slow-moving items (instead of the current arrangement where each depot is served from the closest regional depot for all slow-moving items). Each of the slow-moving items will get stocked at only one of the four regional depots.

Each chapter includes **discussion questions** at the end of the chapter. These questions are designed to facilitate a review of the concepts presented in the chapter.

**Mini projects** are activity- and/or analysis-oriented assignments that give the student a clear view of the problems that a supply chain manager faces in the real world. These are designed to help the reader correlate theory with reality.



**Mini Project**

How will your analysis of the problem discussed in section "Restructure Placement of Inventory in Chain" change if we bring product variety in the analysis: Let us say the company offered three variants and weekly demand for each of the variants in each of the market follows normal distribution with a mean equal to 100 with a standard deviation of 50. The manufacturing company had two sub-stages: manufacturing component and assembly. The manufacturing component accounted for 80 per cent of value addition and lead time.

1. Where should company hold stocks in the system?
2. Determine the optimal level of safety stocks, given the above decision.

**Exercises** are included at the end of selected chapters where key supply chain issues are discussed. These numerical problems are designed to help a student/reader to apply the concepts presented in the chapter to analyse and interpret data.

# The Teaching and Learning Package

## *For Students*

**Study Card:** The study card is a six-page pullout that captures the essential learning from the book. It is designed to enable the reader to rapidly recapitulate the important concepts and equations from each chapter.

## *For Instructors*

**Instructors' Manual:** This book is designed to offer considerable flexibility to instructors in course design. Suggested alternative course outlines have been included in the instructors' manual, available at www.pearsoned.co.in/janatshah. Using these alternative outlines, the instructor can customize the course to meet the needs of the students, keeping their aptitude/background and the number of contact hours in mind.

Apart from this, each chapter is summarized from the instructor's point of view. Teaching tips to make learning more interesting and relevant to student groups are provided. To help the instructor, detailed solutions for numerical exercises have been provided, wherever relevant.

The instructors' manual also features detailed case teaching notes for all the cases in Part V. It is designed to help the instructors in structuring their classroom discussions in an effective manner. These can also be used by the instructor to integrate the theory/models/concepts discussed in the course with the managerial problems presented in the case.

**Lecture Slides (PowerPoint Presentations):** PowerPoint slides for each chapter are available along with the instructors' manual. These provide lecture outlines, important diagrams and additional material that can be used by the instructor to deliver lectures and make presentations in an effective and engaging manner.

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# REVIEWERS

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PART

I

**Chapter 1**
The Role of Supply Chain Management in Economy and Organization

**Chapter 2**
Supply Chain Strategy and Performance Measures

**Chapter 3**
Outsourcing: Make Versus Buy

# Introduction and a Strategic View of Supply Chains

Thanks to the liberalization of economies, firms have discovered that the globe is their playing field. The emergence of global markets has significantly altered the way businesses work. In a globalized economy, efficiency and speed of response becomes even more critical, and supply chains become the new competitive weapon. Firms operating in the Indian scenario face many supply chain challenges that are unique to the Indian context. This book deals with the concepts of supply chain management and dwells on the problems that are unique to the Indian scenario

Chapter 1 defines supply chain management, traces its evolution over the past century and identifies major trends that have made performance critical for business success. The chapter also discusses the implications of the unique challenges that are presented by the complex supply chains of Indian firms for practising managers.

Chapter 2 focuses on supply chain strategy and supply chain performance measures. The framework for integrating business and supply chain strategies is presented with a specific focus on the inherent cost and customer service trade-offs. This chapter also presents the framework for prioritizing supply chain initiatives so as to enhance business performance on an ongoing basis.

Chapter 3 deals with key strategic supply chain decisions regarding the boundary of the firm within the supply chain, including critical issues such as outsourcing versus inhouse operations. In this chapter, several perspectives on outsourcing have been analysed. The chapter also presents the classification approach for various sourcing strategies that may be adopted for different categories of products.

The goal of the three chapters in Part I is to provide a foundation for understanding and analysing supply chains from a strategic perspective. This framework helps in identifying supply chain initiatives that improve business performance. Part I also establishes several leads for the remaining three parts of the book, which focus on supply chain flow and innovations.

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# The Role of Supply Chain Management in Economy and Organization


## Learning Objectives

After reading this chapter, you will be able to answer the following questions:

- Why is a supply chain important?
- What are the key supply chain decisions made by a firm?
- How has the supply chain evolved over the past century?
- What are the unique challenges of managing a supply chain in India?

Picture this scenario: A father–daughter duo walks into a three-storey outlet that houses every imaginable brand of jeans. The daughter wants to buy a new pair of jeans for college. The father, a busy man, is aware that his only role is to flash his credit card at the appropriate time. He impresses on the salesman that he needs to be back in his office within an hour and follows his daughter in a bemused manner from one display to another, as she flits around, turning the place inside out in her hunt for the perfect pair. Meanwhile, the salesman plies the father with offers of food and drink, all of which are impatiently refused. The father cannot imagine why his daughter, surrounded by a veritable sea of denim, cannot find what she wants. Gnawing at his nails, he remembers how, when he was a boy, all it took was 15 minutes to walk into a store, look at everything that was available, and walk out with two pairs of trousers and two shirts. The daughter breaks into his reverie with a casual "Not a thing here, Dad! You can go to your office. I saw some interesting online offers on my mobile. I will order 4–5 jeans on cash on delivery. I will keep one which I like and return rest of them. Sounds familiar? In this era of hypertechnology and globalized markets, customers have become very demanding. They know what they want and will not settle for anything else. To keep up with the demands of such fastidious and fickle customers, it is essential for a company that its supply chain functions efficiently. Supply chain management is not a new concept for businesses. However, companies are just realizing that a wide product variety is not going to give them an edge over their competitors unless it is backed up by an equally efficient supply chain, ensuring that the entire product range is made accessible to a potential customer.

The purpose of this book is to explore ways and means of improving performance on this dimension.

# Introduction

A quick research carried out in a local grocery store will reveal that, on an average, it takes 3–4 months for goods to reach the end customer. Sometimes, it takes as much as a year for goods to reach the end customer in the chain. It is indeed an amazing realization that there is a very complicated chain in place to ensure that one can buy the denims of one's choice at a retail store.

Companies have managed supply chains for decades, but never in history did they have the variety of the kind they handle now, or the kind of competitive pressures that they face now. Companies all over the world have realized that the difference between good and bad supply chain management can affect their profitability significantly. Firms like Apple and Wal-Mart have demonstrated the impact of supply chain management on business performance. Due to its superior supply chain systems, Apple managed a significantly higher return of assets at 20 per cent, compared to other players in same business. Similarly, Wal-Mart has emerged as the largest American corporation with return of assets close to 8 per cent, which is considerably higher than that of its competitors in the retailing business. Within India, firms like Asian Paints and Marico Industries have maintained significantly higher levels of profitability and growth compared to competitors in their respective industries because of their superior supply chain capabilities.

The aim of this chapter is to introduce the concept of supply chain management, trace the evolution of supply chain concepts over the past century and identify major trends that have made supply chain performance critical to success. We briefly look at the performance of the Indian economy and firms across various sectors, focusing on the supply chain dimension. We also identify key supply chain challenges for Indian firms. As the Indian economy is growing at 8 per cent annually, despite the infrastructure bottlenecks, we have to look at the challenges in supply chain management that are unique to the Indian scenario. The goal is not only to understand and apply the concepts that have already evolved but also to continue to look for innovations and solutions customized to meet the requirements of companies operating in the Indian scenario. It is obvious that significant improvements will come only from innovative solutions that can resolve supply chain problems that are specific to the Indian context.

# What Is Supply Chain Management?

The supply chain encompasses all activities involved in the transformation of goods from the raw material stage to the final stage, when the goods and services reach the end customer. Supply chain management involves planning, design and control of flow of material, information and finance along the supply chain to deliver superior value to the end customer in an effective and efficient manner. A typical supply chain is represented in Figure 1.1.

As can be seen from the definition, the supply chain not only includes manufacturers, suppliers and distributors but also transporters, warehouses and customers themselves. Of late, firms have realized that it is not the firms themselves but their supply chains that vie with each other in the marketplace. Thus, it is not Hindustan Unilever (HUL) versus Procter & Gamble (P&G). Rather, the supply chains of both these firms compete against each other. The customer is interested only in the price, availability and quality of the product at the neighbourhood retail outlet, where they actually come into contact with products supplied by HUL and P&G. If customers observe inefficiency on account of non-availability, damaged packaging, etc. at the retail end with regard to HUL's products, they attribute inefficiency to HUL and not to its chain partners. The customer is only interested in getting the desired product at the right place, at the right time and at the right price. For a simple product like soap, the HUL supply chain involves ingredient suppliers, transporters, the company's manufacturing plants, carrying

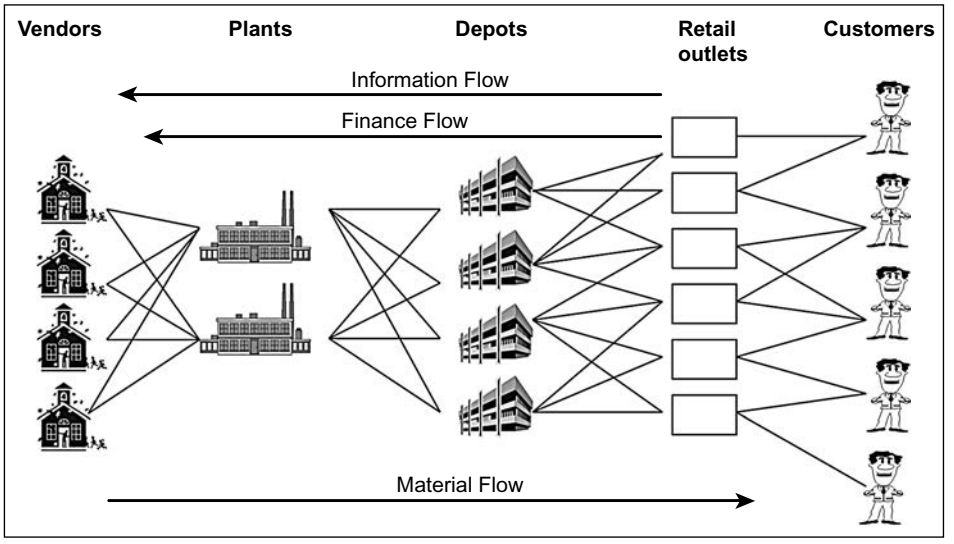


**Figure 1.1**
A supply chain network.

and forwarding agents, wholesalers, distributors and retailers. Obviously, HUL does not own all these entities, but the HUL brand name is at stake and it has to be ensured that the entire chain delivers value to the end customer. HUL cannot afford to focus only on those parts of the chain that are owned by it and ignore the other parts of chain. Firms need to realize that the performance of the chain is determined by its weakest link.

The supply chains of automobile companies (Maruti, Tata Motors and TVS) and other companies like BPL, LG and Whirlpool, dealing in consumer durables, will be very similar to the one depicted in Figure 1.1. On the other hand, companies in the consumer non-durables business—for example, HUL, P&G, Godrej Soaps and Nestlé—have to work with supply chains that are likely to be much longer and more complex. The term *chain* is a little misleading because it gives the impression that there is only one entity at each stage of the supply chain. In reality, as seen in Figure 1.1, multiple entities are involved at each stage: a manufacturer receives material from several suppliers and, in turn, distributes the products through multiple distributors. The more appropriate term probably will be either *supply networks* or *supply web*. However, the term *supply chain* has been widely accepted by both practitioners and academicians; hence, we will continue to use the same throughout the book.

## *Evolution of Supply Chain Management*

The evolution of supply chain management has been a gradual process. Over the last century, there have been three major revolutions in the field of supply chain management and we examine each of them in the context of the broader evolution in the economic and technological environment. Consider the following statement made by the chief executive of an automobile firm:

> Our aim is always to arrange the material and machinery and to simplify the operations so that practically no orders are necessary. Our finished inventory is in transit. So is most of our raw material inventory. Our production cycle is about eighty-one hours from the mine to the finished machine (automobile) in the freight car.[1]

It is clear from this statement that this firm had a well-integrated supply chain in place that allowed it to minimize cost and maximize asset productivity. Most people, including students and business executives, are surprised to learn that the company that achieved this, did so

almost a century ago. Indeed, this statement came not in the 1960s or 1970s. Rather, Henry Ford achieved this fine balance in the 1910s with the Ford Motor Company. Clearly, this achievement set the standard for all managers the world over.

If such a well-integrated and efficient supply chain was achieved a century ago, then the obvious question is why are managers still worrying about it and, more pertinently, why are you reading this book? Before we look for the answer to this question let us take a look at the evolution of supply chain management over the past century and try to understand of the key dimensions over which supply chains have evolved over the past century.

There have been three major revolutions along this journey, and we examine each of them in the context of the broader evolution in the economic environment.

### The First Revolution (1910–1920): Vertical Integrated Firms Offering Low Variety of Products

The first major revolution was staged by the Ford Motor Company where they had managed to build a tightly integrated chain. The Ford Motor Company owned every part of the chain—right from the timber to the rails. Through its tightly integrated chain, it could manage the journey from the iron ore mine to the finished automobile in 81 hours. However, as the famous saying goes, the Ford supply chain would offer any colour, as long as it was black; and any model, as long as it was Model T. Ford innovated and managed to build a highly efficient, but inflexible supply chain that could not handle a wide product variety and was not sustainable in the long run. General Motors, on the other hand, understood the demands of the market place and offered a wider variety in terms of automobile models and colours. Ford's supply chain required a long time for set-up changes and, consequently, it had to work with a very high inventory in the chain.

Till the second supply chain revolution, all the automobile firms in Detroit were integrated firms. Even traditional firms in India, like Hindustan Motors, were highly integrated firms where the bulk of the manufacturing was done in-house.

### The Second Revolution (1960–1970): Tightly Integrated Supply Chains Offering Wide Variety of Products

Towards the end of the first revolution, the manufacturing industry saw many changes, including a trend towards a wide product variety. To deal with these changes, firms had to restructure their supply chains to be flexible and efficient. The supply chains were required to deal with a wider product variety without holding too much inventory. The Toyota Motor Company successfully addressed all these concerns, thereby ushering in the second revolution.

The Toyota Motor Company came up with ideas that allowed the final assembly and manufacturing of key components to be done in-house. The bulk of the components was sourced from a large number of suppliers who were part of the keiretsu system. Keiretsu refers to a set of companies with interlocking business relationships and shareholdings. The Toyota Motor Company had long-term relationships with all the suppliers. These suppliers were located very close to the Toyota assembly plants. Consequently, set-up times, which traditionally used to take a couple of hours, were reduced to a couple of minutes. This combination of low set-up times and long-term relationships with suppliers was the key feature that propelled the second revolution—and it was a long journey from the rigidly integrated Ford supply chain. The principles followed by Toyota are more popularly known as lean production systems.

The Toyota system, involving tight linkages, did get into some problems in the later part of the century. Gradually, when Toyota and other Japanese firms tried to set up assembly plants in different parts of the world, they realized that they would have to take their suppliers also along with them. Further, they found that some of the suppliers in keiretsu had become com-

placent and were no longer cost competitive. With the advent of electronic data interchange (EDI), which facilitated electronic exchange of information between firms, it was possible for a firm to integrate with the suppliers without forcing them to locate their plants close to the manufacturers' plant.

In actual practice, the Toyota supply chain also had certain rigidities, such as a permanent relation with suppliers, which could become a liability over a period of time. This, in turn, led to the third revolution spearheaded by couple of progressive companies like Dell Computers, Apple Inc., and Bharti Airtel, which offered, its customers the luxury of customization with loosely held supplier networks.

### The Third Revolution (1995–2020): Virtually Integrated Global Supply Networks Offering Customized Products and Services

Technology, especially information technology, which is evolving faster than enterprises can find applications for some of the innovations, is the fuel for the third revolution in supply chain. It will probably take at least couple of years before we can fully understand the IT-enabled model that has emerged and begin to apply it to all industries. However, we have enough information to get a reasonably good understanding of the contours of the third revolution. We will illustrate key characteristics of the third revolution using the example of Dell computers, Apple Inc., and Bharti Airtel. The first is a product company, the second combines product and service, and third is a pure service organization. In each of these organisations, we will see different aspects of the third revolution.

Dell computers allows customers to configure their own laptops (in terms of processors, video cards, screen sizes, memory, etc.) and track the same in their production and distribution systems. Apple offers personal digital devices to its customers and iPod is a classic example. However, it is not just about the product. Apple allows the consumer to have a personalized user experience through the features and services. Users can personalize the music and other media content on their device through the various features available on iPod. Similarly, Bharti Airtel allows services like My Airtel through which customer can have unique personalized experience.

As one can see we have moved to the stage where firms offer a bundle of goods that leads to personalized experiences, which would be of great value to individual customer. Value is unique to each customer, and therefore, each customer would wish a customized experience to be fully satisfied with the value delivered to him or her. In summary, we have moved from single product (Model T black colour) to wide variety as offered by Toyota to customization as offered by companies such as Dell computers, Apple, and Bharti Airtel. Businesses can no longer be content in providing select product variety to customers.

Organizations have moved from offering products to offering user experiences, which are a bundle of goods and services selected by the user. This has changed the way supply chains are configured to deliver value.

Let us begin with Dell. To make sure its customers get the completely customized product, Dell has built a strong network of vendors who are cost and technology leaders. These medium term relationships are based on the understanding that the vendors will adhere to a high benchmark on cost and technology leadership which in turn will reflect in Dell's products.

Apple Inc. brings together a product and a user experience in a revolutionary new way. Similar to Dell, Apple has global partners with which it maintains medium term relationships based on cost and technology benchmarking to fulfil its product manufacturing requirements. However, for creating a better user experience, it has gone a step further by creating a platform that enables anyone to contribute to the Apple user experience. Take the example of Apple iTunes and App Store. At the first level, iTunes made it possible for Apple to provide all the music in the world to its users through a seamless and tightly integrated platform. While this was only about entertainment, the App Store took it to the next level. It created a global

community of small and medium sized application development teams who could become partners with Apple, use its App Store platform, and offer a rich bouquet of utilities and applications which would all help create a one-of-its-kind user experience. So now, in addition to its strategic global manufacturing partners, using this platform, Apple also built a global network of partners in a few core areas like app development who had very low engagement with the company itself. Practically, anyone could become a partner to Apple on this platform. A key thing to note here is that the primary driver that enabled Apple to build this platform was information technology and the use of Internet.

In Bharti Airtel, we have a company that has broken several stereotypes. For a telecom company, the core activities like network management and IT being handled in-house was considered a given. However, Bharti Airtel chose to go with strategic outsourcing and partnerships with global partners for these core activities. Although the relationships were still medium term similar to Dell, the companies were thoroughly aligned and worked like a single entity because of common goals and revenue sharing arrangements. This ensured that Bharti Airtel was free to focus on the user experience which was the ultimate service it provided to the consumer.

To summarize, organizations are moving from an era where the central theme was the satisfaction of a customer need with a product to an age where the need is satisfied with a user experience that combines products and services. It is the age of virtual integration where all information regarding the customer is harnessed to provide a personalized customer experience. There are three key characteristics of these global networks that are enabling companies to deliver this experience seamlessly. The first involves high degree of engagement in the medium term with strategic partners based on cost and technology leadership for the core offerings. This is obvious in the way Dell, Apple, and Bharti Airtel create and engage in strategic partnerships with a close group of technology vendors with clear alignment. For example, Bharti Airtel is a telecom major that outsources the core activity of network management to a strategic partner with a clear revenue sharing arrangement, which ensures both are aligned completely. Similarly, Apple, which is known for its amazingly designed products, does none of the manufacturing itself but completely outsources it to its strategic manufacturing partners. The second is the way global resources of varying kinds, which are crucial to delivering the unified customer experience, are harnessed with the help of information technology and a highly evolved and efficient transportation infrastructure world over. Physical proximity of the strategic partner is no longer an important factor in making the choice of partners. Whether it is Dell using specialized chip manufacturers, Apple sourcing apps from the far flung corners of the world, or Bharti outsourcing core telecom activities to global technology leaders, this trend of utilizing global resources from near or far-flung corners of the world is evident in the operations of all leading companies. The third characteristic involves leveraging IT in the creation of a platform using which multiple partners each having very low engagement contribute to non-core activities, which enable the enhancement of the user experience while keeping individual transaction costs very low. Apple's app development platform is an example of this characteristic.

An organization which exhibits these three characteristics—ability to carry out strategic outsourcing by building strong medium term relationships based on cost and technology leadership, ability to harness global resources, and the creation of an easy to use platform to diversify global supply base—are able to create the virtual integration necessary to provide the user experience.

Our discussion of the three major revolutions in supply chain has given us an understanding of how the dynamic markets and rapidly evolving technologies force us to continuously improve our understanding of supply chain concepts. To be able to apply the key concepts of supply chain management, we must be able to observe how they are used in the context of the business and market scenario. With this backdrop in mind, let us look at some of the key supply chain concepts and understand why it has become such a critical success factor in most industries and how firms find better and more efficient ways of managing this crucial aspect of business in today's world.

## Key Concepts in Supply Chain Management

Traditionally, firms have focused their energies on three main functions: purchasing, manufacturing and distribution. Transport and storage activities within individual functions and across functions have not received adequate attention, and have usually been handled by the department managing the logistical aspects of the company. Initially, supply chain management focused on the internal integration of activities in these three functional areas with the logistics function. Gradually, firms realized that these activities have to be coordinated, not just within a firm, but across the entire supply chain, keeping in mind the material/product flow, right from the vendor to the end customer.

To integrate material flow across the chain, information and financial flow across the chain also have to be integrated. As shown in Figure 1.1, a typical supply chain involves managing all the three flows in the chain. In firms like Asian Paints and Marico Industries, material, information and finance flow seamlessly across department and organization boundaries. Customer pull, and not any internal compulsion, governs all the three flows in well-managed chains. In most chains, there exist many blocks, both at the departmental and the organizational boundaries. Individual departments and firms are more interested in performance at the local level rather than the performance at the chain level. Thus, numerous bottlenecks occur at the boundaries and the flow gets badly distorted. As observed earlier, often, material and products seem to spend a significant amount of time at the departmental and organizational boundaries. Since most of the inefficiencies seem to creep in at the boundaries, while studying supply chains, our focus will be on linkages rather than on individual operations. Though a typical supply chain will have a large number of firms, the standard practice is to analyse supply chains from the perspective of a focal firm like HUL, Asian Paints or Marico Industries. The concept of focal firms is discussed in Box 1.1.

In certain situations, apart from the forward flow of material and products, firms are also interested in the reverse flow of material as many companies also have to manage product returns, warranty claims, etc. As per the European Union regulations, firms that manufacture and sell consumer products are also expected to take the responsibility for product disposal at the end of the life of the product. Tougher regulations and increasingly liberal product take backs are forcing firms to focus their attention on reverse material flow as well. There is a growing realization that we need to develop a special field to deal with the reverse flow of material/product from the customer to the manufacturer and it is known as reverse supply chain management. Refer Chapter 14 on Green Supply Chain for details on reverse supply chain management. In this book, by and large, we will focus our attention on the forward flow of materials/products.

**BOX 1.1** Focal Firms

The firm that provides identity to the products in terms of brand has higher stakes in the chain, and such a firm is identified as the main entity in the chain. By virtue of being the main entity, the firm concerned also has the necessary clout and resources and usually takes on the responsibility of designing the incentive systems for the various entities in the supply chain. For example, Nike might not manufacture the product, or may not own the retail outlets, but since the end customers identify the product with Nike, we will identify Nike as the main entity in the supply chain. In general, we will refer to this entity as the focal firm or central node or the main entity in the chain. While studying supply chains, we analyse them from the perspective of this main entity, also known as the focal firm or the nodal firm, which is at the strategic centre of the supply chain. In marketing literature, the focal firm is known as a steward firm that provides leadership to the entire value chain and ensures that the chain simultaneously addresses customers' best interest and drives profit for all chain partners.