PONDICHERRY UNIVERSITY

DIRECTORATE OF DISTANCE EDUCATION

Supply Chain Management

MBA – OPERATIONS & SUPPLY CHAIN MANAGEMENT

SEMESTER III

MBSC3003

Supply Chain Management

MBA – OPERATIONS & SUPPLY CHAIN MANAGEMENT

Authored By:

Manjula M

Program/Project Manager
Goldstone Technologies (working at Cisco)
Vietnam

Pondicherry University
Directorate of Distance Education

Introduction

The aim of every organisation is to deliver products and services to customers in the best condition and well on time. For this, organisations engage in various activities, such as acquiring raw materials, transforming raw materials into finished goods, storing products, and moving the goods to market. In order to perform all these activities in the right way, organisations create supply chains, wherein products are moved from suppliers to customers. The key participants in a supply chain are suppliers, distributors, retailers, manufacturers, etc.

In order to manage a supply chain, organisations need to create an effective coordination between all the activities and participants involved. Supply chain management is an integrated approach used by organisations to plan, implement and control the flow of information, materials and services from the manufacturing of the finished product to the delivery of end products to customers. Supply chain management is adopted by organisations with an aim of making on-time delivery of products to customers through a coordinated flow of physical goods. Moreover, by helping organisations in processing customer orders quickly, supply chain management maximises the profitability. For example, the success of Wal-Mart, one of the leading retail stores is defined by its efficient supply chain.

To ensure the maintenance of responsiveness and efficiency of supply chain, organisations focus on six key drivers, namely facilities, transportation, inventory, information, pricing, and sourcing. Moreover, organisations need to develop competitive strategies for each of the drivers to keep supply chain competitive.

The book 'Supply Chain Management' makes students aware of the different aspects of supply chain management. It enables students to understand the importance of supply chain strategies for an organisation. The book discusses various metrics used by organisations for measuring the performance of supply chain. It also explains the importance of supply chain drivers in increasing its efficiency and responsiveness. Moreover, the book throws light on the role of aggregate planning in the success of supply chain. The students are also acquainted with the role of information system in increasing the efficiency of supply chain. Towards the end, the book discusses the importance of coordination in supply chain using collaborative planning, forecasting and replenishment (CPFR) model.

Syllabus

MBA (Operations & Supply Chain Management) – III Semester

PAPER - XIII

SUPPLY CHAIN MANAGEMENT

Paper Code: MBSC3003

Objectives

◆ To introduce process and functions of supply chain management

◆ Appreciate the design and network in supply chain management

◆ To understand the role of coordination in supply chain management

UNIT I

Introduction to Supply Chain Management- Supply chain – objectives – importance – decision phases – process view – competitive and supply chain strategies – achieving strategic fit – supply chain drivers – obstacles – framework – facilities – inventory – transportation – information – sourcing – pricing.

UNIT II

Designing the Supply Chain Network- Designing the distribution network – role of distribution – factors influencing distribution – design options – e-business and its impact – distribution networks in practice – network design in the supply chain – role of network – factors affecting the network design decisions – modeling for supply chain.

UNIT III

Planning Demand and Supply- Role of forecasting – demand forecasting – approaches – role of IT.

Planning and Managing Inventories- Safety inventory and its appropriate level – impact of supply uncertainty, aggregation and replenishment policies.

UNIT IV

Transportation Networks and Sourcing- Role of transportation – modes and their performance – transportation infrastructure and policies - design options and their trade-offs – Tailored transportation. Sourcing – In-house or Outsource – 3rd and 4th PLs – supplier scoring and assessment.

UNIT V

Coordination in a Supply Chain- Lack of supply chain coordination and the Bullwhip effect – obstacle to coordination – managerial levels – building partnerships and trust – continuous replenishment and vendor-managed inventories – collaborative planning, forecasting and replenishment.

REFERENCES

Sunil Chopra and Peter Meindl, SUPPLY CHAIN MANAGEMENT – STRATEGY, PLANNING AND OPERATION, PHI, *4th Edition*, 2010.

Wisner, Keong Leong and Keah-Choon Tan, PRINCIPLES OF SUPPLY CHAIN MANAGEMENT A BALANCED APPROACH, *Thomson Press, 2005.*.

Coyle, Bardi, Longley, THE MANAGEMENT OF BUSINESS LOGISTICS – A SUPPLY CHAIN PERSPECTIVE, *Thomson Press, 2006.*

Jeremy F Shapiro, MODELING THE SUPPLY CHAIN, *Thomson duxbury 2002.*

Table of Contents

Unit II: Distribution network in supply chain management

Unit III: Planning Demand and Supply in Supply Chain Management

Unit V: Price Management and Coordination in Supply Chain

Introduction to Supply Chain Management

Structure

Learning Objectives

After completing the chapter, you will be able to:

- ❏ define supply chain management
- ❏ identify the decision phases of supply chain management
- ❏ discuss the process view of supply chain management
- ❏ explain the SCOR model of supply chain
- ❏ define electronic supply chain management

1.1 Introduction

In today's highly competitive global markets, the emergence of products with shorter life cycles, coupled with elevated customer expectations, has compelled organisations to place a greater emphasis on their supply chains. A supply chain is a sequence of activities that facilitate the movement of products from the raw materials stage to their final delivery to end users. Ongoing advancements in communication technologies have motivated organisations to implement new approaches for managing their supply chain activities.

Supply chain management entails the integration of various functions, including manufacturing, operations, purchasing, transportation, and physical distribution. The primary objective of supply chain management is to ensure the timely delivery of products to customers through a coordinated flow of physical goods and associated information. This, in turn, contributes to the profitable growth of organisations by efficiently processing customer orders and supporting after-sales services.

In addition to this, the most commonly observed benefits of supply chain management include cost reduction in various areas, such as inventory management, transportation, warehousing, and packaging, ultimately leading to increased revenues. Supply chain management also enhances relationships among different parties involved in the value chain of an organisation, such as suppliers, retailers, wholesalers, and customers. In this unit, you will study about the concept of supply chain management in detail.

1.2 Meaning of Supply Chain Management

The objective of every organisation is to meet the needs of its customers in the most satisfactory way. To achieve this, an organisation must ensure the uninterrupted production and supply of products and services in the market. This necessitates efficient coordination with different stakeholders, including suppliers and distributors, to maintain a seamless flow of products and services. To accomplish this, organisations must devise a supply chain in which resources, raw materials, and components are gathered and arranged for the production of finished products, ensuring timely delivery to end customers. Now, let us understand the concept of supply chain in detail.

According to the American Production and Inventory Control Society (APICS), the term **supply chain** can be defined in two ways. Firstly, supply chain can be defined as "processes from the initial raw materials to the ultimate consumption of the finished product linking across supplier–user companies." Secondly, supply chain can be stated as "the functions within and outside a company that enable value chain to make products and provide services to the customers." Here, value chain comprises a series of activities performed in an organisation to add value to the end products. Apart from this, the following are some popular definitions of supply chain:

According to **Stock and Lambert**, "Supply chain integrates the key business processes of an organisation from end user through original suppliers that provides products, services and information that add value for customers and other stakeholders."

In the words of **Mohanty and Deshmukh**, "A supply chain is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products and the distribution of these finished products to customers."

Taking into consideration the definitions presented above, it is possible to assert that the supply chain is a dynamic process in which numerous parties (including employees, suppliers, distributors, and so on) are involved in order to deliver products and services in accordance with the requirements of customers. Because of the lack of an efficient supply chain, there is a possibility that there will be disruptions in the flow of product delivery, which may ultimately result in the loss of customers. Consequently, it is necessary for an organisation to efficiently manage the network of its supply chain. The term "supply chain management" (SCM) refers to an integrated process that is used to manage the flow of information, materials, and services through the various stages of production. The primary objective of this process is to ensure that products are delivered to the market in an efficient manner. SCM is defined as the "management of material and information flows both in and between facilities such as suppliers, manufacturing and assembly plants, and distribution centres," as stated by Thomas and Griffin (1996) according to their definition of supply chain management. This encompasses a wide range of tasks, including transportation, both incoming and outgoing, warehousing, inventory management, and many more. Fig. 1.1 shows an example of the supply chain management process of an apparel manufacturer:
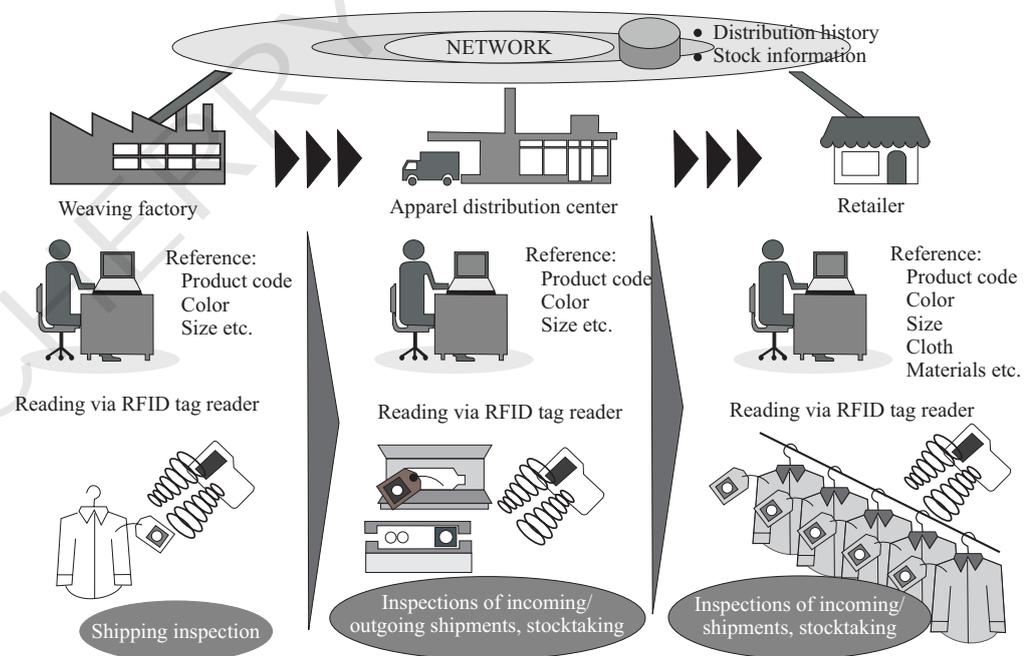
Fig. 1.1: Supply Chain Management at Apparel Organisation
(**Source:** *http://www.fibre2fashion.com/industry-article/21/2031/enhanced-apparel-chain-configurations-for-enhancing-profits1.asp)*

1.2.1   Objectives of Supply Chain Management

The SCM approach is adopted in organisations to build cordial relationships among all the involved parties in the supply chain network. The main objective for any SCM is to ensure a smooth flow of products to maximise customer satisfaction.

Fig. 1.2 lists some of the important objectives of SCM:

To create value for customers

To increase organisational responsiveness towards change

To reduce business risks

To enhance cost efficiencies
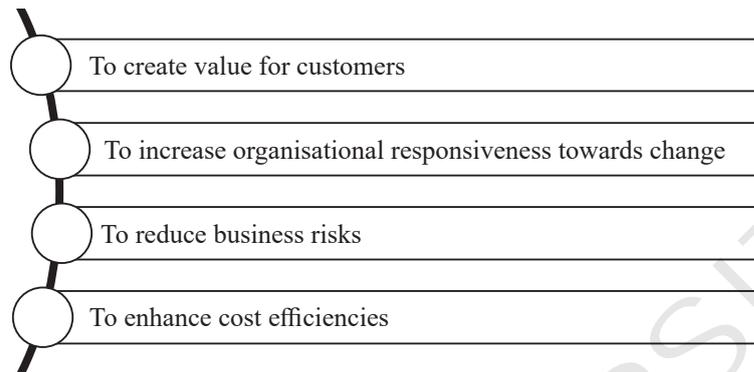
Fig. 1.2: Objectives of SCM

Let us discuss these objectives in detail.

◆ **To create value for customers:** Customer satisfaction is the primary goal of any organisation for its overall success. SCM aims to add customer value by establishing a market-driven customer service strategy based on customer requirements. This results in repetitive business for the organisation.

◆ **To increase organisational responsiveness towards change:** Organisations need to adapt to many changes on a frequent basis with respect to the changes in the business environment, such as the advent of new technologies and changes in government policies. Effective SCM helps the organisation to quickly respond to such changes.

◆ **To reduce business risks:** Many a times organisations encounter various disruptions in the entire business network, such as natural disasters, cataclysmic weather, labour strikes, and supplier failures. These sudden disruptions affect the smooth flow of products and services in the market, which may lead to major consequences for organisations. A sound SCM network enables organisations to reduce such risks by establishing backup plans.

◆ **To enhance cost efficiencies**: The major objectives of SCM are to reduce inventory carrying costs, minimise labour expenses, cut expenditures on freight spend, and so on; thereby achieving cost efficiencies. For this, organisations adopt various measures in SCM, such as using contracts or a bid/proposal to obtain economic resources at the lowest cost possible.

1.2.2　Importance of Supply Chain Management

SCM plays a pivotal role in an organisation's success by enhancing its operational efficiency and maximising customer satisfaction. Moreover, SCM provides a competitive edge to the organisation by ensuring a smooth flow of products and services in the market. The following points explain the importance of SCM:

◆ SCM helps an organisation in bringing down inventory costs by proper inventory management.

◆ Through SCM, information is disseminated effectively between various partners in the network.

◆ SCM also helps the organisation in enhancing customer satisfaction by making on-time delivery.

◆ SCM helps in building trust between various partners as they work together.

◆ It also improves profits of the organisation by increasing the efficiency of operations.

◆ SCM also offers various tools and techniques to identify and diagnose disruptions and solve them in time.

Self-Assessment Questions

1. _____ is a dynamic process wherein various parties (employees, suppliers, distributors, etc.) are involved to deliver products and services as per customers' requirements.

2. The SCM approach is adopted in organisations to build cordial relationships among all involved parties in the supply chain network. (True/False)

3. Which of the following is not an objective of supply chain management?

    a. To create value for customers

    b. To increase business risks

    c. To increase organisational responsiveness towards change

    d. To enhance cost efficiencies

4. Through SCM, information is disseminated effectively between various partners in the network. (True/False)

Activity

List down the activities performed in the supply chain management of an organisation of your choice.

1.3 Decision Phases of Supply Chain Management

To maintain an effective supply chain network, an organisation needs to make many decisions related to the flow of information and products and services. The decisions of SCM are made in three phases, which are shown in Fig. 1.3:
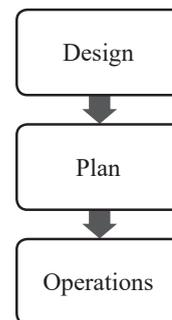
Fig. 1.3: Decision Phases of Supply Chain

Let us discuss these phases in detail.

1. **Design:** In this phase, an organisation makes decisions related to the structure of the supply chain network for the present as well as the future. These are usually long-

term decisions as they cannot be altered easily in short periods. These decisions can be choosing the mode of supply chain (internal or external); selecting the location of a plant and warehousing facilities; determining products to be stored at different locations; defining processes to be performed at the each stage of supply chain; identifying the modes of transportation and the information system to be utilised, and so on.

2. **Plan:** This phase involves planning for a quarter to a year. The aim behind planning is to generate maximum supply chain surplus over a period based on the constraints identified during the design phase. The planning of supply chain begins with the forecast of demand for products in the market in the coming year. The planning phase involves deciding markets to be supplied; the subcontractors to be used for manufacturing; the inventory policies to be followed; marketing and promotional strategies to be adopted, etc. During the planning phase, there are a numbers of factors to be considered, such as change in demand and level of competition.

3. **Operation:** In this phase, supply chain configuration is fixed and planning policies are established. These decisions are made either on a daily or weekly basis. Operational decisions are mainly customer oriented and include:

   ❑ Deciding on allocation of inventory or production to individual orders

   ❑ Setting the date for customer order fulfilment.

   ❑ Generating pick lists at a warehouse.

   ❑ Allocating the order to a shipment.

   ❑ Defining delivery schedules of trucks

   ❑ Placing replenishment orders

Self-Assessment Questions

5. In which phase, an organisation makes decisions related to the structure of the supply chain network for the present as well as the future?

   a. Plan

   b. Operations

   c. Design

   d. Manufacture

6. The _____ involves deciding markets to be supplied; the subcontractors to be used for manufacturing; the inventory policies to be followed; marketing and promotional strategies to be adopted, etc.

7. Operational decisions involve planning for a quarter to a year. (True/False)

1.4 Process View of Supply Chain Management

As discussed earlier, supply chain involves a series of processes to be performed at various stages to fulfil customers' needs by making on-time product delivery. These processes can be viewed in two ways, which are shown in Fig. 1.4:
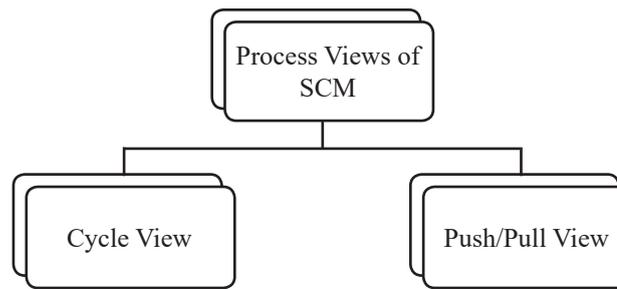
Fig. 1.4: Process View of SCM

Let us discuss these two views in detail.

◆ **Cycle view**: In this view, all processes involved in a supply chain are considered as cycles. These cycles are performed between the two successive stages of the supply chain. The cycles performed in the supply chain are shown in Fig. 1.5:
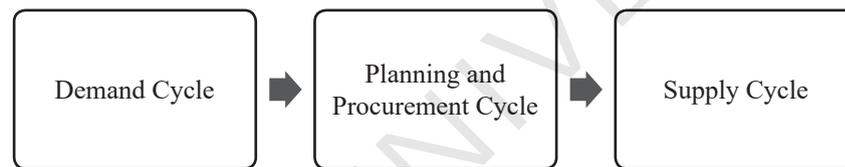
Fig. 1.5: Process Cycles in Supply Chain

Let us discuss these process cycles in detail.

◆ **Demand cycle:** It mainly includes the cycle of time that begins when a customer places an order to a wholesaler or retailer. If the product ordered is available in the stock of the retailer, the demand cycle for supply chain would include activities, such as order request, order fulfilment, and order receiving. However, in the absence of the product in the stock, the customer request will become a part of demand forecast of the product.

◆ **Planning and procurement cycle:** It includes requirements for both short and long period of time. In the planning and procurement cycle, organisations make decisions related to the products to be purchased and manufactured. Based on these decisions, inventory, capacity, and replenishment requirements for supply chain are planned.

◆ **Supply cycle:** The supply cycle can take place in two ways, namely with the manufacturing of a product that requires production schedules or with the purchase of the product from an external supplier which involves a purchase schedule. After the final product is made or received, it is either delivered to the customer directly or stored in warehouses to be distributed to customers in the future.

◆ **Pull/Push view:** In the supply chain, processes can be performed either in response to customer order or their anticipation. Pull processes are ones that are executed at the request of a customer. On the other hand, pull processes are executed when the organisation is expecting new orders in the near future. For example, if an organisation receives the order of producing 1000 bulbs, the manufacturing cycle will be in response to customer's order. Thus, it is a pull process. However, if an organisation produces the FMCG products in the anticipation of demand, the manufacturing cycle is a push process.

Fig. 1.6 shows the push/pull system in a retail network
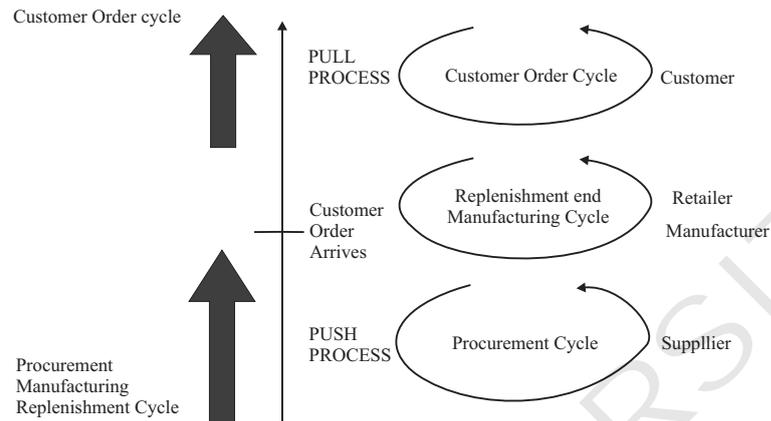
Fig. 1.6: Push/Pull System in Retail Network

(**Source:** *http://books.google.co.in/books?id=zCNKRy2NF9YC&pg=PA380&dq=push/pull+view+of+supply+chain&hl=en&sa=X&ei=TFvjU 47wKMSNuASUjoJg&ved=0CCkQ6AEwAQ#v=onepage&q=push%2Fpull%20view%20&f=false)*

In Fig. 1.6, it is shown that the push process starts only after the customer order is received. Thus, these processes are also called reactive processes. On the other hand, it is clearly seen that the push process starts even before the arrival of customer demand. Thus, the push process is initiated just in the anticipation of customer demand. Due to the anticipating nature of push processes, these are also known as speculative processes.

Self-Assessment Questions

8. Name the view in which all processes involved in a supply chain are considered as cycles.

9. _____mainly includes the cycle of time that begins when a customer places an order to a wholesaler or retailer.

   a. Planning cycle

   b. Procurement cycle

   c. Supply cycle

   d. Demand cycle

10. Pull processes are executed when the organisation is expecting new orders in the near future. (True/False)

1.5 SCOR Model of Supply Chain

To maintain an effective supply chain, the Supply Chain Council (an independent non-profit organisation) has developed the Supply Chain Operations Reference (SCOR) model as a cross-industry standard. This model is developed as a benchmarking standard to evaluate the effectiveness of an existing supply chain of an organisation. SCOR is a reference model that can be used to evaluate processes executed in a supply chain. With the help of SCOR model, an organisation can:

◆ Assess the performance of its existing supply chain.

◆ Identify performance gaps clearly.

◆ Redesign the supply chain network efficiently.

◆ Streamline management reporting and organisational structure.

◆ Align the skills of the supply chain team with strategic objectives.

1.5.1 Significance of SCOR Model

◆ In the dynamic business environment, it is of paramount importance for an organisation to maintain an effective supply chain network. This can be possible for organisations by using the SCOR model. The following points explain the importance of the SCOR model:

◆ **Providing superior customer service**: The SCOR model helps an organisation in determining the performance of the existing supply chain network and identifying the areas of improvement. In addition, the model allows the organisation to evaluate cost/performance trade-offs, develop new strategies for meeting customer expectations, and quickly adapt to changes in the business environment.

◆ **Reducing costs and mitigating risks**: The SCOR model provides various metrics for comparing the performance of the supply chain of organisations with that of other organisations in the industry. By measuring the performance, organisations can ascertain the processes that incur high costs and develop more cost-effective processes. Apart from this, the model helps organisations to identify probable risks that can lead to disruption in the supply chain network.

◆ **Improving supplier/partner relationship**: The SCOR model offers a common platform for different organisations in a supply chain to come and interact with each other. This leads to easy communication among organisations, speedy benchmarking efforts, and implementation of best practices. As a result, the supplier/partner relationship is improved.

◆ **Retaining the best talent**: The SCOR model defines the skills and competencies, roles and responsibilities, and job qualifications of supply chain personnel. This helps organisations in ensuring the availability of an efficient supply chain workforce.

1.5.2 Elements of SCOR Model

The effectiveness of the SCOR model depends on its different elements. Fig. 1.7 shows the important elements of the SCOR model:
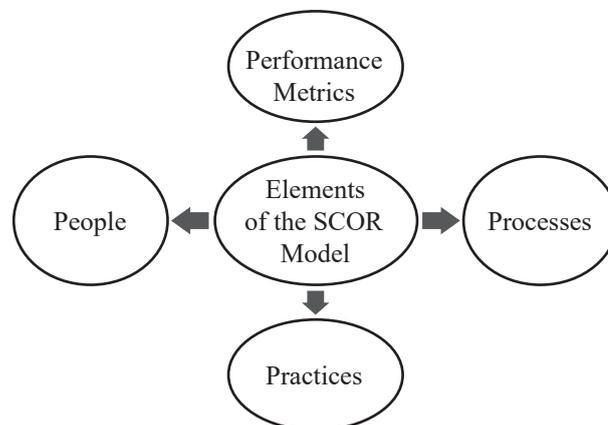
Fig. 1.7: Elements of the SCOR Model

Let us discuss the elements of the SCOR model.

- ◆ **Performance metrics:** To measure the performance of a supply chain, there are various metrics provided in the SCOR model. These metrics are provided at three levels, which are discussed as follows:

  - ❍ **Level 1 metrics**: These metrics are used to diagnose the overall functioning of the supply chain. Level 1 metrics are used by organisations for establishing realistic targets that support strategic objectives.

  - ❍ **Level 2 metrics**: These metrics are used to find the causes for the performance gaps for level 1 metrics.

  - ❍ **Level 3 metrics**: These metrics are used to evaluate the performance of level 2 metrics.

- ◆ **Processes:** In order to fulfil customer requirements, there are various processes identified by the SCOR model. These processes help organisations in standardising their supply chain networks. According to the SCOR model, processes are defined at four levels, which are:

  - ❍ **Level 1 processes**: These processes help in defining the scope and high level configuration required in a supply chain. In the SCOR model, there are five level1 processes.

  - ❍ **Level 2 processes:** These processes help in differentiating the strategies of level 1 processes. There are 26 level 2 processes in the SCOR model.

  - ❍ **Level 3 processes:** These processes are used for defining the ways to perform level 2 processes. In the SCOR model, there are 185 level 3 processes.

- ◆ **Practices:** To configure processes or sub-processes, best practices are developed. In the SCOR model, there are four types of practices existing in an organisation, namely emerging practices, best practices, common practices, and poor practices.

- ◆ **People:** In the SCOR model, a skills framework is provided that comprises needs and issues surrounding skills management for supply chain managers. The skills framework includes technical skills, aptitude, and experience required for the efficient management of a supply chain.

Self-Assessment Questions

11. _____is a reference model that can be used to evaluate processes executed in a supply chain.

12. The SCOR model helps organisations to identify probable risks that can lead to disruption in the supply chain network. (True/False)

13. How many level 2 processes are provided in the SCOR model?

14. With the help of the SCOR model, an organisation can misalign the skills of the supply chain team with strategic objectives. (True/False)

Activity

Using the Internet, find three examples of organisations that have used the SCOR model of supply chain.

1.6 | Electronic Supply Chain Management (e-SCM)

Technological advancements have elevated the need for effective management of supply chain. Businesses constantly experience the need for a fast, flexible, and continuous supply chain model to stay ahead of competition. Therefore, traditional business paradigms are rapidly being replaced by new business processes based on the latest technologies. e-SCM is the result of advancement in technology in the field of supply chain. In this section, let us study about e-SCM in detail.

e-SCM is an integrated business application that automates supply chain activities of organisations. It is developed by combining e-procurement system, e-billing system and other e-business tools. According to David Frederick Ross, "E-SCM is a tactical and strategic management philosophy that seeks to network the collective productive capabilities and resources of intersecting supply channel systems through the application of Internet technologies in the search for innovative solutions and synchronisation of channel capabilities dedicated to the creation of unique individualised sources of customer value."

e-SCM enables supply chain personnel to manage the specifications, quantity, costs and delivery time of materials and products. This results in an increase in the effectiveness of logistics, production, distribution, and other supply chain activities. It integrates various steps in the business cycle of organisations from product design to procurement of raw materials, shipping, distribution and warehousing of the final product to the delivery of products to end users.

1.6.1 Functions of e-SCM

e-SCM helps organisations in reducing overall costs and integrating supply chain processes. Fig. 1.8 shows the major functions of e-SCM:

Advanced production scheduling

Demand forecasting

Transportation planning

Distribution planning

Order commitment
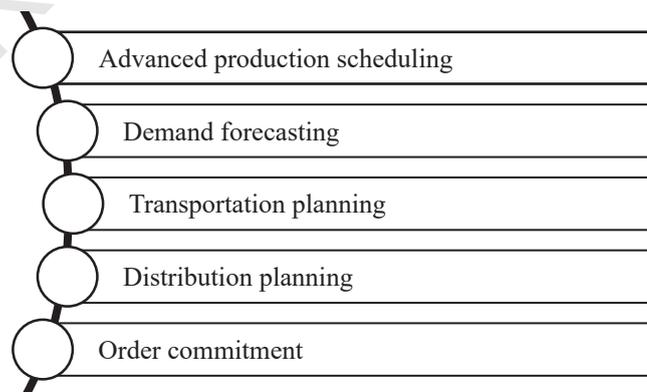
Fig. 1.8: Functions of e-SCM

Let us discuss these functions in detail.

- ◆ **Advanced production scheduling:** e-SCM helps organisations to get the details of production and supply processes based on individual customer orders. This helps an organisation to schedule its production beforehand.

- ◆ **Demand forecasting:** e-SCM provides a range of statistical tools and business forecasting techniques for predicting the requirements of raw material, labour, capital, transportation, etc. This helps organisations in meeting any sudden increase in product demand.

◆ **Transportation planning:** e-SCM helps in comparing various available transportation modes like railways, trucks, airlines along with their availability; thus, helping the organisation in finding the most appropriate mode of transport.

◆ **Distribution planning:** Finished products in inventories need to be distributed to retailers, wholesalers, and customers as per the requested orders. e-SCM helps organisations in keeping track of inventory in and out as per demand forecasting, manufacturing schedule and transportation planning.

◆ **Order commitment:** e-SCM enables vendors to precisely estimate delivery dates by providing insight into the demand fulfilment cycle. This helps organisations to make on-time delivery of products and services.

Self-Assessment Questions

15. _____ is an integrated business application that automates supply chain activities of organisations.

16. e-SCM helps organisations to get the details of production and supply processes based on individual customer orders to schedule the production beforehand. (True/ False)

17. Which of the following is not a function of e-SCM?

 a. Demand Forecasting

 b. Distribution planning

 c. Order Commitment

 d. Supply Forecasting

1.7 Summary

◆ Supply chain is a process of organising resources, raw materials, and components required for producing finished products to be delivered to end customers on time.

◆ Supply chain management (SCM) is an integrated process of administering the flow of information, material, and services at different stages of production for effective product delivery in the market.

◆ SCM is adopted in organisations to create value for customers, increase organisational responsiveness towards change, reduce business risks, and enhance cost efficiencies.

◆ SCM helps organisations in building trust between various partners as they work together and improving profits of the organisation by increasing the efficiency of operations.

◆ Creating an effective SCM involves making various decisions at three phases, namely design, plan, and operations.

◆ The processes involved in SCM are viewed in two ways, namely cycle view and push/ pull view.

◆ To measure the performance of the existing supply chain of an organisation, the Supply Chain Council has developed the Supply Chain Operations Reference (SCOR) model as a cross-industry standard.

◆ The SCOR model defines various metrics, processes, practices, and skills and competencies to be used by organisations for managing their supply chain networks effectively.

◆ e-SCM is an integrated business application developed by combining e-procurement system, e-billing system, and other e-business tools for automating the supply chain activities of organisations.

◆ The main functions of e-SCM include advance production planning, demand forecasting, transportation planning, distribution planning, and order commitment.

1.8 Glossary

◆ **Business network:** It is a group of like-minded business people who come together to identify, create, or act upon business opportunities.

◆ **Performance trade-off:** It is a compromise of performance of a function/machine/ product to enhance the performance of another one.

◆ **Replenishment order:** It is the reordering of inventory that is either consumed or short supplied.

◆ **Supply Chain Management (SCM):** It is the management of all activities that are performed at different stages of production for effective product delivery in the market.

1.9 Terminal Questions

1. Discuss the main objectives of supply chain management.

2. Explain the phases of SCM.

3. Discuss the process view of SCM.

4. Write a short note on the elements of the SCOR model.

5. Write a short note on e-SCM.

1.10 Answers

Q.	Self Assessment Questions
1.	Supply Chain
2.	True
3.	b. To increase business risks
4.	True
5.	c. Design
6.	Planning phase
7.	False
8.	Cycle view
9.	d. Demand cycle
10.	True
11.	SCOR

12.	True
13.	26
14.	False
15.	e-SCM
16.	True
17.	d. Supply Forecasting
Q.	**Terminal Questions**
1.	The main objective of SCM is to ensure a smooth flow of products, create value for customers, reduce business risks, enhance cost efficiencies, etc. Refer to sub-section **1.2.1 Objectives of supply chain management**.
2.	SCM involves making various decisions in three phases, namely design, plan, and operations. Refer to section **1.3 Decision Phases of Supply Chain Management**.
3.	SCM involves various processes which can be viewed in two ways, namely cycle view and push/pull view. Refer to section **1.4 Process View of Supply Chain Management**.
4.	There are four elements of the SCOR model, namely performance metrics, processes, practices, and people. Refer to sub-section **1.5.2 Elements of SCOR model**.
5.	e-SCM is an integrated business application used for automating supply chain activities of organisations. Refer to section **1.6 Electronic Supply Chain Management (e-SCM)**.

1.11 Case Study: Supply Chain at Whirlpool

Whirlpool is a prominent American multinational firm specialising in the production of household appliances. As a Fortune 500 company, it boasts an annual turnover of around $19 billion. The firm operates roughly 70 manufacturing and research centres globally. However, by 2000, Whirlpool's delivery performance began to decline from its usual standards. This decline was primarily attributed to the inadequacies of its supply chain, causing inconsistencies in stock levels and quality that frustrated both retailers and consumers. Recognising the urgency, Whirlpool's senior management sought to address these ongoing supply chain challenges.

The most significant factor that led to supply chain issues was the incorporation of various systems and processes across its geographically scattered sites, which was a consequence of the development of the firm. As a result of all of these problems, the total availability rate of the organisation, which is a measurement that determines how often a product is at the appropriate location at the appropriate time, dropped to 83 percent. It was determined that this was a poor failure for Whirlpool when compared to the standards that are prevalent in the business.

In order to address these issues, the supply chain management and information technology teams at Whirlpool began the process of replacing their many production scheduling and distribution systems with a solution that was more simplified and standardised. There was a single platform in the new system that was used for all of the tasks that were associated with the supply chain. These services included master scheduling, inventory planning, and deployment planning.

Furthermore, the system included collaborative capabilities for forecasting and restocking, which were among its many benefits. Consequently, the organisation was able to realise improved efficiency and cost reductions across the board as a consequence of this matter. Within a short period of time after the new system was put into place, Whirlpool was able to minimise the number of mistakes that occurred during forecasting by fifty percent and the amount of inventory that was present by more than twenty percent. Furthermore, not only did its overall availability rate increase from 83 percent to 93 percent, but it also reached 97 percent within the first five years after it was implemented. The fact that all of these milestones have been achieved demonstrates that an effective management of the supply chain, in conjunction with experienced individuals, may have a significant influence on the overall performance and profitability of the organisation.

Discussion Questions

1. Discuss supply chain problems faced by Whirlpool that affected the organisation's success and efficiency.

   (**Hint:** Inconsistency in inventory levels and quality, difficulty in integrating different systems and processes, etc.)

2. Do you think supply chain management is essential for the success of Whirlpool? Discuss why or why not.

   (**Hint:** Yes, SCM led to cost savings and greater efficiencies in Whirlpool.)

1.12 References and Suggested Readings

◆ Ayers, J. (2001). *Handbook of supply chain management* (1st ed.). Boca Raton, Fla.: St. Lucie Press.

◆ Chopra, S., & Meindl, P. (2014). *Supply Chain Management* (1st ed.). Hallbergmoos: Pearson.

◆ Fredendall, L., & Hill, E. (2001). *Basics of supply chain management* (1st ed.). Boca Raton: St. Lucie Press.

◆ Wisner, J., Leong, G., & Tan, K. (2005). *Principles of supply chain management* (1st ed.). Mason, Ohio [u.a.]: Thomson/South-Western.

E-references

◆ Ecrasia.com,. (2014). The Basic Concepts of Supply Chain Management. Retrieved 12 August 2014, from http://www.ecrasia.com/the-basic-concepts-of-supply-chain-management/

◆ Fibre2fashion.com,. (2014). Overview of Supply Chain Management, Supply Chain Process, Supply Chain Information System. Retrieved 12 August 2014, from http://www.fibre2fashion.com/industry-article/29/2893/an-overview-of-supply-chain-management1.asp

◆ Scm.ncsu.edu,. (2014). What is Supply Chain Management? - SCM | Supply Chain Resource Cooperative (SCRC) | North Carolina State University. Retrieved 12 August 2014, from http://scm.ncsu.edu/scm-articles/article/what-is-supply-chain-management

CHAPTER

2

Strategies of Supply Chain Management

Structure

Learning Objectives

After completing the chapter, you will be able to:

- ❑   explain supply chain strategies
- ❑   discuss how to achieve strategic fit
- ❑   list various obstacles in strategic fit
- ❑   explain various supply chain decisions

2.1   Introduction

In the previous unit, you have studied about the importance of supply chain management in the success of an organisation. Supply chain management revolves around the end-to-end flow of information, products, and services among various parties, such as suppliers, manufacturers, distributors, and customers. The way the supply chain of an organisation is managed largely affects the organisation's efficiency in terms of its responsiveness towards customer requirements. For this, an organisation needs an effective supply chain strategy, which establishes a linkage between various activities and functions throughout the value chain.

A supply chain strategy can be defined as a long-term plan of a value chain to meet customer demands at the lowest possible cost. The supply chain strategy of an organisation aims at adding value to existing products and services in order to exceed customer expectations. A supply chain strategy is formed through the linkage between supply chain processes and business strategy of an organisation. This is because the business strategy of an organisation focuses on meeting customers' requirements on time, while the supply chain strategy aims at using the best way to meet those needs.

A supply chain strategy differs across organisations depending on the type of products produced by them for various customer segments. However, the main goal of any supply chain strategy is to reduce costs and improve overall organisational efficiency. This can be possible if a supply chain strategy is developed by taking into account various factors, such as product attributes, customer requirements, and market characteristics. In this chapter, you will study about the importance of a supply chain strategy in an organisation in detail.

2.2   Competitive Supply Chain Strategies

As discussed in the preceding unit, supply chain is a sequence of activities involved in the production and distribution of a product. In the present scenario, in order to establish supply chain systems and maintain their effectiveness, organisations need to consider various factors, such as globalisation, increased competition, scarcity of resources, and corporate social responsibility. For this, organisations need to have flexible, reliable, and cost-effective supply chain strategies in place. A supply chain strategy can be defined as a plan of activities to be performed for meeting customers' requirements by delivering them products on time at the lowest possible cost. It focuses on what should be done to enhance the performance of the supply chain network of an organisation.

In the present scenario, the supply chain strategy of organisations aims at yielding business profits and staying competitive in the market. A supply chain strategy is formulated on the basis of pre-defined organisational goals and objectives. Thus, a supply chain strategy is aligned with the overall business strategy of an organisation. It focuses on optimising various supply chain activities, such as procurement, production, distribution, storage, and sales.

NOTES

Let us now try to understand the concept of supply chain strategy and its importance with the help of an example. Walmart provides different products at low prices and of reasonable quality under one roof. Thus, the supply chain strategy of Walmart is to provide products at lowest possible prices than its competitors. Walmart's main focus was on establishing a highly structured and advanced supply chain management strategy with an aim to achieve a high competitive advantage and market leadership position.

Self-Assessment Questions

1. A _____ can be defined as a plan of activities to be performed for meeting customers' requirements by delivering them products on time at the lowest possible cost.

2. A supply chain strategy of an organisation is formulated on the basis of pre-defined organisational goals and objectives. (True/False)

3. The supply chain strategy is aligned with the overall _____ strategy of an organisation.

2.3 Achieving Strategic Fit

An organization's supply chain strategy can only be effective if it is in line with the organization's overall business plan. This is the only way for the strategy to be successful. In this context, the word "strategic fit" refers to the need for an organization's supply chain strategy to be brought into alignment with its overall business strategy. To put it another way, it may be described as the consistency that exists between the customer demands that the business strategy seeks to fulfil and the supply chain capabilities that the supply chain strategy focuses on developing. An example of this would be the development of a corporate strategy inside an organisation with the purpose of catering to certain groups of consumer segments and meeting their requirements. In addition, the overall objective of an organization's corporate strategy is to attract clients by providing them with goods at prices that are lower than the market average. It is necessary for an organisation to make certain that its skills in the supply chain are able to support its business strategy in order to accomplish this. To achieve strategic fit, there are a few stages that must be taken, which are shown in Figure 2.1:

Understanding customer needs and supply chain uncertainties

Analysing supply chain capabilities

Achieving a strategic fit
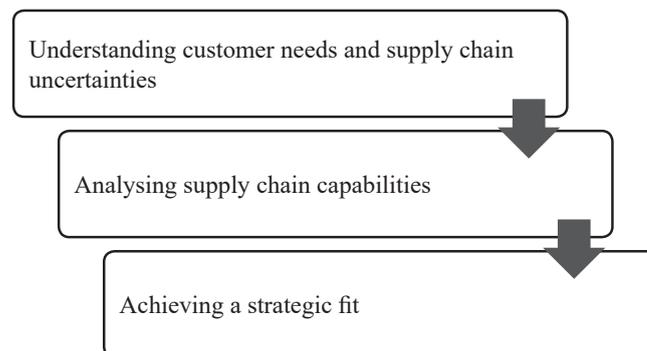
Fig. 2.1: Steps in Achieving Strategic Fit

Let us now discuss the steps in detail.

1. **Understanding customer needs and supply chain uncertainties:** The first step in achieving strategic fit is to recognise the needs of each targeted customer segment and uncertainties that a supply chain may face in meeting those needs. Understanding

customers' needs help the organisation to have a fair idea of the quality of service and cost required. This further helps the organisation to remain prepared for supply chain uncertainties, such as unpredictable delays, disruptions or inability to meet customers' demand.

Uncertainties in supply chain arise due to changes in customers' needs (in terms of product quantity, quality, variety, etc.), response time, level of service required, product price, innovation, and so on. Thus, supply chain capabilities should be properly aligned with customers' requirements so that strategic fit can be achieved.

2. **Analysing supply chain capabilities:** Achieving strategic fit is all about formulating a supply chain strategy that best meets customers' needs. For this, an organisation needs to understand its supply chain capabilities so that it can best make use of these capabilities in achieving strategic fit. An effective supply chain may have the following capabilities:

   ❍ Short response time

   ❍ A large variety of products

   ❍ High rate of product innovation

   ❍ High service level

   ❍ Lesser supply chain uncertainties

3. **Achieving a strategic fit:** This is the final step in achieving strategic fit wherein supply chain capabilities are matched with supply chain uncertainties. At this step, an organisation needs to ensure that its supply chain network and all its functional strategies support its supply chain capabilities.

Self-Assessment Questions

4. _____ can be defined as consistency between customer needs that the corporate strategy aims to satisfy and supply chain capabilities that the supply chain strategy focuses on building.

5. The first step in achieving strategic fit is to formulate a supply chain strategy that best meets customers' needs. (True/False)

6. Matching supply chain capabilities with supply chain uncertainties is the _____ step in achieving strategic fit.

Activity

Imagine yourself as the supply chain manager of an organisation of your choice. How would you achieve strategic fit in your organisation?

2.4 Obstacles in Achieving Strategic Fit

In order to achieve a strategic fit, an organisation needs to find a balance between responsiveness and effectiveness of competitive strategies and supply chain strategies. Over a period of time, with increased customer's demands, globalisation, and shortened product lifecycle, supply chain management has become all the more complex and dynamic. These changes have posed

a number of challenges for an organisation, which act as obstacles. An organisation can only overcome these obstacles if it has a proper understanding of them. Fig. 2.2 shows different obstacles that an organisation can face in achieving strategic fit:

| Increased variety of products |
| Decreased product lifecycle |
| Increased demands of customers |
| Fragmented supply chain ownership |
| Globalisation |
| Difficult execution of new strategies |
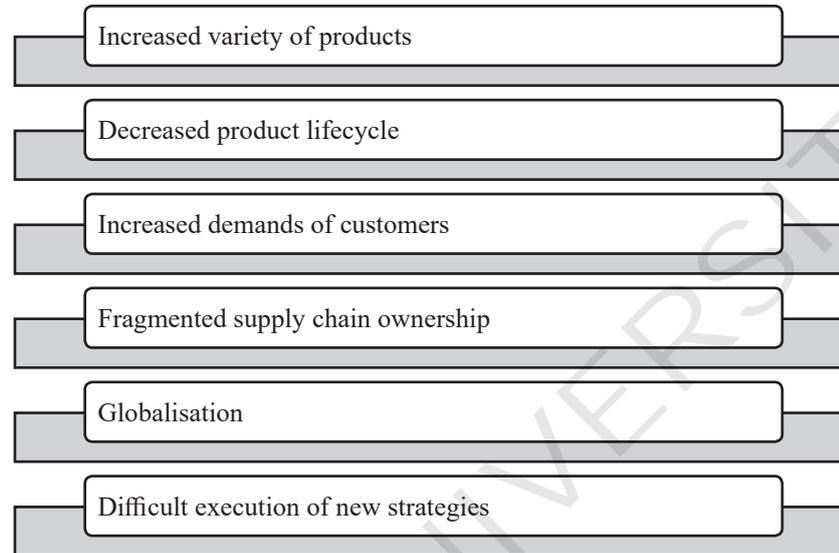
Fig. 2.2: Obstacles in Achieving Strategic Fit

Let us briefly discuss each of the obstacles in detail.

◆ **Increased variety of products:** Today, customers are more aware than before and need customised products. Thus, it has become essential for manufacturers to respond to mass customisation requirements and view each customer as an independent market segment. This will require manufacturers to provide an increased variety of products leading them to frequently develop new strategies or make frequent changes to their existing strategies. Frequent changes or development of strategies consume time and require high costs, which make it difficult for the organisation to attain strategic fit.

◆ **Decreased product lifecycle:** With an increase in product variety, the lifecycle of products has decreased. It has been reduced to months from years of lifecycle. This act as an obstacle in achieving strategic fit as the supply chain strategies need to be restructured frequently to meet the rising demands of products.

◆ **Increased demands of customers:** With a passage of time, customers' demands have changed in terms of response time, cost, and performance of the product. A customer today is not easily satisfied; thus, an organisation needs to frequently alter its competitive strategies.

◆ **Fragmented supply chain ownership:** Most organisations lack vertical integration and work on new ownership structures having lesser layers or no layers in the hierarchy. These new organisational structures have made supply chain management a challenge. This is because a chain divided into owners with their own set of priorities, policies, interests, and preferences. In such a case, running an integrated supply chain network is difficult for an organisation.

◆ **Globalisation:** Though globalisation has allowed organisations to conduct cross-border businesses, it has complicated the supply chain systems of organisations. It has become difficult for organisations to coordinate with suppliers across the globe as it is too time consuming and requires a lot of effort.

◆ **Difficult execution of new strategies:** Various factors, such as increased competition, globalisation, high customer demands, and organisational fragmentation, have made it difficult for organisations to execute new supply chain strategies or reframe the existing ones.

Self-Assessment Questions

7. In order to achieve a strategic fit, an organisation needs to find a balance between _____ and _____ of competitive strategies and supply chain strategies.

8. The increased variety of products has also increased the lifecycle of products. (True/False)

9. Which of the following obstacle allows organisations to have cross-border business but makes it difficult for organisations to coordinate with suppliers?

 a. Increased demands of customers

 b. Fragmented supply chain ownership

 c. Globalisation

 d. Difficult execution of new strategies

Activity

Select any manufacturer of your choice and write down the possible obstacles it would face while attaining the strategic fit.

2.5 Strategic Supply Chain Decisions

In an organisation, a supply chain operates at three levels namely, strategic, tactical, and operational level. At all these levels, supply chain decisions are taken considering the corporate strategy of the organisation. Supply chain decisions are important as they determine the overall direction of the organisation's supply chain. Good decisions help in improving asset efficiency, reduction in transportation and inventory costs, shorter cycle times, etc. Let us discuss some of the major supply chain decisions taken by organisations.

◆ **Decisions related to facilities:** Two major facilities in the supply chain are production facilities and storage facilities. While designing its supply chain network, organisations need to make decisions related to supply chain facilities. These decisions can be related to the following:

 ❍ **Deciding the type of facility**: There can be two types of flexible facilities and dedicated facilities. A flexible facility can produce or store different types of products at the same time. However, this type of facility is less efficient. On the other hand, the dedicated facility can produce or store the same kind of products. Such type of facility is more efficient. The selection of the type of facility depends on the level of production and type of products produced by an organisation.

 ❍ **Deciding the location of facility:** Some organisations prefer to select centralised facilities, while some go for decentralised ones. At a centralised facility, production and storage of products is done at a single place. On the other hand, decentralised facilities are more responsive as they are set up at different locations, which are nearer to customers so that their needs can be immediately met.

◆ **Decisions related to inventory:** Inventory is the stock of raw material, work-in-progress, and finished goods that organisations need to store to meet customers' requirements. The decisions related to inventory includes the following:

○ **Deciding the level of inventory:** Here, an organisation needs to decide the extent of inventory to be maintained so that customer needs can be fulfilled successfully. An organisation should decide an optimal level of inventory. This is because excess inventory leads to high costs and wastage, while the shortage of inventory results in unnecessary delays in production and product delivery.

🔍 **Exhibit**

Inventory Levels

Too much or too little inventory hurts any business. Without enough inventory, the company will have frequent stock-outs and excessive ordering costs. However, overstocking occurs when inventory levels are excessively high. Thus, an organisation must maintain optimal inventory levels. Organizations maintain the following inventory levels:

◆ **Minimum inventory level**: It shows the constant inventory rate an organisation must maintain. Minimal production is safer since emergency supplies may be conserved. So, emergency reserve inventory is termed minimum inventory. Level must never drop below 0. When inventory drops below the minimum, material shortages slow the company's production process. The minimal inventory level formula:

Minimum inventory level = Reordering level − (Normal consumption × Normal reorder period)

Or

Minimum inventory level = Reorder level − (Average Rate of Consumption × Lead time)

◆ **Reordering level:** The inventory rate at which an organisation reorders items. Thus, when inventory drops below a given level, a fresh order is placed for supplies. Before raw material inventories drops to a minimum, the order is sent. Reordering level is between minimum and maximum inventory levels. Formula for calculating reordering level:

Reordering level = Maximum consumption × Maximum reorder point

Or

Reordering level = Lead time (in days) × Average daily usage

◆ **Maximum inventory level:** It refers to the maximum amount of inventory that an organisation should keep with itself. The organisation should not go beyond the maximum inventory level because it would unnecessarily increase inventory holding cost. The formula to calculate the maximum inventory level is as follows:

Maximum inventory level = (Reordering level + Reordering quantity) − (Minimum consumption × Minimum reordering period)

The maximum inventory level depends on the following factors:

○ Rate of consumption of the materials

○ Time required to receive deliveries

○ Amount of capital available

○ Storage space available

○ Possibility of loss due to evaporation and deterioration

○ Current market conditions

○ Economic ordering quantity

○ Government restrictions as in the case of explosive materials

○ Staff and other facilities available for the maintenance of stores

○ Total maintenance cost

○ Need of buffer inventory (safety inventory) in relation to active inventory

◆ **Danger level:** It is the level beyond which inventory should not fall in any case. If the danger level arises, then the immediate steps should be taken to replenish the inventory, even if more cost incurs in arranging the materials. Danger level is determined by the following formula:

Danger level = Average consumption × Maximum reordering point for emergency purchases

There are many factors that affect the inventory levels of organisations. Some of these factors are explained as follows:

◆ **Operational needs:** Organizations' inventory levels rely on output. High-production companies must have the most inventory. An organisation that produces only after receiving consumer orders must maintain a minimum inventory level.

◆ **Delivery time:** This is when requested supplies are sent. Organisations can experience material delivery delays for numerous reasons. These circumstances occur during holidays, bad weather, conflicts, and technological breakdown. In such instances, an organisation must retain enough inventory for production and sales.

◆ **Availability of capital:** It is the major factor that affects inventory levels. An organisation needs to maintain a level of inventory according to the capital available. This is because if the organisation goes beyond the total capital available, it would adversely affect the overall budget of the organisation.

◆ **Cost of storage:** It indicates another crucial factor that influences the inventory level maintained by an organisation. Higher the level of inventory maintained by an organisation, the higher would be the storage cost.

○ **Deciding the inventory control measures:** Inventory control can be defined as a process of supervising the supply, storage, and accessibility of products with an aim to ensure their adequate supply. Just-in-time (JIT) and Economic Order Quantity (EOQ) are the two most common inventory control measures used by organisations.

◆ **Decisions related to transportation:** Transportation related decisions involve determining an optimal plan for the distribution of products from supply centres (sources) to various receiving centres (demand destinations) in such a way so that the total transportation cost is minimised. Transportation plays a vital role in smooth supply chain operations by repositioning inventory among different plants and distribution centres and delivering finished products to end users. Transportation decisions involve the following:

o **Deciding the mode of transportation:** It involves the way or manner in which products would be moved from one location to another in the transportation network. The modes of transportation may include on road, air, water, or rail transportation. An organisation takes decisions on the basis of speed, time, and the cost of shipment.

o **Deciding transportation costs and other aspects:** Transportation decisions also involve determining the cost incurred on moving products from one place to the other. These decisions also involve determining general nature of product flows, including volume, frequency, seasonality, physical characteristics, and special handling requirements.

◆ **Decisions related to sourcing:** These decisions involve making a choice of who will perform major activities and functions of the supply chain. Supply chain functions can be performed within the organisation or may be outsourced. This affects the responsiveness and effectiveness of the supply chain process. If an organisation goes for in-house operations, all supply chain activities starting from manufacturing to product delivery are performed by the organisation itself. On the other hand, when an organisation outsources its supply chain process, it needs to select suppliers for delivering products to customers. Supplier selection is generally done based on the reputation and level of commitment of suppliers.

Self-Assessment Questions

10. In an organisation, a supply chain operates at three levels namely, _____, _____ and _____ level.

11. Inventory is the stock of raw material, work-in-progress, and finished goods that organisations need to store to meet customers' requirements.(True/False)

12. _____ can be defined as a process of supervising the supply, storage, and accessibility of products with an aim to ensure their adequate supply.

2.6 Summary

◆ In order to establish supply chain systems, an organisation needs to have supply chain strategies that aim at yielding business profits and help in the organisation to stay ahead of competition.

◆ The supply chain strategy of an organisation is aligned with its overall business strategy and focuses on optimising various supply chain activities, such as procurement, production, distribution, storage, and sales.

◆ There are certain steps involved in achieving strategic fit namely understanding customer needs and supply chain uncertainties, analysing supply chain capabilities, and achieving a strategic fit.

◆ In order to manage supply chain effectively, an organisation needs to have its supply chain strategy in sync with the overall business strategy of the organisation.

◆ With the passage of time, the supply chain management system has become more dynamic and complex which has also given rise to various obstacles that makes it difficult for the organisation to attain strategic fit.

◆ Proper understanding of obstacles can help an organisation to overcome them. Various obstacles are increased variety of products, decreased product lifecycle, increased demand of customers, globalisation, etc.

◆ A supply chain operates on three levels in an organisation namely strategic, tactical, and operational level. Supply chain decisions are taken at these levels to determine the overall direction of supply chain.

◆ Some of the major supply decisions taken by an organisation can be related to facilities, inventory, transportation, and sourcing.

2.7 | Glossary

◆ **Corporate social responsibility:** It is a voluntary activity taken up by an organisation that benefits the society and the environment.

◆ **Corporate strategy:** It is the business strategy of an organisation which is based on its vision and mission.

◆ **Product lifecycle:** It is referred to as the period of time over which a product is developed, introduced in the market, and removed from the market.

◆ **Response time:** It is the time taken by a supplier in delivering a product to the customer after an order is placed.

2.8 | Terminal Questions

1. Write a short note on supply chain strategies.

2. Explain various steps involved in achieving strategic fit.

3. What are various obstacles that an organisation face while attaining a strategic fit?

4. Write in brief about various factors that help in making strategic supply chain decisions.

2.9 | Answers

Q.	Self Assessment Questions
1.	Supply chain strategies
2.	True
3.	Business
4.	Strategic fit
5.	False
6.	Final
7.	Responsiveness, effectiveness
8.	False
9.	c. globalisation
10.	Strategic, tactical and operational
11.	True
12.	Inventory control

Q.	Terminal Questions
1.	In order to remain in rising competition, organisations need to develop competitive supply chain strategies which are flexible, reliable and cost-effective. Refer to section **2.2 Competitive Supply Chain Strategies**.
2.	There are three basic steps involved in achieving strategic fit, namely understanding customer needs and supply chain uncertainty, analysing supply chain capabilities, and achieving strategic fit. Refer to section **2.3 Achieving Strategic Fit**.
3.	An ever-growing complex and dynamic supply chain system has also given rise to various obstacles, such as increased variety of products and decreased product life-cycle. Refer to section **2.4 Obstacles in Achieving Strategic Fit**.
4.	A supply chain operates at three levels in an organisation namely strategic, tactical, and operational. Some of the major decisions taken by organisations are decisions related to facilities, inventory, transportation, and sourcing. Refer to section **2.5 Strategic Supply Chain Decisions**.

2.10 Case Study: Supply Chain Management at Zara

Zara is a fashion store owned by Inditex, which is the largest apparel manufacturer in Spain. Being in the fashion industry, Zara is committed to meet customers' fashion expectations. In 2004, it did business of 13 billion euros leaving most of its competitors wondering about its strategies and consistency. Zara not only developed suitable strategies but also responsive and efficient ones, which are able to meet fluctuating demands. This is reflected well in the design-to-sale cycle at Zara, which is five to six weeks long, whereas an average apparel manufacturer has it for six months. This outstanding design-to-sale cycle allows Zara to introduce designs every week meeting increasing demands of customers about design and variety enabling Zara to stay ahead of its competitors even in stiff market competition. Besides having speedy production, Zara makes use of quick and flexible sources for its production process as the most of the Zara's sources are there in Portugal and Spain. However, it has outsourced some low-cost supply chain activities to Asia. Zara's strategy is in contrast with the strategies followed by most of apparel manufacturers who have shifted a majority of manufacturing units to Asia. Therefore, the combination of both in-house and outsourced manufacturing allow Zara to reduce on unwanted inventories and forecast errors. Zara also makes the best use of transportation by having a central distribution centre at Spain. It moves shipments from the distribution centre to different store locations twice a week, which allows Zara to have a close match between store inventory and customers' demands.

Discussion Questions

1. How Zara is able to beat most of its competitors in meeting the demands of customers?

   (**Hint**: Highly responsive and efficient strategies at Zara allow it to beat most of its competitors in the market.)

2. How does Zara use its transportation for effective supply chain?

   (**Hint**: Zara has a single distribution centre at Spain from where its shipments are moved twice a week at various stores.)

2.11 References and Suggested Readings

◆ Chopra, S., Meindl, P., Qiao pu la., & Chen, R. (2008). Gong ying lian guan li (1st ed.). Beijing: Zhongguo ren min da xue chu ban she.

◆ Hugos, M. (2003). Essentials of supply chain management (1st ed.). Hoboken, N.J.: John Wiley & Sons.

◆ Simchi-Levi, D., Kaminsky, P., & Simchi-Levi, E. (2000). Designing and managing the supply chain (1st ed.). Boston: Irwin/McGraw-Hill.

E-references

◆ Lcm.csa.iisc.ernet.in,. (2014). An Introduction to Supply Chain Management. Retrieved 21 August 2014, from http://lcm.csa.iisc.ernet.in/scm/supply_chain_intro.html

◆ Limited, I. (2014). Infosys | SCM practice. Infosys.com. Retrieved 21 August 2014, from http://www.infosys.com/supply-chain/

◆ Scm.ncsu.edu,. (2014). What is Supply Chain Management? - SCM | Supply Chain Resource Cooperative (SCRC) | North Carolina State University. Retrieved 21 August 2014, from http://scm.ncsu.edu/scm-articles/article/what-is-supply-chain-management

CHAPTER

3

Metrics and Drivers of Supply Chain

Structure

Learning Objectives

After completing the chapter, you will be able to:

❑ explain the importance of supply chain drivers

❑ describe the framework for structuring drivers

❑ identify different metrics used for measuring supply chain performance

❑ discuss the concept of next generation supply chain

3.1 Introduction

In the previous chapter, you have studied about a supply chain strategy, which is a long-term plan of a value chain to meet customer demands at the lowest possible cost. However, the success of a supply chain strategy depends on supply chain drivers. A supply chain driver is a factor that determines the competitiveness and responsiveness of an organisation with respect to its supply chain network. Supply chain drivers act as metrics to measure the performance of the supply chain network of an organisation.

There are six major supply chain drivers among them three are logistical drivers and the others are cross-functional drivers. Logistical drivers are involved in the movement of products from a supply centre (organisation) to the demand centre (end users). On the other hand, cross-functional drivers contribute to the effectiveness of a supply chain in alignment with other organisational functions, such as manufacturing, marketing, and sales. Logistical drivers include facilities, inventory, and transportation, while cross-functional drivers are information, sourcing, and pricing.

In a supply chain, facilities refer to the physical sites where products are made, put together, and kept. Inventory comprises all raw materials, work-in-progress, and finished goods within a supply chain. Transportation involves the movement of products from one location to another. Information is employed to organize day-to-day supply chain activities linked to the operation of other supply chain factors. Sourcing entails a series of business processes used to buy and distribute products and services. Pricing is focused on determining the amount an organisation would ask for making products and services accessible in the supply chain. In this chapter, you will study about supply chain drivers in detail.

3.2 Supply Chain Drivers

In today's dynamic business world, having an upper hand in competition has become a requirement for every organisation. For this, organisations have begun to adopt various technologies and processes to align their supply chain capabilities with their business strategies. This has forced organisations to strike a balance between supply chain responsiveness and efficiency. To maintain a balance, organisations are required to analyse different supply chain drivers and use them optimally. A supply chain driver can be defined as a factor that helps in making a supply chain responsive and efficient. There are six main supply chain drivers, which are listed in Fig. 3.1:
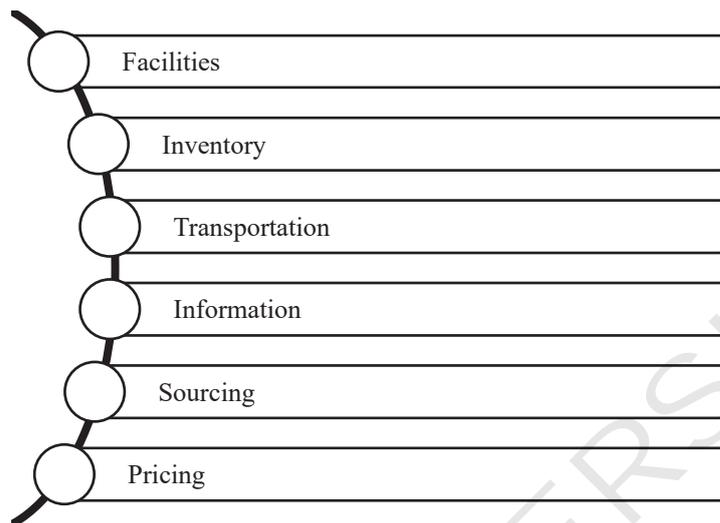
Fig. 3.1: Supply Chain Drivers

The performance of a supply chain depends on interaction between these six supply chain drivers. These drivers are discussed in detail in the subsequent sections.

3.2.1 Facilities

The physical sites inside the supply chain network that are used for the purposes of producing, storing, or shipping items are referred to as facilities. Factory locations, plant sites, distribution centres, and warehouses are the types of facilities that are used in supply chain networks the most often. When it comes to the responsiveness and efficiency of the supply chain, the choices that are made regarding the location, capacity, and flexibility of facilities have a significant influence. For instance, a distributor that is interested in providing a prompt response to the requirements of their consumers can choose a site that is in close proximity to consumption centres.

It should be remembered that facilities are used in different forms in supply chain. For example, facilities used for converting inputs into output are called production/manufacturing plants. Similarly, when materials are stored at a facility, it becomes a warehouse. Irrespective of their type, facility decisions of organisations are always long term, therefore, are fixed and difficult to be changed in short periods. Therefore, various factors are taken into consideration before making facility decisions, such as production capacity, transportation costs, uncertainties in the market, and customer demand.

3.2.2 Inventory

Inventory can be defined as a stock of goods or materials held by a business for the purpose of production and sales. It comprises raw materials (these are inputs used to produce output), work-in-progress (these are semi-finished goods used for production), and finished goods (these are final output). In supply chain, an adequate amount of inventory helps organisations to increase the availability of products and meet increasing customer demands. Moreover, an organisation needs to determine an optimal level of inventory in order to avoid the situations of overstocking and understocking.

There are different types of inventories held by an organisation. These inventories are categorised by considering their role in the overall process of customer satisfaction.

There are five main types of inventories maintained by an organisation, as shown in Fig. 3.2:
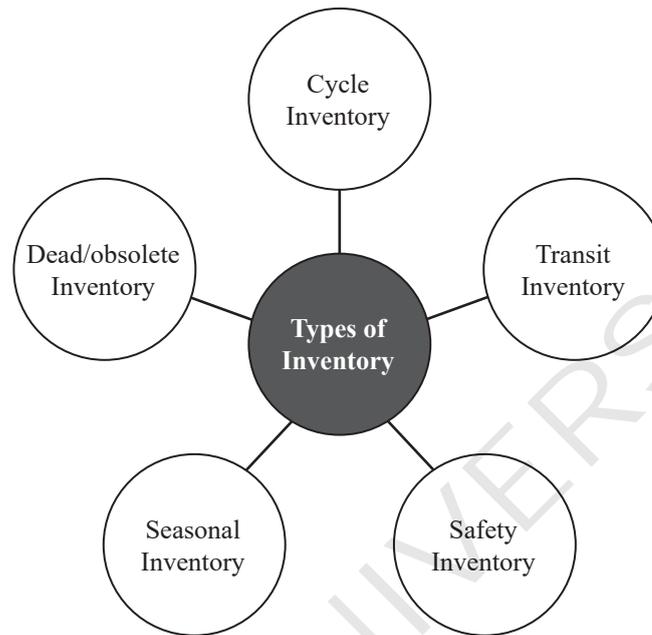
Fig. 3.2: Types of Inventory

Let us discuss these types of inventories in detail.

- ◆ **Cycle inventory:** The stock segment available (or expected to be available) to fulfill regular demand during a specific period. This inventory is necessary only if there is a clear understanding of both demand and supplier lead times.

- ◆ **Transit inventory:** Inventory dispatched by a seller but not yet received by the buyer. Significant distances between manufacturing and consumption centers contribute to increased transportation inventories.

- ◆ **Safety inventory:** An organization maintains additional inventory to manage stockouts. Safety inventory is greater than cycle inventory to accommodate demand, supply, and production uncertainties.

- ◆ **Seasonal inventory:** An organization holds seasonal inventory to address changes in demand during specific times of the year. For instance, umbrella demand increases during the rainy season. Seasonal inventory is kept to mitigate the impact of demand fluctuations or shortages caused by unpredictable supply.

- ◆ **Dead/obsolete inventory:** This refers to inventory consisting of specifically non-moving items that may not be in demand in the future.

Inventory, if effectively managed, plays a significant role in making a supply chain more responsive and efficient. For instance, an organisation can become more responsive by keeping a large amount of inventory closer to consumption centres.

3.2.3 Transportation

Transportation is the movement of products from one place to another (for instance, supplier to manufacturer). It is the most important driver of a supply chain as it directly affects product delivery schedules of organisations. The type of transportation selected by an organisation plays an important role in ensuring the responsiveness and efficiency of a supply chain. If

an organisation adopts faster transportation, the supply chain becomes more responsive. Let us understand this with the help of an example. The supply chain of 7-Eleven retail stores in Japan is a classic example of perfection. The organisation aims at moving products in its stores spread across various geographical locations to match customers' needs. For this, the organisation utilises a responsive transportation system to replenish its stock many times a day to ensure product availability. Moreover, with a responsive transportation system, 7-Eleven has also managed to reduce its transportation costs. In this way, the organisation has carved a niche for itself in the market by delivering satisfaction to customers.

To make the transportation cost effective and responsive, an organisation needs to make strategic decisions at various levels of a supply chain. These decisions are explained as follows:

◆ **Long-term decisions**: These decisions are related to the availability and appropriateness of transportation modes to be used for a long period of time. Managers decide the primary mode of transportation to be used for appropriate inbound, inter-facility, and outbound movement of goods. For this, they need to consider opportunities that feasible in terms of cost and responsiveness. In addition, managers need to decide the level of outsourcing required for product flows. For instance, to centralise stock locations, contract transportation can be used to move products to regional cross-dock facilities for sorting, packaging, and delivering small loads to individual customers.

◆ **Decisions related to lane operations:** These decisions are associated with daily operational freight transactions. At this level, managers use real-time information to coordinate product movements along inbound, inter-facility, and outbound shipping lanes to meet customers' demands in an economical manner. The primary areas considered in lane operations decisions include inbound/outbound consolidation, temporal consolidation, vehicle consolidation, and carrier consolidation.

◆ **Decisions related to the selection of transportation mode:** At this level, managers select the mode and carrier for the movement of goods in a particular freight transaction. For instance, rail container services can be used to cover long distances in a cost effective manner. On the other hand, truck load carriers are suitable for overnight freight movements to make delivery in 24 hours at economical rates.

3.2.4 Information

Information is consolidated data related to various aspects of supply chain, such as facilities, transportation, costs, prices, suppliers, and customers. Supply chain is a crucial function of an organisation as all business activities of an organisation largely depend on this function. Thus, the supply chain function of an organisation requires accurate and timely information. Without adequate information, it would be difficult for an organisation to perform various supply chain activities, such as transportation planning, inventory control, warehouse management, development of customer service standards, and procurement in the design and operation of supply and distribution systems.

Information is one driver that affects greatly other drivers; therefore, it has the most important role in supply chain. For instance, if a pharmaceutical organisation has information on customer demand patterns, it can produce appropriate quantities of products in response to the anticipation of demand. This would ultimately lead to a more responsive and efficient supply chain process. In a supply chain, all the important decisions made by supply chain managers are made on the basis of information available. Accurate information provides insight into the different stages of supply chain; thereby improving coordination and maximising total profitability.

3.2.5 Sourcing

The term "sourcing" refers to the process of making choices for the selection of suppliers for different activities located throughout the supply chain. These activities include manufacturing, storage, transportation, and information management. That is to say, it is about determining whether the tasks of the supply chain will be carried out in-house or if they will be contracted out. One of the most significant factors that determines how responsive and efficient a supply chain is the sourcing process. It is possible to comprehend this with the assistance of an illustration. When Motorola decided to outsource a significant portion of its manufacturing to China, the company saw a significant increase in its efficiency. But the organization's responsiveness decreased as a result of the vast distance, which led to a rise in both the price of transportation and the amount of time it took to deliver the goods.

It is the responsibility of managers to decide which tasks will be outsourced throughout the process of sourcing choices. When the jobs that are to be outsourced have been identified, the next step for managers is to select whether they will source from a single provider or from several vendors. In the event that numerous suppliers are to be chosen, it is necessary to build a portfolio that clearly defines the individual roles that each provider will play. Following that, it is necessary to establish criteria for the selection of suppliers and the evaluation of their performance by the organisation. The criteria are used by supply chain managers to identify supply chain vendors and then negotiate contracts with those suppliers. In order to enhance the performance of the supply chain and reduce the amount of information distortion that occurs between the different phases of the supply chain, the roles that each supply source plays need to be adequately designed.

Sourcing decisions directly affect the efficiencies and responsiveness of a supply chain. Organisations generally outsource their supply chain functions when in-house supply chain requires a huge cost. This situation usually arises in small organisations having limited funds. On the other hand, in large organisations, supply chain processes are performed in-house. This helps organisations in maintaining proper control on the supply chain process. In some cases, organisations outsource their supply chain functions to enhance their responsiveness and focus on their core competencies. Thus, outsourcing decisions must be driven by the aim of increasing supply chain profitability.

3.2.6 Pricing

In the context of the supply chain, pricing refers to the process of establishing the amount of money that an organisation requires in order to make its goods and services accessible to customers. Price is the primary factor that plays a significant role in determining the purchasing choices of consumers. Besides this, price is another factor that plays a significant role in ensuring that the supply and demand of a product in the market are correctly matched. For instance, in order to get rid of supply surpluses, businesses provide clients with discounts for a certain period of time. Pricing is thus a significant component that has an impact on the volume of demand as well as the sort of demand that the supply chain will encounter in the potential future.

With the assistance of an illustration, let us have a better understanding of the significance of price within the supply chain. Cotsco is a warehousing organisation in the United States that operates on a membership basis and offers a diverse selection of items. As part of its philosophy, the organisation has decided to maintain a pricing that is both consistent and affordable for its goods. The demand for Cotsco's goods is reasonably constant as a result of the company's consistent pricing, since consumers are ready to wait for the convenience of availability. Cotsco is working to attract a diverse range of clients by means of its price

strategy. Some of these customers want immediacy, while others require efficiency. A consequence of this is that the organization's supply chain is organised in a manner that takes into consideration the various pricing policies as well as the needs of the consumers.

Self-Assessment Questions

1. Which of the following is not a supply chain driver?

   a. Facilities   b. Inventory

   c. Supply   d. Pricing

2. _____ refers to inventory that has been shipped by a seller but has not yet been received by the purchaser.

3. While making sourcing decisions, tasks to be outsourced are determined by managers. (True/False)

4. _____ decisions are related to the availability and appropriateness of transportation modes to be used for a long period of time.

Activity

Using various sources, such as magazines, newspapers, and journals, find two examples of Indian organisations whose supply chain is responsive and efficient.

3.3 Framework for Structuring Drivers

As discussed earlier, the supply chain of every organisation aims at striking a balance between responsiveness and efficiency in alignment with the organisation's competitive strategy. For this, organisations need to structure an appropriate combination of all the six drivers (discussed in the previous section) of supply chain. All these drivers interact with each other to determine the responsiveness of the supply chain. The framework for structuring these drivers is shown in Fig. 3.3:
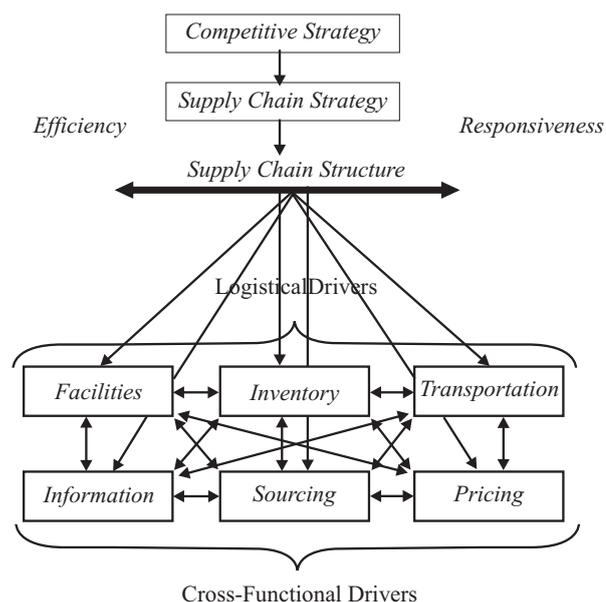
Fig. 3.3: Supply Chain Framework
(**Source:** Supply Chain Management (Strategy, Planning, And Operation) by Sunil Chopra and Peter Meindl)

From Fig. 3.3, it can be said that the supply chain strategy must support the competitive strategy of an organisation. A supply chain strategy aims at achieving efficiency and responsiveness. To perform supply chain activities successfully, both logistical drivers (facilities, inventory, and transportation) and cross-functional drivers (information, sourcing, and pricing) are used. Logistical drivers are those that focus on the movement of products from one place to the other. On the other hand, cross-functional drivers focus on interaction between various activities performed in different departments of an organisation. Let us understand the framework of supply chain drivers with the help of an example.

XYZ is a large retail organisation whose competitive strategy aims at achieving efficiency and responsiveness through its supply chain. For this, the organisation can encompass both logistical and cross-functional drivers in its supply chain in the following manner:

- The organisation can keep low levels of inventory to maintain supply chain efficiency.

- To increase responsiveness, XYZ can use its own fleet that can boost product availability.

- XYZ can also use centrally located distribution centres to enhance the efficiency of its facilities and reduce their number.

- The organisation can maintain a smooth flow of information sharing throughout its supply chain network to improve responsiveness.

- XYZ can determine efficient and reliable sources to sell its products by defining valid criteria for supplier selection.

- The organisation can go for everyday low pricing (EDLP) scheme to ensure steady demand for its products.

Thus, by using a structured framework of supply chain, XYZ can create sync between its competitive strategy and supply chain strategy.

Self-Assessment Questions

5. The supply chain of every organisation aims at striking a balance between _____ and _____in alignment with the organisation's competitive strategy.

6. Which one of the following is a logistical driver?

    a. Information

    b. Sourcing

    c. Inventory

    d. Pricing

7. Logistical drivers focus on interaction between various activities performed in different departments of an organisation. (True/False)

3.4 Managing Supply Chain Performance

With growing competition, organisations keep on improving their supply chain performance so that they can meet customer needs on time. For this, organisations need to constantly check the performance of its supply chain by using various metrics. Every metric measures the performance of supply chain differently. Thus, it is important for an organisation to prioritise metrics based on their usage and importance in measuring the performance of supply chain.

For example, some organisations use metrics that are easy to be applied; however, these metrics do not provide a true picture of supply chain performance. On the other hand, some organisations use metrics that focus on the performance of the logistics department only, which may bring a negative impact on the other parts of a supply chain.

As a large number of metrics are available for the organisation to select from, there are essential requirements that should be looked for while making the final selection. The following are some important pre-requisites for the selection of an effective supply chain metric:

- A metric should be easy to understand so that the performance of supply chain can be measured effectively.

- It should be expressed by an objective value for providing correct measurements.

- It should provide consistent results after each measurement process.

- It should accurately measure processes in the relevant business context.

- It should be retrievable at affordable costs.

Let us now discuss different metrics used for assessing supply chain performance in the next section.

3.4.1   Metrics Used for Measuring Supply Chain

Measuring supply chain's performance is a cumbersome process and involves various activities such as tracking the current status of shipments, monitoring inventory levels, and ensuring that the right orders are shipped to the right places. Therefore, various metrics are developed to measure the performance of a supply chain. Although there are numerous metrics for measuring supply chain performance, some commonly used metrics are discussed as follows:

- **Estimating inventory carrying cost**: Carrying costs are incurred by an organisation to store inventory over a given period of time. To calculate inventory carrying costs, the following formula is used:

  Inventory carrying cost = Inventory carrying rate × Average inventory value

  Organisations use this metric to determine the expected profits on their current inventory. Moreover, suppliers can map out their production cycles by calculating inventory carrying costs.

- **Determining inventory turnover:** It involves determining the number of times an organisation has sold its complete inventory. The formula to calculate inventory turnover is as follows:

  Inventory turnover = Cost of goods sold / Average inventory

  Inventory turnover indicates the quality and demand of inventory carried in an organisation. Low turnover rate is an indicator of inefficiency in supply chain, which leads to difficulties in generating revenues. Thus, inventory turnover must be high.

- **Calculating inventory to sales ratio**: It involves measuring the amount of inventory carried by an organisation in comparison to the number of sales orders completed. It can be stated as:

  Inventory to sales ratio = (Inventory value) / (Sales value)

◆ **Calculating cash-to-cash cycle time:** It includes measuring the amount of time operating capital is tied up. If the cash-to-cash cycle runs fast, a supply chain is profitable for an organisation. It can be calculated by using the following formula:

Cash-to-cash cycle time = Materials payment date – Customer order payment date

◆ **Finding the rate of return:** It involves determining the rate at which shipped items are returned to an organisation. By doing so, the organisation can determine the reason for returns and identify the ways to reduce them.

◆ **Estimating back order rate:** This involves determining the number of orders that cannot be processed at the time of order placement. A high back order rate indicates that customers are forced to wait while an organisation tries to process order. This may adversely affect customer satisfaction. Therefore, the aim of every organisation is to achieve low back order rate.

◆ **Determining perfect order rate**: It involves identifying orders that have been shipped without any incident of damaged goods, inaccurate orders, or late shipments. A high perfect order rate is an indicator of organisational efficiency and high customer satisfaction.

◆ **Determining fill rate**: This involves finding out the percentage of orders processed through the first shipment. Fill rate can also be represented as the percentage of items included in the first shipment. It can be calculated using the following formula:

Fill rate = {1 − [(total items – shipped items) / total items]} * 100

◆ **Determining an average payment period for production materials:** It is the average time taken from the receipt of materials and payment for those materials. It can be calculated using the following formula:

Average payment period for production materials = (Materials payables/Total cost of materials) × Days in period

Longer the average payment period, greater is the efficiency of supply chain.

3.4.2 Next Generation Supply Chain

The advent of globalisation and changing customer needs have forced organisations to act swiftly and decisively. Due to changing trends, organisations now focus on new goals of establishing themselves in the market to grab new opportunities; introducing innovation to differentiate them from the crowd; managing social, political, geographical, and other business challenges. For this, organisations have begun to realise the need to bring advancement in their existing supply chain so that it remains responsive and efficient in the future too.

As organisations focus on achieving competitive differentiation along with customised service offerings, the traditional supply chain practices are no longer relevant. Therefore, there are four key practices that can support in the transformation of existing supply chain of an organisation in the next generation of robust and intelligent supply chains. These practices are discussed as follows:

◆ **Supply chain visibility and transparency**: To create a visible and transparent supply chain, an organisation needs to ensure that all the relevant information can be accessed by all key players through any device at any time. The information must be inclusive of real time data associated with orders and shipments and historical assessment of

demand trends and supplier performance. By bringing visibility and transparency, an organisation can:

- ❏ Improve supplier performance.

- ❏ Decrease operating costs.

- ❏ Reduce variations in demand schedules and orders.

- ❏ Enhance the trust between manufacturers and suppliers.

- ❏ Improve supply chain's responsiveness.

- ◆ **Optimisation of decisions:** With rise in multinational organisations, supply, manufacturing, and distribution networks have become globally located. Moreover, there has been a flood of information from a variety of sources through the Internet. Thus, a need for the optimisation of data also arises to make rational decisions for improving the responsiveness of a supply chain. For this, various optimisation algorithms and systems have been created so that data can be transformed into insights leading to a reduction in costs. Various organisations have begun to develop customised solutions for supply chain activities by adjusting various network parameters, such as supplier and transport lead tad times, economic order quantities, safety stock, reorder points, and demand forecasts.

- ◆ **Streamline operations**: In addition to creating visibility and transparency, organisations must streamline their operations with that of supply chain decisions. The following are the requirements for streamlining operations:

- ❏ An integrated and transparent information system which is accessible by everyone in the network

- ❏ A resilient and secure information technology infrastructure for creating competitive differentiation

- ❏ Automated and established workflows

- ❏ Well defined metrics aligned at all levels in organisation

- ❏ Cross-functional interactions

- ◆ **Development of a risk management program**: There can be various factors, such as uncertain economic conditions and natural calamities that can increase the risks involved in the performance of supply chain. Thus, organisations need to prepare themselves for such uncertainties; otherwise these risks can have a significant financial impact. In such crises, recovery becomes expensive. Therefore, many organisations have begun to follow a proactive approach to manage the unpredictability. To manage the risks of a dynamic nature, following are the four steps that can be followed:

- ❏ Firstly, all the critical parameters must be monitored for early detection of potential problems.

- ❏ Secondly, predictive analysis must be conducted to determine the probability and severity of potential risks.

- ❏ Thirdly, a prioritised set of actions must be created to minimise the impact of risks on the organisation.

Lastly, preventive or corrective actions taken must be tracked on a regular basis to understand managing future incidents.

📝 Self-Assessment Questions

8. Every metric measures the performance of supply chain in the same way. (True/False)

9. _____ = Cost of goods sold / Average inventory.

   a. Inventory turnover

   b. Inventory carrying cost

   c. Cash-to-cash cycle time

   d. Back order rate

10. To create a visible and transparent supply chain, an organisation needs to ensure that all the relevant information can be accessed by all key players through any device at any time. (True/False)

🖥 Activity

Using the Internet, find supply chain performance metrics used by a retail store in your nearby area. Prepare a report on it.

3.5 Summary

- A supply chain driver is a factor that supports in the creation of a responsive and efficient supply chain.

- There are mainly six supply chain drivers, namely facilities, inventory, transportation, information, sourcing, and pricing.

- Facilities can be described as physical locations in the supply chain network used for manufacturing, storing, or transporting products. The most commonly used facilities are factories, plant sites, distribution centres, and warehouses.

- Inventory can be defined as a stock of goods or materials consisting of raw materials, work-in-progress, and finished goods held by a business for production and sales.

- Transportation can be defined as the movement of goods from one place to another in a supply chain.

- Information is consolidated data retrieved from various sources related to various aspects of supply chain, such as facilities, transportation, costs, prices, suppliers, and customers.

- Sourcing can be defined as the selection of suppliers for various supply chain activities, such as production, storage, transportation, and information management.

- Pricing is all about determining the amount to be charged by an organisation from its customers for producing goods and services in the supply chain.

- To create a balance between responsiveness and efficiency, an organisation is required to structure a framework wherein all supply chain drivers interact with each other.

- In order to measure the performance of a supply chain, organisations use various metrics, such as estimating inventory carrying cost, determining inventory turnover, and calculating inventory to sales ratio.

◆ To develop the next generation of robust and intelligent supply chains, four key practices are identified, namely supply chain visibility and transparency, optimisation of decisions, streamline operations, and development of risk management programs.

3.6 Glossary

◆ **Core competencies:** It is a combination of knowledge and technical capacities of an organisation making it a leader in the market.

◆ **Lead times**: It is a period of time between beginning and execution of a process.

◆ **Inventory control:** It is a process of supervising and managing supply, storage, and accessibility of materials to maintain an adequate supply for fulfilling current customer needs.

◆ **Stock outs**: It is an inventory shortfall occurring due to unforeseen demand, inefficient management of inventory, delays in production, and disruptions in replenishment.

◆ **Temporal consolidation:** It is a process of combining various orders at a certain time during a day to manage batch transactions in a supply chain.

◆ **Warehouse management**: It is a process of controlling the movement and storage of materials within a warehouse.

3.7 Terminal Questions

1. Discuss the types of inventory maintained in an organisation.

2. Write a short note on information driver of supply chain?

3. Discuss the framework for structuring drivers in a supply chain.

4. What are the pre-requisites of an effective supply chain metric?

5. List practices that help in the development of next generation supply chains.

3.8 Answers

Q.	Self Assessment Questions
1.	c. Supply
2.	Transit inventory
3.	True
4.	Long-term, decisions
5.	Responsiveness, efficiency
6.	c. Inventory
7.	False
8.	False
9.	a. Inventory turnover
10.	True

Q.	Terminal Questions
1.	There are mainly five types of inventories maintained in an organisation, namely cycle inventory, transit inventory, safety inventory, seasonal inventory, dead/obsolete inventory. Refer to sub-section **3.2.2 Inventory**.
2.	Information can be defined as consolidated data about different aspects of supply chain, such as facilities, transportation, costs, prices, suppliers, and customers. Refer to sub-section **3.2.4 Information**.
3.	The framework of a supply chain comprises six drivers of supply chain, wherein these drivers interact with each other to determine the responsiveness of a supply chain. Refer to section **3.3 Framework for Structuring Drivers**.
4.	The most important pre-requisite of an effective supply chain metric is that it should be easily understood and provide consistent results after each measurement process. Refer to section **3.4 Managing Supply Chain Performance**.
5.	There are mainly four practices that help in the development of next generation supply chain: supply chain visibility and transparency, optimisation of decisions, streamline operations, and development of risk-management programs. Refer to section **3.4.2 Next generation supply chain**.

3.9 Case Study: Old Dutch Foods: An Example of Responsive Supply Chain

Old Dutch Foods is a snack manufacturing organisation engaged in the production of potato chips and other snack items in the Midwestern United States and Canada. The organisation was founded in St. Paul, Minnesota in 1934. Since then, Old Dutch Foods has been committed to offer high quality, great taste products to its US customers.

In 2000, Old Dutch Foods acquired its competitor Humpty Dumpty Snack Foods with an aim to increase its penetration in the Atlantic Canadian market. With this expansion, the organisation felt a need to increase efficiency and accuracy to maintain its leadership position in the market. The following were the objectives of the organisation behind such acquisition:

◆ To create a streamlined organisation where the level of production can be increased with the existing workforce

◆ To maintain product quality

◆ To eliminate inventory shrinkage

◆ To improve distribution centre throughput and process orders on time

To accomplish the aforementioned objectives, the organisation decided to look for a source that could design distribution centres as per the organisation's requirements and implement Warehouse Control System (WCS) successfully. After research, the organisation hired Invata Intralogistics to provide customised distribution centres.

Invata Intralogistics designed a distribution centre that helped Old Dutch Foods in receiving products from manufacturing facilities and delivering orders on time. Manufactured products are transported to warehouses and organised in a forward pick area. As per the lot, cartons

are serialised to ensure first in, first out (FIFO) picking and tracking in the future. Invata also integrated JD Edwards' ERP system (comprehensive resource planning software) with WCS to enable the processing of multiple orders simultaneously.

After the implementation of new development, Old Dutch Foods successfully created a leaner and more streamlined distribution centre in the Atlantic regional market. This further resulted in the elimination of shipping errors and increase in complete visibility and traceability from manufacturing to the retailer and beyond. Moreover, the throughput of the organisation increased to a great extent.

Discussion Questions

1. Do you think the hiring of Invata Intralogistics by Old Dutch Foods was the right decision? Discuss why/why not?

   (**Hint:** Yes, because Invata Intralogistics helped Old Dutch Foods in achieving its objectives of increasing its production level, creating a streamlined organisation, etc.)

2. What are the supply chain drivers that Old Dutch Foods focused on?

   (**Hint:** Logistical drivers are focused, such as sourcing and facility.)

3.10 | References and Suggested Readings

◆ Ayers, J. (2001). Handbook of supply chain management (1st ed.). Boca Raton, Fla.: St. Lucie Press.

◆ Chopra, S., & Meindl, P. (2014). Supply Chain Management (1st ed.). Hallbergmoos: Pearson.

◆ Fredendall, L., & Hill, E. (2001). Basics of supply chain management (1st ed.). Boca Raton: St. Lucie Press.

◆ Wisner, J., Leong, G., & Tan, K. (2005). Principles of supply chain management (1st ed.). Mason, Ohio [u.a.]: Thomson/South-Western.

E-references

◆ Klipfolio.com,. (2014). Supply Chain KPIs and Metrics | KPI Examples - Klipfolio. Retrieved 22 August 2014, from http://www.klipfolio.com/resources/kpi-examples/supply-chain

◆ Scmr.com,. (2014). Transportation Decision-Making in an Integrated Supply Chain - Article from Supply Chain Management Review. Retrieved 22 August 2014, from http://www.scmr.com/article/transportation_decision-making_in_an_integrated_supply_chain

◆ Spacey, J. (2014). 12 Key Metrics For Supply Chain Management - Simplicable. Business. simplicable.com. Retrieved 22 August 2014, from http://business.simplicable.com/business/new/12-key-metrics-for-supply-chain-management

4

Distribution Network in Supply Chain

Structure

Learning Objectives

After completing the chapter, you will be able to:

- ❑ define a distribution network
- ❑ identify factors influencing a distribution network
- ❑ explain how to manage a distribution network
- ❑ discuss e-business and its impact on a supply chain

4.1 Introduction

In the previous unit, you have studied about various supply chain drivers that enhance the effectiveness and responsiveness of a supply chain, such as facilities, inventory, and information. Apart from this, distribution is another driver that is responsible for the success of a supply chain. The term **distribution** refers to the movement of a product from a supplier to customers in a supply chain. Distribution influences the overall profitability of an organisation as it has direct impact on both supply chain cost and customer experience. Therefore, organisations strive to maintain an effective distribution network.

A distribution network is a system utilised by an organisation to transport products from manufacturers to suppliers and ultimately to end users. Essentially, a distribution network can be described as an interconnected arrangement of individuals, storage facilities, and transportation systems that ensure the prompt delivery of products to customers. A swift and dependable distribution network is crucial for a successful business, as it allows customers to obtain products and services when needed.

An efficient distribution network aids organisations in accomplishing supply chain objectives, ranging from cost reduction to heightened responsiveness and efficiency. Consequently, organisations within the same industry often opt for different distribution networks. For instance, Dell directly distributes computers to end users, while companies like Hewlett Packard (HP) and Compaq distribute products through resellers. Dell customers typically experience a waiting period of several days to receive computers, whereas customers can swiftly acquire HP or Compaq computers from reseller stores. In this chapter, you will study about the importance of a distribution network in a supply chain in detail.

4.2 Distribution Network

Distribution is a process through which manufactured products are made available to customers. It is one of the most important aspects in a supply chain as it involves the movement of products and services from a source to end customers; thereby meeting delivery schedules within the specified time. Thus, organisations create a distribution network that helps them in delivering products on time, reducing supply chain costs, enhance responsiveness of a supply chain, etc. A distribution network comprises various distribution channels that act as a path or route through which products move from supply sources to demand destinations.

A distribution network consists of manufacturers and various middlemen, such as wholesalers, agents, and retailers, who act as a medium of interaction between manufacturers and consumers.

In a supply chain, there are three types of distribution networks, which are shown in Fig. 4.1:
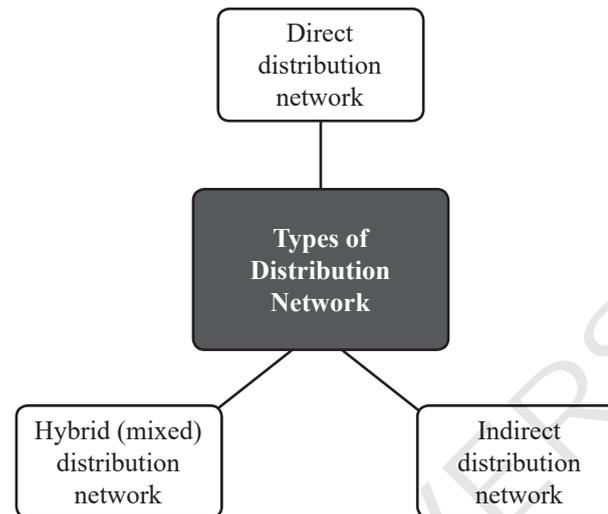
Fig. 4.1: Types of Distribution Networks

Let us discuss these distribution networks in detail.

◆ **Direct distribution network:** In this network, there is no existence of middlemen; thus products are directly made available to consumers by manufacturers through various modes, such door-to-door sales and manufacturer-owned retail stores. Organisations, such as Eureka Forbes, Tupperware, and Asian Sky Shop, use a direct distribution network to reach out to customers. Indian Oil and Bharat Petroleum use manufacturer-owned stores to sell their products.

The direct distribution network is employed in the following situations:

❍ **Local market:** This pertains to a market situated in close proximity to a production unit. For instance, local bread and biscuit manufacturers directly supply products within the local market.

❍ **Small lot size:** This refers to producing a limited quantity of products based on individual customer requirements. Manufacturers produce goods in bulk and sell them in smaller sizes directly through departmental stores and super bazaars.

◆ **Indirect distribution network:** It involves intermediaries for product distribution to customers. Middlemen in a distribution channel can be agents, wholesalers, or retailers. Large-scale manufacturers primarily use an indirect distribution network because they produce goods in bulk, which is challenging to sell directly. This network can be categorized into two parts:

❍ **Single-party selling network:** This entails a single intermediary between a manufacturer and customers, such as retail stores and online retailers.

❍ **Multiple-party selling system:** This involves two or more intermediaries facilitating the distribution of products to end users.

◆ **Hybrid (mixed) distribution network:** It combines more than one distribution network to reach customers. In this network, manufacturers can utilize various distribution channels, including wholesalers, online stores, vending machines, and retail stores, to sell products and services. An organization can reap several benefits, such as increased market penetration and lower distribution costs, by employing a suitable distribution

channel and managing just-in-time delivery of products and services. A hybrid distribution network improves market coverage; therefore, a proper management of hybrid distribution network is important for the success of an organisation.

4.2.1   Role of Distribution Network

From the discussion so far, it can be said that a distribution network plays an important role in making products and services available to end users. A distribution network helps organisations in bridging the space and time between the manufacturing and delivery of products in the market; thereby reducing supply chain costs. The following points discuss the role of a distribution network in a supply chain:

◆ An effective distribution network minimises customers' effort in receiving products by ensuring the timely availability of products in the market.

◆ It helps organisations in exploring new geographical areas, which, in turn, boost organisation's sales and create awareness among prospective.

◆ A distribution channel involved in the network adds value to products by providing various services, such as installation, repair, maintenance, and home delivery of products.

◆ Organisations receive information about products and other aspects, such as preferences, geographical location, type, and feedback of customers, through distribution channels used in the network.

4.2.2   Members of a Distribution Network

The distribution network of an organisation involves various parties for performing different activities, such as order taking, product delivery, and customer service. These parties are called the members of a distribution network. Fig. 4.2 shows various members involved in a distribution network:
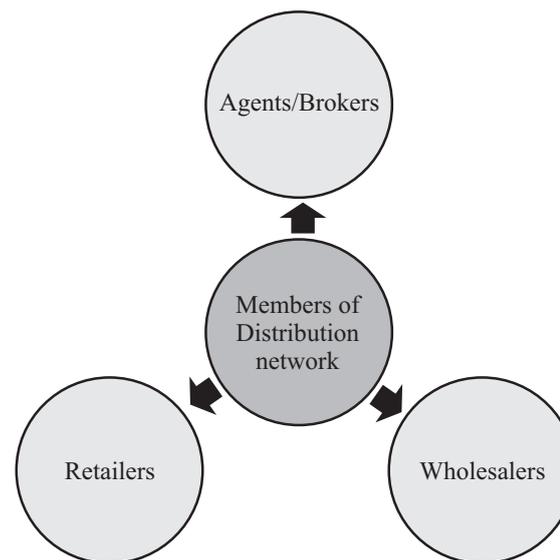
Fig. 4.2: Members of a Distribution Network

Let us discuss about these members in detail.

◆ **Agents/brokers**: They buy products from manufacturers and break the lot size according to the requirements of wholesalers. Agents and brokers are very important intermediaries for both national and international marketing and exports. In some cases, they directly reach out to end users to sell products and services. For example, organisations like LIC, Amway, Oriflame, etc. operate through agents or brokers.

◆ **Wholesalers**: They buy products either from manufacturers or agents in bulk and sell them to retailers. They play a very important role in making products available in the market. However, sometimes wholesalers get indulged in unethical practices, such as hoarding.

◆ **Retailers:** They buy products from wholesalers, agents, or manufacturers and sell those products to end users. Thus, retailers directly interact with end users. In some cases, they add value to products and resell them. There are several retail chains that are owned by manufacturers themselves; for example, Reliance Fresh and Big Bazaar. India has a maximum number of retailers in the world.

4.2.3 Levels of Distribution in Supply Chain

Different organisations distribute products in the market at different levels depending on its scale of business, customer base, market image, and so on. Therefore, determining a right level of distribution is important for an organisation. There are three levels of distribution, which are shown in Fig. 4.3:

Intensive Distribution

Selective Distribution

Exclusive Distribution
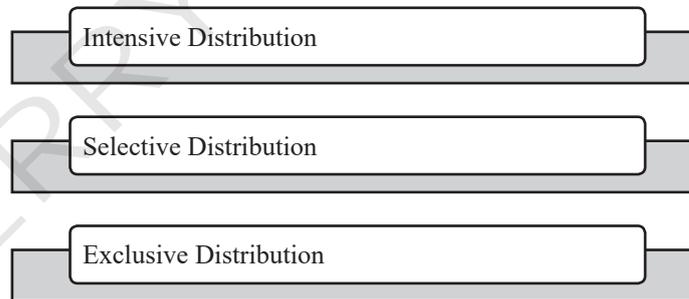
Fig. 4.3: Levels of Distribution

Let us discuss these levels in detail.

◆ **Intensive distribution**: At this level of distribution, products are made available at almost every shop in the market. Intensive distribution is also known as mass distribution. This type of distribution is used for convenience products, such as salt, oil, soap, and sugar.

◆ **Selective distribution**: At this level, focus is laid on specific geographical locations for making products available. For this, suitable resellers are searched in a particular area for selling products. For example, expensive clothing line such as Dolce and Gabbana products are sold at Neiman Marcus stores only.

◆ **Exclusive distribution**: It is a modified form of selective distribution. In exclusive distribution, organisations use one distributor for an entire region. To maintain the exclusivity of products, a limited number of resellers in the market are selected to maintain a high level of service quality. Exclusive distribution is used for various luxury brands, such as Armani, Gucci, and Mercedes-Benz.

Self-Assessment Questions

1. _____ is a process through which manufactured products are made available to customers.

2. In which distribution network, there is no existence of middlemen?
   a. Direct distribution network
   b. Indirect distribution network
   c. Double distribution network
   d. Hybrid distribution network

3. An effective distribution network minimises customers' effort in receiving products by ensuring the timely availability of products in the market. (True/False)

4. _____ buy products either from manufacturers or agents in bulk and sell them to retailers.

5. In selective distribution, products are made available at almost every shop in the market. (True/False)

Activity

Using the Internet, find information on the distribution network used by any manufacturing organisation of your choice. Make a report on it.

4.3 Factors Influencing a Distribution Network

As discussed in the previous section, a distribution network plays a significant role in the overall profitability of an organisation by improving the efficiency of its supply chain. However, there are a number of factors that influence the performance of a distribution network. These factors are listed in Fig. 4.4:

Structure of a distribution network

Product type

Government regulations

Infrastructure utility costs
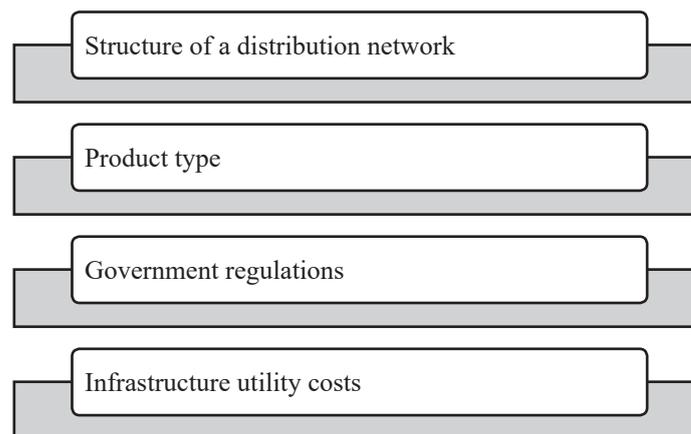
Fig. 4.4: Factors influencing a Distribution Network

Let us discuss these factors in detail.

- ◆ **Structure of a distribution network:** The structure of a distribution network is an important factor that influences the efficiency of a supply chain to a large extent.

A distribution structure can be either centralised or decentralised. In a centralised structure, distribution is carried out from a single supply source. On the other hand, in a decentralised structure, distribution is performed from multiple supply sources. However, a centralised structure is more cost effective as compared to the decentralised one. This is because in a centralised structure, all supply chain functions are performed at a single source; thus requires lesser cost. Therefore, while deciding the structure of a distribution network, organisations must consider various factors, such as total budget, service levels, total facility size, and level of risks associated.

◆ **Product type:** Organisations offer products having different distribution requirements. For instance, the distribution of perishable goods, such as food items, requires refrigerated containers in order to prevent them from getting rotten. Therefore, while making decisions related to the designing of a distribution network, the nature of products must be considered.

◆ **Government regulations:** While designing a distribution network, an organisation must consider and comply with all the government legislations associated with the industry. Taxes, labour regulations, transportation restrictions must be considered while designing a distribution network. For example, while using a road transport, various taxes need to be paid, such as octroi and road tax.

◆ **Infrastructure utility costs:** When there is a change in the cost of energy, electricity, fuel, etc. the operating costs of distribution can be affected. For example, rise in the price of electricity may have an adverse impact on refrigerated warehouses. Similarly, rising costs of fuel such as petrol and diesel may affect motor carriers. Thus, it becomes imperative for organisations to consider such costs before making any decisions before designing distribution networks.

Self-Assessment Questions

6. In a _____ structure, distribution is carried out from a single supply source.

7. Which one of the following is not a factor that influence distribution network?

   a. Product Type

   b. Government regulations

   c. Infrastructure utility costs

   d. Market structure

8. When there is a change in the cost of energy, electricity, fuel, etc. the operating costs of distribution can be affected. (True/False)

4.4 Managing a Distribution Network

To create an effective distribution network, an organisation needs to select channels to be used. These channels must be managed properly to enhance the performance of a distribution network. For this, an organisation needs to focus on making decisions related to the selection, training, motivation, and evaluation of individual intermediaries involved in different channels.

Fig. 4.5 shows different decisions involved in managing a distribution network:

Selecting channel members
Training channel members
Evaluating channel members' performance
Amending channel design and arrangements
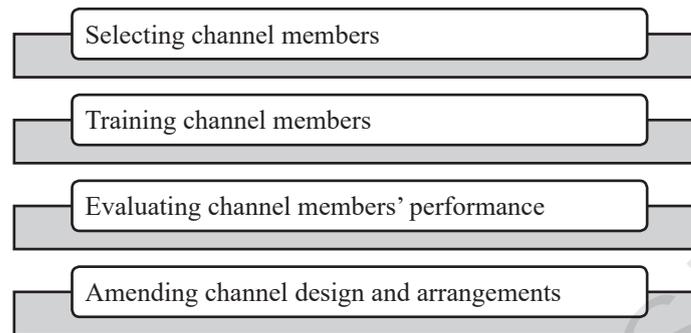
Fig. 4.5: Decisions for Managing a Distribution Network

Let us discuss these decisions in detail.

◆ **Selecting channel members:** For customers, distribution channels are a medium to get in touch with organisations. In other words, these channels represent organisations by selling their products. Therefore, while selecting channel members, an organisation must set the criteria based on various aspects, such as related experience, sales efficiency, product knowledge, and administrative abilities, of potential members.

◆ **Training channel members:** As mentioned earlier, channel members represent organisations by selling their products in the market. In such a case, any mistake at members' end may affect the reputation of an organisation. Therefore, it is an essential for an organisation to train its channel members by conducting various capability enhancing programs for them.

◆ **Evaluating channel members' performance:** It involves assessing the performance of channel members at regular intervals against the set standards. Organisations may use a few standards, such as target achievement, average inventory levels, customer delivery time, handling of lost and damaged goods, and cooperation in promotional and training programs, to evaluate channel members' performance. Channel members who do not perform according to the set standards are counselled and motivated.

◆ **Amending channel design and arrangements**: Reviewing and modifying the channel design periodically is very important. An organisation intends to modify the distribution system when it does not work as planned due to various reasons, such as changes in customers' preferences, level of competition, and introduction of new distribution means. Amendments can take place in channel design in terms of adding or eliminating any channel members or developing new ways to sell goods.

🔍 **Exhibit**

Distribution Channel Conflicts

As there are a number of parties involved in a distribution network, there are chances of conflicts that may happen among these parties over a period of time. There can be three types of conflicts arising in a distribution channel, namely vertical conflicts, horizontal conflicts, and multichannel conflicts. Let us discuss these conflicts in detail.

◆ **Vertical channel conflicts:** Two or more channel members competing for market share and distribution levels cause these disputes.

◆ **Horizontal channel conflicts:** Conflicts between distribution channel participants in the same market occur at the same level.

◆ **Multichannel conflicts:** When manufacturers use many channels to contact clients, these conflicts arise. A manufacturer opens a showroom and factory outlets.

There are various causes of distribution channel conflicts, such as:

◆ Incompatibility of objectives and goals of different channels

◆ Ambiguity in the roles and responsibilities of different members of a channel

◆ Same market for a manufacturer and channel members

Conflicts should be managed by organisations well on time. This is because if conflicts are not managed, they may bring serious repercussions on the supply chain's performance. Conflicts can be managed at a moderate level by taking corrective measures. The following are some ways to manage distribution channel conflicts:

◆ **Negotiation:** It involves contending parties discussing product distribution difficulties.

◆ **Persuasive mechanism:** It refers to taking advice from third parties to resolve conflicts. The third party can be an individual or an organisation.

◆ **Legalistic strategy:** It refers to legal actions that can be taken to resolve conflicts.

◆ **Cooperation and coordination:** It refers to assistance and support among distribution channel members to achieve the goals of distribution channels.

Self-Assessment Questions

9. To create an effective distribution network, an organisation needs to select _____ to be used.

10. Distribution channels represent organisations by selling their products. (True/false)

11. Channel members who perform according to the set standards are counselled and motivated. (True/False)

4.5 E-Business and its Impact on Supply Chain

E-business can be defined as an application of Information and Communication Technologies (ICT) to support various business activities. It mainly includes strategies, tactics, practices, activities, and methodologies that organisations adopt along with information technologies to enhance their business performance. As discussed in the previous unit, information is an important driver in the success of the supply chain network of an organisation. With the growing use of information, e-business has greatly impacted the performance of a supply chain.

Fig. 4.6 shows how e-business affects the supply chain of an organisation:
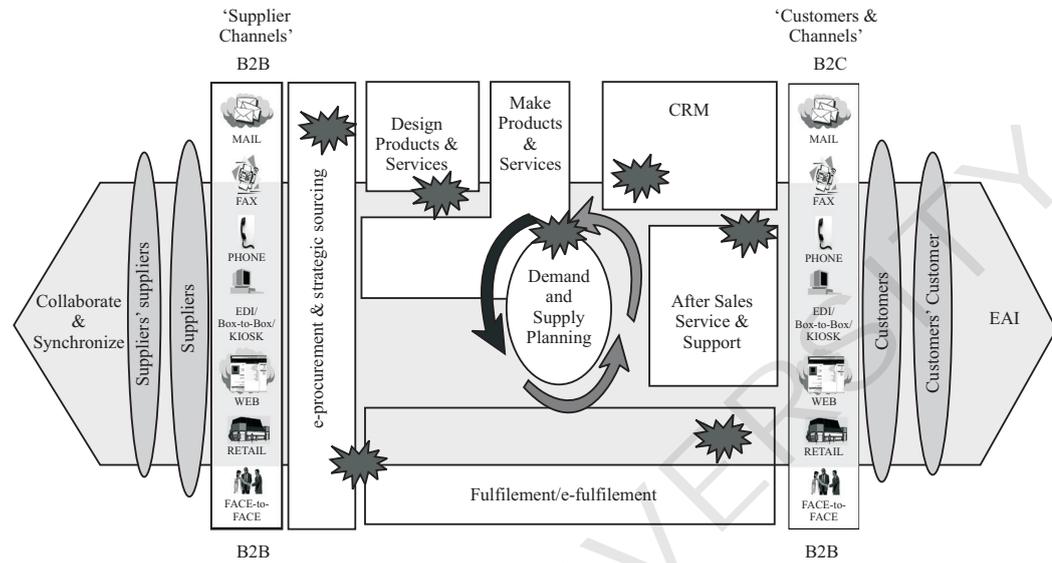
Fig. 4.6: Impact of E-business on Supply Chain
(**Source:** *https://www.ashgate.com/pdf/SamplePages/ghsupplych4.pdf*)

Fig. 4.6 displays the flow of information that takes place between suppliers and customers. Let us now discuss how various aspects of a supply chain are affected by e-business:

- **Procurement:** In a supply chain, procurement is a process of acquiring raw materials or goods from external organisations. The advent of information and communication technologies has automated the procurement process of organisations. Such automated procurement is called e-procurement. Various e-procurement tools, such as CommerceOne, Ariba and Rightworks, help organisations to enhance the efficiency and effectiveness of the procurement process by saving cost and time.

- **Product and service design**: Using e-business solutions, an organisation can enhance product design quality, reduce design time, and improve interactions taking place between various parties, such as manufacturers and suppliers. Collaborative product commerce (CPC) is an integrated technology of product design and manufacturing. It allows effective management of a product through its production stages by using the Internet. CPC offers visibility and cooperation throughout a value chain, which, in turn, enables the organisation to quickly respond to customers and suppliers and market changes.

- **Manufacturing:** e-business solutions also have a great deal of impact on manufacturing by enabling organisation to achieve high levels of mass customisation. E-business provides a mechanism for ensuring that manufacturing in an organisation is highly responsive to customers' demand rather than intermediary demand.

- **Demand and supply planning**: A use of computers, statistics and e-business has proved to be highly successful in planning demand and supply. A number of systems, such as Manugistics, Aspen Tech and i2 Technologies, are available in the market which help in collaborative demand and supply planning.

- **Fulfilment of orders**: Various e-business tools have revolutionised the way products and services are delivered to customers. It has led to the creation of virtual inventory that has completely modified the relationship between end customers, retailers, wholesalers and manufacturers. However, this area is still at its nascent stage.

◆ **Aftersales service and support**: The effectiveness of aftersales services decides the level of repeat business for an organisation. Introduction of various technologies have helped organisations to manage their aftersales services effectively by maintaining proper service schedules.

Self-Assessment Questions

12. _____can be defined as an application of information and communication technologies (ICT) to support various business activities.

13. In a supply chain, _____ is a process of acquiring raw materials or goods from external organisations.
    a. Procurement
    b. Manufacturing
    c. Product and service design
    d. Demand and supply planning

14. e-business provides a mechanism for ensuring that manufacturing in an organisation is highly responsive to intermediary demand rather than customers' demand. (True/ False)

15. Various e-business tools have has led to the creation of _____ that has completely modified the relationship between end customers, retailers, wholesalers and manufacturers

Activity

Using the Internet, find three examples of organisations that have used e-business tools to manage their distribution networks.

4.6 Summary

◆ Distribution is a process through which manufactured products are made available to customers; thereby helping an organisation in meeting delivery schedules within the specified time.

◆ A distribution network includes manufacturers and various middlemen, such as wholesalers, agents, and retailers, who act as a medium of interaction between manufacturers and consumers.

◆ There are three types of distribution networks in a supply chain, namely direct distribution network, indirect distribution network, and hybrid distribution network.

◆ In a distribution network, there are various members involved, such as agents/brokers, wholesalers, and retailers.

◆ Distribution occurs at three levels, namely intensive distribution, selective distribution, and exclusive distribution.

◆ A distribution network is influenced by various factors, such as structure of a distribution network, product type, government regulations, and infrastructure and utility costs.

◆ An organisation needs to make various decisions while selecting channel members, training channel members, and evaluating channel members' performance.

◆ E-business can be defined as an application of information and communication technologies (ICT), that includes strategies, tactics, practices, activities, and methodologies adopted by organisations to enhance their business performance.

◆ With the growing use of information, e-business has greatly impacted various aspects of supply chain, such as procurement, product and service design, manufacturing, and demand and supply planning.

4.7 Glossary

◆ **Convenience products:** These are products that are easily available and purchased frequently by customers without making much effort.

◆ **Hoarding:** It is a malpractice of purchasing large quantities of a product in order to raise its price in the market.

◆ **Lot size:** It is a unit of a product that can be placed in an order to be offered for sale or purchase.

◆ **Market penetration:** It is a measure of the extent to which a product is purchased by customers in the market.

◆ **Octroi:** It is a tax levied by a country's government on products brought in a town or district for consumption.

4.8 Terminal Questions

1. Discuss the role of distribution network in a supply chain.

2. What are different levels of distribution?

3. Explain various factors influencing the performance of a distribution network.

4. Discuss decisions involved in managing a distribution network.

5. Write a short note on e-business and its impact on supply chain.

4.9 Answers

Q.	Self Assessment Questions
1.	Distribution
2.	a. Direct distribution network
3.	True
4.	Wholesalers
5.	False
6.	Centralised
7.	d. Market structure
8.	True
9.	Channels
10.	True

11.	False
12.	e-business
13.	a. Procurement
14.	False
15.	Virtual inventory
Q.	**Terminal Questions**
1.	Through a distribution network, an organisation can bridge the space and time between the manufacturing and delivery of products in the market and reduce supply chain costs. Refer to sub-section **4.2.1 Role of distribution network**
2.	There are three levels of distribution, namely intensive distribution, selective distribution, and exclusive distribution. Refer to sub-section **4.2.3 Levels of distribution in supply chain**.
3.	There are a number of factors that influence the performance of a distribution network, such as structure of a distribution network, product type, and government regulations. Refer to section **4.3 Factors Influencing a Distribution Network**.
4.	To manage a distribution network, an organisation needs to make various decisions, such as selecting channel members, training channel members, evaluating channel members' performance, etc. Refer to section **4.4 Managing a Distribution Network**.
5.	E-business is an application of information and communication technologies (ICT) that involves strategies, tactics, practices, activities, and methodologies to support various business activities. Refer to section **4.5 E-business and its Impact on Supply Chain**.

4.10 Case Study: Distribution Network of PepsiCo

According to **Al Carey**, Chief Operating Officer, PepsiCo Beverages and Foods, North America, "PepsiCo has continually been at the forefront of standards adoption, promoting industry efficiency and adding value throughout our supply chain."

PepsiCo, based in the US, is one of the largest beverage and snacks food organisations of the world. According to various analysts, the major reason for the growth of the organisation over a period of time has been its efficient and strong distribution and logistics management operations. PepsiCo adopted various distribution modes such as Direct Store Delivery (DSD, wherein direct order from grocery and convenience stores are taken and delivered), the broker warehouse system, the vending and food service system, and the pre-sell method. Today, PepsiCo's operations are spread across more than 150 nations and the organisation collects revenue of more than $40 billion.

In India, PepsiCo entered as a joint venture with Punjab Government in 1989. Soon it started its beverage operations with RK Jaipuria Group. PepsiCo established its dominance by gaining an effective means of marketing and distribution in the market. The distribution network adopted by organisations played a significant role in positioning products in the Indian market. The main features of the distribution network of PepsiCo are as follows:

- The organisation adds strength to the overall presence of the organisation in the market through franchisee based operations, which are combined with the organisation's operations. Franchisees hold all decision making rights to takes care of its operations, and PepsiCo does not interfere. However, franchisees are expected to report to PepsiCo at explicit time intervals.

- PepsiCo has developed a good relationship with retailers by providing them superior services and schemes.

- PepsiCo focuses on maintaining a good relationship with distributors as they are a vital part of the organisation, by virtue of being the focal point of the distribution network.

PepsiCo has adopted an advanced distribution system supported by a state-of-the-art logistic system. The products of PepsiCo such as snack foods and beverages are distributed on a regular basis through various retail channels across the world. By doing so, the organisation aims at ensuring the availability of products at all distribution centres so that customers can easily get them. PepsiCo also focuses on the need of adapting the distribution system that could fulfil the need of its global consumers. By using the most modern technology, PepsiCo and its bottlers have gained an ability of improving their distribution system more significantly. PepsiCo launched a new distribution method that was known as chilled DSD system. The chilled DSD system was a comparatively small distribution method created for items that require continuous refrigeration.

PepsiCo have distributors in every area who supply products to different retailers. Some of their products are delivered to customer warehouses and retail stores from manufacturing plants. The next kind of distribution system, which is used by PepsiCo, is known as food service and vending sales force. It distributes snacks, foods, and beverages to vending operators and distributors. This distribution system can be normally seen in schools, stadiums, restaurants, and various other locations. By adopting a modern and strong distribution network, PepsiCo has made a mark in the food and beverages industry across the world.

Discussion Questions

1. Discuss how a distribution network played an important role in the success of PepsiCo?

   (**Hint:** The distribution network helped PepsiCo in dominating the market by ensuring product availability at all times.)

2. What are the distribution modes used by the organisation in the given case study?

   (**Hint:** Direct Store Delivery (DSD), the broker warehouse system, vending and food service system, etc.)

4.11 References and Suggested Readings

- Ayers, J. (2001). Handbook of supply chain management (1st ed.). Boca Raton, Fla.: St. Lucie Press.

- Chopra, S., & Meindl, P. (2014). Supply Chain Management (1st ed.). Hallbergmoos: Pearson.

- Mentzer, J. (2001). *Supply chain management* (1st ed.). Thousand Oaks, Calif.: Sage Publications.

- Zuckerman, A. (2002). *Supply chain management* (1st ed.). Oxford: Capstone Pub.

E-references

◆ Ces.sdsu.edu,. (2014). Professional Development Online | Supply Chain Management and e-Business. Retrieved 25 August 2014, from http://www.ces.sdsu.edu/Pages/Engine.aspx?id=318

◆ Logisticsbureau.com,. (2014). Distribution Network Design | Supply Chain & Logistics | Modelling. Retrieved 25 August 2014, from http://www.logisticsbureau.com/distribution_network_design.htm

◆ mThink,. (2002). Collaborative Product Commerce: Creating Value Across the Enterprise - mThink. Retrieved 25 August 2014, from http://mthink.com/article/collaborative-product-commerce-creating-value-across-enterprise/

Designing the Distribution Network

Structure

Learning Objectives

After completing the chapter, you will be able to:

❑ describe various design options for distribution network

❑ explain the design of distribution network

❑ describe the framework for network design

❑ list various factors that affect network design decisions

❑ describe the modelling for supply chain

5.1 Introduction

In the previous unit, you have studied about a distribution network, which is a system used by an organisation to move products from manufacturers to suppliers and finally to end users. An effective network enables customers to avail products and services as and when required, which, in turn, determines an organisation's profitability. However, the effectiveness of a distribution network depends on how well it is designed.

Every organisation strives to design a distribution network that maximises customer experience and minimises operating costs, capital investments, and risks. Designing such a network can be challenging for an organisation. This requires certain firm decisions to be made at an organisation's end. One such major decision is to select a design for a distribution network that best meets the organisation's requirements and is flexible enough to adapt to the changes that take place in the business environment. For example, changes in the organisation's sales volume, customer base, geographic markets, etc. can necessitate a change in the distribution network.

For designing a distribution network, an organisation first needs to determine the goals of the network. For example, if the goal of an organisation is to improve customer service levels, it may need to expand the number of facilities in its distribution network. Moreover, an organisation needs to consider its existing supply chain constraints while designing its distribution network. These constraints may include distribution throughput, production and storage capacity, expansion potential at existing sites, material handling requirements, customer service requirements, etc. In this chapter, you will study about distribution network design in detail.

5.2 Design Options for Distribution Network

In order to meet customers' needs and expectations and deliver them products on time, an organisation needs to have a well-defined and organised distribution network for its supply chain. A distribution network is generally designed after considering various aspects of a supply chain, such as whether the products would be delivered directly to end users or through intermediaries, such as retailers and wholesalers. The design of a distribution network differs across organisations based on their distribution needs. There are various distribution network designs available; organisations can adopt any of them based on their requirements. Fig. 5.1 shows different designs for a distribution network:

Manufacturer storage with direct shipping

Manufacturer storage with direct shipping and in-transit merge

Distributor storage with package carrier delivery

Distributor storage with last mile delivery

Manufacturer/distributor storage with costumer pickup

Retail storage with customer pickup
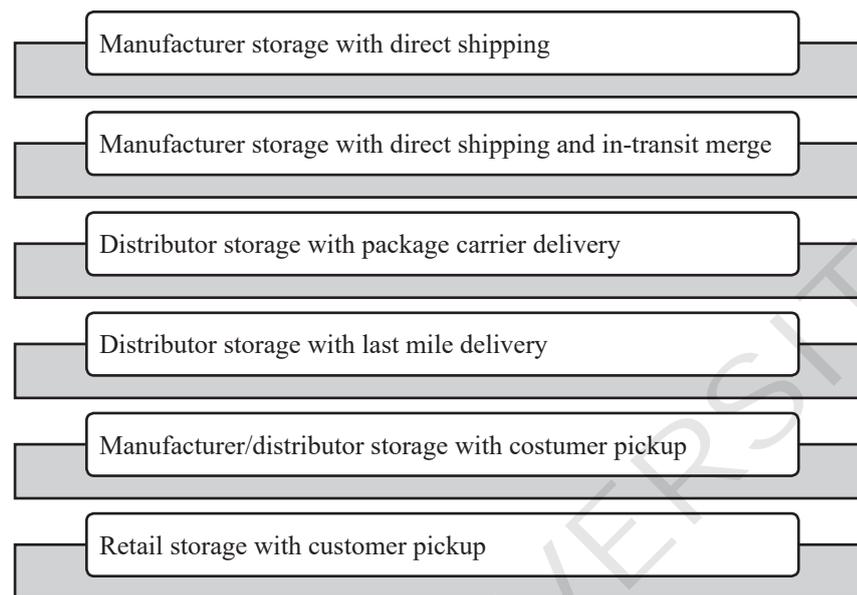
Fig. 5.1: Different Design Options of a Distribution Network

Let us now discuss each of the designs in detail.

◆ **Manufacturer storage with direct shipping:** In this type of distribution design, retailers take orders from customers but do not deliver products to them. The retailers transfer customer orders to respective manufacturers, who then directly deliver products to customers. For example, customers can only place their orders at online shopping portals, such as amazon.in, flipkart.com, and myntra.com. However, products are delivered to customers by manufacturers. This type of delivery is also referred to as drop shipping. In this design option, inventories are all stored by the manufacturer. Thus, the centralisation of inventories is the biggest advantage of drop shopping. However, transportation cost is higher in drop shipping as the average distance between manufacturers and end users is generally longer. In addition, package carrier needs to be used for drop shipping which has a higher shipping cost as compared to truckload (TL) or less-than-truckload carrier (LTL).

An extensive information infrastructure is required in this design option as accurate information need to be given to customers about product availability and delivery status. Response time tends to be higher in case of drop shipping because order details are transmitted from retailers to manufacturers after which it is shipped to customers. This type of distribution design generally works best for high cost and low volume items with low demand where customers can wait for the order. For drop shipping to be successful, there should be only a few sourcing locations for each order placed by customers.

◆ **Manufacturer storage with direct shipping and in-transit merge:** In this design option, orders from different manufacturers are merged for a single customer. Thus, the customer receives the single delivery for multiple orders. In this design option, transportation cost is lower than drop shipping as products are first merged and then delivered to customers. For instance, a customer orders different cosmetic items of different brands, such as Lakme eyeliner, Elle18 lip gloss, Colorbar compact on flipkart.com in a single order cart. Now, flipkart would merge all items from different manufacturers to make a single delivery to the customer. This process of combining products from different manufacturers in a single delivery is referred to as in-transit merge.

In such design, a sensitive and responsive information infrastructure is required that can allow an easy in-transit merge of orders. The response time is similar to drop shipping where customers have to wait for a reasonably long time period. However, customers are likely to have better experience in this design option as they receive a single delivery even for their multiple orders. The only disadvantage of in-transit merge is that it requires additional efforts at a retailer's end to merge orders. In-transit merge can be best implemented where there are only four to five sourcing locations and each customer's order has products of multiple manufacturers.

◆ **Distributor storage with package carrier delivery:** Under this design option, products are stored by distributors and retailers at their warehouses and not by manufacturers. The products are delivered to end users from an intermediate location through package carriers. In this design, transportation costs are lower as the economical mode of transportation, such as truckload, is used. Moreover, the information infrastructure is less complex as information sharing takes place only at a single level i.e. between a customer and the distributor. The response time in this design option is comparatively smaller than in the case of manufacturer storage. This is because the warehouses of retailers and distributors are often situated nearer to customers. This distribution design is ideal for medium and fast moving items. W.W. Grainger, one of the industrial distributors of motors, lighting, material handling, fasteners, plumbing, tools, and safety supplies, uses this design option.

◆ **Distributor storage with last mile delivery:** Last mile delivery is a type of delivery wherein products are directly delivered to customers instead of using a package carrier. The use of last mile delivery is commonly done for the distribution of fast moving and high on demand products such as grocery items. Thus, this design option requires a high level of inventory and a large number of warehouses. The transportation cost in this case is also very high due to a lack of aggregation delivery. However, the transportation cost can be justified in case of bulk orders of products.

In this design option, the information infrastructure is less complex and response time is less. Delivery is made within 24 hours and many distributors charge for such fast service. Thus, this option is suitable where orders are large and customers are ready to pay for availing services.

◆ **Manufacturer or distributor storage with consumer pickup:** In this distribution option, inventory is stored at the warehouses of a manufacturer or distributor. Customers place their orders over phone calls or online and designate a point from where they can pick their orders on their own. The cost of transportation is lower as compared to other design options as customers are responsible for picking up their respective orders.

In this option, manufacturers and distributors use truck loads and less-than-truckload carriers to move products to pick up points; thereby saving transportation cost. Information plays a crucial role in this option because customers are required to be accurately informed about when they can pick up their orders. Thus, a well-maintained and organised information infrastructure is required in this design option. The response time in this case is neither too long nor too short. Customers are provided with pickup information soon after they place the order. The order is then moved from a manufacturer or distributor's warehouse to the pickup site from where it is to be picked up by customers.

◆ **Retail storage with customer pickup:** In this distribution option, inventory is stored at retail stores. Customers have an option of either walking-in stores or placing an

order over the phone or the Internet. Transportation cost is much lower than any other distribution option as products only need to be shipped to stores from production units. A very simple information infrastructure is required as customers can walk-in to stores or contact over the phone or the Internet to obtain any information. This design option has less response time due to the local storage of inventory.

Self-Assessment Questions

1. In which of the following design options, retailers take orders from customers and transfer the orders to manufacturers who directly deliver products to the customers?

   a. Manufacturer storage with direct shipping

   b. Manufacturer storage with direct shipping and in-transit merge

   c. Distributor storage with package carrier delivery

   d. Distributor storage with last mile delivery

2. Last mile delivery is a type of delivery wherein products are delivered to customers using a package carrier. (True/False)

3. Under which design option, products are stored by distributors and retailers at their warehouses and not by manufacturers?

   a. Manufacturer storage with direct shipping and in-transit merge

   b. Distributor storage with package carrier delivery

   c. Distributor storage with last mile delivery

   d. Manufacturer/distributor storage with costumer pickup

Activity

Imagine yourself as a manufacturer of computer chips. Which design option do you think would be most suitable for you?

5.3 Process of Distribution Network Design

Manufacturers always strive to reach out to customers in the best possible way to earn profits and gain customer loyalty. For this, they need to design an effective distribution network. Designing a distribution network is a systematic process that involves a number of steps, which are shown in Fig. 5.2:

Analysing customer service needs

↓

Setting distribution network objectives

↓

Identifying major distribution network alternatives

↓

Evaluating major distribution network alternatives
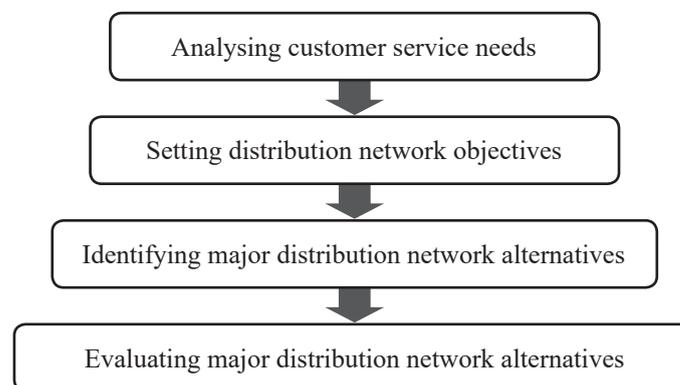
Fig. 5.2: Steps in Designing a Distribution Network

Let us discuss these steps in detail.

1. **Analysing customer service needs:** This is the first step wherein the service needs of a particular customer segment are identified and analysed. For example, customers of the Fast Moving Consumer Goods (FMCG) products need timely delivery and convenience in buying products. Thus, in this case, a manufacturer would require a distribution network that is highly responsive with shorter response time.

2. **Setting distribution network objectives:** This step involves determining the goals of a distribution network after analysing customers' needs. For example, the objective of the distribution network of grocery items would be to achieve responsiveness and efficiency, whereas the distribution network of an online shopping retailer aims to gain cost effectiveness and maintain product quality even if the response time is longer (in some cases). By defining the goals and objectives, an organisation can design a network that best meets its requirements.

3. **Identifying major distribution network alternatives:** As studied earlier, different distribution network options or alternatives are available to organisations to choose from. In case a particular option does not yield the desired results (such as being unable to reach out to customers on time), an organisation may look for other design alternatives. For instance, if an organisation is aims to achieve responsiveness of its distribution network, it may choose from options like distributor storage with last mile delivery or manufacturer or distributor storage with consumer pickup. For this, an organisation has to consider the pros and cons of each alternative with respect to its distribution requirements in order to select the most appropriate distribution network option.

4. **Evaluating major distribution network alternatives:** In this step, the most suitable and profitable distribution network to reach out to customers from all the identified alternatives is selected. This is done by evaluating the strengths and weaknesses of each distribution alternative and taking into account various supply chain drivers and constraints. Generally, organisations adopt a distribution network that can be effectively controlled and managed.

Self-Assessment Questions

4. Which is the first step in the process of designing a distribution network?

    a. Analysing customer service needs

    b. Setting distribution network objectives

    c.   Identifying major distribution network alternatives

    d. Evaluating major distribution network alternatives

5. Identifying major distribution network alternatives involves determining the goals of a distribution network after analysing customers' needs. (True/False)

6. In which of the following step the most suitable and profitable distribution network to reach out to customers from all the identified alternatives is selected?

    a. Analysing customer service needs

    b. Setting distribution network objectives

    c. Identifying major distribution network alternatives

    d. Evaluating major distribution network alternatives

5.4 Framework for Network Design

A framework for the distribution network is a structure that mirrors the functioning of an organization's product distribution function. The distribution framework of any organization can be segmented into various phases. Important decisions must be made by the organization at each phase of the framework. Fig. 5.3 shows the framework for a distribution network:
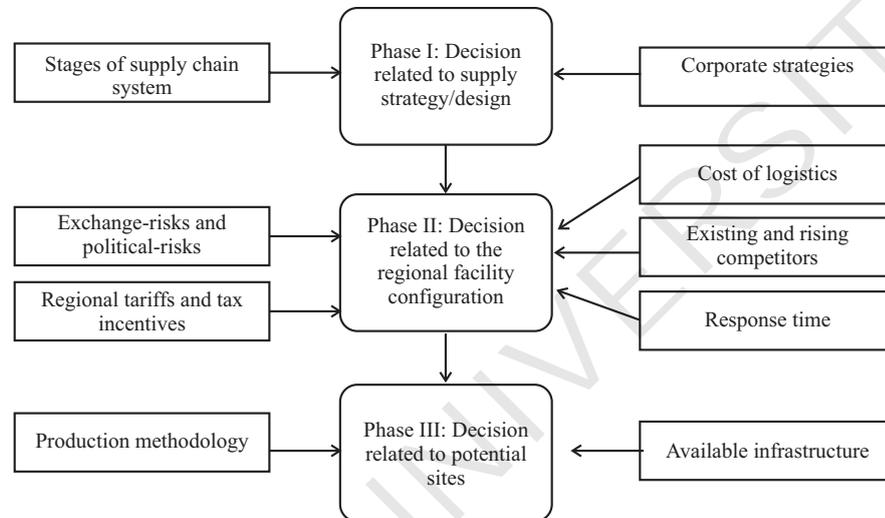
Fig. 5.3: Framework of Network Design Decisions

Let us now discuss the decisions taken at each phase of the framework.

◆ **Phase I: Decisions related to supply chain strategy/design:** Decisions related to supply chain strategy/design: This phase encompasses decisions related to supply chain sourcing (discussed in detail in previous units). In this phase, the organization aligns its supply chain requirements with customer demands. Subsequently, decisions related to supply chain capabilities are made.

◆ **Phase II: Decisions related to the regional facility configuration:** Decisions related to the regional facility configuration: This phase begins with the demand forecasting of products. This helps determine whether customer requirements are consistent or vary across different regions. Homogeneous requirements favor large consolidated facilities, while varied requirements necessitate smaller and localized facilities. Various factors associated with regions influence facility configuration decisions, including:

❑ Exchange and political risks of regional markets

❑ Regional tariffs and tax incentives

❑ Existing and rising competitors of every region

❑ Response time desired by customers in each regional market

❑ Cost of logistics in each region

Based on this information, the organization decides on the approximate number of facilities in the distribution network for each region. Additionally, the organization determines whether a facility will produce a few products for all markets or a specific market.

◆ **Phase III: Decisions related to potential sites:** Decisions related to potential sites: Decisions regarding potential sites are made based on an analysis of available infrastructure that can support the desired production methodology. Infrastructure

requirements can be categorized as hard infrastructure requirements and soft infrastructure requirements. Hard infrastructure includes the availability of suppliers, transportation services, communication, utilities, and warehousing infrastructure, while soft infrastructure includes the availability of a skilled workforce, employee turnover, and community receptivity to business and industry.

Self-Assessment Questions

7. In _____ of the network framework design, supply chain requirements of an organisation are aligned with customer's requirements.

8. This phase II of framework for network design starts with demand forecasting of products. (True/False)

9. Decisions regarding a potential site for the distribution network are taken in which phase of the distribution network framework?

5.5 Factors Affecting Network Design Decisions

In the previous section, you have studied about decisions taken by an organisation at different stages of a distribution framework. Taking decisions at every phase of the framework requires careful supervision and thoughtful consideration. This is because any wrong decision at any phase may bring serious repercussions to the entire distribution network of an organisation. There are a number of factors that affect the network design decisions, which need to be thoroughly considered by an organisation. These factors are listed in Fig. 5.4:

Strategic Factors

Technological Factors

Macroeconomic Factors

Political Factors

Infrastructure Factors

Competitive Factors
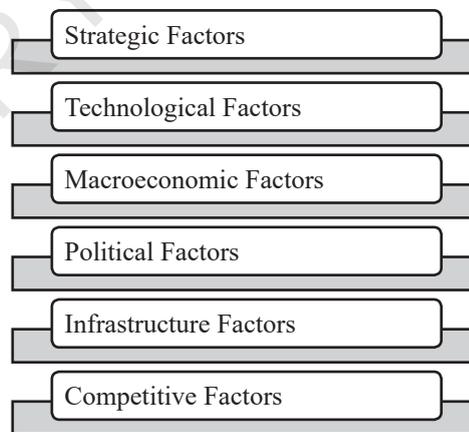
Fig. 5.4: Factors Affecting the Network Design Decisions

Let us now briefly discuss each of the factors.

◆ **Strategic factors:** The competitive strategy of an organisation affects its distribution network design decisions to a large extent. For instance, organisations that focus on attaining cost leadership tend to look for low cost manufacturing locations even if these locations are far from the markets they target. The best example of such strategy can be apparel manufacturers in the United States who moved their manufacturing base to Asian countries in the 1980s. This was because of the availability of low cost labour in such Asian countries. Similarly, the competitive strategy of some organisations focuses on supply chain responsiveness and efficiency. For instance, Zara, an apparel manufacturer, did not move its manufacturing plant outside the US as it had a corporate strategy based on increasing the responsiveness of its supply chain.

◆ **Technological factors:** The network design decisions of an organisation are also influenced by the type of production technology used. For example, if an organisation uses a production technology that focuses on achieving the economies of scale, high capacity locations are the best choice for the organisation.

Apart from this, the level of flexibility of production technology also influences the distribution network decisions of an organisation. For example, if the production technology of an organisation is not very flexible and product requirements of customers differ from one country to the other, the organisation needs to establish local facilities to serve customers in different countries. On the contrary, if the technology is flexible, an organisation can easily combine manufacturing in a few large facilities.

◆ **Macroeconomic factors:** These are external factors and cannot be controlled by an organisation. With the advent of globalisation, a number of macroeconomic factors have emerged that affect the distribution network decisions of an organisation. Some of these factors may include tax incentives, tariffs, and exchange rates. For example, if a country where an organisation operates has high tariffs, the organisation may not serve the local market or establish manufacturing facilities within the country so as to save duty.

◆ **Political factors:** Organisations prefer to invest or conduct businesses in countries that have a politically stable framework. Politically stable nations not only provide a market base to manufacturers but also have well defined rules and laws regarding trade and commerce. Conversely, an unstable political may create frequent legal hassles for organisations. Thus, organisations consider the political stability as one of the important factors in making decisions related to their distribution network.

◆ **Infrastructure factors:** The availability of good infrastructure is the primary requirement for locating a facility in any area. Poor infrastructure incurs additional costs for organisations and leads to production and distribution halts. Many multinational organisations have established their manufacturing plants in China near Shanghai and Tianjin as these locations are popular for good infrastructure in spite these locations do not have cheap labour or low rents. The main infrastructure elements considered by organisations are availability of sites, labour, proximity to transportation, availability of local utilities, etc.

◆ **Competitive factors:** Organisations must also consider strategies of their competitors in the market while making distribution network decisions in order to stay ahead. They need to decide whether to locate their plants near or far from competitors' plants. In many instances, competitors locate their facilities near to each other. This is because the presence of various facilities in a certain area increases the number of visiting customers. This benefits both customers as well organisations.

Self-Assessment Questions

10. With the advent of globalisation, a number of _____ factors have emerged that affect the distribution network decisions of an organisation.

11. Which of the following factors are external and cannot be controlled by an organisation?
    a. Strategic Factors
    b. Technological Factors
    c. Macroeconomic Factors
    d. Political Factors

12. Organisations must consider strategies of their competitors in the market while making distribution network decisions in order to stay ahead. (True/False)

Activity

Visit a manufacturing organisation in your area. Discuss with the supply chain manager of the organisation that how various factors have affected the design of the distribution network of their supply chain system.

5.6 Modelling for Supply Chain

The term 'modelling' is a process of formulating an appropriate model for a supply chain in alignment with an organisation's supply chain requirements. A supply chain model is a roadmap of an organisation's supply chain process, which encompasses suppliers, manufacturers, distributors, retailers, customers, flow of information, product delivery, and so on. The main purpose of a model is to bring transparency in information throughout the supply chain system. Fig. 5.5 shows a model of a supply chain:
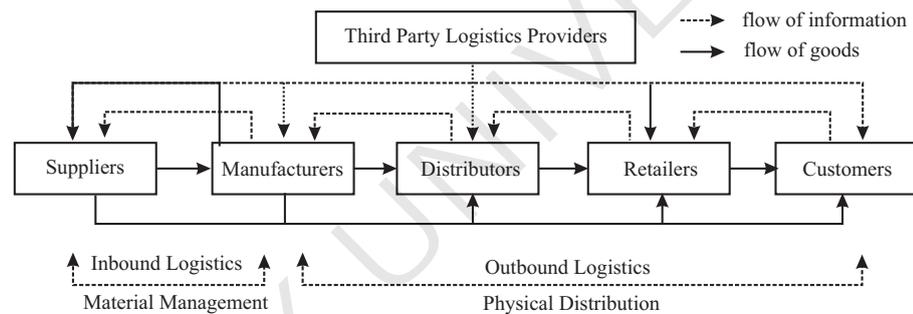
Fig. 5.5: Supply Chain Framework

(**Source**: http://www.transportation.northwestern.edu/docs/research/Chopra_DistributionSupplyChain.pdf)

In order to find the most suitable model for its supply chain, an organisation needs to consider certain components for building a suitable model. The components are explained as follows:

◆ **Supply chain drivers:** While formulating a supply chain model, major driving forces need to be identified. As discussed in the previous units, major supply chain drivers are facilities, response time, transportation, product availability, etc. These drivers affect the modelling of a supply chain to a large extent. For instance, response time is an indicator of the supply chain flexibility. These drivers should be clearly mentioned in the supply chain model so that all parties (like suppliers, manufacturers and distributors) remain informed about the most important aspects of an organisation's supply chain and work accordingly.

◆ **Supply chain constraints:** These are the limitations and restrictions of an organisation's supply chain system. These constraints with their respective measures should be clearly reflected in the supply chain model. This would help supply chain members to perform effectively without any hindrance that may otherwise occur due to constraints. For example, if an organisation has transportation and distance constraints, it must reflect in the respective model of supply chain.

◆ **Supply chain decisions:** As discussed earlier, organisations need to make various decisions related to location, allocation, network structuring, number of facilities and equipment, number of stages, inventory level, size of workforce, and the extent of outsourcing. These decisions of must be clearly mentioned in the model. For instance, if there are certain locations where an organisation cannot serve at all or where it has a good market base, it must reflect in the model.

Self-Assessment Questions

13. The term _____ is a process of formulating an appropriate model for a supply chain in alignment with an organisation's supply chain requirements.

14. A supply chain model is a roadmap of an organisation's supply chain process, which encompasses suppliers, manufacturers, distributors, retailers, customers, flow of information, product delivery, and so on. (True/False)

15. Supply chain _____ are the limitations and restrictions of an organisation's supply chain system.

5.7 Summary

◆ In order to meet customers' needs and expectations, the supply chain system of an organisation needs to have a well-defined distribution network in place.

◆ There are different design options present for a distribution network. Some of them are manufacturer storage with direct shipping and in-transit merge, distributor storage with package carrier delivery, distributor storage with last mile delivery, manufacturer/distributor storage with costumer pickup and etc.

◆ Organisations strive to design the best possible distribution network for their supply chain system. For this, they follow certain steps, such as analysing customer service needs, setting distribution network objectives, identifying major distribution network alternatives, and evaluating major distribution network alternatives.

◆ There is a framework of the distribution network that reflects the working of the product distribution function of an organisation. This framework comprises different phases where various decisions regarding the supply chain system are taken.

◆ While taking decisions in each phase of the distribution network, various factors are considered. Some of these factors are strategic factors, macroeconomic factors, infrastructure factors and etc.

◆ Modelling of supply chain refers to the process of formulating an appropriate model for the supply chain system of the organisation. This model helps the organisation in bringing transparency throughout the supply chain system.

5.8 Glossary

◆ **Aggregation delivery:** It is a combined delivery of the products in case of bulk orders made by customers.

◆ **Economies of scale:** It is the proportionate cost savings achieved after increasing a production scale.

◆ **Exchange rate:** It is the value of one currency with respect to another.

◆ **Less-than-truckload:** It refers to the shipping of relatively small loads where a full trailer is not required for transportation.

◆ **Package carrier:** It refers to the delivery of different products or orders in a single shipment.

◆ **Response time:** It refers to time taken by a manufacturer or retailer in delivering products to after a customer places an order.

◆ **Tariffs:** These are different types of duties paid when products or equipment are moved across the boundaries of nations, states, and cities.

◆ **Tax incentives:** These are tax rebates given by countries, states, and cities to promote outside manufacturers to locate their facilities in certain specific areas.

5.9 Terminal Question

1. What are the various available design options for a distribution network? Discuss with the help of examples.

2. Explain the process of distribution network design.

3. Describe the framework for network design.

4. What are various factors that affect network design decisions?

5. What do you understand by modelling for supply chain?

5.10 Answers

Q.	Self Assessment Questions
1.	a. Manufacturer storage with direct shipping
2.	False
3.	b. Distributor storage with package carrier delivery
4.	a. Analysing customer service needs
5.	False
6.	d. Evaluating major distribution network alternatives
7.	Phase I
8.	True
9.	Phase III
10.	Macroeconomic factors
11.	c. Macroeconomic factors
12.	True
13.	Modelling
14.	True
15.	Constraints
Q.	Terminal Questions
1.	Some of the design options are manufacturer storage with direct shipping and in-transit merge, distributor storage with package carrier delivery, distributor storage with last mile delivery, manufacturer/distributor storage with costumer pickup and etc. Refer to section **5.2 Design Options for Distribution Network**.
2.	The process of distribution network design comprises various steps such as analysing customer service needs, setting distribution network objectives, identifying major distribution network alternatives, and evaluating major distribution network alternatives. Refer to section **5.3 Process of Distribution Network Design**.

3.	The framework of the network design distribution consists of three phases where different decisions are taken regarding the design of the distribution network. Refer to section **5.4 Framework for Network Design**.
4.	There are various factors, such as strategic factors, macroeconomic factors, infrastructure factors and etc. affects the network design decisions. Refer to section **5.5 Factors Affecting Network Design Decisions**.
5.	Modelling of supply chain may be defined as a process of formulating an appropriate model for the supply chain system of the organisation. Refer to section **5.6 Modelling for Supply Chain**.

5.11 Case Study: Supply Chain Management at Amazon.com

Amazon.com, launched in 1995, is the world's second largest, American e-commerce company. Although the idea behind its inception was to sell books over the Internet, it later started offering other products, such as apparel, cosmetics, and stationery items. In 1998, the website was ranked among the top 20 websites in various market surveys. Since then, the website has been expanding and making its strong presence among users across the globe. It has now become a synonym for online shopping. The success story of Amazon.com is attributed to its strong supply chain system.

The organisation has overcome a lot of supply chain challenges over a period of time. It still faces some challenges with respect to the supply chain design, inventory management, order sourcing costs, and transportation. Deciding the number and location of its distribution centres to support its growing business and seasonal demand always remains a challenge for Amazon. The ever rising expansion of business made it to eliminate its various distribution centres in Seattle, Washington, Georgia and McDonough in order to cut on costs. Business expansion also posed a challenge in deciding which item to be stored in which warehouse.

Another challenge for Amazon is the segmentation of the inventory. Amazon delivers products directly to customers. The inventory is stored at both at its distribution centres and at its partners' warehouse. The challenge here is to decide which item to be stored at its own distribution centre and which should be directly supplied by the partner to customers.

The next challenge is to decide order sourcing. Orders placed by customers on the website may be fulfilled through inventories stored at internal facilities or by the external partner. The response time expected by customers from the website is very less as they want products to be delivered within hours. This way the organisation faces a huge challenge in finding out a low cost solution that can balance between fulfilling external and internal customers' needs and meeting their expectations. Presently, the organisation is performing a research for finding out a tool that can aid in taking sourcing decisions.

As Amazon delivers products directly to customers and there are no walk-ins and pickups by customers, transportation cost always remains a challenge for the organisation. Amazon can neither use economical transportation such as truck load and less-than-truckloads nor does it has a luxury of planning cycles as it will have longer response time. Therefore, the cost of transportation poses a challenge for Amazon. Thus, it must find innovative methods that can help in reducing transportation costs at the same time meeting customers' expectations.

Discussion Questions

1. Discuss the supply chain design challenge that Amazon would have faced after its recent launch in India as Amazon.in?

   (**Hint:** Amazon needs to decide whether to set up a distribution centre here in India or to partner with local distributors)

2. Do you think the decision of elimination of some its distribution centres in the US could have helped in cost cutting?

   (**Hint:** The decision of elimination of distribution centres is as important as a decision of setting up centres. If the concerned cities had fewer orders, it could have helped the organisation in cost cutting)

5.12 References and Suggested Readings

- Bolstorff, P. and Rosenbaum, R. (2007). *Supply chain excellence.* 1st ed. New York: AMACOM.

- Chopra, S. and Meindl, P. (2001). *Supply chain management.* 1st ed. Upper Saddle River, N.J.: Prentice Hall.

- Vekris, P. and Moore, S. (1978). *Production/physical distribution scheduling in a two-stage distribution network.* 1st ed. Santa Monica, Calif.: Rand.

E-references

- Programslive.iimcal.ac.in, (2014). *Supply Chain Management Courses - APSCM, IIM Calcutta.* [online] Available at: https://programslive.iimcal.ac.in/advanced-program-supply-chain-management-apscm [Accessed 28 Aug. 2014].

- Scm.ncsu.edu, (2014). *What is Supply Chain Management? - SCM | Supply Chain Resource Cooperative (SCRC) | North Carolina State University.* [online] Available at: http://scm.ncsu.edu/scm-articles/article/what-is-supply-chain-management [Accessed 28 Aug. 2014].

CHAPTER

6

Demand Forecasting in Supply Chain Management

Learning Objectives

After completing the chapter, you will be able to:

- ❑ discuss the concept of demand forecasting
- ❑ identify factors influencing demand forecasting
- ❑ explain methods of forecasting
- ❑ define the systematic approach of demand forecasting

6.1 Introduction

In the previous chapter, you have studied about the importance of a distribution network in a supply chain. To maintain an effective distribution network, one of the most important requirements for an organisation is to ascertain the demand for its products in the market. Supply chain management is a process by which an organisation ensures that it has adequate supply to meet the product demand of customers in the market. In order to maintain the right supply of products, an organisation needs to anticipate the demand for its products that may arise in the near future. Demand forecasting is an analytical process wherein an organisation determines the number of products or services that consumers purchase in the future.

With ever-increasing competition, organisations have shifted their focus from a made-to-order approach to the made-to-stock approach. This implies that organisations are no longer depend on customer orders to produce products rather they keep products in stock so as to fulfil immediate demand of customers at any point. For this, organisations need to forecast the demand for their products that satisfies their customers. This helps organisations to avoid an overcapacity situation where too much products are produced and remain on the shelf as well as an under-capacity problem where organisations find them without inventory to fulfil customer's orders.

Demand forecasting is vital at every stage of the supply chain process. For example, forecasts can be made for an organisation's inventory including raw material, work in progress, and finished goods. They can be used by the production department to plan production, schedule customer orders, maintain safety stock levels, and so on. Demand forecasts should be reviewed on a regular basis so as to ensure that accurate information on future trends is incorporated to predict demand. In this chapter, you will study about the importance of demand forecasting in a supply chain.

6.2 Meaning of Demand Forecasting

An organisation that wishes to be successful in the long run needs to have an efficient supply chain in place. This is because the effectiveness of a supply chain is directly related to customer satisfaction. For this, an organisation should have adequate inventory to be supplied in the market. However, determining the right quantities of products for supplying can be a challenge for an organisation. To overcome such a challenge, an organisation needs to anticipate the demand for products to be produced and supplied in the market The following are some popular definitions of demand forecasting:

According to **Evan J. Douglas**, "*Demand estimation (forecasting) may be defined as a process of finding values for demand in future time periods.*"

In the words of **Cundiff and Still**, "*Demand forecasting is an estimate of sales during a specified future period based on proposed marketing plan and a set of particular uncontrollable and competitive forces.*"

Demand forecasting prepares an organisation to quickly respond to changes in product demand that may take place in the future. It is the first and foremost activity in a supply chain that helps an organisation in making various decisions, such as production planning, facility selecting, and pricing. Let us consider a scenario of a manufacturing organisation that supplies its products to five stores at different locations in a city. For this, it needs to predict the demand for products at each store in order to plan its production accordingly. This is because demand cannot be the same across all stores and is dependent on various factors, such as population in the nearby area, customers' preferences, and income level. Thus, by forecasting demand, the manufacturing organisation can plan for quantities to be supplied at each store so that the needs of customers can be met on time.

In a supply chain, demand forecasting can be performed for long term as well as short term. Long-term forecasting is done to make decisions, such as introduction of new products and business expansion. On the other hand, short-term forecasting helps an organisation in deciding production policy, price policy, credit policy, and distribution policy. The following are the main objectives of demand forecasting:

- To lower inventory levels by evaluating the organisations' requirement for raw material, semi-finished goods, spare parts, etc.

- To develop effective production and delivery schedules so that situations of overproduction and underproduction can be prevented.

- To help an organisation in arranging the required resources for production.

- To establish sales targets and ways to achieve them.

6.2.1   Features of Demand Forecasting

Demand forecasting lays a foundation for an organisation's supply chain process. It supports other supply chain activities, such as inventory management and capacity planning. Thus, it is important for forecasters to understand the features of demand forecasting before actually carrying out the process. The following are the main features of demand forecasting:

- **Forecasts may be inaccurate:** While forecasting, organisations need to make certain assumptions about different aspects of the business environment. However, the business environment is dynamic in nature due to sudden changes in customers' preferences, economic fluctuations, obsolescence of technology, and so on. In such a case, forecasts may turn out to be inaccurate. Therefore, forecasts should include both expected forecast value and a measure of forecast error.

- **Accuracy in short-term forecasts is higher than long-term forecasts**: This implies that standard deviation of forecast error relative to the mean is higher in long term forecasts than that of short term forecasts. Therefore, decisions taken on the basis of short-term forecasts are more effective than those based on long-term forecasts. For example, in a retail store, the forecast is likely to be accurate if it is made for a day as compared to the forecast made for a week.

- **Accuracy in aggregate forecasts is higher than disaggregate forecasts**: This happens because standard deviation of error relative to the mean is lower in aggregate forecasts. For example, to estimate Gross Domestic Product (GDP) of a country is easier than estimating the revenue of an organisation.

6.2.2 Factors Influencing Demand Forecasting

Demand forecasting is a proactive process that helps in determining what products are needed where, when, and in what quantities. However, the demand forecasting process of an organisation is influenced by a number of factors. Some of these factors are shown in Fig. 6.1 :

```
            Factors Affecting
            Demand Forecasting

  Types of   Level of      Price of    Level of      Economic
   Goods     Competition    Goods      technology    Viewpoint
```
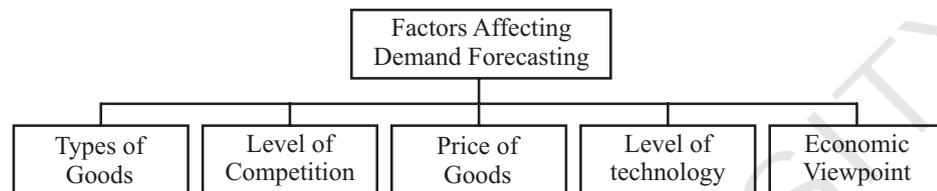
Fig. 6.1: Factors Affecting Demand Forecasting

Let us discuss these factors in detail.

- **Types of products:** The types of goods a company produces have a significant impact on demand predictions. Products can either be new or well-established. Demand information is typically available for established commodities, while predicting demand for new products is challenging. As a result, forecasting varies for each product.

- **Competition level:** This factor plays a crucial role in influencing demand forecasts. In a competitive market, numerous companies may offer identical items, influencing demand forecasts. Customers are likely to purchase fewer items when they are available in large quantities.

- **Price of goods:** The pricing of products has a substantial impact on demand forecasts. Changes in pricing significantly affect a company's demand predictions. When product prices increase, demand tends to decrease, and vice versa. Predicting product demand becomes challenging in such situations.

- **Level of technology:** Technological advancements contribute to accurate demand anticipation. Rapid progress in technology can make current technology or goods obsolete. For example, the introduction of CDs and pen drives for computer data storage has diminished the market for floppy discs. Forecasting future demand for existing items becomes challenging in the face of such technological shifts.

- **Economic viewpoint:** This aspect is essential for demand forecasting. Favorable economic developments, such as globalization and high investment, result in positive demand predictions for organizations, and vice versa.

6.2.3 Role of Demand Forecasting in Supply Chain Management

Demand plays a crucial role in the success of a supply chain by providing insight into potential supply chain risks in advance as well an organisation's capital investment and expansion decisions.

The following points explain the role of demand forecasting in supply chain management:

- **Satisfying customers**: Every supply chain aims at achieving customer satisfaction. Demand forecasting helps in fulfilling this aim by providing a fair idea of market trends, customers' tastes and buying capacity, etc. Based on this information, an organisation can plan its production; thereby fulfilling customers' needs.

- **Preparing budget**: Demand forecasting plays a crucial role in the preparation of budget by estimating costs and expected revenues. Based on the estimate, an organisation can

allocate budget for different supply chain activities. For example, an organisation can decide which supply chain functions need to be outsourced or performed in-house based on its allotted budget.

◆ **Stabilising production**: By producing according to the forecasted demand of products, an organisation can eliminate wastage and reduce cost. This further helps the organisation to hire supply chain personnel as per the requirement. For example, if an organisation expects a rise in the demand for its products, it may opt for extra labour to fulfil the increased demand.

◆ **Evaluating performance**: Demand forecasting also helps an organisation in appraising the performance of its existing supply chain and fulfilling gaps in it. For example, if the demand for an organisation's products is less, it may enhance the quality of its products to boost their demand.

Self-Assessment Questions

1. _____ prepares an organisation to quickly respond to changes in product demand that may take place in the future.

2. One of the main features of demand forecasting is that it is always accurate. (True/False)

3. Which of the following is not a factor that affects demand forecasting?

    a. Types of goods b. Level of competition

    c. Level of technology d. Management

4. _____ plays a crucial role in the success of a supply chain by providing insight into potential supply chain risks in advance.

Activity

Discuss how demand forecasting is done at any manufacturing organisation of your choice.

6.3 Methods of Demand Forecasting

Demand forecasting helps an organisation in anticipating risks and uncertainties in the future and taking appropriate measures. Generally, organisations use two common methods for forecasting demand. These two methods of demand forecasting are shown in Fig. 6.2:
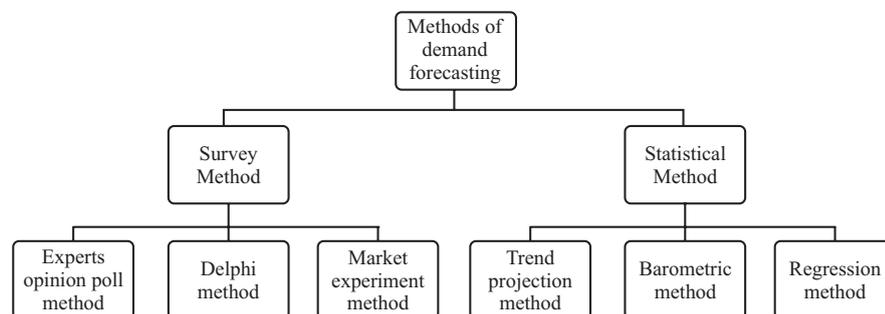
Fig. 6.2: Methods of Demand Forecasting

Let us discuss these methods in detail.

- ◆ **Survey methods:** Methods that include conducting surveys are the most prevalent and straightforward approaches to anticipating demand in the near term. This strategy takes into account the consumers' intents as well as their plans for future purchases. In this approach, an organisation will carry out surveys in order to collect information about demand. The following is a list of surveys that fall under distinct categories:

  - ❍ **Experts' opinion poll**: With this term, we are referring to a technique in which professionals are asked to submit their feedback on various items. For instance, sales representatives at an organisation serve as specialists who are able to evaluate the demand for items in various regions, cities, or sections of the country. Sales people are in regular contact with consumers; as a result, they are fully aware of the customers' future purchase intentions, their responses to changes in the market, and their impressions of other goods that are in competition with their own. They provide a rough approximation of the amount of demand that exists for the things that the organisation offers. This procedure is not only straightforward but also less costly. Nevertheless, the most significant drawback of this approach is that it generates estimates that are contingent on the market expertise of specialists as well as their overall level of experience. There is a wide range of variation in these abilities from person to person. Whenever this occurs, it becomes more challenging to provide demand projections that are correct.

  - ❍ **Delphi method:** It is a strategy for making decisions on predicting that is used by groups of people. For the purpose of obtaining the thoughts of a group of specialists on an upcoming event, this approach involves asking each member of the group a private question. These questions are asked again and over again until an agreement is reached. Additionally, in this technique, each expert is given information on the estimates that were made by other experts in the group. This allows the expert to modify his or her estimates in relation to the estimates that were made by the other experts. In this manner, projections are cross-checked among subject matter experts in order to arrive at decisions that are more accurate. On the estimations provided by other experts, each and every expert is permitted to respond or provide comments. This is done in order to allow impartial assessment and ensure that the identities of experts remain confidential while they are exchanging estimates with one another. As a result of the fact that it is possible to contact a number of specialists in a short amount of time without having to spend money on other resources, this strategy is the most advantageous in terms of both time and money. On the other hand, this approach could result in decisions that are subjective.

  - ❍ **Market experiment method:** It is a technique that entails gathering essential information which pertains to the present and future data of an event. When using this strategy, investigations and tests on customer behaviour are carried out under settings that are representative of the market. Using this approach, some regions of markets are chosen based on characteristics that are comparable to one another, such as the population, income levels, cultural background, and preferences of customers. Experiments on the market are carried out with the assistance of varying prices and expenditures in order to document the changes that occur as a consequence of the occurrence. The findings of this study are helpful in predicting an upcoming incident. On the other hand, it is a costly strategy, which may be beyond the financial means of organisations operating on a smaller scale.

◆ **Statistical methods:** These methods are used in order to anticipate demand over an extended period of time. The forecasting of an event is accomplished by the use of historical data as well as cross-sectional data in these approaches. The term "historical data" refers to the information that existed in the past and was gathered from a variety of sources, including market survey reports and balance sheets from prior years. Cross-sectional data, on the other hand, is gathered via the process of conducting interviews with people and carrying out market surveys. In contrast to survey techniques, statistical procedures are more dependable since they involve a lower degree of subjectivity throughout the research process. The following is a list of several strategies that are used under statistical methods:

❍ **Trend projection metho**d: In the approach of trend projection, it is necessary to have a substantial quantity of trustworthy data in order to make accurate forecasts. Additionally, this strategy operates on the assumption that the elements, such as sales and demand, that were responsible for trends in the past would continue to be the same in the future as well. When using this approach, sales projections are derived by conducting an analysis of historical data obtained from the books of accounts of the preceding year. In the case of freshly established businesses, sales information is obtained from companies that are already operating within the same sector.

❍ **Barometric method:** The barometer method involves making predictions about demand by analysing historical data or analysing important factors that are currently happening in the present instance. It is possible to determine the overall trend of commercial activity with the assistance of this approach. Take, for instance, the scenario in which the government grants the XYZ organisation land for the purpose of erecting structures. The fact that this is the case suggests that there will be a significant demand for cement, bricks, and steel. It is possible to use this strategy even when there is no historical data available, which is the primary benefit of using this method. When it comes to assessing the demand for new items, however, this strategy is not appropriate. Furthermore, its application is rendered null and void in situations when there is no time lag between the economic indicator and the temporal event.

❍ **Regression method**: These are the most popular methods of forecasting. The demand is calculated using the regression approach, which takes into account both the dependent and independent factors on the market. Under these circumstances, demand functions as a dependent variable, while the factors that determine it function as independent variables. It is referred to as a single variable event when there is just one variable that has an effect on the demand. As a result, straightforward regression methods are used. It is referred to as a multi-variable event when demand is altered by a number of different factors. Because of this, several regressions are used in situations like this one.

🔍 Exhibit

Data Collection in Demand Forecasting

Demand forecasting is based on the past data of an organisation's sales, revenue, previous years' demand, market trends, customers' preferences, and so on. Thus, it requires accurate and timely data as any inaccuracy at any level of demand forecasting may lead to serious repercussions for an organisation. For forecasting demand, data can be collected from various sources, such as newspapers, journals, books, interviews, observations, company records, and questionnaires.

There can be two types of data collected by organisations, which are:

◆ **Primary data**: It refers to data that is collected for the first time or does not have existence in the past. Primary data is collected through observation, interviews, questionnaires, surveys, etc. This data is collected by organisations for understanding current trends; however, the reliability of such data cannot be ensured as far as the authenticity of sources is concerned.

◆ **Secondary data**: It refers to data that is collected from sources that have either been used or published in the past. Secondary data is collected through the Internet, newspapers, magazines, company accounting records, reports, journals, books, etc. This data is more reliable as compared to primary data.

Self-Assessment Questions

5. In which method of forecasting, experts are requested to provide their opinions about products?

   a. Delphi method   b. Market experiment method

   c. Experts opinion poll method   d. Barometric method

6. _____ refers to a group decision-making technique of forecasting. In this method, questions are individually asked from a group of experts to obtain their opinions on an event in the future.

7. In the barometric method, sales forecasts are made by analysing the past data taken from the previous year's books of accounts. (True/False)

Activity

Using the Internet, find the methods of demand forecasting used in Tata Motors.

6.4 Demand Forecasting: A Systematic Approach

From the discussion so far, it can be said that demand forecasting is an essential requirement for an organisation to plan production and other supply chain activities. Demand forecasting is a systematic approach wherein a step-by-step procedure is followed. Therefore, it needs to be performed carefully by organisations as the outcome can be misleading and inaccurate in case a single step is missed out. Fig. 6.3 shows the steps involved in demand forecasting:

Setting objectives

Determining time period

Selecting a method for demand forecasting

Collecting data

Estimating results
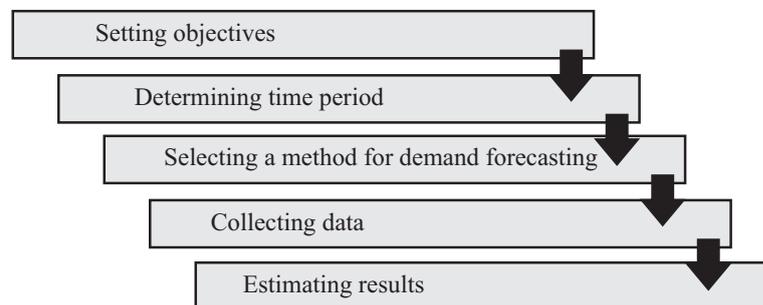
Fig. 6.3: Steps Involved in Demand Forecasting

Let us discuss these steps in detail.

1. **Setting objectives:** This marks the initial and foremost stage of the demand forecasting process. Before commencing, an organisation must clearly outline the purpose of demand forecasting. Establishing objectives for demand forecasting encompasses the following:

   ❍ Deciding the forecasting time frame, whether opting for short-term or long-term forecasting.

   ❍ Determining whether to forecast the overall market demand for a product or solely for the organisation's own products.

   ❍ Choosing whether to forecast the demand for the entire market or for a specific market segment.

   ❍ Deciding whether to forecast the market share of the organisation.

2. **Determining the time period:** This stage involves choosing the temporal perspective for demand forecasting. Demand can be forecasted for a short or long period. In the short term, demand determinants may remain relatively stable, while in the long term, significant changes can occur. Therefore, organisations determine the time period based on their established objectives.

3. **Selecting a method for demand forecasting**: This represents one of the most crucial steps in the demand forecasting process. Various methods, discussed in the preceding section, can be employed to forecast demand. The choice of method varies among organisations based on forecasting objectives, time frame, data requirements, and data availability. Selecting a suitable method is essential for saving time and costs while ensuring data reliability.

4. **Collecting data:** At this stage, researchers gather primary or secondary data for analysis. Primary data involves information collected through observation, interviews, and questionnaires for specific research. In contrast, secondary data refers to previously collected data that can be utilized in current research or scenarios.

5. **Estimating results:** This step entails making forecasts of demand for predetermined years. The results should be easily interpretable and presented in a practical form. It is crucial for the results to be readily understandable by readers or the management of the organisation.

Self-Assessment Questions

8. Which one of the following is the first step in demand forecasting?

   a. Setting objectives   b. Determining the period

   c. Collecting data   d. Estimating results

9. In the short run, determinants of demand may change significantly. (True/False)

10. _____refers to the data that is collected by researchers through observation, interviews, and questionnaires for a particular research.

6.5 Summary

◆ Demand forecasting is a process of projecting the quantities of a product that customers will buy at a particular point in time in the future.

◆ The main objective of demand forecasting is to lower inventories, develop effective production and delivery schedules, etc.

◆ The main features of demand forecasting are: inaccuracy of forecasts, high accuracy in short-term forecasts, and higher accuracy in aggregate forecasts.

◆ Demand forecasting is influenced by various factors, such as types of products, competition level, price of goods, level of technology, and economic viewpoint.

◆ Demand forecasting helps an organisation to satisfy the customers, prepare budget, stabilise production, evaluate supply chain performance, etc.

◆ To forecast the demand, an organisation uses mainly two methods: survey method that includes expert opinion poll method, Delphi method, and market experiment method; and statistical method that involves trend projection method, barometric method, and regression method.

◆ Demand forecasting is a systematic approach that involves mainly five steps, namely setting objectives, determining a time period, selecting a demand forecasting method, collecting data, and estimating results.

6.6 Glossary

◆ **Data collection:** It is a process of gathering data from various sources to get a complete picture of a specific area.

◆ **Demand forecasting:** It is a process of estimating the quantities of products that will be purchased by customers at a specified point in time in the future.

◆ **Regression:** It is a measure of a relationship between one dependent variable and various changing variables.

◆ **Standard deviation:** It is a measure of the amount of variation or dispersion from average.

6.7 Terminal Questions

1. Discuss the concept of demand forecasting.

2. What are the features of demand forecasting? Explain.

3. Discuss the role of demand forecasting in supply chain management.

4. What are the methods used for demand forecasting?

5. Discuss the process of demand forecasting.

6.8 Answers

Q.	Self Assessment Questions
1.	Demand Forecasting
2.	False
3.	d. Management
4.	Demand
5.	c. Experts opinion poll method

6.	Delphi method
7.	False
8.	a. Setting objectives
9.	False
10.	Primary data
Q.	**Terminal Questions**
1.	Demand forecasting is a process of estimating the quantities of a product that customers will buy at a particular point in time in the future. Refer to section **6.2 Meaning of Demand Forecasting**.
2.	One of the most important features of demand forecasting is that it can be inaccurate; therefore, it should include both expected forecast value and a measure of forecast error. Refer to sub-section **6.2.1 Features of demand forecasting**.
3.	Demand forecasting helps an organisation in satisfying customers, preparing budget, stabilising production and so on. Refer to sub-section **6.2.3 Role of demand forecasting in supply chain management**.
4.	There are mainly two methods used for demand forecasting, namely survey method and statistical method. Refer to section **6.3 Methods of Demand Forecasting**.
5.	A process of demand forecasting involves various steps, such as setting objectives, determining a time period, selecting a method for demand forecasting, etc. Refer to section **6.3 Methods of Demand Forecasting**.

6.9 Case Study: Demand Forecasting at Titan Company Limited

Titan Company Ltd. is the fifth largest wrist watch manufacturer in the world. The organisation was established as a joint venture between Tata Group and Tamil Nadu Industrial Development Corporation in 1984. It exports watches to nearly 32 countries around the world.

The major problem that Titan faced was to ascertain the demand for its watches in different markets. Initially, the organisation determined demand based on a gut feeling. However, the organisation was facing hard time in delivering the right products to the right markets. After much consideration, the management realised a need for a demand forecasting system that should be able to deal with issues, such as capacity constraints, multiple sales geographies, and multi-tier distribution channels. Another major challenge for the organisation was to coordinate among different distribution channels. This also necessitated the implementation of a demand forecasting system to predict sales across the country based on various constraints.

Earlier, the organisation had no scientific basis for demand forecasting, which led to mismatched inventory. Moreover, the production alignment ratio was around 70 per cent – which meant that 30 per cent of Titan's inventory was wasted. After much discussion on various demand forecasting systems available, Titan decided to adopt Advance Planning System (APS) to deliver forecasts by taking into account various constraints, such as plant and supply capacity.

The organisation already had a stabilised SAP and ERP backend which was an advantage for using APS. However, implementing APS was a cumbersome task for the organisation as

retrieving data from multiple stores and redistribution stockists was not easy. Gradually, the organisation and retail stores came to accept the system and the demand forecasting process turned out to be a streamlined one.

Using the system, Titan created semi-finished watches at the initial stage of production. After the forecast was confirmed, the semi-finished watches were turned into finished goods. This strategy of postponement helped the organisation in improving its market response time and ensured a minimum quantity of 'non-sellable' watches. The system also helped in reducing production planning time from a week to three days. Moreover, the number of manufacturing units also increased and additional complexities were also taken care of by the new system.

Discussion Questions

1. Discuss the problems faced by Titan in the above case study.

   (**Hint:** Inability to meet demand of various markets, wastage of inventory, etc.)

2. Do you think adopting a demand forecasting system was the right decision in the given case study? Why / Why not?

   (**Hint:** Yes, because, it helped the organisation in delivering an adequate amount of goods to the market and reducing inventory.)

6.10 References and Suggested Readings

◆ Ayers, J. (2001). Handbook of supply chain management (1st ed.). Boca Raton, Fla.: St. Lucie Press.

◆ Chopra, S., & Meindl, P. (2014). Supply Chain Management (1st ed.). Hallbergmoos: Pearson.

◆ Mentzer, J. (2001). *Supply chain management* (1st ed.). Thousand Oaks, Calif.: Sage Publications.

◆ Zuckerman, A. (2002). *Supply chain management* (1st ed.). Oxford: Capstone Pub.

E-references

◆ Forecastingmethods.net,. (2014). *Demand Forecasting Methods.* Retrieved 30 August 2014, from http://www.forecastingmethods.net/Demand-Forecasting-Methods.html

◆ Forecastingmethods.net,. (2014). *Demand Forecasting Methods.* Retrieved 30 August 2014, from http://www.forecastingmethods.net/Demand-Forecasting-Methods.html

◆ Statsoft.com,. (2014). *Demand Forecasting.* Retrieved 30 August 2014, from http://www.statsoft.com/Textbook/Demand-Forecasting

Planning and Managing Safety Inventory

Structure

Learning Objectives

After completing the chapter, you will be able to:

❑   identify the role of safety inventory in a supply chain

❑   explain how to determine an appropriate level of inventory

❑   discuss the impact of supply uncertainty on safety inventory

❑   analyse the impact of aggregation on safety inventory

❑   discuss the concept of vendor managed inventory

7.1 Introduction

In the previous chapter, you have studied about the importance of demand forecasting in a supply chain. Demand forecasting helps an organisation to meet customers' needs well on time. However, demand does not always remain the same as forecasted due to the dynamic features of the market. This may result in unnecessary delays in product delivery to customers. In order to meet variations in demand, an organisation needs to maintain an adequate level of safety inventory. Safety inventory is the stock held by an organisation to satisfy the current demand for products that exceeds the demand forecasted for a given period. It is maintained meet demand uncertainties and prevent the situation of product shortage.

In today's advanced business environment, customers are able to easily search across different stores for the availability of the required products. For example, if a particular product is not available on Amazon.com, customers may check the availability of products on other online stores like Flipkart.com, Snapdeal.com, eBay.com, etc. This increased ease of searching impels organisations to ensure the availability of products. Consequently, markets have turned to be highly heterogeneous and demand for products has become unstable and difficult to forecast. This has pressurised organisations to raise the level of safety inventory.

Safety inventory plays a crucial role in meeting customers' demand for products in the situations of stock out and ensuring the availability of products in the market. However, a supply chain manager needs to be careful while planning for safety inventory and determining its appropriate level. This is because any inaccuracy while planning for safety inventory may increase inventory holding costs of an organisation. Carrying excessive inventory can help the organisation in overcoming demand volatility but can be harmful when new products are introduced in the market. In such a case, the demand for existing products goes down and the inventory on hand becomes obsolete and worthless. In this chapter, you will study about the importance of safety inventory in a supply chain in detail.

7.2 Safety Inventory in Supply Chain

Demand for products always fluctuates from what is forecasted. Sometimes the actual demand exceeds the forecasted one due to various factors. These factors may include changes in customers' expectations, fall in product price, etc. In such a case, a manufacturer has to meet the exceeding demand in order to satisfy customers' needs. The inventory that is kept and used to meet the exceeding demand is referred to as safety inventory or buffer stock or reserve stock.

Let us consider an example of a high-end retail store in the US to understand the importance of safety inventory in a supply chain. The store sells designer handbags of an Italian manufacturer. The transportation cost of importing bags from Italy is high; thus, the store

manager orders handbags in a lot size of 600 units. The average demand for handbags per week is 100 units. The manufacturer takes three weeks to deliver handbags after an order is placed. In the absence of demand uncertainty, if the store sells exactly 100 handbags in one week, the store manager may place the order when there are exactly 300 handbags left in the store. In this case, the new order would arrive as soon as the store sells the last handbag. However, due to demand fluctuations and forecast error, the actual demand over three weeks may be lower or higher than 300 units. In case of higher demand, some customers may not be able to make their purchases, resulting in the potential loss of the margins at the store. Therefore, the store manager decides to place the order when the store has 400 handbags left. In such a case, the store has safety inventory of 100 handbags to meet the rise in demand.

Thus, it can be said that safety inventory is maintained by organisations to carry out a smooth delivery of products even in a stock out situation (when an organisation runs out of stock). This situation arises if there are frequent changes in lead time and usage rate of inventory, which are discussed below. In such situation, if an organisation does not have an adequate level of safety inventory, its delivery schedules can be adversely affected, which may have a serious impact on organisational performance and customer satisfaction. Safety inventory plays a pivotal role under the situations of demand and supply uncertainties. Therefore, it is of utmost importance for a supply chain manager to determine an appropriate level of safety inventory. In the next section, let us study how to find out an adequate level of safety inventory.

7.2.1 Planning Safety Inventory and its Appropriate Level

As discussed in the previous section, safety inventory is the stock stored by an organisation with an aim to prevent a stock out situation or meet exceeding demand. The next question here arises is what should be an appropriate level of safety inventory that an organisation must maintain. This is because maintaining safety inventory incurs huge cost of the organisation; thus excessive safety inventory may lead to severe losses and wastage. The formula to calculate the level of safety inventory is as follows:

Safety inventory = (Maximum usage rate – Average usage rate) * Lead time

Or

Safety stock = Reorder point [– {Lead time (in days) * average usage}]

Where,

Usage rate is the rate at which an organisation uses inventory. For example, if an organisation has the usage rate of 300 units, it means it uses 300 units of inventory every day. Similarly, lead time is the time taken by suppliers in delivering products to customers after a purchase order is placed. The reorder point is stated in terms of the level of inventory at which an order should be placed to replenish the current stock of inventory. In simple words, reorder point may be defined as the level of inventory when a fresh order should be placed for procuring additional inventory. It can be calculated as follows:

Reorder point = (Lead time * Average usage) + Safety stock

Another formula used for calculating safety inventory is one in which the safety stock varies directly as the square root of lead time. Consumption varies and is adjusted according to the degree of safety desired. The formula for safety stock level is:

$S = K \sqrt{D}$

Where

S= Safety stock

K= Value of constant that varies from 1 to 4 depending on the degree of safety desired

D= Average consumption during lead time

Although there is no defined way to identify an appropriate level of safety inventory, there is a common process used by organisations to decide the right level of safety inventory. The process involves a number of steps, which are shown in Fig. 7.1:
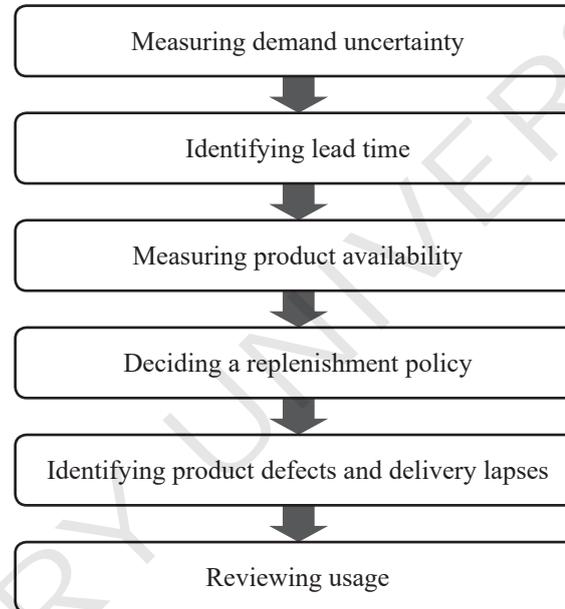
Fig. 7.1: Steps in Determining an Appropriate Level of Safety Inventory

Let us now briefly discuss these steps.

1. **Measuring demand uncertainty:** This is the first step of the process where fluctuations in demand are determined. Uncertainties in demand take place due to various factors, such as a fall in product prices and increase in customers' expectations. In this step, all these factors are considered (that may cause fluctuations in demand) so that the right level of safety inventory can be determined to meet such uncertainties in demand.

2. **Identifying lead time:** This step involves estimating lead time between the placement of orders and projected delivery dates. This can be done by working closely with suppliers to identify the average time required to process orders of a specific quantity. After the expected delivery date of products from suppliers is known, adjustments in the quantity of orders are made to ensure that adequate safety inventory is available to meet delivery schedules until each subsequent order is processed and received.

3. **Measuring product availability:** In this step, product availability, which is a manufacturer's ability to fulfil customer orders from the available inventory, is measured. Product availability is measured by calculating product fill rate, order fill rate, and cycle service level. Product fill rate is the fraction of demand satisfied from the available product inventory. Order fill rate is the fraction of orders filled through the available inventory and cycle service level is the fraction of replenishment cycles that end when customer demand is met.

4. **Deciding a replenishment policy:** Replenishment is a process of refilling safety inventory by making reorders. For this, an organisation needs to decide the replenishment policy to be adopted for refilling inventory. There are two main replenishment policies adopted by organisations namely continuous review policy and periodic review policy. A detailed explanation of these two policies is given later in the section.

5. **Identifying product defects and delivery lapses:** The chances of product defects and delays in product delivery are always there. In this step, the reasons for delays and defects in products are identified. In case of product defects, a percentage difference is created, which is added to the new order. For example, a production process requires replacement of 10 units of a certain item each week. Among 2 out of 10 ordered units are presumed to be defective in some manner, which could slow production. In such a case, the order for 12 units is made. The difference of 2 units is also added to the new order so that even in the case of defective products, safety inventory may not suffer.

6. **Reviewing usage:** In this step, the usage of inventory is regularly monitored so that variation in the level of safety inventory can be determined. The review is done once a month, week, or even twice in a week. The review helps in finding variations in average daily usage of items. The data collected through such reviews is then used to determine the size of the next purchase order that is yet to be placed.

7.2.2   Impact of Supply Uncertainty on Safety Inventory

Like demand is subject to fluctuations, there arise uncertainties in supply too, which has major impact on the level of safety inventory. For example, if suppliers fail to deliver components to Hewlett-Packard (HP) on time, the organisation would be unable to meet its production targets, which would hamper its supply of computers to retailers in the market. Thus, in such a case, HP needs to maintain a certain level of safety inventory of components so that its production process may not hinder and supply to retailers goes smooth.

Generally, suppliers fail to deliver raw material to manufacturers due to various reasons, such as rise in the price of raw material, increase in the number of manufacturers in the market, and adverse climatic and transportation conditions. A lack of supply would lead to product unavailability in the market. This would eventually increase cost at a manufacturer's end as there would be increased efforts such as finding new alternatives for the supply of raw material. In such a case, maintaining an appropriate level of safety stock by the manufacturer would help in carrying out a smooth supply of products to retailers.

7.2.3   Impact of Aggregation on Safety Inventory

In a supply chain, aggregation of inventory is all about storing inventory at a centralised location. In reality, the supply chains of organisations have different degrees of inventory aggregation. For instance, HP sells computers through retail stores with inventory distributed all over the country. On the other hand, Dell has some centralised facilities for shipping customer orders. Seven Eleven Japan has many small convenience stores distributed across Japan.

The impact of aggregation is reverse on safety inventory. This means that with an increase in aggregation, safety inventory tends to reduce, whereas with a decrease in aggregation, safety inventory increases. Let us understand this with the help of an example. Suppose retail chain A holds warehouses at five locations to fulfil demand at all of its retail outlets and retail chain B has warehouses at only two stocking locations for equal number of outlets. In this case, retail

chain B needs to maintain lower safety inventory in comparison to retail chain A. This is because retail chain B has aggregated its inventory by having a less number of stocking locations.

There are a number of benefits that an organisation achieves through the aggregation of inventory. The following are some advantages of aggregation of inventory:

◆ Through aggregation of inventory, safety inventory decreases. This in turn reduces inventory holding costs.

◆ Aggregation of inventory facilitates centralisation of information, which reduces the chances of manipulation of information at different store outlets.

◆ It increases the chances of product substitution, which allows organisations to aggregate demand for products, thereby reducing safety inventories required.

However, there are two disadvantages of aggregation, namely increase in response time and high transportation cost as there can be a longer distance between the centralised warehouse and the store.

7.2.4 Impact of Replenishment Policies on Safety Inventory

As discussed earlier, safety inventory helps in meeting the rising demands and shortfall in supply. Thus, it is necessary to check the availability of buffer stock and replenish it from time to time. Organisations generally adopt two types of replenishment methods, namely continuous review replenishment and periodic review replenishment. In the continuous review replenishment method, inventory is continuously tracked and a lot size is ordered when the inventory drops below the reorder point. For example, in a grocery store, if the store manager continuously reviews inventory of packaged fruit juice which has the reorder point of 400 units, he would immediately reorder juice as soon as the quantity reaches near 400 units.

On the other hand, in the periodic review, inventory is reviewed after a fixed period of time and the orders are made in such a way that the level of current inventory and lot size of the replenishment order must be equal to the size of the pre-specified level of inventory. This specified level of inventory is referred to as order-up-to-level (OUL). This means the lot size of the next order would depend upon the current inventory and the specified inventory in a particular time period. For example, a manager of a retail store reviews the inventory of building blocks once a week and has the OUL of 100 units for this product. After a week, the current inventory for building blocks has left 50 units; he would then place an order for 50 units to make the total of 100 units (which is the OUL for the product). In this way, the methods adopted by organisations for the replenishment of inventory largely affect their level of safety inventory.

Self-Assessment Questions

1. Safety inventory is maintained to meet _____ demand.

2. What is 'D' in the formula $S = K \sqrt{D}$?

3. In which of the following step adjustments in the quantity of orders are made to ensure adequate safety inventory?

   a. Measuring demand uncertainty

   b. Identifying lead time

c. Measuring product availability

d. Reviewing usage

4. There are two types of replenishment policies adopted by organisations namely _____ review policy and _____ review policy.

5. The aggregation has direct impact on safety inventory. (True/False)

Activity

Imagine you own a chain of retail stores and hold stock at different locations. Which replenishment policy would you choose to maintain an appropriate level of safety inventory?

7.3 Vendor Managed Inventory

Vendor Managed Inventory (VMI) is a streamlined approach or system to manage inventory and fulfil customers' orders. In this system, the customers (distributors, retailers, or product end users) of a product provide information regarding product requirements to a vendor or supplier of that product. The supplier in turn is responsible for fulfilling customer orders by maintaining an adequate level of inventory generally at consumption centres (at stores). In this system, a third-party logistics provider can also be engaged in ensuring that customers avail the required products by plugging demand and supply gaps.

VMI helps a vendor in specifying the quantities of products (to be sent to customers through a distribution channel) to the manufacturer using data acquired from Electronic Data Interchange (EDI). In this way, VMI prevents the situations of stock outs by providing information related to inventory requirements in advance and maintaining the right level of inventory in a supply chain. Walmart, Petrolsoft Corporation, and Home Depot are some organisations that are successfully using the VMI system. These organisations have a large number of suppliers of manufactured goods.

Let us understand the importance of VMI by considering an example. Before implementing a VMI system, a distributor of computers operated under a non-VMI business model, which helped in planning, monitoring, and controlling inventory. A purchase order against the manufacturer was placed only a need of more inventories was felt. However, under a vendor managed inventory setup, the computer manufacturer establishes the inventory plan of the distributor. The manufacturer then keeps track of the inventory levels of distributors. The manufacturer generates a purchase order and ships products to the distributor only when inventory levels are too low. In this way, VMI provides control over the inventory to the manufacturer; thereby promoting a strong partnership between the manufacturer and the distributor and preventing a stock out situation.

The main aim of VMI is to optimise an organisation's supply chain process and align it with overall business objectives. The following are some advantages of VMI:

◆ Improved inventory turns

◆ Increased sales

◆ Centralised forecasting

◆ Frequent communication of inventory

◆ Prioritisation of products to be stored

📝 Self-Assessment Questions

6. _____ is used to acquire data in the VMI system from customers?

7. In VMI system, inventory is maintained by the suppliers.(True/false)

📐 Activity

Using the Internet, find out information on the possible challenges that may take place for an organisation during the implementation of VMI.

7.4 Summary

◆ An inventory that is stored to meet the rising demand is referred to as safety inventory.

◆ Identifying an appropriate level of safety inventory involves a number of steps, such as measuring demand uncertainty, checking product availability, and identifying product defects and delivery lapses.

◆ Just like demand uncertainty, safety inventory is also affected by supply uncertainty. Delay in supply may lead to product unavailability, thus it is required to consider supply uncertainty while planning for safety inventory.

◆ Replenishment is a process of reordering in order to refill safety inventory. There are two policies by which replenishment can be done, namely continuous review policy and periodic review policy.

◆ Vendor managed inventory is a streamlined approach where a supplier is responsible for fulfilling customer orders by maintaining an adequate level of inventory generally at consumption centres.

7.5 Glossary

◆ **Electronic Data Interchange (EDI):** It is software used in the VMI system to obtain data from customers in the electronic form. This data is then used by a vendor to specify the quantity of products to a manufacturer.

◆ **Replenishment cycle:** It is a period of time from reordering till the inventory is refilled.

◆ **Safety inventory:** It is inventory maintained by a manufacturer to meet exceeding demand.

7.6 Terminal Questions

1. What do you understand by the term safety inventory?

2. What are the steps in determining an appropriate level of safety inventory?

3. Discuss impact of supply uncertainty on safety inventory.

4. How replenishment policies influence safety inventory levels?

5. Write a short note on VMI.

7.7	Answers
Q.	**Self Assessment Questions**
1.	Exceeding
2.	Average consumption during lead time
3.	b. Identifying lead time
4.	Continuous and Periodic
5.	False
6.	EDI (Electronic data interchange)
7.	True
Q.	**Terminal Questions**
1.	Demand fluctuations take place due to various reasons. A buffer inventory maintained to meet such fluctuation in demand is referred to as safety inventory. Refer to section **7.2 Safety Inventory in Supply Chain**.
2.	The steps involved in determining an appropriate level of safety inventory are measuring demand uncertainty, checking product availability, and identifying product defects and delivery lapses. Refer to sub-section **7.2.1 Planning safety inventory and its appropriate level**.
3.	Supply may be delayed for various reasons. Therefore, a manufacturer is required to consider supply uncertainty while maintaining safety inventory. Refer to sub-section **7.2.2 Impact of supply uncertainty on safety inventory**.
4.	The two types of replenishment policies are often used by organisations namely continuous review policy and periodic review policy. Both these replenishment policies have different impact on safety inventory. Refer to sub-section **7.2.4 Impact of replenishment policies on safety inventory**.
5.	VMI is a streamlined system that helps vendors to specify the quantity of products to the manufacturer. Refer to section **7.3 Vendor Managed Inventory**.

7.8 Case Study: Failure of Supply Chain at PCS

PCS is a retail chain that operates in around twenty locations throughout the country of India. In order to keep the lead time and distance between the warehouse and the outlet as low as possible, the majority of the chain's warehouses are located in close proximity to the places where the stores located. The retail market in India is dominated by the chain to a significant degree. As of late, however, the company has seen a decline in the number of clients who are interested in purchasing its products. Customers praised the new fall collection that the business introduced throughout the autumn season. The collection was a huge success. In light of this, the chain predicted that there would be an increase in demand for the next month, and as a result, merchandise was kept in various warehouses in accordance with the anticipated demand.

Some of the chain's shops were positioned in the central marketplaces of cities, while others were found on the outskirts of the cities. The level of demand for things was very variable depending on the area. Some of the chain's outlets were unable to keep up with the significant rise in demand for the new collection, and as a result, they ran out of stock. As a result of the

out-of-stock scenario, clients were very unsatisfied since they were unable to take advantage of seasonal discounts that were especially appealing to them. The image of the business was severely damaged as a result of this scenario, particularly among the consumers.

The owner of the chain wanted to discover the explanation for such a declining image of the chain and select steps to take in light of the ongoing predicament the chain is now experiencing. Following an exhaustive investigation, it was determined that the supply chain system of the chain included a gaping hole on account of the flaw. Particularly in areas where demand was unpredictable, the majority of the chain's outlets were unable to have an adequate amount of safety merchandise on hand. This resulted in these shops having a scenario where they were out of supply.

Discussion Questions

1. Suggest measures for overcoming the stock out situation of PCS's stores.

   (**Hint:** By maintaining a sufficient level of safety inventory, stores could have been able to meet a rise in demand.)

2. Do you think raising the level of safety inventory can be a costly affair for PCS?

   (**Hint:** PCS can manage costs by introducing the aggregation of inventory and maintaining the right level of safety inventory for all its store locations.)

7.9 References and Suggested Readings

◆ Hugos, M. (2003). Essentials of supply chain management (1st ed.). Hoboken, N.J.: John Wiley & Sons.

◆ Simchi-Levi, D., Kaminsky, P., & Simchi-Levi, E. (2000). Designing and managing the supply chain (1st ed.). Boston: Irwin/McGraw-Hill.

E-references

◆ Lcm.csa.iisc.ernet.in,. (2014). An Introduction to Supply Chain Management. Retrieved 21 August 2014, from http://lcm.csa.iisc.ernet.in/scm/supply_chain_intro.html

◆ Limited, I. (2014). Infosys | SCM practice. Infosys.com. Retrieved 21 August 2014, from http://www.infosys.com/supply-chain/

◆ Scm.ncsu.edu,. (2014). What is Supply Chain Management? - SCM | Supply Chain Resource Cooperative (SCRC) | North Carolina State University. Retrieved 21 August 2014, from http://scm.ncsu.edu/scm-articles/article/what-is-supply-chain-management

CHAPTER

8

Aggregate Planning in Supply Chain Management

Structure

Learning Objectives

After completing the chapter, you will be able to:

❑ define aggregate planning

❑ discuss the role of aggregate planning in a supply chain

❑ describe the aggregate planning process

❑ identify aggregate planning strategies

8.1 Introduction

In the previous chapter, you have studied about safety inventory, which is the stock held by an organisation to satisfy the current demand for products that exceeds the demand forecasted for a given period. However, maintaining an adequate safety inventory level is not sufficient for an organisation to meet the uneven demand. Organisations need to plan production schedules in advance by combining and assessing various available resources and current capacity in order to deliver products on time. Aggregate planning is a process that helps an organisation in smoothly carrying out production and synchronise flow throughout its supply chain.

Aggregate planning can be defined as an approach to strike a balance between demand and supply of products. The main goal of aggregate planning is to formulate a production plan that makes optimum utilisation of organisational resources to meet the expected demand; thereby maintaining an effective supply chain. For this, it focuses on maintaining an appropriate level of the workforce and a steady output rate; matching demand from period to another; and using a combination of decision variables.

Aggregate planning is a broader approach to planning. Planners avoid focusing on individual products or services rather they focus on overall production capacity of an organisation. Aggregate planning lays a foundation for various other corporate decisions, such as budgeting, personnel, and marketing. For example, budgets are generally based on aggregate output, levels of inventory, number of personnel, purchasing levels, etc. Thus, an aggregate plan guides in initial budget development and revisions as per requirements. In this chapter, you will study about aggregate planning and its importance in detail.

8.2 Meaning of Aggregate Planning

Aggregate planning is an attempt to match the demand and supply of products or services by estimating the right quantities of inputs and output and the right time for their transformation. In other words, it can be defined as a process of determining the ideal levels of capacity, production, subcontracting, inventory, stock outs, and even pricing over a period of time. Through aggregate planning, an organisation aims at solving problems that require aggregated decisions while performing supply chain activities. For example, through aggregate planning, an organisation can determine an appropriate production level to be maintained so that customers' needs can be fulfilled successfully.

Aggregate planning helps in minimising the total costs of production, establishing an organisation-wide strategic plan for allocating resources, improving customer service, and reducing investment in inventories. Apart from this, the following are some other objectives of aggregate planning:

◆ To maintain an appropriate production level.

◆ To minimise alterations in production rates.

◆ To make efficient utilisation of available resources.

Let us understand the concept of aggregate planning with the help of an example. ABC is a paper mill that faces seasonal demand for premium paper required for making brochures and company reports. To meet such seasonal demand can be a costly affair for the mill due to high prices of special additives and coatings required for manufacturing premium paper. Thus, to deal with these constraints, ABC needs to perform aggregate planning to determine the right levels of production and inventory in order to maintain an effective supply chain.

8.2.1 Role of Aggregate Planning in Supply Chain

Aggregate planning helps an organisation in making production schedules that make the best utilisation of scarce resources; thereby increasing the effectiveness of a supply chain. The following points explain the role of aggregate planning in a supply chain:

◆ Aggregate planning helps planners in making decisions related to output rates, employment levels, appropriate inventory levels, etc. which are essential for an effective and responsive supply chain.

◆ Through aggregate planning, an organisation arranges resources required for production and timely delivery of products.

◆ In case of changes in demand, aggregate planning helps making decisions related to marketing and operations to match the supply of products.

◆ Aggregate planning also provides a basis for preparing an initial budget for an organisation's supply chain.

8.2.2 Aggregate Planning Process

Aggregate planning is a systematic approach to develop an aggregate plan of an organisation. This aggregate plan acts a roadmap for an organisation to carry out its supply chain activities smoothly. An aggregate plan contains information on factors that may cause fluctuations in demand (price, promotion, back orders, new demand, etc.); capacity factors; and the ways to meet uneven demand in the future. Aggregate planning involves a number of steps, which are shown in Fig. 8.1:

Forecasting demand

↓

Identifying planning variables

↓

Formulating the aggregate plan

↓

Implementing the aggregate plan
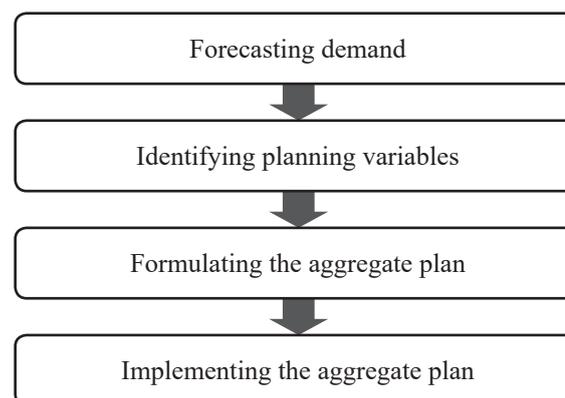
Fig. 8.1: Steps in Aggregate Planning

Let us discuss these steps in detail.

1. **Forecasting demand:** This step involves anticipating the quantities of an organisation's products that customers are willing to purchase in the future. Based on forecasting, an organisation takes various business decisions, such as planning production, procuring raw material, managing funds, and deciding the prices of products.

2. **Identifying planning variables:** In this step, variables for aggregate planning are defined. These variables mainly include the total quantities of aggregate products to be produced in a particular time period and the total number of direct labour required.

3. **Formulating an aggregate plan:** This step involves developing a schedule that contains information related to production rates, workforce levels, inventory investment, customer requirements, capacity limitations, and so on.

4. **Implementing the aggregate plan:** This is the last step of the aggregate planning process that involves putting the plan into action using various optimisation methods. It is not necessary that aggregate planning would be successful as demand may not remain the same as predicted due to the dynamic features of the market. Thus, the aggregate plan that is devised for 6-12 months cannot be used for the next months. Therefore, it is necessary for an organisation to update its aggregate plan constantly.

8.2.3 Requisites for Aggregate Planning

As discussed so far, aggregate planning helps in balancing demand and supply. A poor aggregate plan leads to a loss of sales and profits if the existing inventory and capacity fail to meet demand, thereby raising costs. Therefore, planners need to be careful while doing aggregate planning. The following aspects should be considered while making aggregate plans:

- Demand forecast in each period
- Production costs
  - Labour costs (regular time and overtime costs (per hour)
  - Cost of subcontracting production (per unit/hour)
  - Cost of hiring/laying off workforce (per worker)
  - Cost of adding or removing machine capacity
- Labour/machine hours required per unit
- Inventory holding cost (per unit/period)
- Stock out or backlog cost (per unit/period)
- Constraints
  - Limits on overtime
  - Limits on layoffs
  - Limits on capital available
  - Limits on stock outs and backlogs

Aggregate planning helps an organisation in determining the following:

- **Production quantity**: It can be determined in terms of regular time, overtime, and subcontracted time. The production quantity helps an organisation to determine the number of workers and suppliers required.

◆ **Inventory maintained:** It is used to determine the required warehouse space and working capital.

◆ **Backlog/stock out quantity:** It helps an organisation to define customer satisfaction levels to be achieved.

◆ **Machine capacity increase/decrease:** It helps an organisation in making decisions related to the purchase of new production equipment.

Self-Assessment Questions

1. Through _____, an organisation aims at solving problems that require aggregated decisions while performing supply chain activities.
   a. Forecasting
   b. Scheduling
   c. Production
   d. Aggregate planning

2. In case of changes in demand, employees help in making decisions related to marketing and operations to match the supply of products. (True/False)

3. Which of the following step involves putting the plan into action using various optimisation methods?
   a. Forecasting demand
   b. Implementing the aggregate plan
   c. Identify planning variables
   d. Formulating an aggregate plan

4. _____ is used to determine the required warehouse space and working capital.

Activity

Using the Internet, find an example of an organisation that has used aggregate planning to make its supply chain effective.

8.3 Aggregate Planning Strategies

Aggregate planning plays a vital role in the success of a supply chain. Thus, it requires careful supervision and thoughtful consideration. In order to perform effective aggregate planning, organisations adopt three main types of strategies, which are listed in Fig. 8.2:
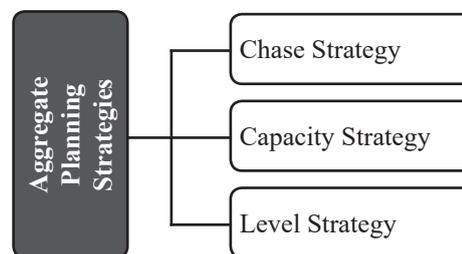
Fig. 8.2: Aggregate Planning Strategies

Let us discuss these strategies in detail.

- **Chase strategy**: This strategy aims at matching the demand and the volume of a product from one period to another. Organisations use this strategy when demand is uncertain and safety inventory is not maintained. The chase strategy focuses on achieving synchronisation between the capacity of machines and employees hired in accordance with the demand. The main advantage of the chase strategy is that it enables an organisation to keep the lowest levels of inventory as the strategy focuses on a make-to-order approach. However, adopting this strategy may have a negative impact on labour due to increased layoffs.

- **Capacity strategy**: This strategy is adopted by organisations in case machines are underutilised. In this strategy, the number of employees remains the same, while the number of hours varies over a period of time to create a balance between production and demand. To achieve a balance, an organisation creates flexible working schedules or plans so that employees can work according to the requirements. The capacity strategy should be used by organisations in situations like high carrying costs for inventory and inexpensive machine capacity.

- **Level strategy**: As the name suggests, the level strategy focuses on maintaining a steady production rate and workforce level. In this strategy, production levels are kept uniform and inventory is accumulated during slack periods and used during peak demand periods. Thus, in the level strategy, no efforts are made to synchronise production with demand. However, due to steady production, there are chances of accumulation of large inventories and delays in product delivery to customers. The level strategy can be used when inventory and back order costs are relatively low.

8.3.1 Aggregating Planning using Linear Programming

The goal of any organisation is to keep production as stable as possible at the same time maintaining low inventory and preventing shortages. Therefore, an organisation must balance the costs of production, overtime, subcontracting, inventory, shortages and changes in production levels. For this, various aggregate planning techniques are used. One commonly used technique is linear programming (LP), which is used to determine maximum profit or revenue or minimum cost on the basis of the availability of scarce resources and various limitations (also known as constraints). Let us now understand how to formulate a linear programming problem.

In order to construct an LP model for aggregate planning, the first step is to identify a set of decision variables whose values need to be determined as a part of the aggregate plan. The following are some decision variables that need to be ascertained:

Wr = Workforce size for Month t

Lr = Number of employees laid off at the beginning of month t

Pt = Number of units produced in month t

It = Inventory at the end of month t

St = Number of units stocked out/backlogged at the end of month t

After identifying decision variables, the next step is to define the objective function of a problem. For instance, the objective function of an organisation is to minimise total cost and maximise profits. There are various types of costs that are incurred while producing output. Some of these costs are shown in Fig. 8.3:
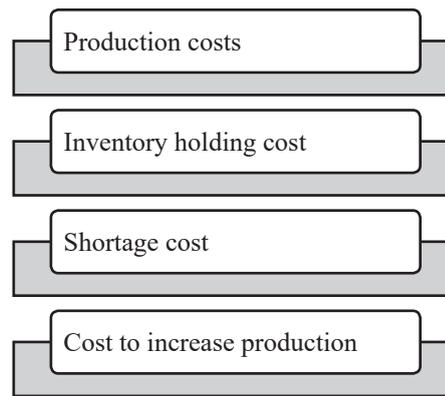
Fig. 8.3: Costs of Production

Let us discuss these costs in detail.

- ◆ **Production costs – regular time, overtime and subcontracting**: These are the per unit production costs incurred on the manufacturing of products.

- ◆ **Inventory (holding) cost**: This is the amount charged for holding one unit of a product for a specific period.

- ◆ **Shortage cost:** This is the amount charged for each unit that is short in a given period. It is assumed that the shortages are backlogged and satisfied as soon as stock becomes available in a future month. Shortage costs are incurred against end-of-month levels.

- ◆ **Cost to increase production**: This is a cost incurred due to the changes in the production schedule. It is incurred on a per unit basis against changes in regular production. If the initial production level is 0, there will be no cost for increasing production in the first period.

The next step is to define the constraints which should not be violated. Constraints can be represented as mathematical equations that define limits within which a solution to the problem must be found. Fig. 8.4 shows three types of constraints, which can be defined by an organisation in aggregate planning:
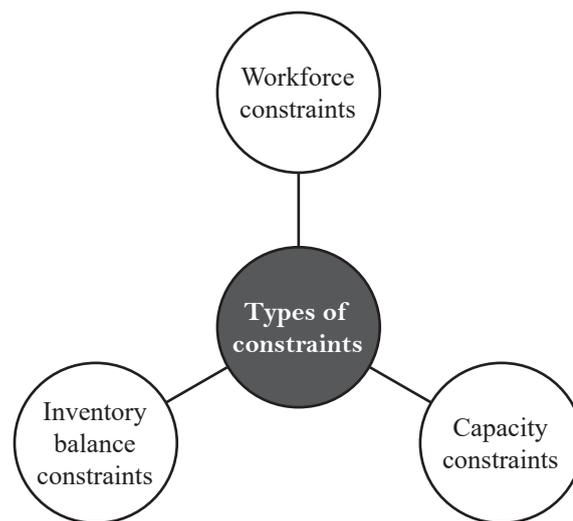
Fig. 8.4: Types of Constraints

Let us discuss these constraints in detail.

- **Workforce constraints**: These constraints define the size of the workforce for each period based on hiring and layoffs. The workforce size W_t in period t can be calculated by adding the number of employees hired H_t in period t to the workforce size W_{t-1} in period t-1, and subtracting the number laid off L_t in period t as follows:

$$W_t = W_{t-1} + H_t - L_t$$

- **Capacity constraints:** These constraints limit the total production by the total internally available capacity. The internal capacity of an organisation is determined on the basis of available labour hours including regular working hours and overtime in the plant. While defining capacity constraints, sub-contracted production is not considered.

- **Inventory balance constraints**: These constraints strike a balance between inventories maintained at the end of each production cycle.

8.3.2 Aggregate Planning Using Excel

Aggregate planning problems can be formulated and solved using Excel. In Excel, aggregate planning is done using spread sheets. These spread sheets can be designed in many ways in a single sheet or across multiple spread sheets. The basic elements to consider for any spread sheet design while performing aggregate planning are as follows:

- Expected unit costs (e.g., cost of materials, inventory holding cost, etc.) during each period of the planning horizon.

- Demand in each period of the planning horizon.

- Historical data about the amount of inventory.

- Historical data about the total number of employees, the number of employees hired, and the number of employees laid off.

- Historical data about the amount of final product subcontracted.

There are relationships to be formulated, which are given as follows:

- Inventory at the beginning of the current quarter (except the first quarter) = Positive inventory of the previous quarter − Units back ordered in the previous quarter

- Number of workers available in the current quarter = Number of workers employed in the previous quarter + Number of workers hired in the current quarter − Number of workers fired in the current quarter

- Regular production hours in a quarter = (Number of workers available in the current quarter) * (Number of working hours per day) * (Number of working days per quarter)

- Actual number of units produced in a quarter = (Regular production hours + overtime production hours) * (Productivity in units per hour)

- Inventory at the end of the current quarter = Actual number of units produced in the current quarter + Inventory at the beginning of the current quarter − Demand forecasted for the current quarter

- Inventory at the end of the current quarter = Positive inventory of the current quarter − Units back ordered in the current quarter

Under costs, various types of costs need to be calculated. These different costs are:

- Straight-time cost = (Regular production hours) * (Straight-time cost per hour)

◆ Overtime cost = (Overtime production hours) * (Overtime cost per hour)

◆ Inventory holding cost = (Ending inventory) * (Holding cost per unit)

◆ Back order cost = (Units back ordered) * (Back order cost per unit)

◆ Hiring cost = (Number of workers hired) * (Hiring cost per worker)

◆ Firing cost = (Number of workers fired) * (Firing cost per worker)

A spread sheet is made to compute the total cost from the given values of inputs and decision variables, which is shown as follows:

	A	B	C	D	E	F	G
1	Class Example						
2							
3	Plan v: Linear optimization						
4							
5	Number of Workers	30					
6							
7	Recruitment costs						
8	Hiring cost	100	for each temporary worker				
9	Firing cost	200	for each worker laid off				
10	Wages						
11	Straight time cost	5	per hour				
12	Overtime cost	8	per hour				
13	Inventory costs						
14	Holding cost	5	per unit-quarter				
15	Backorder cost	10	per unit				
16	Productivity	0.5	units per worker hour				
17	Working hours	8	hours per day				
18		60	days per season				
19							
20		Forecast	Beginning	Workers	Workers	Total	Overtime
21			Inventory	Hired	Fired	Workers	Hours
22							
23	Fall	10000	500	9.58333333	0	39.58333	0
24	Winter	8000	0	0	6.25	33.33333	0
25	Spring	7000	0	0	4.166667	29.16667	0
26	Summer	12000	0	0	0	29.16667	0
27							
28		Regular	Actual	Ending	Positive	Backorder	Ending
29		Production	Production	Inventory	Inventory		Inventory
30		Hours	Units	Computed			Chosen
31	Fall	19000	9500	0	0	0	0
32	Winter	16000	8000	0	0	0	0
33	Spring	14000	7000	0	0	0	0
34	Summer	14000	7000	-5000	0	5000	-5000
35							
36		Bakorder	Overtime	Hiring	Firing	Inventory	Straight-
37		Cost	Cost	Cost	Cost	Holding	time
38						Cost	Cost
39	Fall	0	0	958.333333	0	0	95000
40	Winter	0	0	0	1250	0	80000
41	Spring	0	0	0	833.3333	0	70000
42	Summer	50000	0	0	0	0	70000
43							
44	Total cost	368041.67					

Known input values are entered in each of the following cells:

◆ **B5:** Initial number of workers

◆ **B8:** Hiring cost for each temporary workers

◆ **B9:** Firing cost for each worker laid off

- ◆ **B11:** Straight-time cost per hour
- ◆ **B12:** Overtime cost per hour
- ◆ **B14:** Holding cost per unit-quarter
- ◆ **B15:** Back order cost per unit
- ◆ **B16:** Number of units produced per worker-hour
- ◆ **B17:** Number of hours worked per day
- ◆ **B18:** Number of days worked per quarter
- ◆ **B23 to B26:** Forecast of demand in fall, winter, spring, and summer
- ◆ **C23:** Initial inventory in the beginning of fall

Excel will provide output values of decision variables in the following cells:

- ◆ **D23 to D26:** Numbers of workers hired in fall, winter, spring, and summer
- ◆ **E23 to E26:** Numbers of workers fired in fall, winter, spring, and summer
- ◆ **G23 to G26:** Overtime hours in fall, winter, spring, and summer
- ◆ **E31 to E34:** Units in (positive) inventory in fall, winter, spring, and summer
- ◆ **F31 to F34:** Units back ordered in fall, winter, spring, and summer

Formulae are entered for relationships explained below:

Inventory at the beginning of the current quarter (except the first quarter) = Positive inventory of the previous quarter – Units back ordered in the previous quarter

C24 = E31–F31 (copied to C25 and C26)

Number of workers available in the current quarter = Number of workers employed in the previous quarter + Number of workers hired in the current quarter – Number of workers fired in the current quarter

F23 = \$B\$5 + D23 – E23

F24 = F23 + D24 – E24 (copied to C25 and C26)

Regular production hours in a quarter = (Number of workers available in the current quarter) * (Number of working hours per day) * (Number of working days per quarter)

B31 = F23 * \$B\$17 * \$B\$18 (copied to B32, B33 and B34)

Actual number of units produced in a quarter = (Regular production hours + overtime production hours) * (productivity in units per hour)

C31 = (B31 + G23) * \$B\$16 (copied to C32, C33 and C34)

Inventory at the end of the current quarter = Actual number of units produced in the current quarter + Inventory at the beginning of the current quarter – Demand forecast of the current quarter

D31 = C31 + C23 – B23 (copied to D32, D33 and D34)

Inventory at the end of the current quarter = Positive inventory of the current quarter – Units back ordered in the current quarter

G31 = E31 − F31 (copied to G32, G33 and G34)

Costs:

Straight-time cost = (Regular production hours) * (Straight-time cost per hour)

G39 = B31 * B11 (copied to G40, G41 and G42)

Overtime cost = (Overtime production hours) * (Overtime cost per hour)

C39 = G23 * B12 (copied to C40, C41 and C42)

Inventory holding cost = (Ending inventory) * (Holding cost per unit)

F39 = E31 * B14 (copied to F40, F41 and F42)

Back order cost = (Units back ordered) * (Back order cost per unit)

B39 = F31 * B15 (copied to B40, B41 and B42)

Hiring cost = (Number of workers hired) * (Hiring cost per worker)

D39 = D23 * B8 (copied to D40, D41 and D42)

Firing cost = (Number of workers fired) * (Firing cost per worker)

E39 = E23 * B9 (copied to E40, E41 and E42)

Total cost

B44 = SUM (B39:E42)

The spread sheet could be further extended to generate reports from the data computed. For example, reports can be generated for describing optimal workforce size, the number of new hires, the number of layoffs, production quantity, inventory level, amount subcontracted, amount of overtime, and so on.

Self-Assessment Questions

5. Name a strategy that is used when demand is uncertain and safety inventory is not maintained.

6. _____ is used to determine maximum profit or revenue or minimum cost on the basis of the availability of scarce resources and various limitations (also known as constraints).

7. _____ is the amount charged for each unit that is short in a given period.

    a. Production costs

    b. Inventory costs

    c. Shortage costs

    d. Costs to increase production

8. Which type of constraints limit the total production by the total internally available capacity?

Activity

Make a group of three and discuss the pros and cons of each aggregate planning strategy. Make a report based on your discussion.

8.4 Summary

◆ Aggregate planning can be defined as a process of determining the right quantities of inputs and output and the right time for their transformation to match the demand and supply of products or services.

◆ Using aggregate planning, an organisation can make production related decisions, arrange resources, prepare budget, etc.

◆ The process of aggregate planning involves various steps: forecasting demand, identifying planning variables, formulating the aggregate plan, and implementing the aggregate plan.

◆ While making aggregate plans, an organisation needs to consider various aspects, such as demand forecast in each period, production costs, stock outs, and constraints.

◆ There are mainly three types of aggregate planning strategies that can be used by an organisation. These are chase strategy, capacity strategy, and level strategy.

◆ A common technique that is used for aggregate planning is linear programming, wherein profit is maximised on the basis of the availability of scarce resources and various constraints.

◆ The construction of a linear programming problem involves three steps namely, identifying a set of decision variables, defining the objective function, and determining constraints.

◆ Aggregate planning problems can also be formulated and solved through Excel using spread sheets.

8.5 Glossary

◆ **Aggregate planning:** It is a process of planning production activities to meet the demand.

◆ **Subcontracting:** It is a business practice of assigning functions and activities to another party through a contract.

◆ **Layoffs:** It is an act of discharging employees temporarily or permanently from their services.

◆ **Make-to-order approach:** It is a strategy of making a product only after a customer order is received.

◆ **Spread sheet:** It is an electronic document, wherein data is arranged in rows and columns for manipulations and calculations.

8.6 | Terminal Questions

1. Explain the concept of aggregate planning.

2. Discuss the role of aggregate planning in a supply chain.

3. Describe the process of aggregate planning.

4. What are the main aspects to be considered while making aggregate plans?

5. Discuss different aggregate planning strategies that can be used by an organisation.

8.7 | Answers

Q.	Self Assessment Questions
1.	d. Aggregate planning
2.	False
3.	b. Implementing the aggregate plan
4.	Inventory maintained
5.	Chase Strategy
6.	Linear programming
7.	c. Shortage costs
8.	Capacity constraints
Q.	**Terminal Questions**
1.	Aggregate planning can be defined as a process of determining the ideal levels of capacity, production, subcontracting, inventory, stock outs, and even pricing over a period of time to match the demand and supply. Refer to section **8.2 Meaning of Aggregate Planning**.
2.	Through aggregate planning, an organisation can make decisions related to output rates, employment levels, appropriate inventory levels, etc. to create an effective and responsive supply chain. Refer to sub-section **8.2.1 Role of aggregate planning in supply chain**.
3.	The process of aggregate planning involves various steps, such as forecasting demand, identifying planning variables, and formulating an aggregate plan. Refer to sub-section **8.2.2 Aggregate planning process**.
4.	While making aggregate plans, there are various aspects to be considered, such as demand forecast in each period, production costs, and constraints. Refer to sub-section **8.2.3 Requisites for aggregate planning**.
5.	There are mainly three types of aggregate planning strategies that can be used by an organisation, namely chase strategy, capacity strategy, and level strategy. Refer to section **8.3 Aggregate Planning Strategies**.

8.8 Case Study: Need for Aggregate Planning at ABC Ltd.

ABC Ltd. produces replacement automobile glass for all brands of cars. The organisation has a demand forecasting system that makes use of previous years' data to identify seasonal factors and long-term trends that cause fluctuations in demand. The following table shows demands forecasted for the upcoming year on a weekly basis:

Week		Demand	Week		Demand
April	15	1,829	November	4	1,864
	22	1,820		11	1,989
	29	1,887		18	2,098
May	6	1,958		25	2,244
	13	2,011	December	2	2,357
	20	2,063		9	2,368
	27	2,104		16	2,387
June	3	2,161		23	2,402
	10	2,258		30	2,418
	17	2,307	January	6	2,417
	24	2,389		13	2,324
July	1	2,434		20	2,204
	8	2,402		27	2,188
	15	2,385	February	3	2,168
	22	2,330		10	2,086
	29	2,323		17	1,954
August	5	2,317		24	1,877
	12	2,222		3	1,822
	19	2,134		10	1,803
	26	2,065		17	1,777
September	2	1,973		24	1,799
	9	1,912		31	1,803
	16	1,854	April	7	1,805
	23	1,763			
	30	1,699			
October	7	1,620			
	14	1,689			
	21	1,754			
	28	1,800			

ABC uses these forecasts to plan and schedule its production. Further, the forecasted demands are aggregated. From the above table, it can be seen that the demand pattern is highly seasonal or cyclic in nature.

Recently, ABC has developed a production plan for the subsequent year. For this, the organisation has taken into account the seasonal nature of the demand pattern. It has also considered costs incurred on hiring or laying off workers; paying overtime; subcontracting; holding inventory; or stock outs. The organisation has a current capacity to produce 1,900 units of glass per week. This capacity cannot be surpassed under any plan. At most, 2,000 units can be subcontracted in a given week and overtime is limited to 250 units per week. However, ABC has not been able to determine whether demands not met in the on-going month can be met later or whether these orders were lost.

Discussion Questions

1. Which aggregate planning strategy should ABC use to determine whether demands not met in the on-going month can be met later and why?

   (**Hint:** ABC can use the chase strategy as demand is seasonal and uncertain.)

2. In your opinion, how aggregate planning would help ABC?

   (**Hint:** Aggregate planning would help ABC to meet uncertain demand by defining appropriate levels of inventory.)

8.9 References and Suggested Readings

◆ Ayers, J. (2001). Handbook of supply chain management (1st ed.). Boca Raton, Fla.: St. Lucie Press.

◆ Chopra, S., & Meindl, P. (2014). Supply Chain Management (1st ed.). Hallbergmoos: Pearson.

◆ Fredendall, L., & Hill, E. (2001). Basics of supply chain management (1st ed.). Boca Raton: St. Lucie Press.

◆ Wisner, J., Leong, G., & Tan, K. (2005). Principles of supply chain management (1st ed.). Mason, Ohio [u.a.]: Thomson/South-Western.

E-references

◆ Sba.pdx.edu,. (2014). Aggregate Planning Options - Advantages and Disadvantages. Retrieved 6 September 2014, from http://www.sba.pdx.edu/faculty/karlt/Ch13/sld012.htm

◆ Uoguelph.ca,. (2014). AGGREGATE PLANNING. Retrieved 6 September 2014, from http://www.uoguelph.ca/~dsparlin/aggregat.htm

◆ Web.bahcesehir.edu.tr,. (2014). Retrieved 6 September 2014, from http://web.bahcesehir.edu.tr/scokelez/AGGREGATE%20PLANNING.doc

Information Technology in Supply Chain Management

Structure

Learning Objectives

After completing the chapter, you will be able to:

- ❑ discuss the impact of IT on supply chain
- ❑ explain IT framework in a supply chain
- ❑ define customer relationship management
- ❑ describe the functions of enterprise resource planning
- ❑ discuss supplier relationship management

9.1 Introduction

In the previous chapters, you have studied about supply chain management (SCM), which encompasses various activities involved in sourcing, procurement, conversion, and logistics. In addition, it involves coordination and collaboration among suppliers, intermediaries, third-party service providers, and customers. The effectiveness of all these activities depends on the availability of timely and accurate information. Hence, it is essential for an organisation to handle and archive its information in a way that facilitates easy retrieval when necessary. In this context, the involvement of information technology (IT) becomes crucial.

Information Technology encompasses a collection of interconnected components that gather, store, process, produce, and distribute information to facilitate efficient business decision-making. Within a supply chain, information systems and technologies are employed to connect different entities into a cohesive and well-coordinated system. This in turn results in cycle time reduction, redesigned cross-functional processes, and utilisation of cross-selling opportunities.

Information technology facilitates a smooth flow of relevant information between the supply chain point of origin and its point of consumption. This information can be related to inventory levels, sales forecasts, order status, delivery schedules, etc. In this chapter, you will study about the role of information technology in a supply chain.

9.2 Information Technology and Supply Chain

Information is a key driver of the responsiveness and efficiency of an organisation. It is required for maintaining coordination among various parties involved in a supply chain. Timely and accurate information helps supply chain personnel to make the right decisions at the right time. These decisions can be related to inventory levels, production level, plant capacity, suppliers' selection, and so on. In the absence of adequate and complete information, decisions made by supply chain professionals lose rationale, which can affect coordination in a supply chain. Therefore, it becomes imperative for organisations to manage information in the best possible way.

To ensure smooth information flow at different stages of a supply chain, organisations have begun to adopt a combination of various technologies. Information technology (IT) is an application of computers for storing, retrieving, transmitting, and manipulating data for decision making in an organisation. In supply chain, IT helps an organisation in various ways:

- ◆ **Customer satisfaction**: It is the ultimate goal of every supply chain. For serving customers properly, organisations need IT to get updates about order status, product availability, delivery schedules, etc. This information helps in improving supply chain processes; thereby making timely deliveries and responding to customers' needs quickly.

◆ **Inventory management**: By providing complete information, IT enables supply chain professionals to make appropriate decisions associated with inventory management. IT tools enable an organisation to reduce inventory levels so that wastage can be prevented.

◆ **Strategy development**: IT provides organisations information on various aspects, such as markets, customers' needs and preferences, and economic conditions. This helps organisations in developing their supply chain strategy and plan adequately for various operations, such as production, distribution, and transportation.

In addition, information technology enables an organisation to perform the following operations in a supply chain:

◆ Data capturing and communication

◆ Data storage and retrieval

◆ Data manipulation and reporting

◆ Information availability and visibility

◆ Single point of contact for data

◆ Collaboration among supply chain partners

Fig. 9.1 shows the functional roles of IT in supply chain:

```
              ┌─────────────────────────────┐
              │  Functional roles of IT In SCM │
              └─────────────────────────────┘
          ┌──────────────┬───────────────────┐
┌──────────────────┐ ┌───────────────────────────┐ ┌────────────────┐
│Transaction execution│ │Collaboration and coordination│ │ Decision support │
└──────────────────┘ └───────────────────────────┘ └────────────────┘
```
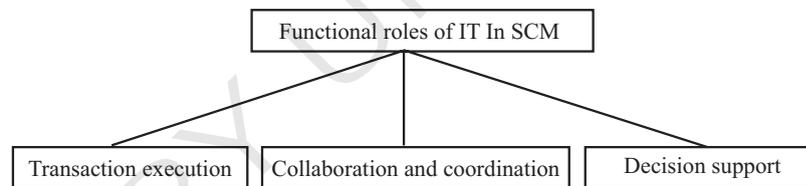
Fig. 9.1: Functional Role of IT in Supply Chain

The most typical role of IT in supply chain is to reduce friction in transactions between supply chain partners through cost-effective information flow. On the other hand, IT is more importantly viewed to have a supporting role in the collaboration and coordination of a supply chain through information sharing. In addition, IT provides assistance to decision making related to supply chain.

IT has played an important role in transforming the gamut of supply chain. Organisations can adopt various types of supply chain systems to achieve functional integration in their supply chain processes. For example, organisations can easily source the required raw material at competitive prices using E-procurement tools. There are mainly two types of supply chain systems that are used in organisations, namely inter-firm information system and intra-firm information system. Let us discuss these systems as follows:

◆ **Inter-firm information system:** This system permits information flow between an organisation and its suppliers and/or customers. The increasingly uncertain business environment has forced organisations to adopt inter-firm information system. These systems enable organisations in eliminating redundant pools of inventory at different stages of a supply chain).

◆ **Intra-firm information system**: This system enables information flow throughout the internal supply chain of an organisation. The most commonly used intra-firm information systems used by organisations are Warehouse Management System (WMS), Transportation Management System (TMS), Decision Support System (DSS), and Enterprise Resource Planning (ERP).

📄 Self-Assessment Questions

1. Timely and accurate information helps supply chain personnel to make the right decisions at the right time. (True/False)

2. In the absence of adequate and complete information, decisions made by supply chain professionals lose _____, which can affect coordination in a supply chain.

3. _____ is an application of computers for storing, retrieving, transmitting, and manipulating data for decision making in an organisation.

4. Intra-firm information system enables information flow throughout the internal supply chain of an organisation. (True/False)

🖥 Activity

Find out information on how IT tools have helped organisations in meeting their delivery schedules.

9.3 IT Framework of Supply Chain

As per Geunes et al. (2002), "To ensure long-term competitiveness and survival, companies implement new strategies, based on collaboration with business partners and an advanced utilization of IT and Web services." IT has transformed the ways organisations used to carry out their supply chain processes. This transformation is driven by various factors. Some of these factors are listed as follows:

◆ Introduction of new products or upgrade for the existing products

◆ Improvement in the existing processes

◆ Allocation of newly acquired resources and optimisation of existing ones

◆ Selection of new suppliers

◆ Changes in demand patterns for products

◆ Changes in lead times for product and process life cycles

The IT framework of a supply chain can be viewed as having three integrated segments, which are shown in Fig. 9.2:
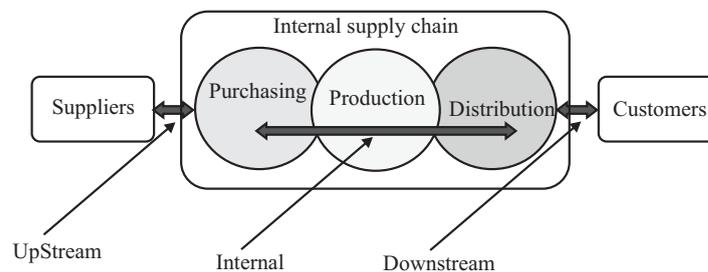

Fig. 9.2: IT Framework of Supply Chain

◆ **Upstream**, where sourcing or procurement from external suppliers occurs.

◆ **Internal**, where manufacturing or assembly takes place.

◆ **Downstream**, where distribution (often by external distributors) and sales takes place.

Typical supply chain activities include,

- ◆ Forecasting => In all segments

- ◆ Production planning and execution => Internal

- ◆ Inventory management => Internal/downstream

- ◆ Sourcing and procurement => Upstream

- ◆ Warehousing and logistics => Downstream

- ◆ Distribution and transportation => Downstream

- ◆ Marketing and sales => Downstream

- ◆ Payments and financial flows => Upstream/downstream

The process view of a supply chain consists of Customer Relationship Management (CRM) (downstream), Enterprise Resource Planning (ERP) (internal), and Supplier Relationship Management (SRM) (upstream). Integration of CRM, ISCM and SRM is crucial for an efficient supply chain system. Let us discuss about these three in detail in the following sections.

9.3.1 Customer Relationship Management

Customers have a wide variety of options available to them when it comes to a single product in today's highly competitive business environment. Because of this, they are more likely to move from one brand to another, depending on the quality of the product and the price of the goods. As a result, businesses have come to the realisation that it is essential to attract the attention of customers by building a distinctive brand identity and offering exceptional customer service. At the beginning, the primary emphasis of the organisations was on generating huge profits; however, they are now shifting their attention to the management of friendly relationships with their clients. As a result, businesses need to engage in consistent communication with their clientele in order to get an understanding of their requirements, preferences, and tastes. Given that the ultimate goal of a supply chain is to ensure that consumers are satisfied, it is essential for an organisation to have a platform that can handle interactions with customers, whether they are direct or indirect. The term "Customer Relationship Management" (CRM) refers to a business technique that assists an organisation in developing robust ties with its clientele.

Using customer relationship management (CRM), an organisation is able to determine the requirements and anticipations of its customers and then meet those requirements, which ultimately leads to a high degree of customer satisfaction. To put it another way, customer relationship management (CRM) is centred on the pleasure and retention of customers. When it comes to collecting and analysing information pertaining to consumers, such as their name, contact history, wants and preferences, and repeat purchases, it is a complex system that stores and analyses this information. With this knowledge, organisations are able to make intelligent choices about their company.

There are mainly four types of CRM systems used in a supply chain, which are explained as follows:

- ◆ **Operational CRM:** This assists an organisation in carrying out diverse marketing activities, including customer segmentation and event-based marketing, by furnishing precise customer information such as income level, age, tastes, preferences, and needs. Additionally, operational CRM automates sales-related tasks like lead generation and

qualification. It aids in creating a list of potential customers (leads) and assigning them to salespeople. This facilitates salespeople in contacting leads, monitoring their responses, and generating reports.

- **Analytical CRM:** This supports an organisation in analysing the gathered information to make various decisions in the supply chain. It aids in:

  - ❍ Conducting marketing campaigns to enhance marketing efficiency.

  - ❍ Executing customer campaigns, such as customer acquisition and cross-selling.

  - ❍ Analysing customer behavior for informed product-related decisions.

  - ❍ Making various management decisions, like financial forecasting and customer profitability analysis.

- **Sales Intelligence CRM:** It enables an organisation to monitor available sales opportunities, improve sales productivity, and offer better customer service. Sales Intelligence CRM is primarily tailored for organisations engaged in wholesale, distribution, and manufacturing. In today's fiercely competitive market environment, it assists organisations in tracking cross-sell, switch-sell, and up-sell opportunities by analyzing customer buying trends.

- **Collaborative CRM:** This integrates information collected by different departments of an organisation, such as sales, marketing, and operations, when dealing with customers. This shared information helps departments in making informed business decisions. For instance, customer feedback gathered by the customer support department can aid the marketing department in gauging the demand for products and services in the market. The primary goal of this collaboration is to enhance the quality of customer service, ultimately achieving high customer satisfaction.

9.3.2 Enterprise Resource Planning

Supply chain is often considered to be a function that takes place outside an organisation. However, this is not actually the case. In practice, there are a number of supply chain activities that are managed within an organisation.

Most organisations use Enterprise Resource Planning (ERP) system to manage internal supply chain operations. ERP stores and manages data related to customers, suppliers, finished goods, raw materials, components, and purchased parts. It helps an organisation to perform various functions, which are as follows:

- ◆ Sales order entry

- ◆ Purchase order generation

- ◆ Invoice generation

- ◆ Inventory control

- ◆ Distribution

- ◆ Manufacturing work orders

ERP systems of organisations are always linked to their external supply chain systems in order to facilitate better collaboration and information flow among supply chain partners.

9.3.3 Supplier Relationship Management

Supplier relationship management (SRM) is an integrated system to manage interactions and streamline processes between an organisation and its suppliers. It aims at boosting contract

negotiations and enforcing compliance with procurement guidelines. Apart from this, SRM automates, simplifies, and accelerates an organisation's procure-to-pay processes for products and services. This in turn reduces purchasing errors, eliminates manual tasks, and prevents maverick buying.

In addition, SRM helps in building collaborative supplier relationships, integrating suppliers into procurement processes of an organisation and accelerating procurement orders and invoicing cycle times. Many vendors, such as 12 Technologies, Manugistics, PeopleSoft, and SAP, provide SRM products. These products help in managing better relationships between organisations and their suppliers. Before selection a vendor, an organisation needs to take into consideration the following aspects, which are:

◆ Quality (level of and/or consistency)

◆ Delivery (consistency, predictability, etc.)

◆ Price or cost

◆ Transaction efficiency (speed, simplicity, transparency)

◆ Value addition

◆ Innovation

◆ Logistics, manufacturing, service needs

◆ Assurance of supply

Self-Assessment Questions

5. As per _____, "To ensure long-term competitiveness and survival, companies implement new strategies, based on collaboration with business partners and an advanced utilization of IT and Web services."

6. Which of the following is related to the sourcing or procurement from external suppliers?

   a. Internal

   b. Upstream

   c. Downstream

7. Which of the following is a not a downstream function in the IT framework of supply chain?

   a. Warehousing and logistics   b.   Distribution and transportation

   c. Marketing and sales   d.   Sourcing and procurement

8. Customer Relationship Management (CRM) is a business strategy that helps an organisation to establish strong relationships with its suppliers. (True/False)

9. Which of the following type of CRM integrates information collected by different departments of an organisation, such as sales, marketing, and operations, while dealing with customers?

   a. Operational CRM   b.   Analytical CRM

   c. Sales intelligence CRM   d.   Collaborative CRM

10. _____ is an integrated system to manage interactions and streamline processes between an organisation and its suppliers.

Activity

Using the Internet, find out the drawbacks of SRM, CRM, and ERP.

9.4 Summary

◆ In an organisation, timely and accurate information helps supply chain personnel to make the right decisions at the right time. For this, organisations adopt various technologies.

◆ Information technology is an application of computers for storing, retrieving, transmitting, and manipulating data for decision making in an organisation.

◆ IT helps an organisation in various ways, such as achieving customer satisfaction, managing inventory, developing strategy, communicating data, and collaborating among various supply chain partners.

◆ There are mainly two types of supply chain systems that are used in organisations, namely inter-firm information system and intra-firm information system.

◆ The transformation of supply chain by IT is driven by various factors, such as introduction of new products, selection of new suppliers, and improvement in the existing processes.

◆ Customer Relationship Management (CRM) is a business strategy that identifies the needs and expectations of customers and fulfils them, which results in achieving a high level of customer satisfaction.

◆ Enterprise Resource Planning (ERP) system is used by organisations to store and manage data related to customers, suppliers, finished goods, raw materials, components, and purchased parts.

◆ Supplier relationship management (SRM) is an integrated system used by organisations to manage interactions and streamline processes between an organisation and its suppliers

9.5 Glossary

◆ **Cross-sell**: It is a practice of selling related or complimentary products to an existing customer.

◆ **Data manipulation**: It includes various operations, such as sorting, merging, generating reports without altering the actual meaning.

◆ **Enterprise resource planning**: It is a business management system used by an organisation to integrate various data sources and processes into a unified system.

◆ **Procure-to-pay:** It is the process of receiving and managing inputs required for manufacturing a product.

◆ **Switch-sell**: It is a selling technique that involves offering good bargain to prospects for buying something different from what he/she wants to.

◆ **Up-sell**: It is a selling technique that involves persuading a customer to purchase additional or more expensive products.

9.6 Terminal Questions

1. Discuss the importance of information in a supply chain.

2. How IT helps in achieving customer satisfaction?

3. Write a short note on operational CRM.

4. Discuss the functions of ERP.

5. What is the role of supplier relationship management in a supply chain?

9.7 Answers

Q.	Self Assessment Questions
1.	True
2.	Rationale
3.	Information technology (IT)
4.	False
5.	Geunes et al. (2002)
6.	b. Upstream
7.	d. Sourcing and procurement
8.	False
9.	d. Collaborative CRM
10.	Supplier relationship management (SRM)

Q.	Terminal Questions
1.	Information helps supply chain personnel in making decisions related to various areas, such as inventory levels, production level, plant capacity, and suppliers' selection. Refer to section **9.2 Information Technology and Supply Chain**.
2.	IT provides timely updates about order status, product availability, delivery schedules, etc. to improve customer serving processes. Refer to section **9.2 Information Technology and Supply Chain**.
3.	Operational CRM helps an organisation to perform various marketing activities, such as customer segmentation and event-based marketing, by providing accurate customer information. Refer to sub-section **9.3.1 Customer relationship management**.
4.	There are various functions of ERP, such as sales order entry, purchase order generation, invoice generation, and inventory control. Refer to sub-section **9.3.2 Enterprise resource planning**.
5.	Supplier relationship management (SRM) is an integrated system that helps in boosting contract negotiations and enforcing compliance with procurement guidelines. Refer to sub-section **9.3.3 Supplier relationship management**.

9.8 Case Study: Implementation of Supply Chain Solutions at Yuasa

Yuasa is one of the largest organisations in the U.S. that supplies and manufactures batteries for many large automotive suppliers across the globe. It is the largest, American manufacturer and distributor of batteries for motorcycles, snowmobiles, scooters, all-terrain vehicles, and personal watercraft.

In 2003, Yuasa established Yuasa Battery Europe as the centre of business operations for its European subsidiaries. The main problem faced by Yuasa was the volatile nature of the resource market, wherein the price of lead (an input for manufacturing batteries) fluctuated often. Due to this, the cost and quantity of batteries to be produced was affected. This led to high control of suppliers in dictating the availability of orders, which, in turn, had a great impact on both industrial and automotive sides of the business.

The organisation was having a hard time in making on-time deliveries due to increased lead times (that stretched for many weeks). Under the current system, any change in orders was communicated manually by supply chain planners across the system. Moreover, demand for batteries was seasonal; in winter; demand would rise at more than six times than that in the spring. However, suppliers had limited capacity and could not cater to the seasonal demand. All these problems forced Yuasa to look for a system to level this demand on suppliers throughout the year.

To increase visibility and automation in its supply chain, Yuasa decided to implement Microsoft Dynamics AX ERP solution in 2006. By adopting the system, the organisation was able to cascade the information providing access to everyone about the latest orders. Moreover, custom logic was implemented to solve and automate monthly purchasing decisions. Further, an Electronic Data Interchange (EDI) interface was developed to allow Microsoft Dynamics AX to accommodate electronic orders and invoicing. Microsoft Dynamics AX also helped Yuasa to show critical data, generate reports, and automatically send financial reports to executives through e-mail.

The implementation of the new information system helped the organisation in saving a lot of time in processing orders. Easy access to information and real-time updates through Microsoft Dynamics AX enabled planners to easily forecast business demands and the sales team to provide better customer service.

Discussion Questions

1. Discuss the role of an information system in improving the supply chain of Yuasa.

   (**Hint:** By implementing the new information system, the information flow became smooth and processing order time was reduced.)

2. If you are assigned a responsibility for finding an apt solution in the abovementioned case study, how would you face challenges in Yuasa? Discuss.

   (**Hint:** By searching the best IT solution that matches the need of the organisation and implementing it.)

9.9   References and Suggested Readings

◆ Ayers, J. (2001). *Handbook of supply chain management* (1st ed.). Boca Raton, Fla.: St. Lucie Press.

◆ Chopra, S., & Meindl, P. (2014). *Supply Chain Management* (1st ed.). Hallbergmoos: Pearson.

◆ Fredendall, L., & Hill, E. (2001). *Basics of supply chain management* (1st ed.). Boca Raton: St. Lucie Press.

◆ Wisner, J., Leong, G., & Tan, K. (2005). *Principles of supply chain management* (1st ed.). Mason, Ohio [u.a.]: Thomson/South-Western.

◆ Michael H. Hugos (2011). *Essentials of Supply Chain Management.* John Wiley & Sons

◆ Li, Gang et. al.: Comparative analysis on value of information sharing in supply chains, in: Supply Chain Management: An International Journal, Vol. 10 (2005).

◆ Lee and Whang: Information sharing in a supply chain, pp. 375-381.

E-references

◆ Cobe.boisestate.edu,. (2014). Information Technology and Supply Chain Management | College Of Business and Economics. Retrieved 9 September 2014, from http://cobe.boisestate.edu/itscm/

◆ Uww.edu,. (2014). Information Technology & Supply Chain Management - University of Wisconsin - Whitewater | Online MBA - Graduate Programs - Business School - Wisconsin, USA | University of Wisconsin-Whitewater. Retrieved 9 September 2014, from http://www.uww.edu/cobe/itscm

◆ Yücesan, E. (2007). Impact of Information Technology on Supply Chain Management. Trends In Supply Chain Design And Management, 127-148. doi:10.1007/978-1-84628-607-0_6

10

Transportation in Supply Chain Management

Structure

Learning Objectives

After completing the chapter, you will be able to:

❑ define transportation

❑ discuss the role of transportation in a supply chain

❑ list various modes of transportation used in a supply chain

❑ explain different types of transportation design

10.1 Introduction

In the previous chapter, information is vital to the success of a supply chain. Apart from this, transportation is another driver that is crucial for the supply chain's responsiveness and efficiency. Transportation is all about moving products from one location to another. In a supply chain, it plays a key role in a supply chain starting from the manufacturing of products to their delivery to end users. Transportation involves a number of modes like air, package carriers, trucks, rails, water, pipelines, intermodal, etc. Organisations use a combination of all these modes for a transportation purpose based on their requirements and budget.

A responsive and economical transportation network enables organisations to implement major strategic changes by reducing costs and increasing customer service levels along with reduced disruptions to the overall supply chain flow. A responsive transportation network is characterised with end-to-end network visibility, which allows organisations to centralise production operations so that any uncertainty within the network can be easily monitored and managed. This further helps in keeping inventory levels as low as possible. Transportation has even a more significant role to play in global supply chains. International trade has become a buzzword in today's world economy. Thus, the success of any supply chain is closely linked to the appropriate use of transportation.

There are many parties involved in the transportation network of an organisation's supply chain. A carrier is a party that invests in transportation equipment (such as locomotives, trucks, and airplanes) and infrastructure. Based on these investments, the carrier makes operating decisions in order to maximise returns. On the other hand, a shipper makes decisions to minimise total cost incurred on transportation, inventory, information, sourcing, and facility at the same time responding to customers' requirements. In this chapter, you will study about the role of transportation in a supply chain.

10.2 Meaning of Transportation

As discussed in the previous chapters, transportation is one of the important drivers of a supply chain. Transportation is the movement of products from one place to the other using different modes. To make transportation effective, an organisation takes into consideration various aspects, such as input materials to be deployed, production quantities to be moved, inventory levels to be maintained, and distribution network to be configured. Transportation enables an organisation in market penetration by providing an uninterrupted flow of products. An organisation can also achieve the economies of scale by maximising materials handling capacities through effective transportation; thereby reducing per unit cost of moving products.

The transportation system of an organisation has three key players, which are as follows:

◆ **Shipper:** It is a party that requires the movement of products between two points in the supply chain.

◆ **Carrier**: It is a party that moves or transports products.

◆ **Consignee:** It is a party that receives the shipment.

An organisation can either be a carrier or shipper depending on its delivery requirements. However, there are certain costs associated with both carrier and shipper decisions, which are discussed in Table 10.1:

Table 10.1: Costs affecting Carrier and Shipper Decisions	
Costs Associated with Carrier	
Costs incurred on vehicles	These costs are considered to be fixed costs for short-term operations.
Fixed operating costs	These costs are incurred for rendering services at terminals, airport gates, railways, etc.
Costs related to quantity	These costs are incurred on loading/unloading and fuel.
Overhead costs	These costs are borne by organisations for planning and scheduling a transportation network.
Cost Associated with Shipper	
Transportation cost	It is the total amount paid to various carriers for transporting products to customers.
Inventory cost	It is the cost incurred for holding inventory in the supply chain network of a shipper.
Facility cost	It is the cost incurred for maintaining various facilities in the shipper's supply chain network.
Processing cost	It is the cost incurred by a shipper for loading/unloading orders.
Service level cost	It is the cost borne by organisations for not being able to meet delivery commitments.

10.2.1 Role of Transportation in Supply Chain

Transportation plays an integral role in a supply chain's responsiveness. It is involved at various stages of a supply chain beginning from production to the final delivery of products at the desired destination. Fig. 10.1 explains the importance of transportation:

Product movement

Product availability
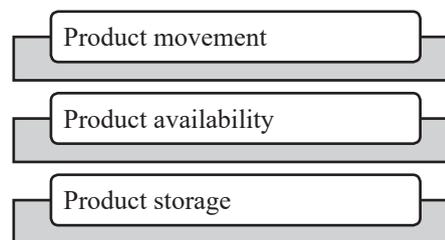
Product storage

Fig. 10.1: Role of Transportation

Let us discuss these points in detail.

◆ **Product movement**: Transportation enables the movement of products from one place to other. For instance, products are moved from a manufacturing plant to warehouses through trucks. Thus, transportation adds value to products by delivering them at the right destination at the right time.

◆ **Product availability**: The most important advantage of using transportation is that it increases product availability in the market. By making timely delivery of raw materials, it enables on-time production. As a result, end products are delivered in the market as and when required.

◆ **Product storage**: Transportation also acts as a medium for storing products temporarily. There are times when perishable items need temporary storage before being moved to warehouses. In such a case, transport carriers are used as storage containers. This helps in eliminating the chances of possible damage to products.

10.2.2 Modes of Transportation and their Performance

To move products, an organisation needs to select an appropriate mode of transportation. For this, the organisation must analyse various factors, such as size of operations, product to be manufactured, and delivery destination. Fig. 10.2 lists various modes of transportation supply chain:
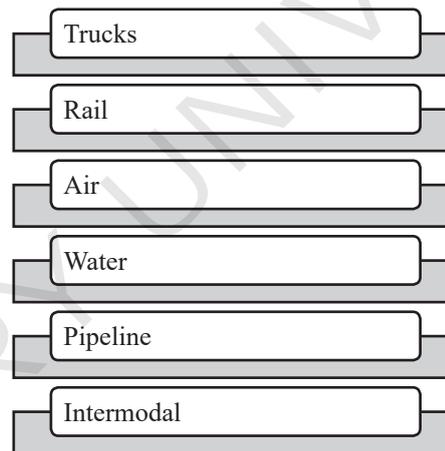
Fig. 10.2: Modes of Transportation

Let us discuss these modes in detail.

◆ **Truck:** It is a dominant mode of transportation in many countries. The trucking industry consists of two major segments: Truck Load (TL) and Less than Truck Load (LTL).TL operations are charged for full truck irrespective of the quantity loaded. However, rates vary with the distance travelled. TL operations have relatively low fixed costs. The idle time and travel distance between successive loads adds to the cost of the TL industry. Carriers, thus, try to schedule shipments to meet service requirements while minimising both their trucks' idle and empty travel time. TL is appropriate for moving products between various facilities such as manufacturing plants, distribution centres, and warehouses or between suppliers and manufacturers.

On the other hand, LTL operations are charged on the basis of quantity loaded and distance travelled. These operations are cheaper in comparison with that of TL operations.

◆ **Rail**: Rail transport can be described as movement of people, animals or goods by one or more connected vehicles, which run on parallel tracks known as railroads. These are run by a locomotive that forms an engine for the whole body. Each vehicle in the body of a train is referred to as a coach or boggy or compartment or wagon. Trains form the main body of transport within cities in a country.

Rail is priced low to encourage large shipments over a long distance. The price structure and heavy load capability makes rail an ideal mode for carrying large, heavy, or high density products over long distances. However, there can be long transportation time involved with rail. Thus, rail is ideal for heavy and low-value shipments that are not very time sensitive. Major operational issues in railroads include vehicle and staff scheduling, track and terminal delays, and poor on-time performance.

◆ **Air:** Air transport can be described as the movement of people and products through carriers flying in air. Commercial planes are used as carriers in air transport for the movement of products. Air transport is able to deliver shipments over long distances in a matter of hours. However, air transport is expensive as labour and fuel costs are based on trips made. Presently, air transport constitutes relatively small amounts of freight. The major issues associated with air carriers are identifying a location and number of hubs; assigning planes to routes; establishing maintenance schedules for planes; scheduling crews; managing prices; ensuring the availability of planes at different prices; and so on.

◆ **Water:** Water transport is the movement of passengers or freight over a water body like a lake, river, canal, sea or ocean. However, it is restrained to certain areas. Water transport is used when there are large shipments to be delivered at long distances. It is used more often by organisations due to low costs. It can be used to transport all types of products, such as cars, grains, and apparel. One major disadvantage of using water transport is that it is the slowest among all modes of transport, which can result in delays. Thus, it is not appropriate for short-haul trips.

◆ **Pipeline**: Pipelines are used for transporting crude petroleum, refined petroleum product and natural gas. It is ideally suited when there is a requirement for relatively stable and large flows of products. The cost of constructing pipelines depends on three aspects: the diameter of the pipe; the distance over which the transportation has to be done; the number of pumping stations required along the way.

◆ **Intermodal:** It is described as the utilisation of more than one mode of transportation for moving goods. Intermodal transportation involves easy movement of cargoes from one mode to another; for example, road, railways, inland waterways, open seas, and air. The most common intermodal combination used by organisations is truck-rail. Intermodal is best suited for global trade operations to reach destinations located far away. The major issues involved in intermodal transportation are the delays brought by shipment transfers.

10.2.3   Transport Infrastructure and Policies

As discussed so far, transportation is a prime requirement for moving products from one place to another. However, the transportation structure differs in different countries based on their requirements, geography, climate, etc. Here, in this section, let us discuss the transportation infrastructure in India:

◆ **Railways:** Indian Railways are one of the largest railways in the world and are an important player in the country's trade and commercial activities. It is in operation through a vast network comprising 6896 railway stations covering 63320 kilometres of route length. Of this, around 49, 800 kilometres is covered using broad gauge lines that contribute 85% per cent of the cargo movement in the country. About 2, 53, 186 wagons with the carrying capacity of 10.6 million tonnes are used for moving goods. 96 per cent of Indian Railways' cargo is consisting of bulk items like coal, iron ore, cement,

fertilisers, and raw materials for steel plants and others. Indian Railways also provides container services for serving the domestic and international trade needs of customers.

◆ **Roads:** Roads are the main mode of transportation in India today. They carry nearly 90 per cent of India's passenger traffic and 65 per cent of its freight. For road transportation, mainly trucks are used. There are more than 7.0 million trucks running on the Indian roads. However, the condition of Indian roads is not very good; thus the average distance covered by a truck is only 250-300 kilometres. Through road, cargos are moved using national and state highways expanding over 34,850 and 1, 37,120 kilometres, respectively. As compared to other nations like China, Brazil, Mexico, etc., India is by far better place in per capita road availability.

◆ **Sea:** In shipping, India stands 6th in Asia and 15th in world merchant shipping trade. Currently, the Indian shipping industry consists of 240 overseas fleets and 270 coastal ships. Among coastal ships, there are 70 offshore vessels and 25 supply vessels for offshore services. Moreover, there are 11 ports that control 95 per cent of international trade and 85 per cent of domestic sea trade. In addition to these 11 major ports, there are 117 small ports.

◆ **Air:** Air transport is the safest mode of transport among all others. However, it is a costly mode and is used mainly for transporting goods that are either perishable in nature or have a short life. In India, the entire air cargo is handled through eight international airports, 87 domestic airports, and 28 civilisation airports. Air cargo traffic is mainly converged around gateway airports that comprise Mumbai, Chennai, Delhi, Kolkata, and Bangalore. To increase the participation of airways in India's GDP, the Indian government is inviting private participation to take care of growing passenger and cargo traffics.

◆ **Pipelines:** In 1870, pipelines were first developed for the transportation of petroleum. Later on, pipelines began to be used for transporting other goods, such as coal, iron ores (both in slurry forms), and natural gas. The length of pipelines in India is 6350 kilometres used for transporting 58.7 million tonnes of oil per year.

Self-Assessment Questions

1. Which one of the following is not a key player in a transportation system?
   a. Shipper
   b. Market
   c. Carrier
   d. Consignee

2. By making the timely delivery of raw materials, _____ enables on-time production.

3. _____ operations are charged on the basis of quantity loaded and distance travelled.

4. Pipeline is described as the utilisation of more than one mode of transportation for moving goods. (True/False)

Activity

Using the Internet, find about various modes of transport used in Coca Cola in India. Make a report on it.

10.3 Transportation Design

To design a transportation network, an organisation needs to consider two factors: modes of transportation and transport infrastructure. A transportation network can be defined as the arrangement of various modes, such as air, water, and road for moving products from manufacturers to customers and vice versa. By analysing both the factors, organisations can design their transportation network. There are mainly four types of transportation network that can be used by an organisation. These transportation networks are discussed as follows:

◆ **Direct shipment network:** This type of transportation network is designed in such a manner that all shipments come directly from different suppliers to each buyer location. In the direct shipment network, routing of each shipment needs to be defined and quantities to be shipped is decided by a supply chain manager. Fig. 10.3 shows the structure of direct shipment network:
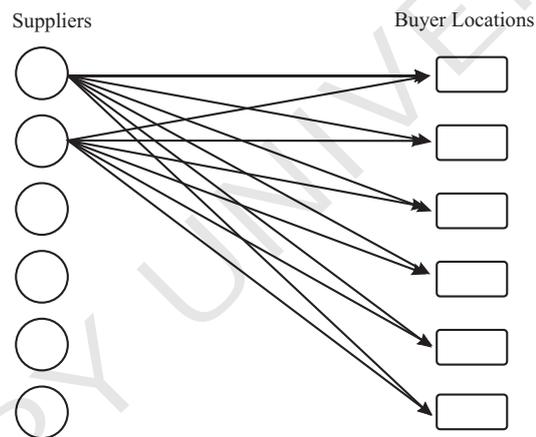
Fig. 10.3: Direct Shipment Network

From Fig. 10.3, it can be observed that each supplier transports its products to all the buyers. The main advantage of using this network is to eliminate intermediate warehouses and facilitate coordination in a supply chain.

◆ **Direct shipping with milk runs:** Milk run is a route in which a truck either delivers products from a single supplier to multiple retailers or goes from multiple suppliers to a single retailer. In the direct shipping with milk runs network, a supplier delivers directly to multiple buyer locations through trucks or trucks pick up deliveries destined for the same buyer location from many suppliers. Moreover, a supply chain manager needs to define the routing of each milk run. Fig. 10.4 shows direct shipping with milk runs:
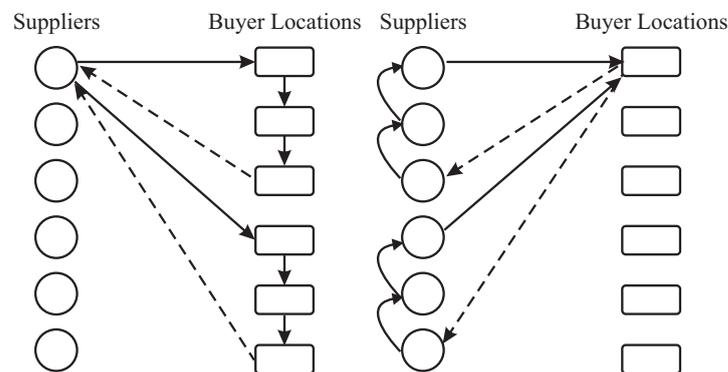
Fig. 10.4: Direct Shipping with Milk Runs

In Fig. 10.4, it can be seen that the product is delivered from a single supplier to multiple buyers in one case, while the product is delivered to a single buyer from multiple suppliers. Direct shipping with milk runs helps in avoiding direct small shipments through LTL shipments; thereby reducing transportation costs.

- **Shipments via central distribution centre (DC):** In this network option, buyer locations are divided based on geographic regions and the suppliers send their shipments to buyers through a central distribution centre (not directly). Mahindra & Mahindra uses its Mumbai and Nasik plants for shipping tractors to customers located across the country. Fig. 10.5 shows all shipments via a central distribution network:
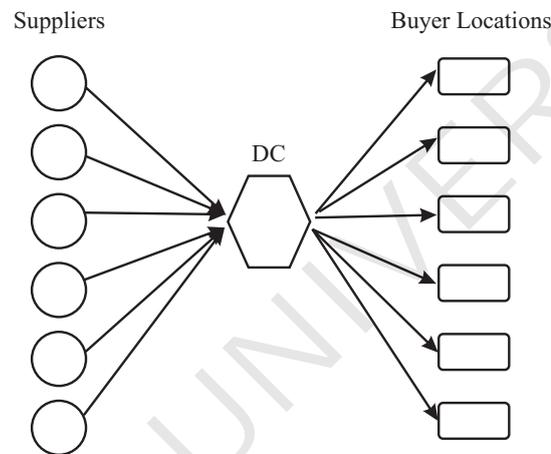
Fig. 10.5: Shipments via a Central Distribution Centre

In Fig. 10.5, it can be observed that there is a single DC where suppliers store their products for making deliveries. Products are delivered to multiple buyers from a single DC.

- **Shipping via DC using milk runs:** This network is the extension of direct shipping with milk runs, with an addition of DC between a supplier and the customer. This network design is used by Pepsi and Coca Cola for distributing their soft drinks to customers. Fig. 10.6 shows shipping via DC using milk runs:

Fig. 10.6: Shipping via DC using Milk Runs

This network design allows an organisation to reduce the costs of transportation incurred for the movement of products from a plant to the warehouse and the warehouse to a customer. However, there are high costs for warehousing in this design.

10.3.1 Trade-Offs in Transport Design

Every transportation design has its own shortcomings. Therefore, while selecting any transport design, organisations need to achieve trade-offs between efficiency (cost of transporting a given product) and responsiveness (the speed at which that products are transported) of a supply chain. Let us study about these two trade-offs in detail.

◆ **Transportation and inventory cost trade-off:** To achieve this trade-off, an organisation needs to decide on the selection of transportation mode and inventory aggregation, which are described as follows:

○ **Selection of transport mode**: While selecting the transportation mode, the organisation needs to select carriers to be used for the movement of products and the transportation mode for a particular shipment. Generally, organisations prefer fast modes of transportation for lowering inventories by supplying large quantities. On the other hand, slower modes are preferred by organisations for transporting products having a small value to the weight ratio to reduce transportation costs.

○ **Inventory aggregation**: It is sum of products (finished goods, raw materials, and components) kept in a storage facility. Organisations can significantly reduce safety inventory by physically aggregating inventories in one location. However, transportation costs increase when inventory is aggregated. Thus, organisations that plan for inventory aggregation must consider a trade-off between transportation, inventory, and facility costs.

◆ **Transportation and customer responsiveness trade-off:** The degree of responsiveness of any supply chain is closely link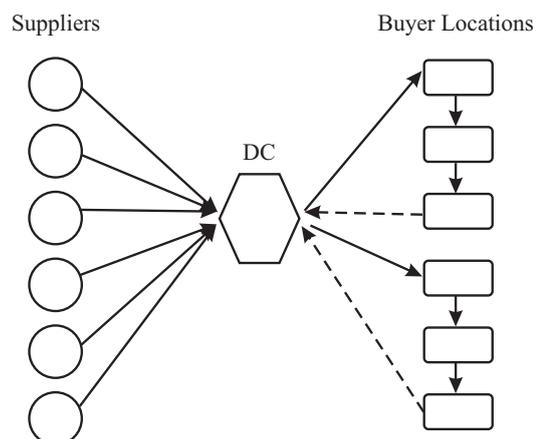ed to transportation costs. If an organisation wants to be more responsive, it has to ship all orders within a day of their placement by customers. As shipments are small, they incur high cost for an organisation. Thus, a trade-off between responsiveness and transportation cost should be considered while designing its transportation network.

📑 Self-Assessment Questions

5. Which type of transportation network is designed in such a manner that all shipments come directly from different suppliers to each buyer location?

    a. Direct shipment network

    b. Direct shipping with milk runs

    c. Shipments via central distribution centre

    d. Shipping via DC using milk runs

6. Generally, organisations prefer fast modes of transportation for lowering inventories by supplying small quantities. (True/False)

7. The degree of responsiveness of any supply chain is closely linked to _____.

🛠 Activity

Using various sources, find two examples for each transportation design network explained in this section.

10.4 Tailored Transportation

Organisations are often engaged in selling a variety of products and catering to the diverse needs of customers. Therefore, they cannot depend on any particular type of transportation mode. They need to use a combination of two or more transportation modes. Tailored transportation is a process of combining various transportation modes and networks to move products. Organisations design tailored transportation networks based on the following factors:

- **Customer density and distance**: While designing a tailored transportation network, an organisation analyses customer density and distance to be covered. For instance, if an organisation wants to serve high density of customers in the nearby area of DC, it has to own a fleet of trucks that can be used with milk runs through DC. In this way, vehicles can be used in the best manner at low costs.

- **Size of customers**: Here, customer size and location also play a vital role when designing transportation networks. A large number of customers can be served using a TL carrier, whereas a small number of customers would require an LTL carrier with milk runs. Using milk runs involves transportation cost based on total route distance covered and delivery cost based on number of deliveries made. Thus, in this case, transportation costs remain the same irrespective of the size of customers.

Self-Assessment Questions

8. _____ is a process of combining various transportation modes and networks to move products.

9. Name the factors on which tailored transportation is based.

10. A large number of customers can be served using a TL carrier, whereas a small number of customers would require an LTL carrier with milk runs. (True/False)

10.5 Summary

- Transportation is an important driver of responsiveness and efficiency of a supply chain. It is the movement of products from one place to the other using different modes.

- The transportation system of an organisation has three key players, namely shipper, carrier, and consignee.

- Transportation helps in a supply chain by ensuring product availability, product movement, and product storage.

- There are various modes of transportation used in a supply chain, such as trucks, rails, air, water, pipeline, and intermodal.

- For designing a transportation network, an organisation needs to consider two factors: modes of transportation and transport infrastructure.

- There are mainly four types of transportation design networks, namely direct shipment network, direct shipping with milk runs, shipments via central distribution centre (DC), and shipping via DC using milk runs.

- While selecting any transport design, organisations need to achieve trade-offs between efficiency and responsiveness of a supply chain. Therefore, an organisation strives to

achieve two types of trade-offs, namely transportation and inventory cost trade-off and transportation and customer responsiveness trade-off

◆ Tailored transportation is a process of combining various transportation modes and networks to move products. It can be based on customer density and distance and size of customers.

10.6 Glossary

◆ **Customer Density:** It is the number of prospective customers within a given unit of area or on a given length of distribution line.

◆ **Intermodal:** It is a type of transportation mode that involves two or more different modes for moving goods to the destination.

◆ **Less than Truck Load (LTL**): It is transportation carrying small quantities through trucks.

◆ **Market Penetration:** It is a process of increasing the market share of an organisation's existing products.

◆ **Milk Runs:** It is a round trip wherein both distribution and collection of products are facilitated.

◆ **Truck Load**: It is transportation carrying large quantities of similar products.

10.7 Terminal Questions

1. Explain the concept of transportation.

2. What are the costs associated with shipper decisions?

3. Discuss various modes of transportation used in a supply chain.

4. What are the trades-offs in transportation design? Discuss.

5. Write a short note on tailored transportation.

10.8 Answers

Q.	Self Assessment Questions
1.	b. Market
2.	Transportation
3.	Less than Truck Load
4.	False
5.	a. Direct shipment network
6.	False
7.	Transportation costs
8.	Tailored transportation
9.	Customer density and distance and size of customers
10.	True

Q.	Terminal Questions
1.	Transportation is the movement of products from one place to the other for which different modes are used. Refer to section **10.2 Meaning of Transportation**.
2.	The costs associated with shipper decisions are transportation cost, inventory cost, facility cost, processing cost, and service level cost. Refer to section **10.2 Meaning of Transportation.**
3.	In supply chain, various modes are used for transportation, such as trucks, rails, air, water, and intermodal. Refer to sub-section **10.2.2 Modes of transportation and their performance**.
4.	In transport design, an organisation needs to achieve two types of trade-offs; namely transportation and inventory cost trade-off and transportation and customer responsiveness trade-off. Refer to sub-section **10.3.1 Trade-offs in transport design**.
5.	Tailored transportation is a process of combining various transportation modes and networks to move products. Refer to section **10.4 Tailored Transportation**.

10.9 Case Study: Transportation Solutions by Mode Transportation

Truckload, less-than-truckload, intermodal, air, and maritime services are all provided by Mode Transportation, which is one of the most prominent third-party logistics organisations in North America. Mode Transportation is involved in the delivery of these services. More than 22,000 carriers and drivers are employed by the organisation, which is run by highly experienced transportation specialists and has a presence over the whole of North America. Maintaining long-term connections with consumers is something that the organisation is committed to encouraging. In order to cater to the specific shipping requirements and capacity demands of its clients, Mode is outfitted with a comprehensive and integrated transportation service network.

One of Mode Transportation's customers contacted the company in search of a dependable answer to the transportation issues that it was experiencing. One of the most significant producers of decorative paint and performance coating at the global level is the organisation that serves as the customer. The ability to transport these items to a variety of places proved difficult due to the fact that they are susceptible to temperature deterioration. In order to do this, the organisation required rail transportation during the summer months and temperature-controlled truckload services during the winter months. Because of this discrepancy in travel, there were delays in delivery, which meant that clients were unhappy with the service they received. Additionally, the client organisation incurred additional expenditures as a consequence of the use of several carriers.

Through the development of a multi-modal solution, Mode Transportation was able to fulfil the product and service requirements of the client organisation regardless of the time of year. Additionally, Mode offered the client organisation a centralised transportation management system to handle their transportation needs. Because of this, the client organisation was able to improve delivery time variations and make more accurate predictions about expenditures. Because of this, the client organisation did not have to make any concessions in order to maintain the necessary levels of product protection. The client organisation was able to

boost product security by reducing the distance travelled thanks to the implementation of the combination of truckload and rail transportation, which was made possible with the assistance of Mode's solution. Additionally, the client organisation was able to make significant reductions in overall expenses by using a multi-modal transportation system and a single-source supplier.

Discussion Questions

1. What problems were faced by the client organisation in the abovementioned case study?

   (**Hint:** The products of the client organisation were sensitive towards temperature change and were prone to damage. Therefore, they were difficult to be transported at long distances.)

2. How did Mode Transportation help the client organisation in improving its transportation system?

   (**Hint:** Mode transportation provided an intermodal solution and centralised transportation management system to the client organisation; thereby reducing transportation damage and costs.)

10.10 References and Suggested Readings

◆ Ayers, J. (2001). Handbook of supply chain management (1st ed.). Boca Raton, Fla.: St. Lucie Press.

◆ Chopra, S., & Meindl, P. (2014). Supply Chain Management (1st ed.). Hallbergmoos: Pearson.

◆ Fredendall, L., & Hill, E. (2001). Basics of supply chain management (1st ed.). Boca Raton: St. Lucie Press.

◆ Wisner, J., Leong, G., & Tan, K. (2005). Principles of supply chain management (1st ed.). Mason, Ohio [u.a.]: Thomson/South-Western.

E-references

◆ Freequality.org,. (2014). Retrieved 10 September 2014, from http://www.freequality.org/documents/Training/modes_of_transportation_2.ppt

◆ Goldsby, T., Iyengar, D., & Rao, S. (2014). The Critical Role of Transportation in Business and the Economy | Transportation and Logistics | FT Press. Ftpress.com. Retrieved 10 September 2014, from http://www.ftpress.com/articles/article.aspx?p=2171313

◆ Mitid.edu.in,. (2014). Transportation Design Courses In India, Transportation Designing Course In Pune, India. Retrieved 10 September 2014, from http://www.mitid.edu.in/Transportation-Design-Courses.html

Sourcing in Supply Chain Management

Structure

Learning Objectives

After completing the chapter, you will be able to:

❑ explain the meaning of sourcing

❑ highlight the role of sourcing in a supply chain

❑ discuss the need for in-house sourcing vs. outsourcing

❑ explain the role of third and fourth party logistics providers

❑ describe the process of supplier scoring and assessment

11.1 Introduction

In the previous chapter, you have studied about the role of transportation in a supply chain. Transportation is the movement products between various parties in a supply chain with an aim to meet demand and supply. Besides transportation, the efficiency and responsiveness of a supply chain also depend on effective sourcing. Sourcing can be defined as a value addition process of selecting suppliers for an organisation's supply chain network. The sourcing process is supported by advanced analytics, market intelligence, information on suppliers' performance, and a well-developed strategy. Organisations adopt sourcing for meeting various objectives, such as achieving cost reduction, concentrating on core competencies, stabilising the supply process, and minimising supply chain risks.

Sourcing is one of the crucial processes in a supply chain. This is because a wrong selection of suppliers may result in unnecessary costs and sub-optimal use of organisational resources. Thus, effective sourcing requires streamlining supplier base, reconfiguring supply specifications, developing strategic partnerships with selected suppliers, and so on.

In addition, active management of suppliers' performance is an important part of strategic sourcing. Before selecting a supplier, an organisation must have extensive data on the supplier's performance and its impact on the organisation's operations. This data is used by organisations in the selection and negotiation process in order to make sound sourcing decisions that ensure the lowest total cost. In this chapter, you will study about the role of sourcing in a supply chain in detail.

11.2 Meaning of Sourcing

To survive in today's stiff competition, organisations are constantly looking for ways to minimise their purchase and procurement costs. One of these techniques is referred to as **sourcing.** Sourcing is a practice of finding, selecting and evaluating suppliers of goods and services for long term association. It involves the management of the supply market for ensuring access to adequate resources, identifying potential suppliers, and defining a supply strategy for the organisation. The main objectives of sourcing are to achieve large and sustainable cost reductions and long-term supply stability of a supply chain as well as minimise supply risks. The sourcing decisions of an organisation encompass critical analysis of all supply chain activities, such as procurement, manufacturing, inbound logistics, outbound logistics, operations, sales, and aftersales services. Thereafter, the organisation assesses whether these activities should be performed internally or outsourced to an external party. Sourcing decisions are often referred to as **make or buy decisions**, which is an act of making a strategic choice between manufacturing a product internally (in-house) or buying it from an outside supplier (outsourcing).

Earlier, organisations used to perform all supply chain activities internally and tend to source from external parties only if there is a compelling logic to do so. For example, an automobile manufacturer would not outsource the manufacturing of engines for its automobiles to an external party as engines are vital to an automobile's performance. However, activities, such as assembling smaller components, purchasing tyres, etc. could be outsourced to an external supplier.

Sourcing involves complex decision making as it has a direct impact on the performance and competitive advantage of an organisation. Generally, organisations follow a standard method to arrive at a sourcing decision. The sourcing/make or buy decision involves four main stages, which are shown in Fig. 11.1:
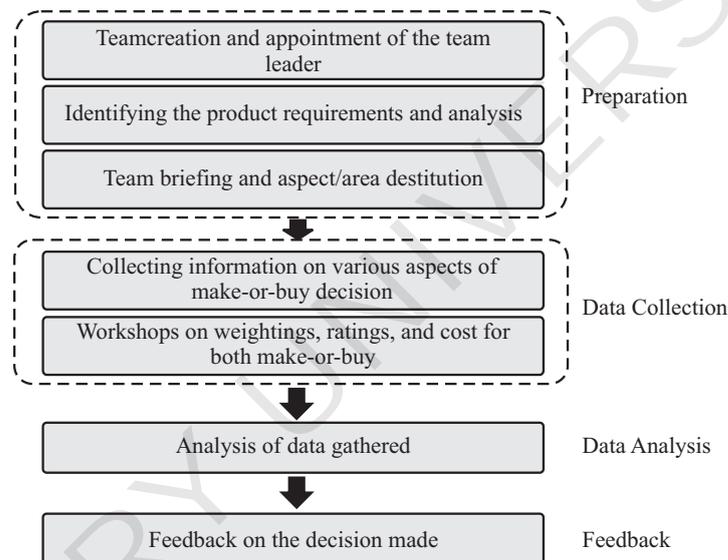
Fig. 11.1: Stages of a Sourcing Decision
(**Source:** *http://www.tutorialspoint.com/management_concepts)*

Let us discuss each of these stages in detail.

1. **Preparation:** This stage involves creating a team to collect information on the requirements in a particular area of supply. The team is assigned a team leader who allots the team members with particular areas that need to be analysed.

2. **Data collection:** At this stage, the team collects the required data from historical records and compares the figures against various aspects of the make-or-buy decision. The team can also collect information from workshops on supplier weightings, ratings, and cost related to both make and buy decisions for an organisation's products.

3. **Data analysis:** After collecting data, the team analyses the collected data to make the final sourcing decision. At this stage, the team also analyses various factors, such as such as the quality of products, reliability of suppliers, and impact of the decision on suppliers and customers. For example, material and labour costs are analysed by comparing the estimates for in-house production against outsourcing. Based on the analysis, the team takes the decision to either make or buy a particular product.

4. **Feedback:** Eventually, the team receives feedback on the decision taken from different departments of the organisation. The feedback is consolidated to arrive at a consensus based on which the final sourcing decision is made.

📑 Self-Assessment Questions

1. _____ is a practice of finding, selecting, and evaluating suppliers of goods and services for long term association.

2. The act of making a strategic choice between manufacturing a product internally or buying it from an outside supplier is known as _____.

3. The sourcing/make or buy decision involves four main stages, which are:

   a. _____

   b. _____

   c. _____

   d. _____

11.3 Role of Sourcing in Supply Chain

In today's competitive business environment, organisations are constantly seeking out creative ways to reduce supply chain costs, improve the quality of the final product, achieve a faster delivery time, and improve customer service. Organisations can successfully achieve these objectives through effective sourcing. Sourcing assists the supply chain managers to locate the best quality materials at the lowest possible price from the most reliable suppliers. The following sourcing processes help supply chain managers to arrive at the best possible procurement decision for an organisation:

- **Supplier selection:** It is a process by which organisations identify, evaluate, and contract with suppliers. The selection of competent suppliers has direct impact on an organisation's competitive advantage. Thus, an organisation should consider various factors before selecting suppliers. Some of these factors are as follows:

  - Technology

  - Willingness to share technologies and knowledge

  - Value for money

  - Quality of products

  - Reliability

  - Delivery time

  - Service

  - Communication capability

  - Location

- **Procurement:** The procurement process under sourcing is aimed at continuously improving and evaluating the purchasing activities of an organisation. It involves various activities, which are:

  - Assessing the organisation's current purchase expenses

  - Assessing the supply market

❍ Identifying suitable suppliers

❍ Developing a procurement sourcing strategy including supplier details, demand and supply situations, costs, etc.

❍ Negotiating with suppliers

❍ Implementing the new procurement system

❍ Tracking results and re-evaluating for improvement

◆ **Contract negotiation:** It refers to a discussion between two or more parties for a potential partnership arrangement in the future. Through contract negotiation, both the parties agree to a written contract with specifications about the terms and conditions of the partnership. The written agreement protects the interests of the organisation and replicates the offer made by the supplier in response to the requirement presented by supply chain personnel. The elements that need to checked before finalisation of a contract are shown in Table 11.1:

Table 11.1: Elements of Contract Negotiation	
Elements	**Inclusion**
Technical aspects	Warranties, aftersales service, life cycle support agreements, quality output issues
Special standings	Type of bonds, guarantees, insurance, payment schedules
Management information	Frequency of reporting, content of reports, acceptance criteria for certain indicators
Timeframe	Contract duration, key indicators, delivery dates, response times
Performance incentives	Cost incentives, delivery incentives, and quality incentives
Personnel	Key team members, principal contact points, subcontracting arrangements

◆ **Design collaboration:** It can be referred to as a system by which certain organisations develop products and services in collaboration with the suppliers to meet customer requirements. It is based on the notion that supplier involvement in the product design stage has substantial benefits. The development of design chain collaboration helps organisations in the following ways:

❍ Overcoming constant pressure to reduce product development time and costs

❍ Improving product offerings

❍ Minimising the tendency of organisations to outsource a significant proportion of their manufacturing activities

❍ Developing communication technologies that offer improved levels of communication between organisations, suppliers, customers, and other stakeholders

Design collaboration offers suppliers a favourable situation in which product components could be designed disjointedly and simultaneously. Such design collaboration between several suppliers is referred to as a design chain.

An example of design collaboration is shown in Fig. 11.2:
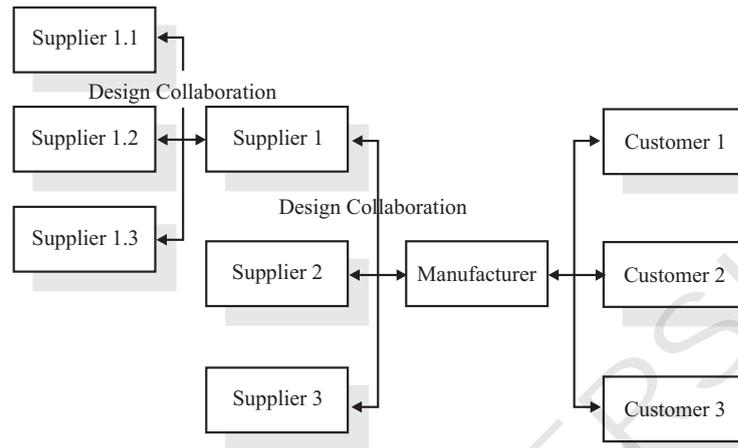
Fig.11.2: Design Collaboration between Suppliers

◆ **Sourcing planning and analysis:** This process is a fundamental part of purchasing and supply management process in organisations. Sourcing planning and analysis is a logical process involving the application of analytical tools by skilled, competent and knowledgeable personnel. It is required for the analysis of supply markets and selection of suppliers with the objective of delivering best practices and supply chain solutions; thereby meeting the pre-determined business requirements.

Self-Assessment Questions

4. The supplier selection process under sourcing is aimed at continuously improving and evaluating the purchasing activities of an organisation.(True/False)

5. _____ is a system by which certain organisations develop products and services in collaboration with the suppliers to meet customer requirements.

6. Developing a procurement sourcing strategy including supplier details, demand and supply situations, or cost is part of which of these sourcing activities?

    a. Supplier selection

    b. Design collaboration

    c. Procurement

    d. Sourcing planning and analysis

Activity

Visit IBM's website and note the steps of its contract negotiation process.

11.4 In-House Sourcing and Outsourcing

Every organisation has to determine whether it should perform a business activity itself in-house or outsource that particular activity to an outside vendor. In-house sourcing refers to conducting a business activity or operation within an organisation instead of relying on external sources. It is adopted by organisations for activities that are core to its operations

and for which the organisation has the required skills and expertise. For example, IT firms employ in-house engineers to write technical manuals for equipment designed by them instead of outsourcing the work to a technical writing organisation. An organisation uses its own employees and time to keep a division or business activity in-house. The various reasons why organisations adopt in-house sourcing are shown in Fig. 11.3:

Proprietary Technology

Lack of Competent Supplier

Better Quality Control

Idle Capacity

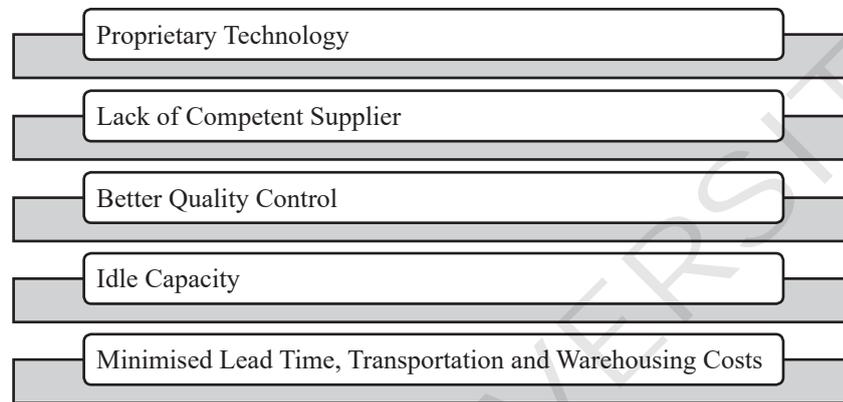| Minimised Lead Time, Transportation and Warehousing Costs |
|---|

Fig. 11.3: Reasons for In-House Production

Let us discuss these in detail:

◆ **Proprietary technology:** One of the main reasons for in-house sourcing is to protect proprietary technology. Organisations develop certain technologies and procedures that need to be preserved to attain a competitive advantage. Organisations generally do not wish to reveal a certain technology to their suppliers even if it is patented. In such cases, organisations opt for in-house sourcing.

◆ **Lack of competent suppliers:** If suppliers in the market do not meet the required selection criteria, organisations opt for in-house manufacturing for a short-term. Later, the organisation may develop a supplier development strategy to outsource the task to an existing or new supplier.

◆ **Better quality control:** In-house sourcing allows direct control over the manufacturing process to an organisation. In addition, there exists better control of the organisation over various factors such as cost, quality, labour, and design if it adopts in-house sourcing. In cases where the organisation is efficient and capable to manufacture good quality products compared to those of suppliers, the organisation tends to opt for in-house sourcing of its processes.

◆ **Idle capacity:** In certain cases, organisations have excess idle capacity, which can be utilised to manufacture products in-house for a short period of time. This strategy is particularly useful for organisations that manufacture seasonal products, such as woollen clothes and umbrella. It helps in avoiding the layoffs of skilled labour and meeting a sudden rise in demand.

◆ **Minimised lead time, transportation and warehousing costs:** The in-house sourcing option allows for better control over lead time and logistics costs as the organisation overlooks all phases of design, manufacturing, and delivery processes. Certain organisations prefer to purchase raw material from suppliers and manufacture finished products on their own near consumption centres in order to minimise warehousing costs.

However, there are various organisations that prefer to subcontract their processes to suppliers and other organisations. Outsourcing refers to the process of contracting certain non-essential

or non-core processes of an organisation to an external party with proven expertise in the field. The major reason why organisations outsource their processes is the significant cost reduction that results from outsourcing. Outsourcing allows an organisation to focus on their core competencies by providing a responsibility of peripheral (not necessary processes) to external agencies. For example, an IT company would focus on developing a new technology and software while outsource its peripheral activities like data entry, maintaining employee database, customer service, etc. Fig. 11.4 lists the reasons for outsourcing business processes:

Cost Advantage

Insufficient Capacity

Lack of Expertise

Quality
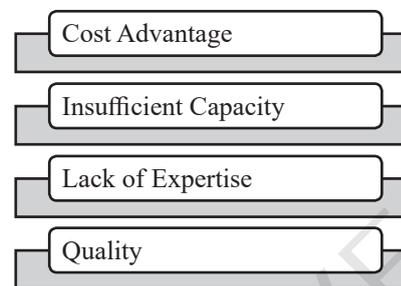
Fig. 11.4: Reasons for Outsourcing

Let us discuss these reasons in detail.

◆ **Cost advantage:** There are several supplies that are non-vital to organisational operations. For example, standardised or generalised supplies for which suppliers own the advantage of economies of scale can be conveniently purchased from external parties. Moreover, most of the times the quantity of supplies required are so small that the capital investment in manufacturing them internally cannot be justified. In such cases, the organisation considers it best to purchase such supplies from external parties. Apart from this, certain organisations outsource their activities owing to low labour and/or material costs.

◆ **Insufficient capacity:** There are instances when organisations lack capacity to produce certain components internally. This could happen if product demand rises abruptly against anticipation or when expansion strategies fail to meet the increasing demand. In such cases, organisations prefer to buy parts or components from suppliers and focus on their vital operations. This process of assigning a part of task under a contract to an external party is referred to as **subcontracting**.

◆ **Lack of expertise:** Sometimes organisations do not have the required technology and expertise to manufacture parts or components internally. In such cases, organisations prefer to outsource the activity to a supplier organisation and focus on their core activities. Sometimes, suppliers may have patent for a manufacturing process, which makes it necessary for an organisation to purchase from the suppliers.

◆ **Quality:** Suppliers generally have access to better technologies and expertise in manufacturing a product. They have skilled labour, improved procedures, and an advantage of economies of scale. This would result in better quality of products, which organisations need to stay ahead in competition.

Self-Assessment Questions

7. _____ refers to conducting a business activity or operation within an organisation instead of relying on external sources.

8. In-house sourcing does not allow direct control over the manufacturing process to an organisation. (True/False)

9. _____ refers to the process of contracting certain non-essential or non-core processes of an organisation to an external party with proven expertise in the field.

10. The process of assigning a part of task under a contract to an external party is referred to as subcontracting. (True/False)

11.5 Third and Fourth Party Logistics Providers

The trend of subcontracting with external partners in supply chain management has become a common practice. These partners are referred to as 'third party logistics providers' or '3PL' in short. 3PL is all about hiring an external agency to perform all or part of an organisation's purchase management and product distribution functions. A 3PL can either be a standalone operator or an integrated association. A standalone operator is referred to as a wholesaler and extends only a single type of service in which they excel. Such operators generally offer services in areas such as warehousing, transportation, packaging, and inventory management. An integrator, on the other hand, is a 3PL provider who offers all supply chain services and logistics solutions to its client organisations.

The concept of 3PL providers came into existence in the 1990s when organisations shifted their focus to supply chain management and realised that logistics is core to supply chain in an organisation. The main reasons for rapid adoption of 3PL providers are reduced logistics costs and lead times. The research on supply chain management practices in India shows that outsourcing of logistics activities is gaining popularity in Indian organisations with an increase in the number of third-party logistics providers over the last few years. The use of 3PL services is a strategic decision based on its impact on business performance. Some of the criteria for the assessment of 3PL providers are as follows:

◆ Impact on customer satisfaction

◆ Impact on logistics performance

◆ Decrease in capital investment in equipment and facilities

◆ Reduction in labour cost

◆ Improvement in inventory turnover rates

◆ Improvement in delivery times

◆ Increase in productivity

With the introduction of information technology in supply chain management, a new trend has emerged in supply chain and logistics system of an organisation. IT firms provide logistics solutions to organisations by integrating the logistics system with information technology. These firms are referred to as 'fourth party logistics providers' or '4PL' in short. The term '4PL' was coined by Anderson Consulting Company (now Accenture) in 1996 and is a relatively new concept in supply chain management. Accenture defined **4PL** as follows:

"*A 4PL is an integrator that assembles the resources, capabilities, and technology of its own organisation and other organisations to design, build and run comprehensive supply chain solutions.*"

4PL is an arrangement in which an organisation outsources its logistics operations to two or more 3PLs and takes the help of an IT firm for coordinating the activities of the 3PLs. 4PL providers include strategic supply chain consultants who assist organisations on logistics, transportation, warehouse management, and integration of their demand and supply chains. A 4 PL firm is one that fulfils the following conditions:

◆ Covers the entire supply chain of the client organisation

◆ Collaborates between two or more logistics service providers on a resource sharing basis

◆ Provides IT-based solutions rather than asset based as in the case of 3 PLs

4PLs identify supply chain optimisation potential of client organisations and offer necessary solutions like IT systems or supply chain software to these organisations. There are various benefits of 4PL providers, some of which are as follows:

◆ Access to a broader base of potential suppliers

◆ Supply chain system integration

◆ Standardisation and automation of order placement

◆ Reduced procurement costs

◆ Reduced order cycle times

Exhibit

Integration of Supply Chain System by 4PL Providers

A 4PL provider is a supply chain integrator that assembles and manages all resources, capabilities, and technologies of an organisation's supply chain and its array of providers.

4 PL is similar to Business Process Outsourcing (BPO) that aims to manage people, processes, and technologies.

(**Source:** *http://supplychain.enchange.com/*)
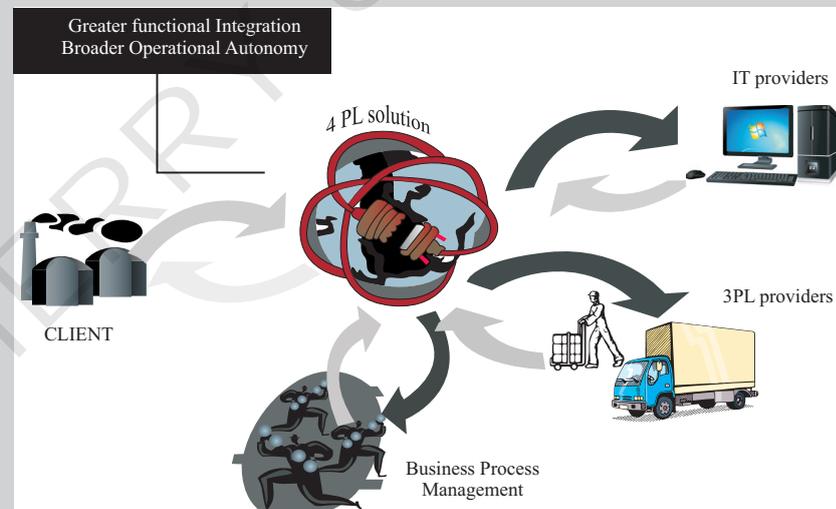
Self-Assessment Questions

11. _____ is about hiring an external agency to perform all or part of an organisation's purchase management and product distribution functions.

12. _____ is an integrator that assembles the resources, capabilities, and technology of its own organisation and other organisations to design, build and run comprehensive supply chain solutions.

13. 4PL is an arrangement in which an organisation outsources its logistics operations to two or more 3PLs and takes the help of an IT firm for coordinating the activities of the 3PLs. (True/False)

Activity

List down the main points of differences between 3 PL and 4 PL in supply chain management.

11.6 Supplier Scoring and Assessment

To have a competitive advantage, organisations must be able to produce quality products at reasonable prices. The quality of products directly depends on the efficiency of an organisation's workforce and its suppliers. Organisations aim to maintain partnerships with the best suppliers to leverage their expertise and technological skills for long-term benefits. In order to select efficient suppliers who consistently outperform their counterparts, organisations must carefully analyse and evaluate potential suppliers. As discussed earlier, sourcing in supply chain management includes supplier selection decision, supplier contracts negotiation, design collaboration, procurement of material and services, and supplier performance evaluation. Supplier selection decision, which is the first step in the sourcing process is perfromed on the basis of supplier scoring and assessment. Supplier scoring and assessment refers to a process used to rate supplier performance. The basis of supplier performance assessment is their impact on the supply chain surplus and total cost.

Organisations rate suppliers on supplier scorecards before final assessment. A supplier scorecard comprises main groupings of metrics by which suppliers are assessed. These groupings are listed in Fig. 11.5:
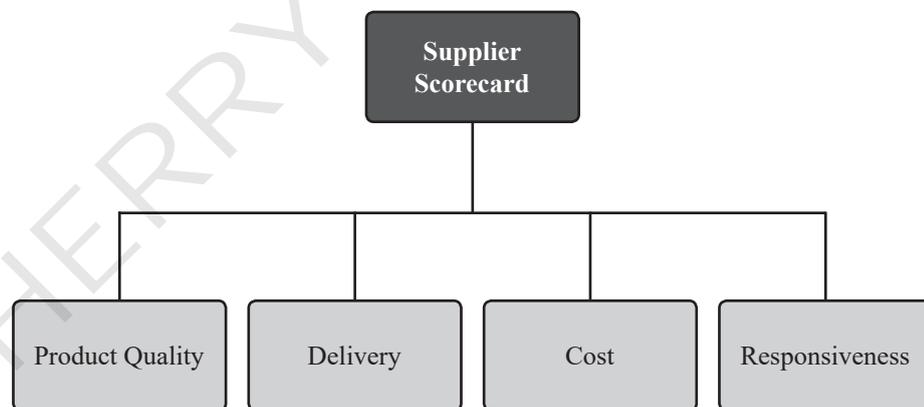
Fig. 11.5: Basis of Supplier Scoring

Each of these groupings is assigned a definite weightage, which is converted to the overall supplier score within the supplier scorecard. Let us discuss the rating criteria for each of these groupings in detail:

1. **Product quality:** It accounts for 30 points of the overall scorecard rating. For this, the RPPM (rejected parts per million) of each supplier is calculated on the basis of the amount of non-conforming materials against the total amount of materials received in a given time period. For example, a supplier makes a shipment of 100, 000 units of raw material to a firm of which 7 are found to be non-conforming. Therefore,

$$\text{RPPM} = \frac{7}{100,0000} \times 1000,000 = 70$$

Here, the score comes out to be 12. The minimum acceptability is 25 points.

The RPPM rating is compared against the score using the RPPM rating table:

RPPM Rating	Score
00 - 25	30
26 - 30	28
31 - 35	26
36 - 40	24
41 - 45	22
46 - 50	20
51 - 55	18
56 - 60	16
61 - 65	14
66 - 70	12
71 - 75	10
76 - 80	8
81 - 85	6
86 - 90	4
91 - 95	2
96 - 100	0

2. **Delivery:** It accounts for 30 points of the overall scorecard rating. Delivery ratings are calculated based on the amount of shipments having errors against the total amount of shipments in a given time period. This information is then converted into a percentage. Mathematically,

Delivery % = [(Total shipments - Number of occurrences) / Total shipments] x 100

For example, suppose a supplier ships 36 consignments in a month, of which 1 consignment is late and 1 is short of the ordered quantity. This accounts to 2 errors. Therefore,

Delivery % = [(36-2) / 36] x 100 = 94.4 %.

Here, the score comes out to be 18. The minimum acceptability is 26 points.

The delivery percentage is compared against the score using the following table:

Delivery Occurrence Percentage	Score
100	30
99.6 - 99.9	29
98.6 - 99.5	28
97.6 - 98.5	26
96.6 - 97.5	24
95.6 - 96.5	22
94.6 - 95.5	20
93.6 - 94.5	18
92.6 - 93.5	16
91.6 - 92.5	14
90.6 - 91.5	12
89.6 - 90.5	10
88.6 - 89.5	8
87.6 - 88.5	6
86.6 - 87.5	4
85.6 - 86.5	2
85.5 Or less	0

3. **Cost:** The cost criterion of scoring is used to assess suppliers against the cost benefits they provide to the organisation. This is done by calculating the supply chain surplus created by a supplier. The percentage total cost reduction in the supply chain year after year forms the basis of assessing a supplier for cost benefits.

4. **Responsiveness:** This accounts for 20 points of the overall scorecard. Responsiveness ratings are assessed on the basis of the following factors:

   ❍ In-time and accurate response to emergency requests

   ❍ In-time and accurate response to quality issues

   ❍ In-time and accurate documentation

   ❍ Compliance with payment terms

   ❍ Overall communication

   For example, suppose a supplier fails to attend to 2 of the emergency orders requested by the firm. The responsiveness rating is compared against the score using the following table:

Service Incidences	Score
0	20
1	16
2	12
3	8
4	4
5 or greater	0

In this case, the supplier's score is 12. The minimum acceptability is determined by the organisation based on the severity of failed response.

Self-Assessment Questions

14. A supplier scorecard comprises main groupings of metrics by which suppliers are assessed. These are:

   a. _____

   b. _____

   c. _____

   d. _____

15. Delivery accounts for 20 points of the overall scorecard rating. (True/False)

16. _____ of each supplier is calculated on the basis of the amount of non-conforming materials against the total amount of materials received in a given time period.

11.7 Summary

◆ Sourcing is a practice of finding, selecting, and evaluating suppliers of goods and services for long term association.

◆ Sourcing decisions are often referred to as make or buy decisions, which is an act of making a strategic choice between manufacturing a product internally or buying it from an outside supplier.

- The sourcing/make or buy decision involves four main stages, which are preparation, data collection, data analysis, and feedback.

- Supplier selection is a process by which organisations identify, evaluate, and contract with suppliers.

- The procurement process under sourcing is aimed at continuously improving and evaluating the purchasing activities of an organisation.

- Contract negotiation refers to a discussion between two or more parties for a potential partnership arrangement in future.

- Design collaboration can be referred to as a system by which certain organisations develop products and services in collaboration with the suppliers to meet customer requirements.

- Sourcing planning and analysis is a logical process involving the application of analytical tools by skilled, competent and knowledgeable personnel.

- In-house sourcing refers to conducting a business activity or operation within an organisation instead of relying on external sources.

- In-house sourcing is adopted by organisations for activities that are core to its operations and for which the organisation has the required skills and expertise.

- Outsourcing refers to the process of contracting certain non-essential or non-core processes of an organisation to an external party with proven expertise in the field.

- 3PL is all about hiring an external agency to perform all or part of an organisation's purchase management and product distribution functions.

- A 4PL is an integrator that assembles the resources, capabilities, and technology of its own organisation and other organisations to design, build and run comprehensive supply chain solutions.

- In order to select efficient suppliers who consistently outperform their counterparts, organisations must carefully analyse and evaluate potential suppliers.

- Supplier scoring and assessment refers to a process used to rate supplier performance.

- A supplier scorecard comprises main groupings of metrics by which suppliers are assessed. These are product quality, delivery, cost, and responsiveness.

11.8 Glossary

- **Idle capacity:** It refers to the means the unused or partially used facilities inside an organisation combined with insufficient raw materials and skilled labour.

- **Inventory turnover:** It refers to a measure of the number of times inventory is sold or used by an organisation in a time period.

- **Make or buy decision:** It is an act of selecting between manufacturing a product in-house or procuring it from an external supplier.

- **Market intelligence:** It refers to the information related to an organisation's markets, collected and analysed for decision-making by managers.

- **Patent:** It refers a set of exclusive rights granted to an inventor of a product, idea, technology, etc. for a limited period of time in exchange for detailed public disclosure of the invention.

- **Proprietary technology:** It encompasses confidential concepts, formulae, software code, technical information, etc. that offer a competitive advantage to an organisation.

◆ **Supplier scorecard:** It refers to a supplier assessment technique whereby supplier performance on various dimensions important to an organisation is rated.

◆ **Supply chain surplus:** It refers to value addition to an organisation's product, profitability, logistics and other factors by its supply chain function.

11.9 Terminal Questions

1. Explain the meaning of sourcing.

2. Highlight the role of sourcing in supply chain.

3. Discuss the need for in-house sourcing vs. outsourcing.

4. Explain what are third and fourth party logistics providers.

5. Describe the process of supplier scoring and assessment.

11.10 Answers

Q.	Self Assessment Questions
1.	Sourcing
2.	Make or buy decision
3.	a. Preparation
	b. Data collection
	c. Data analysis
	d. Feedback
4.	False
5.	Design collaboration
6.	c. Procurement
7.	In-house sourcing
8.	False
9.	Outsourcing
10.	True
11.	3PL
12.	4PL
13.	True
14.	a. Product quality
	b. Delivery
	c. Cost
	d. Responsiveness
15.	False
16.	RPPM

Q.	Terminal Questions
1.	Sourcing is a practice of finding, selecting and evaluating suppliers of goods and services for long term association. Refer to section **11.2 Meaning of Sourcing**.
2.	Sourcing processes help supply chain managers to arrive at the best possible procurement decision for an organisation. It involves supplier selection, procurement, contract negotiation, design collaboration, and sourcing planning and analysis. Refer to section **11.3 Role of Sourcing in Supply Chain**.
3.	In-house sourcing is adopted by organisations for activities that are core to its operations and for which the organisation has the required skills and expertise. Outsourcing allows an organisation to focus on their core competencies by providing a responsibility of peripheral (not necessary processes) to external agencies. Refer to section **11.4 In-House Sourcing and Outsourcing**.
4.	3PL is all about hiring an external agency to perform all or part of an organisation's purchase management and product distribution functions. A 4PL is an integrator that assembles the resources, capabilities, and technology of its own organisation and other organisations to design, build and run comprehensive supply chain solutions. Refer to section **11.5 Third and Fourth Party Logistics Providers**.
5.	Supplier scoring and assessment refers to a process used to rate supplier performance. A supplier scorecard comprises main groupings of metrics by which suppliers are assessed. These are product quality, delivery, cost, and responsiveness. Refer to section **11.6 Supplier Scoring and Assessment**.

11.11 Case Study: MUL Cuts Down Costs through Supplier Sourcing

In the year 2000, Maruti Suzuki India Limited initiated a cost-cutting initiative to counter the reductions in automobile prices mandated by the Government of India. On June 24, 2000, the prices of Maruti 800, Omni, and Wagor RLX models were reduced by approximately ₹12,000 to ₹25,000. This reduction in car prices resulted in a significant decrease in the organization's profit figures. To maintain profitability, Maruti Suzuki decided to reduce overall costs, with a particular focus on the supply chain function, which consumed a significant portion of the organization's resources. As a result, Maruti shifted its attention to lowering supply chain and logistics expenses. The primary objective of Maruti's cost-cutting efforts was to achieve substantial savings through its suppliers. To reach this goal, the organization implemented a supplier development exercise, encompassing the following initiatives:

Maruti sent 11 of its top suppliers to Japan to participate in a workshop on cost reduction organized by Suzuki Motor Company. The workshop explored strategies for suppliers to leverage local technologies, thereby reducing expenditures on the import of automobile parts and components. This approach aimed to bring down overall supply chain costs by four to five percent. Additionally, Maruti streamlined its supplier base from 350 to 200, enabling suppliers to benefit from economies of scale, as a single supplier was now responsible for larger volumes. The purchase department at Maruti worked to establish a strategic sourcing environment, connecting the organization to a robust supplier network equipped with superior tools, expertise, and information.

◆ Sourcing of suppliers

◆ Developing a supplier selection strategy

◆ Training of selected suppliers

◆ Creating short and long-term supplier strategies

◆ Evaluating the performance of suppliers

◆ Renegotiating with suppliers for cost benefits

Maruti sent 11 of its top suppliers to Japan for attending a workshop on cost reduction conducted by Suzuki Motor Company. The workshop discussed strategies on the use of local technologies by suppliers to cut expenditures on import of automobile parts and components which could bring down overall supply chain costs by four to five per cent. Maruti also brought down its supplier base from 350 suppliers to 200 suppliers, which helped suppliers to gain from economies of scale as a single supplier was now responsible for supplying larger volumes. The purchase department at Maruti worked to develop a strategic sourcing environment that connected the organisation to a powerful supplier network with superior tools, expertise, and information.

By the end of the year, Maruti was able to lower down its costs to the tune of approximately ₹ 60 crores. Sourcing strategies used by Maruti helped it in gaining the following advantages:

◆ Lead time reduced by 25-30 per cent

◆ Delivery time improved by 20 per cent

◆ Inventory costs lowered by 25-50 per cent

◆ Increased responsiveness to customer needs and market dynamics

Discussion Questions

1. Critically evaluate the sourcing strategy used by Maruti Udyog Limited.

   (**Hint:** Advantages: The supplier base was reduced to gain economies of scale, a workshop for suppliers to use local technologies, long and short-term supplier contracts helped Maruti in gaining a competitive edge. Disadvantages: Excessive cut down of costs may affect the product quality, the research and development team could have worked to re-engineer supply friendly products.)

2. Supply chain management is core to the functioning of an automobile enterprise. Suggest a few ways to improve the supplier selection and logistics functions for Maruti Suzuki India Limited.

   (**Hint:** Supplier rating and scoring methods to evaluate the performance of suppliers can be used for supplier selection. The performance of suppliers should be assessed based on various aspects, such as product quality, cost, delivery, and responsiveness. Moreover, partnerships can be formed with 3PL and 4PL providers for the automation and integration of supply chain activities.)

11.12 References and Suggested Readings

◆ Crandall, R., Crandall, W., & Chen, C. (2010). Principles of supply chain management (1st ed.). Boca Raton, Fla.: CRC Press.

◆ Shah, J. (2009). Supply chain management (1st ed.). Upper Saddle River, N.J.: Pearson Education.

◆ Wisner, J., Leong, G., & Tan, K. (2005). Principles of supply chain management (1st ed.). Mason, Ohio [u.a.]: Thomson/South-Western.

E-references

◆ (2014). Retrieved 15 September 2014, from http://www-personal.umich.edu/~dbeil/ Supplier_Selection_Beil-EORMS.pdf

◆ (2014). Retrieved 15 September 2014, from https://www.kpmg.com/RO/en/ IssuesAndInsights/ArticlesPublications/Factsheets/Advisory/Internal-Audit-Strategic-Sourcing/Documents/Outsourcing and co-outsourcing EN.pdf

◆ Referenceforbusiness.com,. (2014). Make-or-Buy Decisions - strategy, levels, definition. Retrieved 15 September 2014, from http://www.referenceforbusiness.com/ management/Log-Mar/Make-or-Buy-Decisions.html

Pricing and Revenue Management in Supply Chain Management

Structure

Learning Objectives

After completing the chapter, you will be able to:

❑   discuss the role of pricing and revenue management in a supply chain

❑   explain pricing and revenue for multiple customer segments

❑   describe pricing and revenue management for seasonal demand

❑   discuss pricing and revenue management for bulk and spot contracts

❑   explain the process of revenue management

12.1 Introduction

In the previous chapter, you have studied about the importance of sourcing in a supply chain. Sourcing is a value addition process of selecting suppliers for an organisation's supply chain network. However, sourcing alone cannot ensure the effectiveness of a supply chain. An organisation needs to formulate sound pricing and revenue management strategies.

Pricing is a process of setting an amount to be charged from customers by an organisation in exchange of products and services. In a supply chain, pricing plays a key role in creating a balance between demand and supply. The prices of products and services are decided by organisations using various methods. Some of these methods are pricing by purchase channel, pricing by purchase location, pricing by time of use, pricing by quantities purchased, and pricing by metering.

Pricing of an organisation directly affects the revenues generated. This is because an organisation earns revenues through the sale of products and services. Thus, it is of paramount importance for an organisation to manage its revenues in order to use its supply chain resources optimally. In this chapter, you will study about pricing and revenue management in supply chain management in detail.

12.2 Pricing and Revenue Management in Supply Chain Management

As discussed so far, there are different drivers that are crucial for the success of an organisation's supply chain. Pricing is one of the major drivers that help in improving the efficiency and responsiveness of the supply chain. Moreover, it helps in increasing the profitability of a supply chain by striking a balance between demand and supply. This is because any increase or decrease in price has a direct impact on demand and supply of products. Thus, it is important for an organisation to be careful while deciding the prices of its products.

In addition, revenues of an organisation are dependent on its pricing strategies. This is because revenues are generated by an organisation from the prices at which products are sold to customers. Therefore, it is important for an organisation to manage its revenues in order to maintain an effective supply chain. Revenue management is a process wherein pricing strategies are used to increase profits and optimise the allocation of available supply chain resources. In a supply chain, there are two types of resources, which are:

◆   **Capacity resources**: These resources are used for production, transportation, and storage in the supply chain.

◆   **Inventory resources**: These resources are used throughout the supply chain to improve product availability.

Organisations use a number of approaches to revenue management. Some of the commonly used approaches are explained as follows:

◆ Charging lower prices from customers placing their orders far in advance and higher prices from customers placing orders at the last minute.

◆ Charging lower prices from customers who have long-term associations with the organisation and high prices from customers ordering for the first time and at the last minute.

◆ Charging higher prices when the demand for products is high and lower prices during periods of low demand.

Revenue management affects supply chain profitability under the following conditions:

◆ When product value varies in different market segments

◆ When products are perishable in nature

◆ When demand for products is seasonal

◆ When products are sold both in bulk and in the spot market

American Airlines is an example of an organisation that has maintained a responsive supply chain through effective revenue management. The organisation adopted the differential pricing approach to revenue management and reduced prices for a specified set of seats to attract more passengers. In this way, American Airlines beat its major rival People Express and strengthened its position in the market.

Self-Assessment Questions

1. _____ of an organisation is dependent on its pricing strategies.

2. Name the two types of resources in a supply chain.

3. Revenue management affects supply chain profitability when demand for products is seasonal. (True/False)

12.3 Pricing and Revenue Management for Multiple Customer Segments

A market comprises different customer segments with varied tastes, preferences, needs, income levels, etc. Therefore, an organisation needs to identify and differentiate between various customer segments and structure its pricing accordingly. For this, the organisation needs to decide strategies to control demand so that all available assets are not over-utilised by one lower price segment. Fig. 12.1 lists various strategies used by organisations for structuring pricing for multiple customer segments:
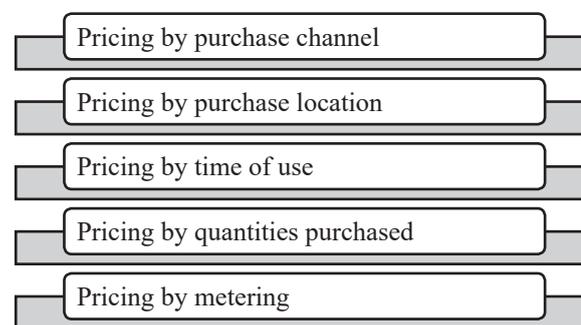
Pricing by purchase channel

Pricing by purchase location

Pricing by time of use

Pricing by quantities purchased

Pricing by metering

Fig. 12.1: Strategies for Structuring Pricing for Multiple Customer Segments

Let us discuss these strategies in detail.

- **Pricing by purchase channel**: In this strategy, prices are decided on the basis of channels used by customers for purchasing products. For instance, customers can use various channels for purchases, such as in-store, online, mail order, and phone. Due to the varying costs associated with each channel in a supply chain, organisations apply different pricing strategies depending on channels they have used for making products available to customers.

- **Pricing by purchase location**: In this strategy, pricing is decided by an organisation based on customers' location. For instance, mineral water of a particular brand is sold at a higher price at tourist spots, whereas the same bottle would be available at a lower price in some residential area.

- **Pricing by time of use:** In this strategy, prices for products are decided on the basis of time products would be used. This type of strategy is used in industries having a fixed capacity and perishable inventory, such as hospitality, airline, parking garage, rental car, and telecommunications. For example, telecom organisations offer various discount options and free calls during nights.

- **Pricing by quantities purchased**: Organisations often provide huge discounts for large quantities purchased by customers. This is done due to price sensitivity of such customers, intense competition for large orders, lower costs in serving large orders, etc.

- **Pricing by metering**: It refers to deciding the prices for products based on their usage by customers. For example, metered pricing is done by actual meter counting usage, such as electricity drawn from the grid.

In order to manage revenues efficiently while serving multiple customer segments, an organisation can adopt the following tactics in its supply chain:

- Prices should be decided based on the value assigned by each customer segment.

- Different prices should be set for each segment.

- Forecasting should be done at the segment level.

Exhibit

Types of Differential Pricing

The following are the different types of differential pricing:

- **Negotiated pricing**: It implies a pricing strategy in which a price is decided through bargaining between a customer and the seller.

- **Secondary market pricing**: It involves establishing different prices for various markets. The price in the primary market differs from that in the secondary market. The primary market is the intended market where products are initially introduced, while the secondary market is the target market where the product is introduced after achieving success in the primary market. Prices in the primary market are generally higher than those in the secondary market. However, if the cost of serving the secondary market is higher compared to the cost of the primary market, the price charged in the secondary market is higher. An example of a secondary market could be an isolated area in domestic and foreign country markets.

A secondary market also includes a segment that purchases products during off-peak times. For example, restaurants offer various discount options to early customers during the off-peak season. Customers are presented with early bird menus that feature food items at lower prices.

◆ **Periodic discounting**: This refers to a pricing strategy involving a temporary reduction in product prices on a systematic basis. For instance, many clothing outlets offer discounts during festive seasons or on a seasonal basis. The main challenge with periodic discounting is that customers can easily predict price reductions, leading them to delay their purchases. For example, Big Bazaar has introduced the well-known Wednesday bazaar concept, providing discounts on almost all products every Wednesday. Big Bazaar has designated Wednesday as "Hafte Ka Sabse Sasta Din" (the cheapest day of the week).

◆ **Random discounting**: This entails offering discounts on an unsystematic basis to prevent customers from easily predicting the discounts. When prices are randomly reduced, customers cannot anticipate price reductions. Random discounting is primarily used to attract new customers.

Self-Assessment Questions

4. In which strategy, prices are decided on the basis of channels used by customers for purchasing products?

   a. Pricing by purchase channel

   b. Pricing by time of use

   c. Pricing by purchase location

   d. Pricing by metering

5. In order to manage revenues efficiently prices should be decided based on the value assigned by each customer segment. (True/False)

6. _____refers to deciding the prices for products based on their usage by customers.

Activity

Find out the pricing strategies used by McDonald's in India?

12.4 Pricing and Revenue Management for Seasonal Demands

Organisations need to manage revenues to handle seasonal demand with an aim to shift demand from the peak to the off-peak period; thereby balancing supply and demand to maximise supply chain's profitability. This is done by charging higher prices from customers during a peak period and lower prices during off-peak periods. By doing so, organisations can easily shift demand from peak to the off-peak period. This strategy is beneficial for organisations if the discount offered during the off-peak period is higher compared to a decrease in cost caused during off season. In this way, organisations can generate high revenues during both the periods.

Let us understand the pricing and revenue with the help of an example. Amazon.com is an organisation with the peak period in December. During this period, the organisation faces expensive short-term capacity and reduction in profits margins. Therefore, to shift the peak periods and deal with shortage, the organisation offers discounts and free shipping to customers placing orders in November. In this way, Amazon successfully brings a fall in demand during the peak period without compromising on profits.

By offering discounts in off-peak periods, an organisation can make its revenue management highly successful. This strategy is more suitable for manufacturers or transporters in any supply chain facing seasonal peak demand. This is because bringing changes in production or transportation capacity over time is expensive. Moreover, the strategy also attracts new customers during the off-peak discount period; thereby increasing profits of a supply chain.

Self-Assessment Questions

7. Organisations need to manage revenues to handle seasonal demand with an aim to shift demand from the peak to the off-peak period. (True/False)

8. By offering discounts in _____, an organisation can make its revenue management highly successful.

Activity

Find out how seasonal demand is catered by any apparel organisation of your choice

12.5 Pricing and Revenue for Bulk and Spot Contracts

An organisation sells its products both through bulk and spot contracts. Bulk contracts can be defined as an agreement whereby large quantities of products are sold at a discount for consumption or resale by a third party. These types of contracts are used by the travel industry for selling airlines tickets to a third party for resale. Spot contracts, on the other hand, are agreements of buying or selling products on the spot date. Organisations need to decide whether assets to be kept for selling through bulk contracts of spot contracts. Similarly, purchasers also need to make such decisions for buying, production, warehousing, and transportation assets.

Most often organisations that own supply chain assets prefer to sell large quantities to fulfil bulk demand and offer only reminiscence to small customers. On the other hand, there are some organisations that target only customers with emergency demand. There are organisations that fulfil both types of customers (large and small).

The following is the formula used by an organisation to determine the optimal amount of the asset to be purchased in bulk:

$$Q^* = F^{-1}(p^*, \mu, \sigma) = NORMINV(p^*, \mu, \sigma)$$

Where,

p^* = Probability demand for the asset

Q^* = Optimal amount of the asset to be purchased in bulk

In the above equation, p^* is calculated as:

$$p^* = (CS - CB) / CS, \text{ where}$$

CB= Bulk rate

CS = Spot market price

The amount of bulk purchase increases if either of the following two conditions occurs:

◆ Increase in the spot market price

◆ Decrease in the bulk price

Self-Assessment Questions

9. _____can be defined as an agreement whereby large quantities of products are sold at a discount for consumption or resale by a third party.

    a. Spot markets

    b. Bulk markets

    c. Financial markets

    d. Regional markets

10. Most often organisations that own supply chain assets prefer to sell small quantities to fulfil bulk demand and offer huge quantities to small customers. (True/false)

11. The amount of bulk purchase increases if either there is an increase in the spot market price or decrease in the bulk price. (True/False)

12.6 Process of Revenue Management

As discussed earlier, revenue management is a vital factor in any supply chains' profitability. Revenue management is a systematic process that involves a number of steps, which are listed in Fig. 12.2:


```
┌─────────────────────────────────────────┐
│         Evaluating the market            │
└─────────────────────────────────────────┘
                  ↓
┌─────────────────────────────────────────┐
│  Analysing the need for revenue management │
└─────────────────────────────────────────┘
                  ↓
┌─────────────────────────────────────────┐
│     Implementing a forecasting process   │
└─────────────────────────────────────────┘
                  ↓
┌─────────────────────────────────────────┐
│         Optimising forecasts             │
└─────────────────────────────────────────┘
                  ↓
┌─────────────────────────────────────────┐
│      Aligning sales and operations       │
└─────────────────────────────────────────┘
                  ↓
┌─────────────────────────────────────────┐
│ Integrating supply chain with revenue management │
└─────────────────────────────────────────┘
```
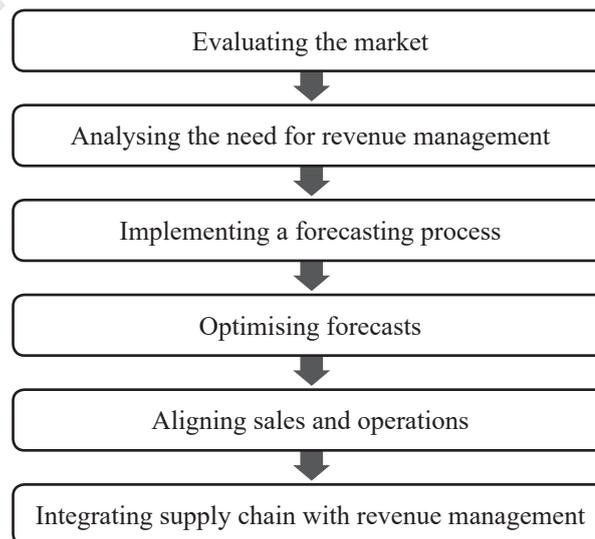
Fig. 12.2: Steps in Revenue Management

Let us discuss these steps in detail.

1. **Evaluating the market:** This is the first step in revenue management where an organisation needs to identify customer segments to be served. By doing so, the

organisation endeavours to understand the needs and preferences of customers. For example, to manage revenues efficiently, an airline needs to consider various needs of customers, such as availability of seats, last minute bookings, and alteration in boarding plans. After identifying customer needs, it is crucial for the organisation to collect and assimilate accurate and complete data related to products offered, prices, level of competition, and customer behaviour. By analysing the data, the organisation can gain a complete understanding of customer preferences.

2. **Analysing the need for revenue management:** In this step, an organisation needs to quantify the expected benefits of managing revenues before actually initiating it. In order to estimate benefits, the organisation must analyse historical data and use a good model of customer preferences through simulation. After analysis, the organisation would receive revenue targets to be achieved during a specified period. These revenue targets must be realistic and achievable. Moreover, all people involved in the organisation's supply chain must be focused on achieving these targets.

3. **Implementing a forecasting process:** After setting the reward targets, an organisation must forecast the demand for its products. The forecasting must also include expected error to the forecast as predictions cannot be always accurate. Both the estimated value and the expected error are used as inputs for developing a revenue management model. For example, to do overbooking, an airline needs to forecast cancellation patterns.

4. **Optimising forecasts:** In this step, an organisation needs to optimise the forecasts of customer behaviour to determine the most effective revenue management strategy. For example, a hotel follows the practice of overbooking to generate maximum revenues. A high level of overbooking will only lead to dissatisfaction among customers. On the other hand, low level of overbooking may result in an increased number of empty rooms. Thus, the hotel must identify the level of overbooking that maximises profits.

5. **Aligning sales and operations:** In this step, the organisation needs to align revenue management with both sales and operations. For this, salespeople need to have an understanding about the importance of revenue management. The sales force should be able to identify different customers segments (those who truly need the supply chain assets during the peak period and those who can move their orders to the off-peak period without losing). In this way, the organisation can maximise its profits at the same time satisfying customers. Similar to sales staff, operations staff should also understand the potential outcomes of revenue management and actual results.

6. **Integrating supply chain with revenue management:** This is the last step wherein revenue management is put into practice. In this step, the organisation needs to integrate the existing supply chain with revenue management. For this, the organisation must combine revenue management and supply chain decisions. By understanding interactions among supply, demand, and pricing, the organisation bring positive results in the supply chain and overall profitability.

Self-Assessment Questions

12. Which one of the following is the first step in process of revenue management?

    a. Analysing the need for revenue management

    b. Implementing a forecasting process

    c. Optimising forecasts

    d. Evaluating the market

13. Name the step, an organisation needs to optimise the forecasts of customer behaviour to determine the most effective revenue management strategy?

14. By understanding interactions among supply, demand, and pricing, the organisation bring positive results in the supply chain and overall profitability. (True/False)

12.7 Summary

◆ Pricing is one of the major drivers that help in improving the efficiency and responsiveness of the supply chain and helps in increasing the profitability of a supply chain by striking a balance between demand and supply.

◆ Revenue management is a process wherein pricing strategies are used by organisations to increase profits and optimise the allocation of available supply chain resources (capacity and inventory resources).

◆ To structure the prices for multiple customer segments, organisations use various strategies such as pricing by purchase channel, pricing by purchase location, pricing by time of use, pricing by quantities purchased, and pricing by metering.

◆ In order to manage revenues efficiently, Prices should be decided based on the value assigned by each customer segment, different prices should be set for each segment, and forecasting should be done at the segment level.

◆ Organisations manage revenues to handle seasonal demand with an aim to shift demand from a peak to the off-peak period by charging higher prices from customers during a peak period and lower prices during off-peak periods.

◆ An organisation sells its products both through bulk and spot contracts. Bulk contracts agreements whereby large quantities of products are sold at a discount for consumption or resale by a third party, whereas spot contracts are agreements of buying or selling products on the spot date.

◆ There are mainly six steps in revenue management, namely evaluating the market analysing the need for revenue management, implementing a forecasting process, optimising forecasts, aligning sales and operations, and integrating supply chain with revenue management.

12.8 Glossary

◆ **Differential pricing**: It is a method of pricing identical products differently for various types of customers or markets.

◆ **Metering**: It is a process of measuring the quantity consumed by a user through a meter.

◆ **Simulation:** It is process of imitating a real-life process or system to find a cause of a past occurrence.

◆ **Spot market**: It is a market where products are traded in cash for immediate delivery.

12.9 Terminal Questions

1. What are different resources that exist in a supply chain?

2. Discuss various strategies used by organisations for structuring pricing for multiple customer segments.

3. Explain how organisations deal with seasonal demand.

4. What are bulk markets and spot contracts? Explain.

5. Explain the steps involved in the process of revenue management.

12.10 Answers

Q.	Self Assessment Questions
1.	Pricing
2.	Capacity resources and inventory resources
3.	True
4.	d. Pricing by metering
5.	True
6.	Pricing by metering
7.	True
8.	Off-peak periods
9.	b. Bulk markets
10.	False
11.	True
12.	d. Evaluating the market
13.	Optimising Forecasts
14.	True
Q.	Terminal Questions
1.	There are two types of resources that exist in a supply chain, namely capacity resources and inventory resources. Refer to section **12.2 Pricing and Revenue Management in Supply Chain Management**.
2.	Organisations use various strategies structuring pricing for multiple customer segments, such as pricing by purchase channel, pricing by purchase location, pricing by time of use, and pricing by quantity used. Refer to section **12.3 Pricing and Revenue Management for Multiple Customer Segments**.
3.	Organisations charge higher prices from customers during a peak period and lower prices during off-peak periods to deal with seasonal demand. Refer to section **12.4 Pricing and Revenue Management for Seasonal Demands**.
4.	Bulk contract is an agreement whereby large quantities of products are sold at a discount for consumption or resale by a third party. Refer to section **12.5 Pricing and Revenue for Bulk and Spot Contracts**.
5.	Revenue management has mainly six steps, namely evaluating the market analysing the need for revenue management, implementing a forecasting process, optimising forecasts, aligning sales and operations, and integrating supply chain with revenue management. Refer to section **12.6 Process of Revenue Management**.

12.11 Case Study: Revenue Management at El Cortez Hotel and Casino

The longest continuously running hotel and casino in Las Vegas El Cortez was established in 1941. The hotel has displayed an apt example of adopting revenue management successfully by shifting its focus on profit maximisation.

In 2008, due to economic downturn, the casino's revenues were highly struggling. The downturn also led to some changes in the way casino customers were spending. To rise above the crises, El Cortez began to work with revenue management consultants. The hotel needed a strategy to generate incremental cash through transitory and wholesale channels. In such a scenario, the hotel came up with two measures to improve its business: implementation of a revenue management system (RMS) and adoption of a new pricing strategy.

Implementation of Revenue Management System (RMS)

To implement the strategy successfully, the hotel installed a new RMS. The system provided an alert feature to flag up key dates. The newly implemented RMS tracked a JavaScript tag on the hotel's booking engine to keep a vigil on lost business. This helped the hotel in gaining an understanding of shopping behaviour on a daily basis. As a result, the hotel was now able to evaluate the impact of a day's pricing strategy on the website's booking conversion rate.

Adoption of New Pricing Approach

El Cortez also decided to adopt a new dynamic pricing approach by identifying different customer segments and addressing their needs. After evaluating the data, it was revealed that lower room rates were required through midweek to be more competitive while prices could be raised during certain high peak periods. The RMS also allowed the hotel to identify lowest worth customer segments being provided complimentary or discounted cash rooms, which was unprofitable. The hotel assessed its existing discounting strategy, and removed discounts during periods where the hotel could achieve capacity without them. Discounts provided through third parties led to a rise in average day rate (ADR) by 10% with an average occupancy rise of 6.3%.

After implementing revenue management, the hotel had a standardized casino yielding process and the occupancy by casino players was lowered so that these rooms could be marketed to more profitable paying guests. The new revenue management and price strategies helped the hotel in increasing its cash revenue year by year of more than 30% in the first seven months of 2013.

Discussion Questions

1. Do you think implementing new RMS was the right decision taken by El Cortez in the above case study?

   (**Hints:** Yes, it increased the revenues of the hotel by more than 30 % and helped in focusing on customers' needs.)

2. Discuss the key benefits of RMS for El Cortez due to which the hotel was able to gain its position after economic slowdown.

   (**Hints:** RMS helped in forecasting, identifying customer segments, making pricing recommendations, and so on.)

12.12 References and Suggested Readings

◆ Ayers, J. (2001). Handbook of supply chain management (1st ed.). Boca Raton, Fla.: St. Lucie Press.

◆ Chopra, S., & Meindl, P. (2014). Supply Chain Management (1st ed.). Hallbergmoos: Pearson.

◆ Fredendall, L., & Hill, E. (2001). Basics of supply chain management (1st ed.). Boca Raton: St. Lucie Press.

◆ Wisner, J., Leong, G., & Tan, K. (2005). Principles of supply chain management (1st ed.). Mason, Ohio [u.a.]: Thomson/South-Western.

E-references

◆ prezi.com,. (2014). *Ch 16: Pricing and Revenue Management.* Retrieved 15 September 2014, from http://prezi.com/mrn4dlgllz3m/ch-16-pricing-and-revenue-management/

◆ Rasendria's Weblog,. (2008). *Pricing and Revenue Management in the Supply Chain.* Retrieved 15 September 2014, from http://rasendria.wordpress.com/.../pricing-and-revenue-management-in-the-sup...

◆ Theglobaljournals.com,. (2014). Retrieved 15 September 2014, from http://www.theglobaljournals.com/ijar/file.php?val=August_2014...106...

CHAPTER

13

E Coordination in a Supply Chain

Learning Objectives

After completing the chapter, you will be able to:

❑   define supply chain coordination

❑   identify obstacles of coordination in supply chain

❑   explain how to build partnership and trust

❑   discuss continuous replenishment and vendor managed inventories

❑   describe collaborative planning, forecasting, and replenishment

13.1 Introduction

In the previous chapters, you have studied about various drivers in the success of a supply chain. Each of these drivers has a unique role to play in ensuring the effectiveness and responsiveness of a supply chain. Apart from these drivers, coordination among different partners in a supply chain is an essential requirement for the supply chain's success.

Supply chain coordination is the integration of all members involved in various stages of a supply chain. It is all about how organisations manage their business processes across the supply chain in association with multiple trade members. An essential requirement for supply chain coordination is to consider the effects of actions performed at each stage on other stages. In addition, there should be an effective flow of information among all the members of a supply chain.

Unfortunately, coordination is not always in the interest of the supply chain members. This is because members usually have conflicting objectives and self-serving focus. Lack of coordination takes place when there is absence of trust and harmony among the members of a supply chain. This results in delayed and distorted flow of information, fluctuations in orders placed, inaccurate demand forecasting, and so on. Therefore, organisations should ensure that proper coordination takes place among all the members of a supply chain. For this, they can adopt various practices, such as continuous replenishment program (CRP), vendor managed inventories (VMI), and collaborative planning, forecasting, and replenishment (CPFR). In this chapter, you will study about the importance of coordination in a supply chain.

13.2 Meaning of Supply Chain Coordination

A supply chain is an integrated system that involves various functions (like production, distribution, supplier selection, warehousing, etc.) and parties (such as manufacturers, suppliers, and distributors). In order to improve the overall performance of a supply chain, all the parties involved need to behave as a part of a unified system and coordinate with each other so that all functions are performed properly and information flow occurs smoothly. Supply chain coordination is all about integrating all functions and making members work together to achieve the goals of an organisation's supply chain. The following are some popular definitions of supply chain coordination:

According to **Larsen (2000)**, supply chain coordination is *"Collaborative working for joint planning, joint product development, mutual exchange information and integrated information systems, cross coordination on several levels in the companies on the network, long term cooperation and fair sharing of risks and benefits"*

According to **Arshinder (2008)**, *"Supply chain coordination can be defined as identifying interdependent supply chain activities between supply chain members and devise mechanisms for manage those interdependencies. It is the measure of the of implementation of such aggregated coordination mechanisms, which helps in improving the performance of supply chain in the best interests of participating members."*

Supply chain coordination is required to improve the performance of a supply chain by aligning the plans and the objectives of the parties involved. The main aim of coordination is maintain lower levels of inventory and streamline ordering decisions.

13.2.1 Coordination and Bullwhip Effect

The aim of any supply chain is to offer the right kind of products and services to customers in the best possible way. To achieve the aim, all the members of a supply chain are required to function efficiently and coordinate with each other. However, coordination is a supply chain is affected due to a number of reasons. One such reason is a mismatch between demand and supply. Such mismatch happens due to inaccurate demand forecasts, which leads to wrong flow of information among supply chain members. This ultimately makes it difficult for organisations to respond properly to supply and production needs; thereby negatively affecting customer satisfaction. Such variance in supply and production in response to changes in demand is called the **bullwhip effect**.

The concept of Bullwhip was first introduced by Jay Forrester's Industrial Dynamics (1961) with the name **Forrester effect**. An example of an organisation that observed the bull-whip effect in its supply chain is Proctor & Gamble (P&G) for Pampers diapers. The organisation discovered significant fluctuations in raw material orders. However, at retailers' end, fluctuations were relatively small. Due to high variability in orders for raw material, P&G faced difficulties in matching supply and demand.

In a supply chain, various factors can cause bull-whip effect resulting in losses for organisations. These factors are listed in Fig. 13.1:
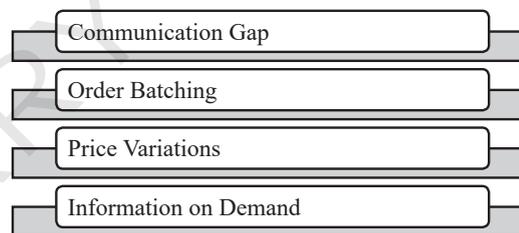

Fig. 13.1: Factors Causing Bull-Whip Effect

Let us discuss these factors in detail:

◆ **Communication gap**: Many a times, there is a lack of communication between members in a supply chain. This hampers a smooth functioning of supply chain activities. For instance, due to a lack of communication, different parties may perceive demand for products differently. As a result, there can be variation in ordered quantities.

◆ **Order batching**: Organisations often do not respond to every customer order immediately right after it is placed. They wait for an accumulation of demand for processing the orders (usually for a week or month). This results in variability in demand due to a surge in demand at some stage followed by no demand thereafter.

◆ **Price variations**: Special discounts and other cost changes that are done by organisations can have an impact on demand. As a result, there can be a change in regular buying patterns as customers would like to purchase large quantities in a short time period. Due to this, distorted demand information can be generated resulting in uneven production.

◆ **Information on demand**: Supply chain professionals, generally, rely on past demand information to forecast current demand patterns for products. They do not take into account forecasting errors and overlook fluctuations in demand that may arise over a period of time. This may result in variations in demand orders which could be difficult to match by organisations.

In order to reduce the bull-whip effect, organisations need to understand the drivers of customer demand and inventory consumption. Moreover, communication between various partners in a supply chain should be more frequent. Organisations can also adopt various pricing strategies to reduce the bull-whip effect. For instance, by offering products at fair prices, organisations can reduce buying surges caused by promotional discounts.

Self-Assessment Questions

1. _____is an integrated system that involves various functions (like production, distribution, supplier selection, warehousing, etc.) and parties (such as manufacturers, suppliers, and distributors).

2. _____ is all about integrating all functions and making members work together to achieve the goals of an organisation's supply chain.

   a. Supply chain coordination   b. Inventory management

   c. Supplier selection   d. Supply management

3. Organisations often do not respond to every customer order immediately right after it is placed. (True/False)

4. A variance in supply and production in response to changes in demand is called the_____

13.3 Obstacles of Coordination in Supply Chain

In a supply chain, there are various factors that may cause information delay, distortion, and variability, which may lead to a lack of coordination among supply chain members. Such factors are referred to as obstacles of coordination in a supply chain. If these obstacles are identified well on time, appropriate actions can be taken to maintain effective coordination in a supply chain. Fig.13.2 lists various obstacles that are detrimental to supply chain coordination:
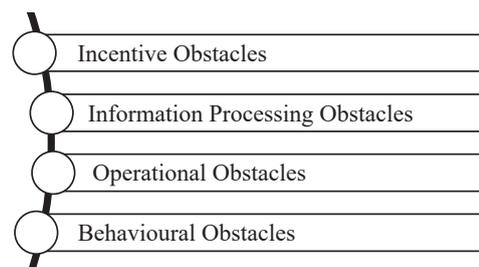

Incentive Obstacles

Information Processing Obstacles

Operational Obstacles

Behavioural Obstacles

Fig. 13.2: Obstacles of Supply Chain Coordination

Let us discuss these obstacles in detail.

◆ **Incentive obstacles**: These obstacles occur as a result of incentives offered to different participants in a supply chain. This leads to an increase in variations and a decrease in total supply chain profits. For example, if a transportation manager at an organisation is offered the compensation based on average transportation cost per unit, he would deliberately take actions to lower transportation costs without being concerned about an increase in inventory costs; thereby hurting customer service.

◆ **Sales force obstacles**: These obstacles occur when sales force incentives are inaccurately measured. Many a times organisations link incentives of sale force to quantity sold to distributors or retailers (sell-in), not the quantity sold to end users (sell-through during an evaluation period of a month or quarter). This often leads to false information

generation providing inaccurate demand forecast for the next quarters. As a result, variability in customer demand increases leading to an increase in inventory costs.

◆ **Information processing obstacles:** Information processing obstacles occur when distorted demand information is shared at different stages of a supply chain. The information can be inaccurate when:

❍ The basis of forecasting is orders and not customer demand

❍ Information is not shared by all key participants of the supply chain

◆ **Operational obstacles**: These obstacles occur as a result of actions taken during placing and filling orders, which leads to an increase in variability. Operational obstacles occur due to the following reasons:

❍ **Orders are placed in large lots**: Organisations generally place orders in lot sizes that are completely different from the actual demand. Such differences result in variations in demand.

❍ **Replenishment lead times are large**: Variations in demand are increased if replenishment lead times are large in between different stages of a supply chain. This mainly happens when a random increase or decrease in demand is considered as a growth trend for making replenishment decisions.

◆ **Behavioural obstacles**: These are the obstacles that may arise due to improper structuring of the supply chain within an organisation. Behavioural obstacles occur under the following conditions:

❍ When a participant at each stage of the supply chain fails to see the effect of its actions on other stages of a supply chain.

❍ When different participants of the supply chain blame each other for fluctuations rather than trying to identify root causes.

When there is a lack of trust among supply chain participants.

Self-Assessment Questions

5. Various factors that may cause information delay, distortion, and variability leading to a lack of coordination among supply chain members are referred to as _____ of coordination in a supply chain.

6. Which type of obstacle occurs as a result of incentives offered to different participants in a supply chain?

   a. Sales force obstacle   b. Incentive obstacle

   c. Information obstacle   d. Behavioural obstacle

7. Information processing obstacles occur due to improper structuring of the supply chain within an organisation. (True/False)

13.4 | Building Partnerships and Trust

To ensure proper coordination in a supply chain, it is essential that there should be partnerships and trust between supply chain participants. This can only be possible if there is a smooth flow of information between supply chain partners. Through accurate and timely information sharing, organisations can better match supply and demand throughout the supply chain. The following are the major advantages of building partnerships and trust among supply chain partners:

♦ By building trust, one party becomes more considered towards the objectives of other parties involved in a supply chain. This results in unified decisions.

♦ Information sharing becomes a reliable source of decision-making among parties due to trust and long-term partnerships.

♦ The common objectives make it easy to implement operational improvements and design appropriate pricing schemes.

♦ Duplication of efforts is eliminated at every stage when each party trust the action of other parties involved in a supply chain.

However, long-term relationships and trust between partners in a supply chain do not always have positive effects. For instance, in a power-based relationship, a stronger party can use its power for achieving its aims at the expense of others. Thus, there should be harmonious relationships between all the parties so that they can work in an integrated manner. To build cooperation and trust among supply chain members, organisations can adopt any of the following two ways:

♦ **Making formal contracts**: Parties involved in a supply chain can use various formal contracts to ensure effective cooperation. Through contracts, parties gain each other's trust for self-interest.

♦ **Holding long interactions**: Trust and cooperation can be built among parties due to a series of interactions over time. Cooperation among parties is strengthened through positive interactions.

Self-Assessment Questions

8. To ensure proper coordination in a supply chain, it is essential that there should be partnerships and trust between supply chain participants. (True/False)

9. Name the two ways by which cooperation and trust among supply chain members can be built.

10. By building trust, one party becomes more repulsive towards the objectives of other parties involved in a supply chain. (True/False)

13.5 Continuous Replenishment and Vendor Managed Inventories

In the previous section, you have studied that the bull-whip effect can adversely affect the performance of an organisation's supply chain. Thus, an organisation needs to take timely measures to reduce the bull-whip effect. One such measure is to assign the responsibility of replenishment across a supply chain to a single entity. Through a single point responsibility, transparency is ensured across the supply chain. There are mainly two practices that are adopted in supply chains for assigning a responsibility to a single entity: continuous replenishment programs (CRP) and vendor-managed inventory (VMI). Let us discuss these two practices.

♦ **Continuous Replenishment Program (CRP)**: In this program, the replenishment of products takes place at the retailer's end based on point-of-sale data. Thus, in CRP, a retailer is the owner of inventory at its end. CRP is managed by either supplier or distributor or a third party. By using CRP systems for warehouse withdrawals, data can be easily shared by retailers across the supply chain. This data is used to make decisions related to production, which further helps in matching demand and supply.

◆ **Vendor Managed Inventory (VMI)**: In VMI, all decisions related to product inventories at the retailer's end are taken by either a manufacturer or the supplier. This results in complete control of the manufacturer or the supplier over replenishment decisions and the control of the replenishment decisions moves to the manufacturer/supplier instead of the retailer. In case of VMI, the manufacturer/supplier is the owner of the inventory until it is sold by the retailer.

Self-Assessment Questions

11. In _____, the replenishment of products takes place at the retailer's end based on point-of-sale data.

12. In case of VMI, the manufacturer/supplier is the owner of the inventory until it is sold by the retailer. (True/False)

Activity

Using the Internet, find out the cons of CRP and VMI.

13.6 Collaborative Planning, Forecasting and Replenishment (CPFR)

According to the **Voluntary Interindustry Commerce Standards (VICS) Association, CPFR** is "*a business practice that combines the intelligence of multiple partners in the planning and fulfilment of customer demand.*" CFPR is a holistic approach to supply chain management in which planning skills of trading partners are combined with common metrics and agreements to fulfil customer demand and improve the efficiency of a supply chain. The aim behind adopting CPFR is to increase the availability of products to customers at reduced inventory, transportation, and logistics costs.

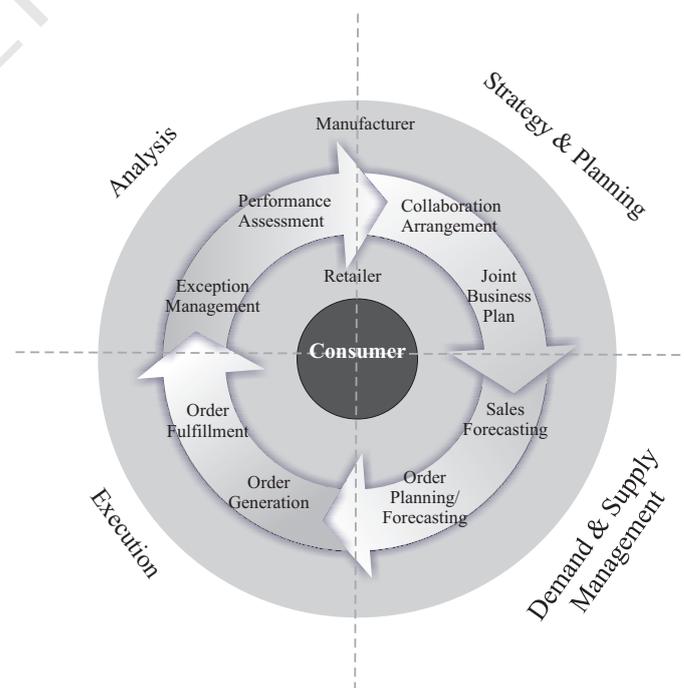Fig. 13.3 shows the CPFR model that can be used in a supply chain:

Fig. 13.3: CPFR Model

(**Source:** *http://www.socialsupplychains.com/what-is-collaborative-planning-forecasting-and-replenishment-cpfr/*)

The CPFR model is the basic framework for the flow of information, goods, and services in a supply chain. In Fig. 13.3, customer is placed at the centre of the model, followed by retailer (buyer) in the middle ring, and the manufacturer (seller) in the outer ring. In a supply chain, demand for products generates from customers, whereas the retailer provides these products. The manufacturer becomes the supplier of customers' demanded products to the retail channels/ stores. Fig. 13.3 also shows the four phases of CPFR, which are discussed as follows:

1. **Strategy and planning:** In this phase, the ground rules for collaborative relationships to be formed are defined, such as business goals, scope of collaboration, assignment of roles, responsibilities, checkpoints and escalation procedures. These rules are determined by partners involved in a supply chain.

2. **Demand and supply management:** In this phase, collaborative sales are projected by the partners to estimate consumer demand at the point of sale. Based on the projection, a collaborative order plan is created to determine future orders, delivery requirements, replenishment lead times, etc.

3. **Execution:** In this phase, orders are generated on the basis of forecasts. After that, partners involved in a supply chain begin working on various activities for the fulfillment of orders, such as production, shipping, and storage of products.

4. **Analysis:** In this phase, focus is laid on identifying exceptions and assessing performance to uncover trends and develop alternative strategies for further improvements.

13.6.1 Benefits of CPFR

By implementing CPFR, the overall profits of a supply chain can be achieved through better coordination among all trade partners. Fig.13.4 shows the main benefits of CPFR:
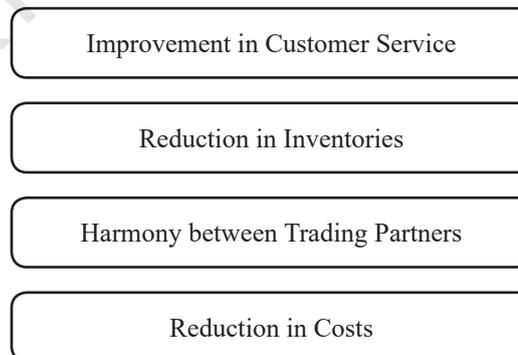
Improvement in Customer Service

Reduction in Inventories

Harmony between Trading Partners

Reduction in Costs

Fig. 13.4: Benefits of CPFR

Let us discuss these benefits in detail.

◆ **Improvement in customer service**: Through CPFR, forecasting becomes more reliable. This helps in planning production capacity accordingly. Moreover, chances of stock-outs are also avoided, which leads to increased revenues and improved customer service.

◆ **Reduction in inventories**: CPFR also helps in making accurate predictions for consumer demand that provide a better understanding of production needs. Thus, by efficient production plans, safety stock inventory can be reduced, which decreases carrying costs, storage space, and potential spoilage/obsolescence. In addition, material flow is improved between various stages in a supply chain.

◆ **Harmony between trading partners**: Effective use of CPFR techniques helps in creating an understanding between all partners, such as manufacturers, suppliers, distributors and retailers. Trading partners gain a better understanding of each other's business through regular information sharing and make decisions that benefit all. Thus, a win-win situation is created for all partners.

◆ **Reduction in costs**: A major advantage of using CPFR is that set-up times for production are reduced, which, in turn, results in reduction in variations. This helps in utilising production capacity efficiently; thereby reducing costs.

Self-Assessment Questions

13. The aim behind adopting _____ is to increase the availability of products to customers at reduced inventory, transportation, and logistics costs.

14. Which one of the following is the last phase in CPFR model.

   a. Strategy planning

   b. Demand management

   c. Analysis

   d. Execution

15. By efficient production plans, safety stock inventory can be reduced, which decreases carrying costs, storage space, and potential spoilage/obsolescence. (True/False)

Activity

Using various sources, such as the Internet, business magazines, etc., list down some organisations that have successfully adopted CPFR.

13.7 Summary

◆ In order to improve the performance of a supply chain, all the parties involved need to behave as a part of a unified system and coordinate with each other.

◆ Supply chain coordination is integration of functions and members involved in a supply chain that allows alignment of the plans and the objectives of the parties involved.

◆ The variation in supply and production in response to changes in demand is called the bullwhip effect. Bull-whip effect is caused by various factors, such as communication gap, order batching, price variations, and information on demand.

◆ There are many obstacles that are detrimental to supply chain coordination, such as communication gap, order batching, price variations, and information on demand.

◆ To ensure proper coordination in a supply chain, there should be partnerships and trust between supply chain participants. This could be achieved through formal contracts and long interactions

◆ Two practices are adopted in a supply chain for assigning the responsibility of replenishment to a single entity: continuous replenishment programs (CRP) and vendor-managed inventory (VMI).

◆ In continuous replenishment program, the replenishment of products takes place at the retailer's end based on point-of-sale data. On the other hand, in VMI, all decisions related to product inventories at the retailer's end are taken by either a manufacturer or the supplier.

◆ CFPR is a holistic approach to supply chain management, wherein planning skills of trading partners are combined with common metrics and agreements to increase the availability of products to customers at reduced inventory, transportation, and logistics costs.

◆ CFPR helps all the partners involved in supply chain in various ways, such as improving customer service, reducing inventories, creating harmony between trading partners, and reducing in costs

13.8 Glossary

◆ **Collaborative working**: It is working together by two or more organisations to achieve common goals.

◆ **Collaborative Planning, Forecasting and Replenishment (CFPR)**: It is a technique of integrating planning skills of trading partners with common metrics and agreements to fulfil customer demand and improve the efficiency of a supply chain.

◆ **Escalation**: It is an increment in the intensity of an issue or problems.

◆ **Point of sale**: It is a point at which a transaction takes place between a retailer and the customer.

◆ **Replenishment lead time**: It is a period of time beginning from the moment product to be reordered is determined until the product is on the shelf (available for use).

13.9 Terminal Questions

1. Define supply chain coordination.

2. What are the obstacles of coordination in a supply chain?

3. Discuss the advantages of building partnerships and trust among supply chain partners.

4. Write a short note on vendor managed inventory.

5. Discuss the phases of CPFR model.

13.10 Answers

Q.	Self Assessment Questions
1.	Supply chain
2.	a. Supply chain coordination
3.	True
4.	Bull-whip effect
5.	Obstacles
6.	b. Incentive obstacle
7.	False
8.	True
9.	Making formal contracts and holding long interaction
10.	False
11.	Continuous Replenishment Program

12.	True
13.	Collaborative Planning, Forecasting and Replenishment
14.	c. Analysis
15.	True
Q.	**Terminal Questions**
1.	Supply chain coordination can be defined as integrating all functions and making members work together to achieve the goals of an organisation's supply chain. Refer to section **13.2 Meaning of Supply Chain Coordination**.
2.	There are various obstacles of coordination in a supply chain, such as incentive obstacles, information processing obstacles, operational obstacles, and behavioural obstacles. Refer to section **13.3 Obstacles of Coordination in Supply Chain**.
3.	One of the main advantages of building trust is that one party becomes more considered towards the objectives of other parties involved in a supply chain. Refer to section **13.4 Building Partnerships and Trust**.
4.	In vendor managed inventory, all decisions related to product inventories at the retailer's end are taken by either a manufacturer or the supplier. Refer to section **13.5 Continuous Replenishment and Vendor Managed Inventories**.
5.	There are four phases in CPFR, namely strategy and planning, demand and supply management, execution, and analysis. Refer to section **13.6 Collaborative Planning, Forecasting and Replenishment (CPFR)**.

13.11 Case Study: VMI at Robert Bosch North America's (RBNA)

The Charleston, North Carolina division of Robert Bosch North America's (RBNA) is the leading suppliers of raw material to all OEM's in North America, Europe, and Asia. The division supplies automotive goods in more than 350 subsidiaries across 60 countries.

The main problem faced by RBNA Charleston (North Carolina) plant was to adopt a replenishment system based on consumption to fulfil customer orders on time. The division was also having problems in measuring suppliers' performance. It realised the need for a vendor inventory management system to achieve maximum coordination among supply chain partners and maintain inventory at reduced costs. After much consideration, the division implemented VMI/Web EDI by SupplyOn for managing its inventory.

Through the VMI system, the suppliers of the division could determine their next shipment quantity. In addition, Advanced Shipping Notifications (ASNs) could be created online, which helped the division in managing in-transit material. Supply chain planners at RBNA Charleston could also track late or missed shipments and manage part critical shortages more efficiently by analysing consumer demand accurately.

The new VMI also helped the Charleston division to evaluate supplier's performance by evaluating accuracy and timeliness of the shipment. This data helped in tracking inventory levels and determining under and over shipments. Moreover, through VMI, RBNA interacted with their third party logistics providers to design and support milk-run and full truck load deliveries to North American plants. The suppliers at Charleston division were also able to

view current stock-on-hand levels, determine correct shipment quantities, track ASNs and Goods Receipts, and control their delivery performance

The key benefit of using VMI for Charleston was that the system improved the communication between suppliers and the division. The system also enabled the plant in matching OE requirements with the plants' production schedule. After the implementation of the system, material planners could easily set inventory levels and inform suppliers of their next shipment quantity. VMI also brought a reduction in daily inventory levels by 30 percent, premium freight by over 70 percent, and improvement in delivery performance of suppliers. The success of VMI pushed RBNA to expand the system to all its North American plants.

Discussion Questions

1. Discuss the need for VMI in the abovementioned case of RBNA (Charleston).

    (**Hint:** RBNA needed VMI for managing inventory, reducing costs, and measuring suppliers' performance.)

2. How did RBNA (Charleston) benefitted from VMI implementation?

    (**Hint:** VMI helped RBNA in integrating inventory functions at one end, improving communication, and tracking shipments.)

13.12 References and Suggested Readings

◆ Ayers, J. (2001). Handbook of supply chain management (1st ed.). Boca Raton, Fla.: St. Lucie Press.

◆ Chopra, S., & Meindl, P. (2014). Supply Chain Management (1st ed.). Hallbergmoos: Pearson.

◆ Fredendall, L., & Hill, E. (2001). Basics of supply chain management (1st ed.). Boca Raton: St. Lucie Press.

◆ Wisner, J., Leong, G., & Tan, K. (2005). Principles of supply chain management (1st ed.). Mason, Ohio [u.a.]: Thomson/South-Western.

E-references

◆ Sciencedirect.com,. (2014). Handbooks in Operations Research and Management Science | Vol 11, Pgs 1-765, (2003) | ScienceDirect.com. Retrieved 17 September 2014, from http://www.sciencedirect.com/science/handbooks/09270507/11

◆ Slideshare.net,. (2014). Supply Chain Management Coordination.. Retrieved 17 September 2014, from http://www.slideshare.net/ialwaysthinkprettythings/scm-module-6

◆ Slideshare.net,. (2014). The bullwhip effect. Retrieved 17 September 2014, from http://www.slideshare.net/abhinavjohnson/the-bullwhip-effect-3787201

Pondicherry University
Directorate of Distance Education

R. Venkataraman Nagar, Pondicherry University, Kalapet, Puducherry 605014
Website: pondiuni.edu.in