

Warehousing and Supply Chain Management

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Index

I. Content	II
II. List of Figures	VI
III. List of Tables.....	VIII
IV. Abbreviations	IX
V. Case Study.....	128
VI. Bibliography	132
VII. Self Assessment Answers.....	136
Book at a Glance	

Contents

Chapter I.....	1
Introduction to Warehousing.....	1
Aim	1
Objectives	1
Learning outcome	1
1.1 Introduction.....	2
1.2 Need for Warehousing	2
1.3 Types of Warehouses	3
1.4 The Value of Warehousing in the Economy.....	3
1.5 Requirements for a Warehouse	3
1.6 Characteristics of Ideal Warehouses	5
1.7 Functions of Warehouses	5
1.8 Advantages of Warehousing.....	6
1.9 Warehouse Operations Assessment.....	6
1.10 Warehouse Key Performance Indicators.....	7
1.11 Benchmarking	7
1.12 Determining KPIs	8
1.13 Establishing Warehouse Performance Measures	10
1.14 Identifying Expectation.....	10
1.15 Establishing Measures	11
1.15.1 Customer Measures	11
1.15.2 Employee Measures.....	12
1.15.3 Financial Measures	12
1.16 Implementing Your Measures	12
Summary.....	14
References	14
Recommended Reading.....	14
Self Assessment.....	15
 Chapter II	 17
Material Flow and Activity Profiling	17
Aim	17
Objectives	17
Learning outcome	17
2.1 Introduction to Material Flow.....	18
2.2 The Fluid Model of Product Flow	18
2.3 Units of Handling.....	18
2.4 Two Fundamental Resources	19
2.5 Storage: “Dedicated” versus “Shared”.....	21
2.6 Activity Profiling	22
2.7 Statistical Analysis.....	26
2.8 Patterns of Work.....	28
Summary.....	29
References	29
Recommended Reading.....	29
Self Assessment.....	30

Chapter III.....	32
Warehouse Operations and Benchmarking.....	32
Aim	32
Objectives	32
Learning outcome	32
3.1 Introduction to Warehouse Operations.....	33
3.2 Benchmarking	33
3.3 Performance Measurement	33
3.4 Types of Benchmarking	34
3.4.1 Ratio-based benchmarking	34
3.4.2 Aggregate Benchmarking	34
3.5 Benchmarking Against a Community of Warehouses	35
3.6 Constructing the Benchmark Warehouse	35
Summary.....	36
References	36
Recommended Reading.....	36
Self Assessment	37
 Chapter IV.....	 39
Supply Chain Management.....	39
Aim	39
Objectives	39
Learning outcome	39
4.1 Introduction.....	40
4.2 Supply Chain.....	40
4.3 Supply Chain Management.....	42
4.4 Objective of Supply Chain Management.....	43
4.5 Importance of Supply Chain Management	43
4.6 Activities of Supply Chain Management	44
4.7 Decision Phases in a Supply Chain.....	45
4.8 Process View of Supply Chain.....	46
4.9 Linking Competitive(business) and Supply Chain Strategies	47
4.10 Supply Chain Drivers	48
4.11 Barriers of Supply Chain Management.....	48
4.12 Scope of Supply Chain Activities	49
4.13 Marketing Mix Model.....	49
Summary.....	51
References	51
Recommended Reading.....	52
Self Assessment.....	53
 Chapter V.....	 55
Design of Supply Chain and Planning Transportation Networks.....	55
Aim	55
Objectives	55
Learning outcome	55
5.1 Introduction.....	56
5.2 Role of Distribution Network	56
5.3 Factors Influencing Distribution Network Design.....	57
5.4 Design Options for a Distribution Network	58
5.5 E-business and its Impact	63
5.5.1 Advantages of E-Business	65
5.5.2 Disadvantages of E-Business.....	66
5.6 Distribution Networks in Practice	66
5.7 Distribution Network Design in the Supply Chain.....	66

5.8 Factors Affecting Network Design Decisions.....	67
5.9 Supply Chain Model	69
5.10 Transportation in Supply Chain	70
5.11 Importance of Transportation	71
5.12 Role of Transport in Supply Chain	72
5.13 Transportation Modes in Supply Chain	72
5.14 Transportation Infrastructure and Policies	74
5.15 Design Options for Transportation Network	74
5.16 Trade-off in Transportation Design.....	77
5.17 Routing and Scheduling in Transportation	77
5.18 Making Transportation Decisions in Practice.....	78
Summary.....	79
References	79
Recommended Reading.....	80
Self Assessment.....	81
 Chapter VI.....	 83
Sourcing and Pricing	83
Aim	83
Objectives	83
Learning outcome	83
6.1 Introduction.....	84
6.2 Sourcing	84
6.3 In-house and Outsource	84
6.4 3PL and 4PL	86
6.5 Benefits of Effective Sourcing Decisions	86
6.6 Supplier Scoring and Assessment	87
6.6.1 Scoring Suppliers.....	87
6.6.2 Ranking Suppliers.....	87
6.7 Supplier Selection	88
6.8 Procurement Process.....	89
6.9 Sourcing Planning and Analysis	89
6.10 Pricing and Revenue Management for Multiple Customers.....	89
6.11 Perishable Products and Seasonal Demand	91
Summary.....	93
References	93
Recommended Reading.....	93
Self Assessment.....	94
 Chapter VII	 96
Dimensions of Logistics	96
Aim	96
Objectives	96
Learning outcome	96
7.1 Introduction	97
7.2 Macro and Micro Dimension	97
7.2.1 Macro Dimension	97
7.2.2 Micro Dimensions.....	99
7.3 Logistics Activities.....	101
7.4 Approach to Analysing Logistics Systems.....	102
7.5 Logistics and Systems Analysis	106
7.6 Techniques of Logistics System Analysis.....	106
7.7 Factors Affecting the Cost and Importance of Logistics.....	108
Summary.....	110
References	110

Recommended Reading	111
Self Assessment.....	112
 Chapter VIII.....	 114
Demand Management and Customer Service	114
Aim	114
Objectives	114
Learning outcome	114
8.1 Introduction.....	115
8.2 Outbound to Customer Logistics Systems	115
8.3 Supply and Demand Relationship.....	115
8.4 Graphical Representation of Supply and Demand Relationship.....	116
8.5 Demand Management	118
8.5.1 The Demand Management Process.....	119
8.6 Demand Forecasting	120
8.7 Demand Planning.....	120
8.8 Demand Forecasting Error	120
8.9 CPFR.....	121
8.10 Customer Service	122
8.11 Cost of Stock-Outs	123
8.12 Channels of Distribution	123
Summary.....	125
References	125
Recommended Reading	125
Self Assessment.....	126

List of Figures

Fig. 1.1 Typical warehousing cost distribution	8
Fig. 2.1 Comparison of pipes with respect to size	18
Fig. 2.2 Units of handling	19
Fig. 2.3 Correlation between popularity and physical volume of product sold	20
Fig. 2.4 Variation in the popularity among these 25,000 skus	20
Fig. 2.5 An idealisation of how the inventory level at a location changes over time	21
Fig. 2.6 About two-thirds of the orders are for a single line but these account for only about one-third of the picks	28
Fig. 4.1 A conceptual model of a basic supply chain	40
Fig. 4.2 A supply chain network	41
Fig. 4.3 Key parts of supply chain	41
Fig. 4.4 Flows in a supply chain	42
Fig. 4.5 Supply chain management activities	44
Fig. 4.6 Cycle view of supply chain	46
Fig. 4.7 Push/pull view of supply chain	47
Fig. 4.8 Linking competitive (business) and supply chain strategies	47
Fig. 4.9 Supply chain drivers	48
Fig. 4.10 Elements of marketing mix	50
Fig. 4.11 Market space model	50
Fig. 5.1 Relationship between number of facilities and logistics cost	58
Fig. 5.2 Manufacturer storage with direct shipping	59
Fig. 5.3 Manufacturer storage with direct shipping and in-transit merge	60
Fig. 5.4 Distributor storage with package carrier delivery	61
Fig. 5.5 Distributor storage with last mile delivery	62
Fig. 5.6 Manufacturer or distributor storage with costumer pickup	63
Fig. 5.7 Elements of e-business domain	64
Fig. 5.8 Areas of e-business	65
Fig. 5.9 Supply chain model	69
Fig. 5.10 Flow of product along the supply chain	71
Fig. 5.11 Direct shipping network	75
Fig. 5.12 Direct shipping network with milk runs	75
Fig. 5.13 Shipments via central distribution network	76
Fig. 5.14 A Tailored network	76
Fig. 5.15 Savings matrix method	78
Fig. 6.1 Pricing charges into supply chain	90
Fig. 6.2 The 4 “R” strategy of revenue management	90
Fig. 6.3 Pegging in SCM	91
Fig. 6.4 Warehousing in SCM	92
Fig. 7.1 Seven ‘R’s in supply chain	98
Fig. 7.2 Logistics costs as a percentage of GDP	99
Fig. 7.3 Push and pull systems in supply chain	100
Fig. 7.4 Logistic activities	102
Fig. 7.5 Inbound and outbound logistics	103
Fig. 7.6 Nodes and links in a logistics system	105
Fig. 7.7 A simple logistics channel	105
Fig. 7.8 Relationship between required inventory and order cycle length	108
Fig. 7.9 Relationship of the cost of lost sales to inventory cost	108
Fig. 7.10 Relationship of product dollar value to various logistics costs	109
Fig. 8.1 Supply and demand balance	116
Fig. 8.2 Supply and demand equilibrium	117
Fig. 8.3 Shift in demand	118
Fig. 8.4 Demand management process	119
Fig. 8.5 Demand forecasting error	121

Fig. 8.6 Collaborative planning, forecasting and replenishment process	122
Fig. 8.7 Customer service strategy.....	123
Fig. 8.8 Channels of distribution.....	124
Fig. 8.9 Distribution network.....	124

List of Tables

Table 1.1 Types of warehouses	3
Table 2.1 Top ten items of a chain of retail drug stores	23
Table 2.2 Top ten items of a chain of retail drug stores, as measured by the number of customer requests (picks) during 3 weeks	24
Table 2.3 Top ten items of a chain of retail drug stores	24
Table 2.4 Top ten office products measured by customer requests during a year.....	25
Table 2.5 Top ten wholesale office products by weight shipped during a year	25
Table 6.1 Scoring and assessment of suppliers.....	88
Table 6.2 Categories of procurement	89
Table 7.1 Analysis of total logistics cost with a change to higher cost mode of transport	104
Table 7.2 Analysis of total logistics cost with a change to more warehouses.....	104
Table 7.3 Static analysis of C & B chemical company (50,000 pounds of output)	107
Table 8.1 Demand fluctuations based on price and supply.....	117

Abbreviations

ASN	-	Advanced Shipping Notice
AS/RS	-	Automated Storage and Retrieval System
CPFR	-	Collaborative Planning, Forecasting and Replenishment
CRM	-	Customer Relationship Management
EDI	-	Electronic Data Interchange
EBIDA	-	Earnings Before Interest, Depreciation and Amortisation
EVA	-	Economic Value Added
GDP	-	Gross Domestic Product
JIT	-	Just-In-Time
KPI	-	Key Performance Indicator
SCM	-	Supply Chain Management
SKU	-	Stock-Keeping Unit
3PL	-	Third-Party Logistics
4PL	-	Fourth-Party Logistics

Chapter I

Introduction to Warehousing

Aim

The aim of this chapter is to:

- introduce the concept of warehousing
- evaluate the requirement of warehousing
- enlist need for warehousing

Objectives

The objectives of this chapter are to:

- elucidate the types of warehousing
- explain the characteristic of ideal warehousing
- describe the functions of a warehouse

Learning outcome

At the end of this chapter, you will be able to:

- understand the advantages of warehouse
- recognise various measure for warehouse establishment
- identify various expectations from warehousing

1.1 Introduction

Warehousing has become a core competency, a strategic weapon that many companies are using to enhance their competitive position. At the same time, the warehouse is undergoing unbelievable challenges that make warehouse excellence harder to achieve. The planning, managing and improving of today's warehouse operations require a much more professional approach to warehousing than previously adopted.

Warehouse – definition

We need different types of goods in our day-to-day life. We may buy some of these items in bulk and store them in our house. Similarly, businessmen also need a variety of goods for their use. Some of them may not be available all the time. But, they need those items throughout the year without any break. Take the example of a sugar factory. It needs sugarcane as raw material for production of sugar. You know that sugarcane is produced during a particular period of the year. Since sugar production takes place throughout the year, there is a need to supply sugarcane continuously. But how is it possible? Here storage of sugarcane in sufficient quantity is required. Again, after production of sugar it requires some time for sale or distribution. Thus, the need for storage arises both for raw material as well as finished products. Storage involves proper arrangement for preserving goods from the time of their production or purchase till the actual use. When this storage is done on a large scale and in a specified manner it is called 'warehousing'. The place where goods are kept is called 'warehouse'. The person in-charge of warehouse is called 'warehouse-keeper'.

Warehousing refers to the activities involving storage of goods on a large-scale in a systematic and orderly manner and making them available conveniently when needed. In other words, warehousing means holding or preserving goods in huge quantities from the time of their purchase or production till their actual use or sale. Warehousing is one of the important auxiliaries to trade. It creates time utility by bridging the time gap between production and consumption of goods. Warehousing is one of the important auxiliaries to trade. It creates time utility by bridging the time gap between production and consumption of goods.

1.2 Need for Warehousing

Warehousing is necessary due to the following reasons:

- **Seasonal production:** You know that agricultural commodities are harvested during certain seasons, but their consumption or use takes place throughout the year. Therefore, there is a need for proper storage or warehousing for these commodities, from where they can be supplied as and when required.
- **Seasonal demand:** There are certain goods, which are demanded seasonally, like woollen garments in winters or umbrellas in the rainy season. The production of these goods takes place throughout the year to meet the seasonal demand. So there is a need to store these goods in a warehouse to make them available at the time of need.
- **Large-scale production:** In case of manufactured goods, now-a-days production takes place to meet the existing as well as future demand of the products. Manufacturers also produce goods in huge quantity to enjoy the benefits of large-scale production, which is more economical. So the finished products, which are produced on a large scale, need to be stored properly till they are cleared by sales.
- **Quick supply:** Both industrial as well as agricultural goods are produced at some specific places but consumed throughout the country. Therefore, it is essential to stock these goods near the place of consumption, so that without making any delay these goods are made available to the consumers at the time of their need.
- **Continuous production:** Continuous production of goods in factories requires adequate supply of raw materials. So there is a need to keep sufficient quantity of stock of raw material in the warehouse to ensure continuous production.
- **Price stabilisation:** To maintain a reasonable level of the price of the goods in the market there is a need to keep sufficient stock in the warehouses. Scarcity in supply of goods may increase their price in the market. Again, excess production and supply may also lead to fall in prices of the product. By maintaining a balance of supply of goods, warehousing leads to price stabilisation.

1.3 Types of Warehouses

After getting an idea about the need for warehousing, let us identify the different types of warehouses. You have learnt that warehousing caters to the storage needs of different types of commodities. In order to meet their requirement various types of warehouses came into existence, which may be classified as follows:

Private Warehouses	The warehouses, which are owned and managed by the manufacturers or traders to store, exclusively, their own stock of goods are known as private warehouses. Generally these warehouses are constructed by the farmers near their fields, by wholesalers and retailers near their business centres and by manufacturers near their factories. The design and the facilities provided therein are according to the nature of products to be stored.
Public Warehouses	The warehouses, which are run to store goods of the general public are known as public warehouses. Any one can store his goods in these warehouses on payment of rent. An individual, a partnership firm or a company may own these warehouses. To start such warehouses a licence from the government is required. The government also regulates the functions and operations of these warehouses. Mostly these warehouses are used by manufacturers, wholesalers, exporters, importers, government agencies, and so on.
Government Warehouses	These warehouses are owned, managed and controlled by central or state governments or public corporations or local authorities. Both government and private enterprises may use these warehouses to store their goods. Central Warehousing Corporation of India, State Warehousing Corporation and Food Corporation of India are examples of agencies maintaining government warehouses.
Bonded Warehouses	These warehouses are owned, managed and controlled by government as well as private agencies. Private bonded warehouses have to obtain licence from the government. Bonded warehouses are used to store imported goods for which import duty is yet to be paid. In case of imported goods the importers are not allowed to take away the goods from the ports till such duty is paid. These warehouses are generally owned by dock authorities and found near the ports.
Co-operative Warehouses	These warehouses are owned, managed and controlled by co-operative societies. They provide warehousing facilities at the most economical rates to the members of their society.

Table 1.1 Types of warehouses

1.4 The Value of Warehousing in the Economy

It is important for all warehouse managers to ponder the question, “Does warehousing add value to a product?” The traditional school of thought has concluded that, no, warehousing does not add value to a product; in fact, warehousing is strictly a cost-adding activity that is a necessary evil. In firms that follow this school of thought, warehousing costs are typically classified as indirect costs. Often, these cost categories are spread over the direct costs of the firm in such a way that the cost of warehousing is not distinguishable.

1.5 Requirements for a Warehouse

A key to taking a more scientific approach to warehousing is an awareness and acceptance of the warehousing requirements of success. These requirements of success answer the following three questions:

- What is the science of warehousing?
- What are the rules of the warehousing games?
- What are the warehouses paradigms in which we believe?

The warehousing requirements of success are:

- **Professionalism:** Warehousing will be viewed as a critical logistics step and a competitive strength and not as a necessary evil.
- **Customer awareness:** Successful warehouse operations will have a high regard for the customer, will know the customer's requirements, and will consistently met these requirements.
- **Measurement:** Warehouse standards will be established, performance will be measured against these standards and timely actions will be taken to overcome any deviations.
- **Operations planning:** Systems and procedures will be put into effect that allows the warehouse manager to proactively plan the operations as opposed to reactively respond to external circumstances.
- **Logistics network:** Warehouses will not be viewed as independent operations, but as elements of the overall, well-planned logistics system.
- **Third party:** The reduction of lead times, shorter product lives and increased inventory turnover will result in an increased use of third parties.
- **Pace:** The reduction of lead times, shorter product lives and increased inventory turnover will result in an increase in the pace of the warehouse.
- **Variety:** More SKUs and more special customer requirements will result in an increase in the variety to tasks performed in the warehouse.
- **Flexibility:** Due to the increase in warehouse pace and variety, all warehouse systems, equipment and people will be more flexible.
- **Uncertainty:** All uncertainty will be minimised, discipline will be increased.
- **Integration:** Activities within the warehouse (receive, store, pick and ship) will be more integrated and the warehouse will be more integrated within the overall logistics system.
- **Inventory management:** Real-time warehouse management systems will utilise cycle counting to manage inventory accuracy and accuracy above 99 percent will be the norm.
- **Space utilisation:** Space will be more efficiently and effectively utilised.
- **Housekeeping:** Quality housekeeping will be a priority and a source of employee pride.
- **Order picking:** The criticality of order picking will be understood and procedures and layouts will be designed to maximise picking efficiency and effectiveness.
- **Team-based continuous improvement:** The power of the people will be unleashed via a methodical team-based process.
- **Continuous flow:** There will be a clear focus on pulling product through the logistic system and not on building huge inventories.
- **Warehouse management systems:** A real-time, bar-code based, RF communication WMS (warehouse management system) will be required to meet today's requirements.
- **Total costs of logistics:** The goal will be to minimise the total life cycle costs of logistics from order submission to product delivery, whole providing excellence in customer service.
- **Leadership:** There must be a balance between the control aspects of management and harnessing the energy of change to create peak-to-peak performance of leadership.

These requirements of success may then be used as a foundation upon which to assess the status of one's warehouse operations.

1.6 Characteristics of Ideal Warehouses

In each of the warehouses adequate arrangements are made to keep the goods in proper conditions. However, any warehouse is said to be an ideal warehouse if it possesses certain characteristics, which are given below:

- Warehouse should be located at a convenient place near highways, railway stations, airports and seaports where goods can be loaded and unloaded easily.
- Mechanical appliances should be there to loading and unloading the goods. This reduces the wastages in handling and also minimises handling costs.
- Adequate space should be available inside the building to keep the goods in proper order.
- Warehouses meant for preservation of perishable items like fruits, vegetables, eggs and butter etc. should have cold storage facilities.
- Proper arrangement should be there to protect the goods from sunlight, rain, wind, dust, moisture and pests.
- Sufficient parking space should be there inside the premises to facilitate easy and quick loading and unloading of goods.
- Round the clock security arrangement should be there to avoid theft of goods.
- The building should be fitted with latest fire-fighting equipments to avoid loss of goods due to fire.

1.7 Functions of Warehouses

You have learnt that warehouses preserve goods on a large-scale in a systematic and orderly manner. They provide protection to goods against heat, wind, storm, moisture, etc. and also cut down losses due to spoilage, wastage etc. This is the basic function of every warehouse. In addition to this, warehouses now-a-days also perform a variety of other functions. In this section let us learn about the various functions of warehouses. Warehouses perform the following functions.

- Storage of goods
- Protection of goods
- Risk bearing
- Financing
- Processing
- Grading and branding
- Transportation

These functions are discussed further below.

- **Storage of goods:** The basic function of warehouses is to store large stock of goods. These goods are stored from the time of their production or purchase till their consumption or use.
- **Protection of goods:** A warehouse provides protection to goods from loss or damage due to heat, dust, wind and moisture, etc. It makes special arrangements for different products according to their nature. It cuts down losses due to spoilage and wastage during storage.
- **Risk bearing:** Warehouses take over the risks incidental to storage of goods. Once goods are handed over to the warehouse-keeper for storage, the responsibility of these goods passes on to the warehouse-keeper. Thus, the risk of loss or damage to goods in storage is borne by the warehouse keeper. Since it is bound to return the goods in good condition, the warehouse becomes responsible for any loss, theft or damage, etc. Thus, it takes all precautions to prevent any mishap.
- **Financing:** When goods are deposited in any warehouse, the depositor gets a receipt, which acts as a proof about the deposit of goods. The warehouses can also issue a document in favour of the owner of the goods, which is called warehouse-keeper's warrant. This warrant is a document of title and can be transferred by simple endorsement and delivery. So while the goods are in custody of the warehouse-keeper, the businessmen can obtain loans from banks and other financial institutions keeping this warrant as security. In some cases, warehouses also give advances of money to the depositors for a short period keeping their goods as security.

- **Processing:** Certain commodities are not consumed in the form they are produced. Processing is required to make them consumable. For example, paddy is polished, timber is seasoned, and fruits are ripened, etc. Sometimes warehouses also undertake these activities on behalf of the owners.
- **Grading and branding:** On request warehouses also perform the functions of grading and branding of goods on behalf of the manufacturer, wholesaler or the importer of goods. It also provides facilities for mixing, blending and packaging of goods for the convenience of handling and sale.
- **Transportation:** In some cases warehouses provide transport arrangement to the bulk depositors. It collects goods from the place of production and also sends goods to the place of delivery on request of the depositors.

1.8 Advantages of Warehousing

Warehousing offers many advantages to the business community. Whether it is industry or trade, it provides a number of benefits which are listed below.

- **Protection and Preservation of goods:** Warehouse provides necessary facilities to the businessmen for storing their goods when they are not required for sale. It provides protection to the stocks, ensures their safety and prevents wastage. It minimises losses from breakage, deterioration in quality, spoilage etc. Warehouses usually adopt latest technologies to avoid losses, as far as possible.
- **Regular flow of goods:** Many commodities like rice, wheat etc. are produced during a particular season but are consumed throughout the year. Warehousing ensures regular supply of such seasonal commodities throughout the year.
- **Continuity in production:** Warehouse enables the manufacturers to carry on production continuously without bothering about the storage of raw materials. It helps to provide seasonal raw material without any break, for production of finished goods.
- **Convenient location:** Warehouses are generally located at convenient places near road, rail or waterways to facilitate movement of goods. Convenient location reduces the cost of transportation.
- **Easy handling:** Modern warehouses are generally fitted with mechanical appliances to handle the goods. Heavy and bulky goods can be loaded and unloaded by using modern machines, which reduces cost of handling such goods. Mechanical handling also minimises wastage during loading and unloading.
- **Useful for small businessmen:** Construction of own warehouse requires heavy capital investment, which small businessmen cannot afford. In this situation, by paying a nominal amount as rent, they can preserve their raw materials as well as finished products in public warehouses.
- **Creation of employment:** Warehouses create employment opportunities both for skilled and unskilled workers in every part of the country. It is a source of income for the people, to improve their standards of living.
- **Facilitates sale of goods:** Various steps necessary for sale of goods such as inspection of goods by the prospective buyers, grading, branding, packaging and labelling can be carried on by the warehouses. Ownership of goods can be easily transferred to the buyer by transferring the warehouse keeper's warrant.
- **Availability of finance:** Loans can be easily raised from banks and other financial institutions against the security of the warehouse-keeper's warrant. In some cases warehouses also provide advance to the depositors of goods on keeping the goods as security.
- **Reduces risk of loss:** Goods in warehouses are well guarded and preserved. The warehouses can economically employ security staff to avoid theft, use insecticides for preservation and provide cold storage facility for perishable items. They can install fire-fighting equipment to avoid fire. The goods stored can also be insured for compensation in case of loss.

1.9 Warehouse Operations Assessment

An operations assessment is a process that evaluates ten categories of performance in the warehouse. The ten categories in the operations assessment are:

Customer service

This should be a primary concern of all members of the company management team. Corporate goals for customer service must include input from and acceptance by a significant percentage of important customers. Once goals are established, measurement of order-to-delivery cycles and order completion ratios will occur.

Control systems

Control system evaluation looks at the paperwork used, how data integrity is maintained, the duplication of efforts or paperwork that exists, how special requests are serviced and how effectively computer systems and controls are used. Most top-rated warehouses use real-time, online, order entry systems that develop truck loads, batch orders for picking, pre-route and pre-post picking and manage labour with real-time instructions via data terminals that are strategically located throughout the warehouse.

Inventory accuracy

It is critical since customer service, resupply from vendors, labour utilisation and systems integrity all rely on inventory availability and accuracy. Corporate goals for the accuracy of total inventory levels and individual SKUs should be developed and accuracy ratings assigned based on performance against corporate goals.

Space utilisation

This is calculated for the entire warehouse, the utilisation of each functional area, the square footage of the areas, and the total square footage of the warehouse are used to calculate the overall utilisation, usually 80 to 90 percent, to determine the operating utilisation.

Labour productivity

It measures how effectively labour is utilised relative to properly established procedures and standards.

Facility layout

Facility layout is integral to successful performance in all operational areas. Evaluation of the facility layout rates how well the following objectives are being met:

- Effective space utilisation
- Efficient material handling
- Economic storage relative to cost of equipment, use of space, damage to materials and materials handling labour

Housekeeping / safety

It is measured against operational, industrial and governmental standards of performance. Attention to the issues of housekeeping and safety is directly related to professionalism.

1.10 Warehouse Key Performance Indicators

The performance indicator or key performance indicator (KPI) is a measure of performance of the business in order to benchmark against the competition and explore the possibility to improve in order to gain competitive advantage. Warehousing function is a very critical within any supply chain. If the products do not move seamlessly within supply chain business would face serious service related challenges. Hence, it is necessary to drive the performance of the warehouse through key performance indicators. Further, in a continuous improvement environment, it is essential to benchmark against the industry standards in order to drive improvements.

1.11 Benchmarking

Benchmarking is the process of comparing one's business processes and performance metrics to industry bests and/or best practices from other industries. Benchmarking is essentially a process to measure a business's processes against the competition, world standards or the business itself.

The benchmark scope typically includes productivity, quality, time, and cost. The objective of this activity is to improve from learning the performance measurement in order to execute things better, faster, and cheaper. The benchmarking effort is driven by a desire to evaluate business processes to see if they may be improved. The resulting improvements should then be related to how those improvements may be implemented to help a company better meet the requirements of its customers.

Operating cost break-up in a typical warehouse

As you can see from the below given pie chart (source: recent survey of warehousing professionals) that the order picking is the most expensive operation and it is directly linked to customer satisfaction. Any wrong pick would lead to an unhappy customer. In order to drive improvements it is very important to identify the cost distribution and identify improvement areas. Generally the improvement activities are identified based on cost or productivity linked activities. The order pick activity is both highly labour intensive and 50% of warehouse costs were spent on this activity.

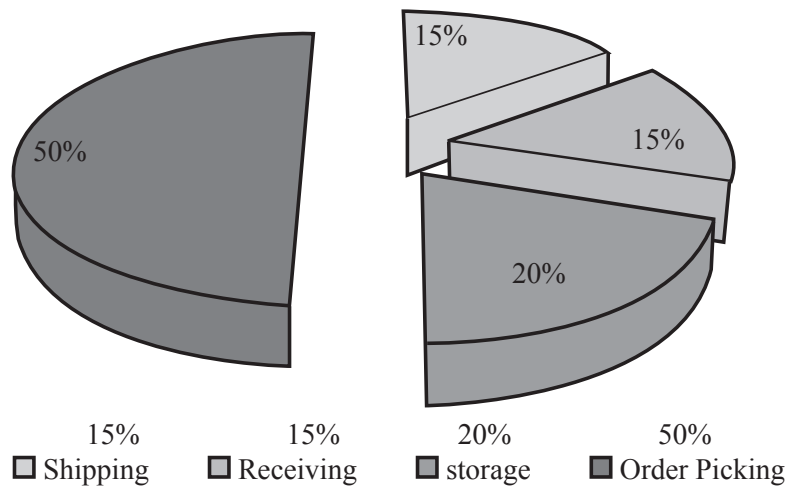


Fig. 1.1 Typical warehousing cost distribution

(Source: <http://vijaysangamworld.wordpress.com/2010/08/27/warehouse-key-performance-indicators>)

1.12 Determining KPIs

People, Cost, Space and Systems drive the performance inside the warehouse. Hence, generally warehouse KPIS are based on the above mentioned drivers and focused on activity in order micromanage the performance. The following activities are common in any warehouse:

Receiving

The receiving activity is fundamental to warehousing function. Unless the merchandise is properly received, it will be very difficult to handle all other subsequent functions. The receiving function allows warehouse operators to receive product against a purchase order, and against an Advanced Shipping Notice (ASN) that has been received via Electronic Data Interchange (EDI). Receiving process could include goods physically received at the warehouse and stored or directly delivered at customer site or cross-docked.

The relevant KPIs for receiving function should include the following:

- **Cost:** Cost of Receiving per receiving line
- **Productivity:** Volume received per man-hour
- **Utilisation:** Receiving Dock door utilisation %
- **Quality:** Accurate receipts %
- **Cycle time:** Time taken to process a receipt

Put-away

Once receiving activity is completed, the accepted merchandise has to be stored in a location that is convenient to retrieve for further action. This process is called put-away and this is just reverse of order pick function. We have different types of put-away processes.

- **Direct put-away:** Put-away directly to primary or serve locations
- **Directed put-away:** Put-away directed by warehouse management system

- **Batched and sequenced put-away:** Received material sorted and put-away processed in batches to maximise the efficiency
- **Interleaving:** Combine put-away and retrieval to avoid empty travel

The KPIs for this activity should include the following:

- **Cost:** Cost per put-away line
- **Productivity:** Put-away per man-hour
- **Utilisation:** Utilisation % of labour and equipment
- **Quality:** Perfect put-away %
- **Cycle time:** Time taken for each put-away

Storage

Broadly, we have two types of storage systems and they are manual storage and the second one is automated storage and retrieval system (AS/RS). Again within manual storage, we have six different types of storage and they are:

- **Block stacking:** Units loads stacked on top of each other and stored on the floor on the storage lanes.
- **Stacking frames:** They are either frames attached to standard wooden pallets or self-contained units made up of decks and posts. Stacking frames are portable and enable users to stack material several loads high.
- **Single-deep selective pallet rack:** It is a simple construction of metal uprights and cross-members providing immediate (pick-face) access to each load stored (that is, no honey combing).
- **Double-deep rack:** They are mostly selective racks that are two pallets position deep.
- **Drive-in rack:** The extend of the reduction of aisle space begun with double-deep rack by providing storage lanes from five to ten load deep and three to five loads high.
- **Drive-thru rack:** It is merely drive-in rack that is accessible from both sides of the rack.

The KPIS for this activity would include:

- **Cost:** Storage cost per item
- **Productivity:** Inventory per sq. foot
- **Utilisation:** % Location and cube occupied
- **Quality:** % Location without inventory discrepancies
- **Cycle time:** Inventory days on hand

Pick-n-pack

This activity again can be broadly divided into two parts. First one deal with case picking and the second one deal with small item picking. Further case picking can be classified into three categories. The first one is known as Pick-face palletising where warehouse operator palletises at the pick-face as he/she traverses the picking tour. The second one is downstream palletising where cases are picked onto conveyors and sorted at the staging area. The third one is direct loading where the cases were conveyed directly into the truck.

Further, the small item picking can be classified into three categories. The first one is known as picker-to-stock, where the picker moves around to pick the cases. The second one is stock-to-picker. In this case stock was sent to the stationed picker through AS/RS machine. The third one is known as automated item picking. In this process items are automatically dispensed into shipping cartons or tote pans.

The relevant KPIs for this activity would include:

- **Cost:** Cost of picking per order line
- **Productivity:** Order lines picked per hour
- **Utilisation:** Picking labour and equipment utilisation %

- **Quality:** Perfect picking lines %
- **Cycle Time:** Order Pick cycle time per order

Shipping

Shipping is the last step in warehouse activity in handling shipping goods to the customer or handling stock transfers. This process is the origin to moving product from point A to point

The KPIs for this activity could include:

- **Cost:** Cost of shipping per order
- **Productivity:** Order process for shipping per man hour
- **Utilisation:** Utilisation of shipping docks in %
- **Quality:** Perfect shipping %
- **Cycle Time:** Shipping time (from the time order picked to physically movement of the truck) per order

1.13 Establishing Warehouse Performance Measures

Measuring the performance of your warehouse is an important step in establishing a sound operation. To insure customer satisfaction and cost effectiveness, some level of measurement is necessary. Every business question should start with the customer. Warehouse performance measures are no exception. Following are the performance measurement in the following order.

- What is 'success' as defined by the customer?
- What is 'success' as defined by the financial organisation?
- What is 'success' as defined by the human resource organisation?
- What is 'success' as defined by the operations organisation?

First, it is necessary to understand what the expectations of the environment are. What is success? Once that's understood, we begin the process of defining specific measures. We want to identify those measures necessary for us to achieve the desired level of 'success' our environment demands. We'll look at the warehouse measures in this order:

- Customer measures
- Employee measures
- Financial measures

We want to link the performance measurements in each area to the environment's expectations. Once these links are established, you're ready to plan the implementation. We'll conclude with a step-by-step review of how to implement performance measures in your warehouse.

1.14 Identifying Expectation

Let us now begin by examining the expectations of your environment regarding your warehouse performance.

What is 'success' as defined by the customer?

Who is your customer? Is your customer is the end user or a department in your own company? Or is your customer distribution point that serves the end customers? It is not important who your customer is, but rather you know who your customer is.

Once you know the customer. What's the nature of their product? Is it a speciality product or a commodity? Is the velocity of the product fast or slow? Is the product high or of low value? Does it require special handling or security measures? Or do they have the mix of all of the above. The answers to these questions will help you define a profile of expectation. The expectations can lead to measurements in your operation.

When you know your customer and understand their product's characteristics, it's as simple as answering one question. When a customer looks to your warehouse, what do they expect? Define the expectations from the customer's point of view. Poor customer service is simply a violation of expectations, whether stated or unstated. Successful warehouse performance measures are like thread that links key customer expectations to the warehouse operation. These are the most important measures to establish.

What is 'success' as defined by the financial organisation?

What does your finance organisation expect? Do they expect to deliver on plan or budget performance? Or do they expect you to improve your operation 5 or 10% per year? Do they loom over your shoulder each month or are they hands off? What are the key measures your company uses to measure performance? Are they into EBIDA (Earnings Before Interest, Depreciation and Amortisation) or EVA (Economic Value Added)?

It is important to know what the finance people expect of you. You need to align with the overall measures of the company. You need to provide the information they need. When the finance folks look into your organisation, what do they expect from you? If the answer is something or nothing, you need to know it. Only then one can build link successful measures between your two organisations.

What is 'success' as defined by the human resource organisation?

What is the company position on measuring employee performance? What will you do with the data? Will you discipline employees for poor performance? What is poor performance? Will the human resources people support your decision? The answers to these questions are very important as you design your performance measures.

The relative strength or weakness of the human resources department will play a role in your success. It is important to be aligned with them before you launch the performance measurement program. It is important to know exactly what their expectations are with regard to performance programs in your company.

As with the previous expectations, you must link human resources expectations with the thread that runs to your specific performance measures. You must understand in advance what will you do with the measures. You need the support of your human resource people to make this succeed.

What is 'success' as defined by the operations organisation?

What other measures exist in operations? Is your warehouse a part of a larger distribution or logistic organisation? What measures do they have in place? What is important to them? What do they value on a daily basis? You need to understand exactly where you fit in order to establish effective performance measures.

The important thing to remember is the link. Just as with the other measures, you want to insure alignment with the over all organisation. You need to establish a thread that runs to the over all organisation. Make sure that you are aligned with other current measures that are in place.

Understanding the expectations around you is important. It is the first step in establishing effective performance measures. When you are thoroughly answered the questions above, it is the time to look at specific measures. You want to match measures to expectations. The measures are simply early warning signs. They should link to specific performance expectations to let you know how are you doing.

1.15 Establishing Measures

You should establish specific measures in the following areas.

1.15.1 Customer Measures

Following are the customer measures:

On time delivery

This indicator tells you whether you are meeting the customer's needs by providing their product, when they want it. You would need to have a tracking system that captured and compared the customer's desired delivery time against actual delivery time.

You may find other measures of success that are important in your operation. Use what is critical but don't over do it. Nothing is more demoralising than trying to keep up with too many, mostly unused, measures.

1.15.2 Employee Measures

Following are the employee measures:

Productivity

This indicator tells you the productivity of your employees and equipment. It can be measured in many different ways. If your employees are paid by the hour, it could be pieces, cases or units shipped or handled per hour. It could be dollars per piece, case or unit. It must correlate with your method of compensation.

You would measure equipment productivity in much the same way. It could be the number of pieces, cases or units moved per forklift, yard horse or whatever type of equipment you use.

There are many other employee measures you can use. The important thing is to ensure that they are meaningful. You do not want a bunch of measures that aren't linked to customer, employee or financial performance.

1.15.3 Financial Measures

From what you know about your financial organisation's expectations...what should you measure? At the very minimum you should measure the following:

Cost per piece, case or unit

This indicator tells you the cost to move a piece, case or unit through your facility. Whatever type of movement you have, be it piece, case or unit, measure the cost to move it through your system. Measure the overall cost. That's an all-inclusive cost of your operation.

Note: It's also important to establish a measure for inbound performance. This would measure the performance of inbound goods that are critical for your outbound shipments.

At a minimum, you should have at least one measure in the inbound area. It's most important to link your warehouse financial measures, you're ready to implement. Implementation is the final step in the process.

1.16 Implementing Your Measures

When you implement your measures, you put them into action. Here are some simple steps:

- **Involve your customers:** It is important to involve your customers early on. You need to validate that what you are about to measure is important to them. Once you do this, and confirm that it is important, you must follow it through or lose all credibility.
- **Involve the employees:** It is important to involve the employees early in the process. You need a sanity check to insure that what you are doing makes sense. You involve not only employees in the warehouse, but in other parts of the organisation as well. They need to understand what the measures are, why you are now measuring performance and how the measures will be used.
- **Keep it simple:** The measures that you implement must be simple. If you are the only one who understands them, they will fail. There must be an obvious connection between the work and the measure. If the connection is not obvious then you fail.
- **Less is better:** The fewer measures, the better. The more measures you roll out, the less chance you have of success. You have less chance of anyone actually using the measures. This goes in hand with keeping it simple.
- **Make sure that it fits:** The measures that you implement must 'fit' into your current system of work. They cannot be an 'add on' or they will fail. If you expect the employees to track their own performance and give you a report card, it would not happen. The measures need to complement what you are now doing or they will not be adopted into the mainstream. Automate all measures, where possible.

- **It must be accurate:** Your program must produce accurate measures right out of the starting gate. If you are found to have inaccurate data, your credibility is gone. Once you lose your credibility, your performance measures will not work. Accuracy is a key ingredient of success.
- **Use it or lose it:** Once implemented, you must use your measurements, just as you said you would. Nothing will crush a performance measurement initiative more quickly than lack of use. When you post results and do not mention them again, your program has begun its descent. You must 'walk the talk' in a performance measurement program.

Summary

- Warehousing refers to the activities involving storage of goods on a large-scale in a systematic and orderly manner and making them available conveniently when needed.
- Warehousing is one of the important auxiliaries to trade. It creates time utility by bridging the time gap between production and consumption of goods.
- A key to taking a more scientific approach to warehousing is an awareness and acceptance of the warehousing requirements of success.
- In each of the warehouses adequate arrangements are made to keep the goods in proper conditions.
- Warehouses provide protection to goods against heat, wind, storm, moisture, and so on and also cut down losses due to spoilage, wastage and so on.
- Warehousing offers many advantages to the business community.
- An operations assessment is a process that evaluates ten categories of performance in the warehouse.
- The performance indicator or key performance indicator (KPI) is a measure of performance of the business in order to benchmark against the competition and explore the possibility to improve in order to gain competitive advantage.
- Benchmarking is the process of comparing one's business processes and performance metrics to industry bests and/or best practices from other industries.
- The receiving activity is fundamental to warehousing function. Unless the merchandise is properly received.
- Shipping is the last step in warehouse activity in handling shipping goods to the customer or handling stock transfers.

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Self Assessment

1. _____ creates time utility by bridging the time gap between production and consumption of goods.
 - a. Distribution
 - b. Business
 - c. Warehousing
 - d. Promotion
2. Which of the following is not a reason for the need of warehousing?
 - a. Seasonal production
 - b. Quick supply
 - c. Large-scale production
 - d. Price-hike

3. Match the following.

1. Private warehouses	A. Both government and private enterprises may use these warehouses to store their goods.
2. Public warehouses	B. These warehouses are owned, managed and controlled by government as well as private agencies.
3. Government warehouses	C. The warehouses which are owned and managed by the manufacturers or traders.
4. Bonded warehouses	D. To start such warehouses a licence from the government is required.

- a. 1-C, 2-D, 3-A, 4-B
 - b. 1-A, 2-D, 3-C, 4-B
 - c. 1-D, 2-C, 3-A, 4-B
 - d. 1-B, 2-A, 3-D, 4-C
4. Which of the following is not a function of warehouses?
 - a. Storage of goods
 - b. Protection of goods
 - c. Risk bearing
 - d. Inflation
5. Which of the following is not an advantage of warehousing?
 - a. Regular flow of goods
 - b. Protection and Preservation of goods
 - c. Transportation
 - d. Easy handling
6. An/A _____ assessment is a process that evaluates ten categories of performance in the warehouse.
 - a. warehousing
 - b. production
 - c. operations
 - d. housekeeping

7. _____ is the process of comparing one's business processes and performance metrics to industry bests and/or best practices from other industries.
 - a. Benchmarking
 - b. Key performance
 - c. Continuity
 - d. Integration
8. Which of the following is not one of the activities of warehousing?
 - a. Receiving
 - b. Put-away
 - c. Storage
 - d. Security
9. In which of the following storage, units loads stacked on top of each other and stored on the floor on the storage lanes?
 - a. Block stacking
 - b. Stacking frames
 - c. Drive in rack
 - d. Drive thru rack
10. Measuring the _____ of your warehouse is an important step in establishing a sound operation.
 - a. satisfaction
 - b. security
 - c. storage
 - d. performance

Chapter II

Material Flow and Activity Profiling

Aim

The aim of this chapter is to:

- explain material flow
- discuss activity profiling
- describe fluid model of product flow

Objectives

The objectives of this chapter are to:

- elucidate units of handling
- distinguish between dedicated and shared storage
- explain statistical analysis

Learning outcome

At the end of this chapter, you will be able to:

- analyse the two fundamental resources
- enlist the types of warehouse activity profiling
- comprehend the patterns of work

2.1 Introduction to Material Flow

Here, we briefly discuss a few issues that help lay the foundations for warehouse analysis. The most fundamental idea is of the management of two resources: space and time (that is, labor or person-hours).

2.2 The Fluid Model of Product Flow

The “supply chain” is the sequence of processes through which product moves from its origin toward the customer. In our metaphor of fluid flow we may say that warehouses represent storage tanks along the pipeline.

The analogy with fluid flows can also convey more substantial insight. For example, consider a set of pipe segments of different diameters that have been joined in one long run. We know from elementary fluid dynamics that an incompressible fluid will flow faster in the narrower segments of pipe than in the wider segments. This has meaning for the flow of product: The wider segments of pipe may be imagined to be parts of the supply chain with large amounts of inventory. On average then, an item will move more slowly through the region with large inventory than it will through a region with little inventory.

The fluid model immediately suggests other general guidelines to warehouse design and operation, such as:

- Keep the product moving; avoid starts and stops, which mean extra handling and additional space requirements.
- Avoid layouts that impede smooth flow.
- Identify and resolve bottlenecks to flow.

It is worth remarking that the movement to “just-in-time” logistics is roughly equivalent to reducing the diameter of the pipe, which means product flows more quickly and so flow time and in-transit inventory are reduced.

As shown in the figure below if two pipes have the same rates of flow, the narrower pipe holds less fluid. In the same way, faster flow of inventory means less inventory in the pipeline and so reduced inventory costs.

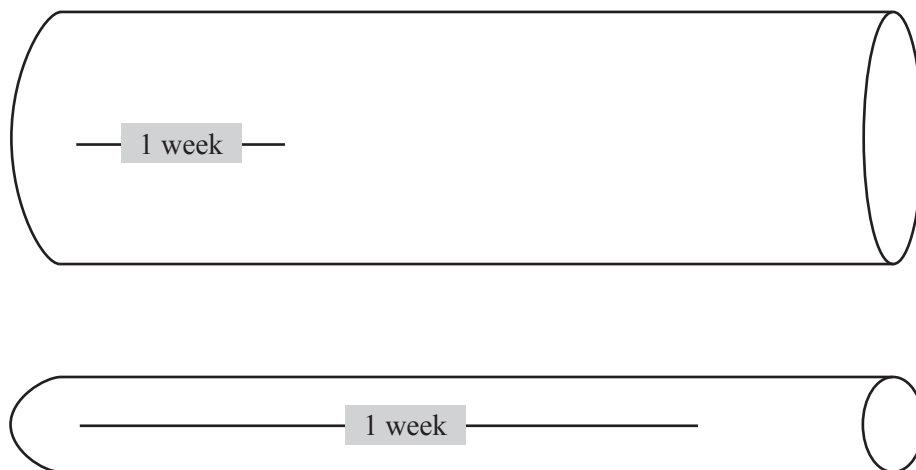


Fig. 2.1 Comparison of pipes with respect to size

(Source: <http://www2.isye.gatech.edu/~jjb/wh/book/editions/wh-sci-0.94.pdf>)

2.3 Units of Handling

Even though it is a frequently useful metaphor, most products do not, of course, flow like incompressible fluids. Instead, they flow more like slurry of sand and gravel, rocks and boulders. In other words, the product is not infinitely divisible but rather is granular at different scales. A stock keeping unit, or sku, is the smallest physical unit of a product that is tracked by an organisation. For example, this might be a box of 100 Gem Clip brand paper clips. In this case the final customer will use a still smaller unit (individual paper clips), but the supply chain never handles the product at that tiny scale.

Upstream in the supply chain, product generally flows in larger units, such as pallets; and is successively broken down into smaller units as it moves downstream, as suggested in figure below. Thus, a product might move out of the factory and to regional distribution centres in pallet-loads; and then to local warehouses in cases; and finally to retail stores in inner-packs or even individual pieces, which are the smallest units offered to the consumer. This means that the fluid model will be most accurate downstream, where smaller units are moved. As shown in the figure below, a product is generally handled in smaller units as it moves down the supply chain.

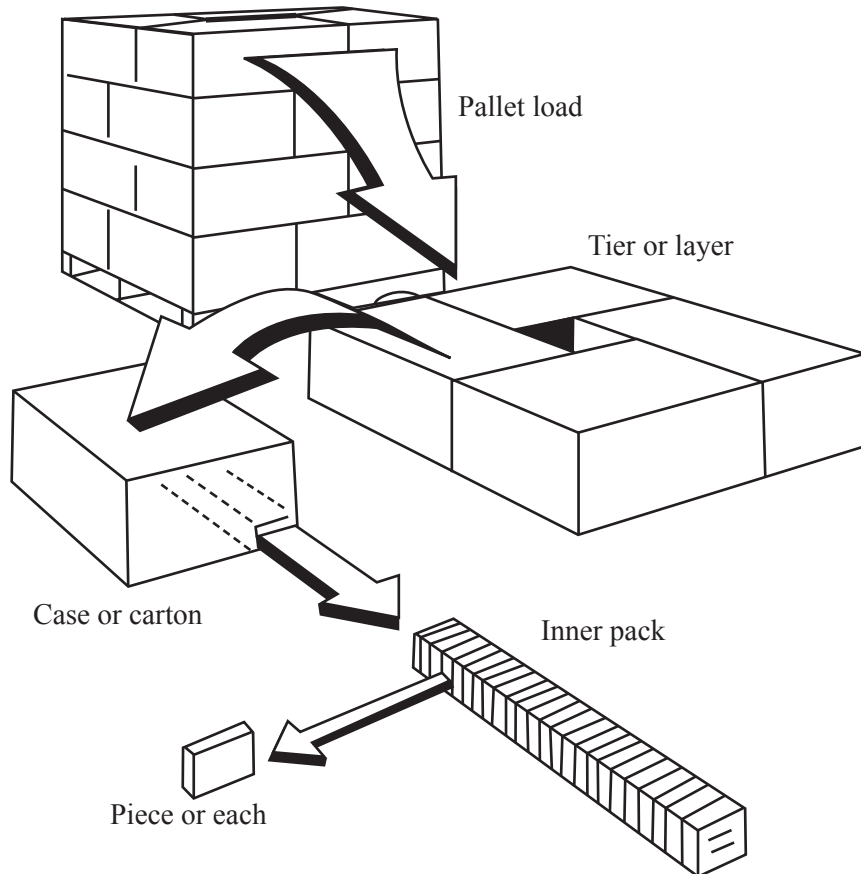


Fig. 2.2 Units of handling

(Source: <http://www2.isye.gatech.edu/~jjb/wh/book/editions/wh-sci-0.94.pdf>)

2.4 Two Fundamental Resources

Warehouse management is all about careful use of space and time (that is, labour or person-hours). Both space and time are expensive and so one would like to use as little of each as possible in delivering product to customers. Figure below shows a plot of the popularity (number of times requested, or picks) of each sku of a warehouse together with the physical volume (flow) of the sku moved through the warehouse during one month. There is little correlation between popularity and flow, and this is one of the challenges of warehouse management, because it is hard to design processes that work well with skus that may be any combination of popular/unpopular and low-volume/high-volume. Among these 25,000 skus there is little correlation between popularity and physical volume of product sold.

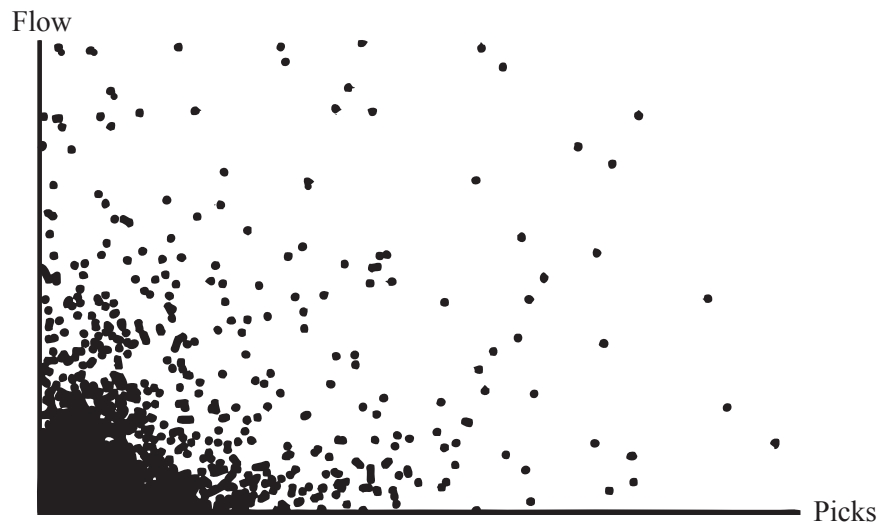


Fig. 2.3 Correlation between popularity and physical volume of product sold

(Source: <http://www2.isye.gatech.edu/~jjb/wh/book/editions/wh-sci-0.94.pdf>)

Figure below plots just the popularity of the same set of about 25,000 skus, here ranked from most popular to least. This is typical of such plots in that a small fraction of the skus account for most of activity. It is easy to design processes for these skus because they are fairly predictable. If popular yesterday, such a sku is likely to be popular again tomorrow. On the other hand, consider all the skus in the so-called long-tail, in this case the 20,000 skus that are requested infrequently. It is impossible to know whether any particular sku will be requested tomorrow. Such skus, by their sheer number, occupy most of the space in a warehouse. This effect is further magnified by safety stock, which is held to protect against stock out in the face of customer demand that is highly variable in comparison to the amounts held. Each warehouse then is, in a sense, two warehouses. The first is organised around a small set of predictably popular skus that are easy to plan for and for which the challenge is to manage flow. The other warehouse is much larger, and for which the work is predictably only in aggregate. This makes it much harder to plan and one is forced to hedge decisions. The first warehouse is where labour is concentrated; and the second consumes space. As shown in figure below, popularity among these 25,000 skus varies enormously, which presents special challenges to effective management.

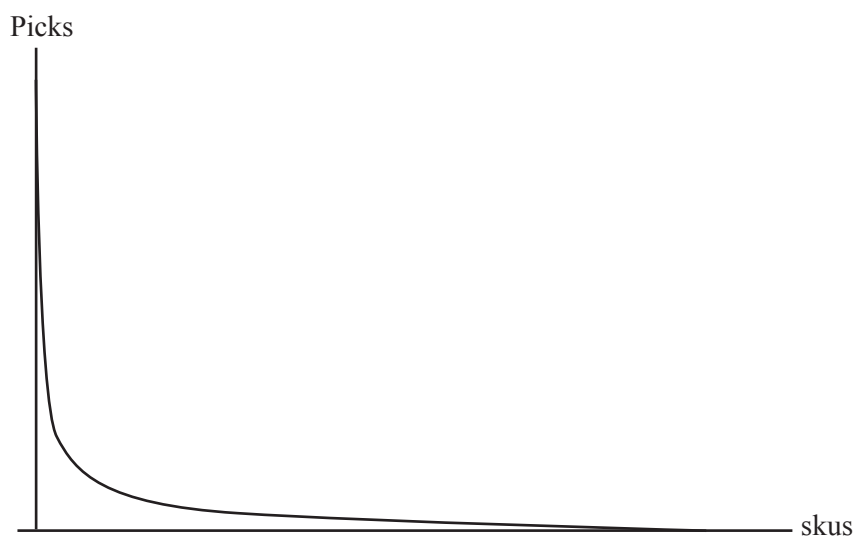


Fig. 2.4 Variation in the popularity among these 25,000 skus

(Source: <http://www2.isye.gatech.edu/~jjb/wh/book/editions/wh-sci-0.94.pdf>)

2.5 Storage: “Dedicated” versus “Shared”

Each storage location in a warehouse is assigned a unique address. This includes both fixed storage locations, such as a portion of a shelf and mobile locations such as the forks of a lift truck. Storage locations are expensive because they represent space, with consequent costs of rent, heating and/or air-conditioning, security, and so on. In addition, storage locations are typically within specialised equipment, such as shelving or flow rack, which are a capital cost. These costs impel us to use storage space as efficiently as possible.

There are two main strategies used in storing product. The simplest is dedicated storage, in which each location is reserved for an assigned product and only that product may be stored there. Because the locations of products do not change, more popular items can be stored in more convenient locations and workers can learn the layout, all of which makes order-picking more efficient.

The problem with dedicated storage is that it does not use space efficiently. This can be seen by tracking the amount of inventory in a given location. If we plot the inventory level, measured for example by volume, we would see a sawtooth shape such as in figure below (which represents an idealisation of the inventory process.) In one cycle the storage location is initially filled but empties as product is withdrawn to send to customers. As a result, on average this storage location is half empty.

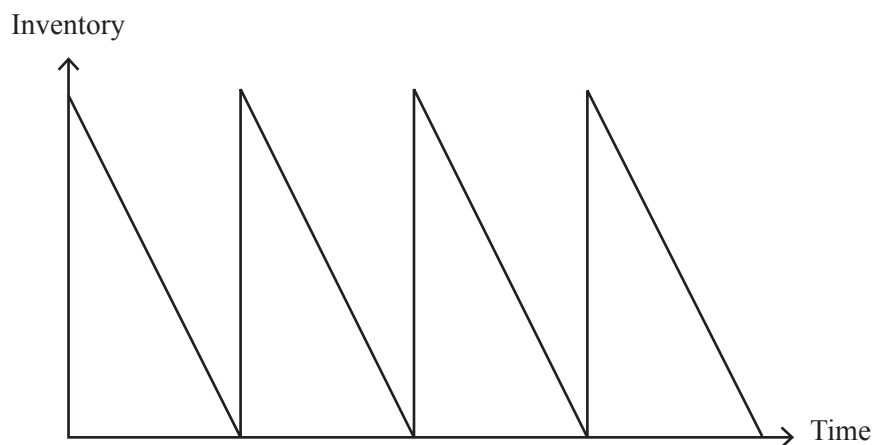


Fig. 2.5 An idealisation of how the inventory level at a location changes over time

(Source: <http://www2.isye.gatech.edu/~jjb/wh/book/editions/wh-sci-0.94.pdf>)

A warehouse may have thousands or tens-of-thousands of storage locations. If using dedicated storage, each will have an assigned product. Each product may have a different replenishment cycle and so, upon entering such a warehouse, one expects to see many storage locations that are nearly empty, many that are half-full, and many that are nearly full. On average the storage capacity is only about 50% utilised. To improve on this, one can use a strategy of shared storage. The idea here is to assign a product to more than one storage location. When one location becomes empty, it is available for reassignment, perhaps to a different product. This space then can be filled again, rather than waiting until the original product is replenished (presumably when the last of the warehouse supply has been exhausted). The more storage locations over which a product is distributed, the less product in each location, and so the sooner one of those locations is emptied and the sooner that space is recycled. Therefore, expect better utilisation of space when shared storage is used.

Unfortunately, shared storage also has some disadvantages. Most immediately, the locations of products will change over time as locations are emptied and restocked with other products. This means that workers cannot learn locations and so must be directed to locations by a warehouse management (software) system. Another disadvantage is that it becomes more time-consuming to put away newly received product because it has to be taken to more locations. There can be other, social complications as well. For example, imagine an order picker who has been directed to the other side of the warehouse to pull a product for a customer. That order picker may be tempted to pick the product from a more convenient location, thus creating discrepancies between book and physical inventory at two locations.

For these reasons, shared storage requires greater software support and also more disciplined warehouse processes. Shared storage is generally more complicated to manage because it introduces many possible trade-offs. In particular, one can manage the trade-off between space and time (labour) on an activity-by-activity basis. For example, one can retrieve product from the least-filled location (to empty and recycle that location as soon as possible) or from the most convenient location (to save labour). Similarly, one can replenish product to the most nearly empty location to fill that empty space or to the most convenient location to save labour time.

2.6 Activity Profiling

A warehouse is a complicated and busy place and it can be hard to get an accurate sense of what is happening. Warehouse activity profiling is the careful measurement and statistical analysis of warehouse activity. This is a necessary first step to almost any significant warehouse project: Understand the customer orders, which drive the system.

There are several simple statistics that are the first things to learn about a warehouse.

Each gives some hint as to the economics of that warehouse; but these are to be treated carefully because many are simple averages and so can be misleading. Their primary advantage is to summarise the warehouse environment succinctly (but at the cost of hiding much complexity).

The key facts to learn include the following:

- What is the business? Who are the customers? What are the service requirements? What special handling is required?
- Area of warehouse (a larger warehouse will require either more labour or more equipment to move product) and types of storage, material handling equipment
- Average number of skus in the warehouse (a rough indicator of complexity of work)
- Average number of pick-lines shipped per day
- Average number of units (pieces, cases, pallets) per pick-line
- Average number of customer orders shipped in a day (more shipments mean a larger shipping dock and/or more labour)
- Number of order-pickers and how many shifts devoted to pallet movement, to case-picking, and to broken-case picking (suggests where to look for opportunities to reduce operating expenses, which are primarily due to order-picking)
- Average number of shipments received in a day (more shipments mean a larger receiving dock and/or more labour)
- Average rate of introduction of new skus (it is difficult to maintain a rational storage policy when the population of skus changes quickly)
- Seasonality

Warehouse activity profiling

Warehouse activity profiling is detailed below.

ABC analysis

It is a truism of engineering that only a few things within any operation account for most of the activity. This is encoded in folklore by various rules-of-thumb, such as 80-20 rules (for example, “Twenty percent of the skus account for 80 percent of the activity”); or in ABC analysis, which simply classifies skus as A (the small fraction of skus that account for most of the activity), B (moderately important), or C (the bulk of the skus but only a small portion of the activity).

One of the first things to know about any warehouse is what skus matter. This is usually a simple matter of ranking the skus by various criteria. This helps reveal the contours of the economic terrain within the warehouse. It is a popular misconception that an ABC analysis refers exclusively to the ranking of skus by dollar-volume, which is dollars/year in sales of each sku. This is merely one of many useful ways of looking at the activity of a warehouse. In fact, dollar-volume will be of little interest to us because it represents a financial perspective, while we are interested mainly in efficient warehouse operations. Consequently we will want to see the extent each sku consumes resources such as labour and space.

Frequently, an ABC analysis yields surprising results. For example, here are three different views of the activity at the national distribution centre of a large retail drugstore chain. First, let us see which skus accounted for the most cases moving through the warehouse. This would be of interest to the receiving, put-away, and restocking operations because each case must be handled separately to put it on a shelf. It also might reveal what is flowing in greatest quantity along a conveyor in the warehouse. Table below gives the ten most important skus by number of cases moved. Note that skus with relatively few pieces per case, such as the number 1 item, can appear on this list even though its total sales (pieces) are only moderate. Effects like this sometimes make the results of ABC analysis surprising. As shown in the table below, top ten items of a chain of retail drug stores, as measured in number of cartons moved during 3 weeks.

SKU		CARTONS
1	UL SLIMFAST BONUS CHOC ROYALE	514.17
2	BANDAID FAMILY TWIN PACK	374.00
3	SATHERS PIXY STIX	360.00
4	GEMINI VIDEO TAPE T-120	302.50
5	HOUSE BRAND ASPIRIN 5 GR.	262.00
6	HOUSE BRAND COMPLETE ALLERGY CAPS	243.75
7	ACT II MICRO BUTTER	238.62
8	HOUSE BRAND PAIN REL CAPLETS 500MG	233.50
9	HOUSE BRAND GESIC	231.75
10	SATHERS S/F ASST SOUR MIX	210.00

Table 2.1 Top ten items of a chain of retail drug stores

Most of the labour in warehouse operations is devoted to order-picking and so it is useful to rank skus by the number of times they were picked during some recent interval. It shows the top ten items of a chain of retail drug stores, as measured by the number of customer requests (picks) during 3 weeks.

SKU		PICKS
1	ACT II MICRO BUTTER	806
2	BEACH BAG SET	781
3	ACT II MICRO LITE BUTTER	570
4	HOUSE BRAND PAIN REL CAPLETS 500MG	569
5	ACT II MICRO WHITE CHEDDAR	553
6	HOUSE BRAND COMPLETE ALLERGY CAPS	538
7	HOUSE BRAND OINTMENT TRIPLE ANTIBIO	534
8	WRIGLEY PLEN-T-PAK BIG RED	530
9	WRIGLEY PLEN-T-PAK DOUBLEMINT	526
10	UL SLIMFAST BONUS CHOC ROYALE	525

Table 2.2 Top ten items of a chain of retail drug stores, as measured by the number of customer requests (picks) during 3 weeks

Finally, consider the number of pieces sold of each. This is of interest because each piece must be handled by a sales clerk ringing up merchandise in a retail store. Surprisingly, the ten busiest skus with respect to pieces sold are almost all baseball cards and microwave popcorn. It seems that much retail labour is devoted to handling these.

SKU		PIECES SOLD
1	UPPER DECK BASEBALL LOW#1992	70,524
2	ACT II MICRO BUTTER	34,362
3	SCORE 92 BASEBALL SERIES II	25,344
4	ACT II MICRO LITE BUTTER	21,276
5	TOPPS 92 WAX PACK BASEBALL	18,684
6	ACT II MICRO WHITE CHEDDAR	15,870
7	WRIGLEY PLEN-T-PAK DOUBLEMINT	14,736
8	ACT II MICRO NATURAL	13,284
9	WRIGLEY PLEN-T-PAK BIG RED	12,792
10	HERSHEY REESE PEANUT BUTTER CP	12,708

Table 2.3 Top ten items of a chain of retail drug stores

We find similar surprises in examining activity at a wholesale distributor of office products, for whom the ten most frequently requested skus, were as shown in table below. Notice that the ABC distribution for office products is not strongly skewed (that is, the number of picks falls off relatively slowly as you move down the list). This is a reflection of the maturity of the product and is typical of product movement in hardware and staples. In contrast, the ABC analysis of fashion products can be extraordinarily skewed; for example, the top-selling 100 music CDs from a population of 100,000+ may account for 25% of all sales.

SKU		PICKS
1	TAPE,TRANS,MAGIC,3/4"W,1"CO	2,225
2	CLIP,BINDER,SMALL	2,171
3	FOLDER,FILE,LETTER,1/3,MAN	2,163
4	CRTDG,INK,DESKJT,BK	2,157
5	DISK,3.5,DS-HD,IBM FRMT	2,097
6	MARKER,SHARPIE,FN,PERM,BLCK	2,075
7	NOTE,HIGHLAND,3X3,YELLOW	2,062
8	CLIP,GEM,SIZE 1,REGULAR	2,049
9	PAD,LEGAL,LTR SIZE,WHITE	2,009
10	PEN,BALL PT,MED,STICK,BK	2,008

Table 2.4 Top ten office products measured by customer requests during a year

If the same population of office products is examined by total weight sold, we get a clue as to which skus account for most of our shipping costs, which are based most strongly on weight.

SKU		Total weight shipped
1	CRTDG,TONER,3035,4045,BK	45,490.1
2	FLDR,LT,11PT,SGL,1/3MA10330	37,080.6
3	PPR,TW,25%RAG,8.5X11,20#,WE	28,194.5
4	CARD,INDEX,CNT,3X5,5C/yPK	21,411.0
5	POCKET,FLE,9.5X14.75,3.5,RR	20,426.5
6	FLDR,LT W/2B FST/150L-13	19,885.8
7	FLDR,LG,11,SGL,1/3MA 15330	16,231.2
8	PROTECTOR,SURGE,6OUT,6',PTY	13,578.2
9	FOLDER,LTR,2 PLI,STRT,24110	13,495.4
10	FASTENER,P/S,2/68220	12,910.7

Table 2.5 Top ten wholesale office products by weight shipped during a year

2.7 Statistical Analysis

To design a new warehouse, retrofit an existing warehouse, or improve warehouse operations requires detailed understanding of the workload in the facility. One must analyse the patterns of customer orders and how this determines the workload within the facility.

Data sources

There are three main types of data required to support profiling: data pertaining to each sku, data pertaining to customer orders, and data pertaining to locations within the warehouse.

Sku data

Useful information to gather about each sku includes:

- A unique ID that distinguishes it from all other skus, which allows us to connect this data with that from other sources
- A short text description, which is useful in validation and error checking
- Product family, which may have implications for storage and/or handling. These tend to be particular to an industry and so require knowledge of the context. For example, product families for a drug store chain might include hair care products, dental products, shaving products and so on, which are displayed together at the retail store. For a grocery distributor product families might include dry goods, dairy, produce, refrigerated, frozen and so on. For a candy distributor product families might include chocolate (sensitive to heat), mint-flavoured candies (odoriferous), and marshmallow (light and tends to absorb the smells of its neighbours), and so on. For an apparel distributor product families might include garment type, mill, style, colour, or size. Note that a sku might be in more than one product family.
- Addresses of storage locations within the warehouse. This might include zone, aisle, section, shelf and position on the shelf.
- For each location at which this sku is stored:
 - Scale of the storage unit, such as pallets or cases. This is useful in validation and error checking.
 - Physical dimensions of the storage unit (length, width, height, weight), which are useful in understanding space requirements.
 - Scale of the selling unit, such as cases or pieces, which is useful for validation and error-checking.
 - Number of selling units per storage unit. This could be 1.
- Date introduced, which helps identify skus that may be underrepresented in activity because newly introduced.
- Maximum inventory levels by month or week, which helps determine how much space, must be provided for this sku.

Order history

The order history is simply a concatenation of all the shopping lists submitted by all the customers during the preceding year. It contains the following information.

- Unique ID of this order, to distinguish it from the shopping lists of other customers and from the shopping list of the same customer on another day or later on the same day
- Unique ID of sku, which allows us to look up the sku to see where it is stored
- Customer
- Special handling
- Date/time order picked
- Quantity shipped

Warehouse layout and location addresses

A map of the warehouse allows us to see where each sku is stored. We can infer that an order-picker had to travel to this location to retrieve the product; and from the map we can infer something about the required travel. This will enable us to evaluate alternative layouts and warehouse designs. This type of information is generally least standardised and may be found in the form of blueprints, sketches, CAD files such as DWG format, and so on.

Where and when is the work?

How can we estimate the work in a warehouse? Work is generated by the customer orders; each customer order is a shopping list comprised of “pick lines”; and each pick line generates travel to the appropriate storage location and subsequent picking, checking, packing and shipping the product. Pick lines are then a strong indicator of work; and fortunately there is almost always a historical record of them because they correspond to entries in a sales invoice, which is one of the first pieces of information to be computerised.

We use this information to infer where the work is; that is, how it is distributed among

- Skus
- Product families
- Storage locations
- Zones of the warehouse
- Time (time of day, days of the week, weeks of the year, and so on)

Sometimes this is referred to as activity analysis because we examine the activity of each sku, in particular, how many times was it requested; and how much of the sku was sold? Notice that these are two different questions: The first asks “on how many customer orders did this sku appear?”; and the second asks “How many pieces, cases or pallets moved through the warehouse?”.

If a customer requests a quantity that is less than a full case, this is termed a broken case pick. A broken-case pick can be further classified as to as an inner-pack pick, and so on, depending on how the product is packaged. If a customer requests a quantity that is an integer multiple of a case quantity but less than a pallet (unit) load, this is termed a full-case pick. A pallet pick represents an order quantity that is a multiple of a pallet load quantity. It is not uncommon for a customer request quantity to involve a mixed pick; that is, a pick involving either a broken- and full-case quantity or both a fullcase and pallet-load quantity. Broken-case picking requires more time to process than a full-case pick, which takes more time to process than a pallet pick, when normalised by the quantity handled. It is therefore desirable to know how much of each activity is taking place each period.

Seasonalities

It is important to understand how the intensity of work varies over time. Most products have some natural “cycle” that repeats over the year or quarter or month or week. In North America, and particularly in the US, the annual holiday season of roughly November–December is by far the busiest time for retail sales and this determines the timing of product flow upstream. Predictably, supply chains to meet this demand are full in the months preceding.

The selling season in the US has been increasingly extended into January due to increased sales of gift certificates. Typically, these are given as holiday gifts and are then redeemed in the weeks following the holiday.

Not all seasonalities are obvious. For example, the manager of Allied Foods in Atlanta, Georgia tells us that even dog food has seasonalities: Demand increases slightly but dependably over the end-of-the-year holidays.

Other seasonalities include:

- Office products sell most heavily on Mondays and Fridays, in January and in August. Among these, calendars sell most briskly in January, with sales dropping until June, when it disappears.
- The two fastest-moving items at Home Depot at Father’s Day are (barbecue) grills and (electric) drills. Barbecue grills sell in the spring up to July 4, when sales plummet.

2.8 Patterns of Work

Here, we want to go beyond measuring the quantities of work to understand the patterns of work generated by the customer orders.

If no customer ordered more than one sku, then the preceding activity analysis gives a sufficient view of the warehouse; but this is rarely the case and customers order multiple skus. It is then important to understand the patterns in the customer orders. For example, one indication of inherent work is the average lines per order. When this number is small, say up to about 4, it may be preferable to batch orders and assign one picker to each batch. When the number of lines per order exceeds that, orders will typically be assembled by some form of zone picking, with orders progressively assembled. If the number of lines is much larger, the zones may pick in parallel and feed pick-lines to a downstream process to accumulate and sort the orders (to reduce the number of packages sent to each customer and thereby reduce downstream shipping and handling costs).

But, as always, one must beware of averages. It is always more informative to examine the complete distribution of lines per order. It shows the fraction of orders for a single sku, for exactly two skus, and so on. In this example, most orders are for a single line, which suggests some opportunities for efficient handling. For example, if these are mostly back-orders, then they could be cross-docked. If they are rush orders, they could be grouped together into a single batch and then picked in storage sequence.

A related graph is the distribution of picks by order-size. That is, it depicts the fraction of all picks that come from single-line orders, two-line orders, and so on. Because picks are a good indication of work, this shows which types of orders, small or large, contain the most aggregate work. About two-thirds of the orders are for a single line but these account for only about one-third of the picks.

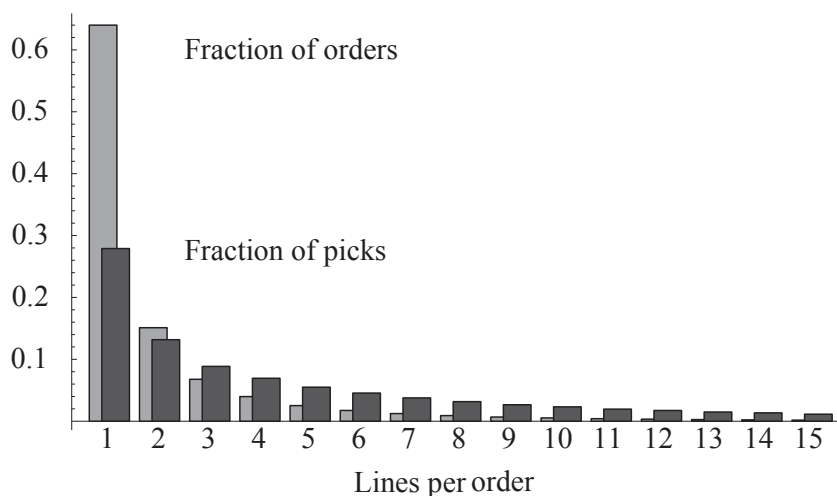


Fig. 2.6 About two-thirds of the orders are for a single line but these account for only about one-third of the picks

(Source: <http://www2.isye.gatech.edu/~jjb/wh/book/editions/wh-sci-0.94.pdf>)

Here is an application. At a telecommunications facility, workers pushed order-picking carts through a series of zones to progressively assemble orders. Due to space limitations on each cart, the transfer batch was small. An analysis of orders showed that about 10% of the orders were relatively large, for more than 100 lines each, whereas the remaining 90% averaged less than 2 lines per order. It was decided to assign one worker to pick each extremely large order, one at a time, so that the remaining orders could be picked and transferred in larger batches, thereby increasing order-picking efficiency.

Summary

- The most fundamental idea is of the management of two resources, such as space and time (that is, labor or person-hours).
- The “supply chain” is the sequence of processes through which product moves from its origin toward the customer.
- The movement to “just-in-time” logistics is roughly equivalent to reducing the diameter of the pipe, which means product flows more quickly and so flow time and in-transit inventory are reduced.
- A Fluid model will be most accurate downstream, where smaller units are moved.
- There is little correlation between popularity and flow.
- Each storage location in a warehouse is assigned a unique address.
- In dedicated storage, each location is reserved for an assigned product and only that product may be stored there.
- The problem with dedicated storage is that it does not use space efficiently.
- Shared storage involves assigning a product to more than one storage location.
- Warehouse activity profiling is the careful measurement and statistical analysis of warehouse activity.
- Most of the labour in warehouse operations is devoted to order-picking and so it is useful to rank skus by the number of times they were picked during some recent interval.
- There are three main types of data required to support profiling, namely; data pertaining to each sku, data pertaining to customer orders, and data pertaining to locations within the warehouse.
- The order history is simply a concatenation of all the shopping lists submitted by all the customers during the preceding year.
- Each customer order is a shopping list comprised of “pick lines”; and each pick line generates travel to the appropriate storage location and subsequent picking, checking, packing and shipping the product.

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Self Assessment

1. The _____ is the sequence of processes through, which product moves from its origin toward the customer.
 - a. chain market
 - b. supply chain
 - c. pick lines
 - d. activity profiling

2. _____ involves assigning a product to more than one storage location.
 - a. Shared storage
 - b. Dedicated storage
 - c. Assigned storage
 - d. Multiple storage

3. In _____ each location is reserved for an assigned product and only that product may be stored there.
 - a. shared storage
 - b. dedicated storage
 - c. assigned storage
 - d. multiple storage

4. Each storage location in a warehouse is assigned a unique _____.
 - a. number
 - b. identity
 - c. code
 - d. address

5. There is _____ correlation between popularity and flow.
 - a. large
 - b. little
 - c. no
 - d. indirect

6. The _____ is simply a concatenation of all the shopping lists submitted by all the customers during the preceding year.
 - a. activity profiling
 - b. pick lines
 - c. order history
 - d. sku data

7. The fluid model will be most accurate downstream, where _____ units are moved.
 - a. smaller
 - b. bigger
 - c. slower
 - d. faster

8. The most fundamental idea is of the management of two resources: space and _____
- products
 - quality
 - quantity
 - time
9. Which of the following statements is false?
- Dedicated storage uses space most efficiently.
 - Order-picking is useful to rank skus by the number of times they were picked during some recent interval.
 - The movement to “just-in-time” logistics is roughly equivalent to reducing the diameter of the pipe.
 - A pick line generates travel to the appropriate storage location and subsequent picking, checking, packing and shipping the product.
10. Warehouse _____ is the careful measurement and statistical analysis of warehouse activity.
- activity profiling
 - pick lines
 - order history
 - sku data

Chapter III

Warehouse Operations and Benchmarking

Aim

The aim of this chapter is to:

- define warehouse
- explain the warehouse operations
- recognise the types of benchmarking

Objectives

The objectives of this chapter are to:

- describe benchmarking
- explain performance measurement
- discuss benchmarking against a community of warehouses

Learning outcome

At the end of this chapter, you will be able to:

- elucidate the process of constructing the benchmark warehouse
- explain the ratio-based benchmarking
- describe aggregate benchmarking

3.1 Introduction to Warehouse Operations

A warehouse reorganises and repackages product. Product typically arrives packaged on a larger scale and leaves packaged on a smaller scale. In other words, an important function of this warehouse is to break down large chunks of product and redistribute it in smaller quantities. For example, some skus may arrive from the vendor or manufacturer in pallet quantities but be shipped out to customers in case quantities; other skus may arrive as cases but be shipped out as eaches; and some very fast-moving skus may arrive as pallets and be shipped out as eaches. In such an environment, the downstream warehouse operations are generally more labour-intensive.

This is still truer when product is handled as eaches. In general, the smaller the handling unit, the greater the handling cost. It can require much labour to move 10,000 boxes of paper clips if each box must be handled separately, as they may when, for example, stocking retail stores. Much less labour is required to handle those 10,000 boxes if they are packaged into cases of 48 boxes; and still less labour if those cases are stacked 24 to a pallet.

Even though warehouses can serve quite different ends, most share the same general pattern of material flow. Essentially, they receive bulk shipments, stage them for quick retrieval; then, in response to customer requests, retrieve and sort skus, and ship them out to customers. The reorganisation of product takes place through the following physical processes.

3.2 Benchmarking

A warehouse, like any other enterprise, should constantly measure its performance, compare with others, and plan to improve. Each of these presents challenges: What to measure? With whom to compare? How to improve?

Generally there is not much to learn by comparing with an ideal because that ideal might not be practical; and, furthermore, it gives no hints on how to achieve similar performance. It makes more sense to compare a warehouse with its peers. If a peer is outperforming our warehouse, we can examine its facilities and processes to understand why and then try to adopt similar practices.

3.3 Performance Measurement

What should you measure to judge the performance of a warehouse or distribution centre? It is not enough to measure only output because that says nothing about the expense required to generate that output. Instead, we typically measure performance by a ratio as:

$$\text{Performance} = \frac{\text{units of output achieved}}{\text{units of input required}}$$

These ratios generally are intended to summarise the following:

- Operating costs, such as warehouse costs as a percentage of sales
- Operating productivity, such as pick-lines, orders, cartons, pallets handled per person-hour
- Response time, measured, for example, as order-cycle time (minutes per order)
- Order accuracy, measured, for example, as fraction of shipments with returns

Many warehouses are managed from a list of measurements, which are referred to as key performance indicators (KPI). Ideally, a measure of productivity will be unbiased, customer-focused, and consistent with corporate goals. None of the KPI's mentioned above fits these criteria perfectly. For example, "total units shipped" is probably inconsistent with corporate goals because it omits concern for whether the correct items were shipped; furthermore, it is biased because it depends on total units ordered by the customer and so is not under direct control of the warehouse.

Similarly, "pick-lines per labour hour", a popular performance indicator, is biased because it depends on the units being picked: One would expect a higher score if picking cartons instead of pieces. And it is not focused on the customer. "Order-cycle time" seems more defensible; but "warehousing costs as a percentage of sales" is biased because it depends on sales and so could be skewed by marketing. In addition, it is not customer-focused.

3.4 Types of Benchmarking

Benchmarking is the comparison of one warehouse with others. One can try to make the comparison more meaningful by suitably restricting the community of warehouses to which comparison is made. Benchmarking may be done internally, on the processes within a single company; or externally, on the same process in other industries; or on the same process in competitors. There are challenges of diplomacy and information sharing when benchmarking against other companies, especially competitors.

3.4.1 Ratio-based Benchmarking

In ratio-based benchmarking, it is typical to report a collection of KPI's for a warehouse. But how do you compare two such scores? This sounds like a simple question but there can be surprising subtleties. Consider, for example, the following three warehouses, each of which has been evaluated by three KPI's. (For simplicity assume the score for each KPI has been scaled to lie within $[0; 1]$, with 1 being the best possible. This is similar to the scoring scheme used by Consumer Reports.)

	KPI ₁	KPI ₂	KPI ₃
Warehouse A	0.75	0.25	0.50
Warehouse B	0.50	0.75	0.25
Warehouse C	0.25	0.50	0.75

Which of these warehouses is performing “best”? A simple way of comparing them is to count the number of KPI's in which each warehouse scores best. Warehouse A beats B in KPI1 and KPI3 but loses to B in KPI2. Because A beats B in two out of three KPI's, it is tempting to say that A is performing better warehouse than B. Similarly, B beats C. But—and here is where the trouble starts—C beats A! Strangely, while it seems to make sense to compare one warehouse with another in this way, it does not seem to make sense to ask which is the best.

Worse yet, it is possible to imagine a series of warehouse “improvements” that lead nowhere. Suppose, for example, that we are managing warehouse A. If we observe that warehouse B is more productive, we might reengineer warehouse A to resemble B. But later we discover that our new warehouse is bested by warehouse C and so we reengineer again to copy the configuration of C. But this configuration is not as efficient as the original configuration of warehouse A. It is possible to make more sophisticated methods of aggregating the KPI's, such as by weighting the relative importance of each; but all such attempts are capable of paradoxical outcomes. How do we know this? One can interpret ratio-based benchmarking as a type of election in which each KPI is a voter and each warehouse is a candidate for most efficient. Deep results in the theory of voting and social choice tell us that there is no voting scheme that is free of undesirable behaviour.

In summary, the fundamental problem with simple, ratio-based performance indicators is that each represents a limited and therefore possibly misleading point of view; and there is no wholly satisfactory model or structure to combine the measures of productivity into some integrated view.

3.4.2 Aggregate Benchmarking

In systems-based benchmarking, we take an aggregate point of view and consider, not single inputs or outputs, but entire portfolios of inputs and outputs. We want to measure how well we are achieving a portfolio of outputs for a given portfolio of inputs. Consider these two warehouses:

	Labour (hrs x 10 ³)	Capital (\$M)	Annual pick-lines (M)
Warehouse A	100	1:0	1:6
Warehouse B	50	0:5	0:8

Each warehouse uses two inputs, labour and capital, to produce one output, picks (retrievals of product for customers). (This is a purposefully simplistic view of the inputs and outputs of a warehouse. In a more realistic model we would itemise the various types of labour, capital, and ways of measuring output; but for now our simple model serves a pedagogical purpose.)

Most people would find it plausible to consider warehouses A and B to be equally efficient. Warehouse B produces only half the output of warehouse A but consumes only half of each input and so they are perfectly proportional. One seems to be an exact but scaled version of the other. Presumably one could build an exact replica of warehouse B beside the original and this combined warehouse would be just as efficient as warehouse A.

3.5 Benchmarking Against a Community of Warehouses

Now we come to the heart of the question of benchmarking: How well does the warehouse of concern compare to a community of warehouses? We will rephrase the question as this: What is the most efficient synthesis of existing warehouses that can be compared directly with warehouse A? Any candidate must lie along the efficient frontier—that represents all scaled and blended warehouses that are not dominated by any other. The benchmark warehouse is that one that consumes inputs in exactly the same proportion as warehouse A and so may be compared directly with it.

3.6 Constructing the Benchmark Warehouse

So how do we find the benchmark warehouse, that one that suggests what might be possible if we could blend the best ideas of all others? Fortunately, we can use algebra to explore and manipulate the geometrical model. In fact, for any target warehouse A, we can synthesize a benchmark warehouse, a scaled and blended warehouse that can be compared directly to A and that most dramatically reveals any weaknesses of A. Furthermore, this direct comparison will allow us to assign an efficiency score in the range (0; 1] to A.

This evaluation is done by linear programming and here is the formulation that computes the relative efficiency of warehouse A in comparison to a collection of $i = 1; \dots; n$ other warehouses, using our simple model of two inputs and one output. Suppose that warehouse A uses C_A be the capital and L_A labour to produce output O_A . Similarly, warehouse i uses C_i be the capital and L_i labour to produce output O_i . Then the efficiency score of warehouse A may be determined by solving the following linear program.

Summary

- A warehouse reorganises and repackages product.
- A warehouse, like any other enterprise, should constantly measure its performance, compare with others, and plan to improve.
- Many warehouses are managed from a list of measurements, which are referred to as key performance indicators (KPI).
- Benchmarking is the comparison of one warehouse with others.
- Benchmarking may be done internally, on the processes within a single company; or externally, on the same process in other industries; or on the same process in competitors.
- In ratio-based benchmarking, it is typical to report a collection of KPI's for a warehouse.
- In systems-based benchmarking, we take an aggregate point of view and consider, not single inputs or outputs, but entire portfolios of inputs and outputs.

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Self Assessment

1. _____ typically arrives packaged on a larger scale and leaves packaged on a smaller scale.
 - a. Product
 - b. Warehouse
 - c. Order
 - d. Shipments
2. Many warehouses are managed from a list of measurements, which are referred to as _____.
 - a. key performance indicators
 - b. performance measurement
 - c. operating productivity
 - d. order accuracy
3. A warehouse reorganises and repackages _____.
 - a. product
 - b. shipment
 - c. order
 - d. cartons
4. A fraction of shipments with returns is an example of _____.
 - a. operating costs
 - b. operating productivity
 - c. response time
 - d. order accuracy
5. The pallets handled per person-hour are an example of _____.
 - a. operating costs
 - b. operating productivity
 - c. response time
 - d. order accuracy
6. The order-cycle time is an example of _____.
 - a. operating costs
 - b. operating productivity
 - c. response time
 - d. order accuracy
7. Which of these is a popular performance indicator?
 - a. Pick-lines per labour hour
 - b. Warehousing costs as a percentage of sales
 - c. Pallets handled per person-hour
 - d. Minutes per order

8. Which of the following statements is false?
- In general, the larger the handling unit, the greater the handling cost.
 - A warehouse, like any other enterprise, should constantly measure its performance, compare with others, and plan to improve.
 - Ideally, a measure of productivity will be unbiased, customer-focused, and consistent with corporate goals.
 - Benchmarking may be done internally, on the processes within a single company; or externally, on the same process in other industries; or on the same process in competitors.
9. Which of the following statements is true?
- In systems-based benchmarking, it is typical to report a collection of KPI's for a warehouse.
 - In ratio-based benchmarking, we take an aggregate point of view and consider not single inputs or outputs, but entire portfolios of inputs and outputs.
 - The pick-lines per labour minutes are a popular performance indicator.
 - Operating costs may include warehouse costs as a percentage of sales.
10. Match the following.

1. Performance measurement	A. Comparison of one warehouse with others
2. Operating productivity	B. Reorganises and repackages product
3. Warehouse	C. Units of output achieved/ units of input required
4. Benchmarking	D. Pick-lines

- 1-A, 2-D, 3-B, 4-C
- 1-C, 2-D, 3-B, 4-A
- 1-B, 2-A, 3-D, 4-C
- 1-D, 2-B, 3-C, 4-A

Chapter IV

Supply Chain Management

Aim

The aim of this chapter is to:

- define supply chain and supply chain management
- explain the key parts and flows of supply chain
- elaborate the need of supply chain management

Objectives

The objectives of this chapter are to:

- describe the supply chain concept
- explain the decision phases in supply chain management
- elucidate the marketing mix model

Learning outcome

At the end of this chapter, you will be able to:

- understand the barriers of supply chain management
- examine the strategies in supply chain management
- describe the supply chain drivers

4.1 Introduction

The global market faces a fierce competition today. The introduction of products with shorter life cycles and the heightened expectations of customers have forced business enterprises to invest in, and focus attention on, their supply chains. This, together with continuing advances in communications and transportation technologies (example, mobile communication, internet, and overnight delivery), has motivated the continuous evolution of the supply chain and of the techniques to manage it effectively. Recently, the pressure of the competitive market and new information technologies has affected the structures of the production systems, calling for:

- Reduction of time to market
- Higher flexibility of the systems
- Drastic reduction of costs
- Extended quality concept

4.2 Supply Chain

A supply chain is a system of organisations, people, technology, activities, information and resources involved in moving a product or service from supplier to customer. A supply chain is a network of retailers, distributors, transporters, storage facilities, and suppliers that participate in the production, delivery and sale of a product to the consumer. These activities are associated with the flow and transformation of goods from the raw materials stage to the end user, as well as the associated information and funds flows.

Supply chain activities transform natural resources, raw materials and components into a finished product that is delivered to the end customer. In simple terms, a supply chain is the link between a firm or business and its suppliers and customers.

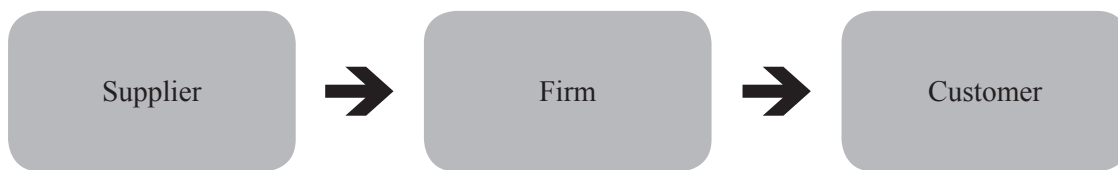


Fig. 4.1 A conceptual model of a basic supply chain

The supply chain, which is also referred to as the logistics network, consists of suppliers, manufacturing centres, warehouses, distribution centres, and retail outlets, as well as raw materials, work-in-process inventory, and finished products that flow between the facilities.

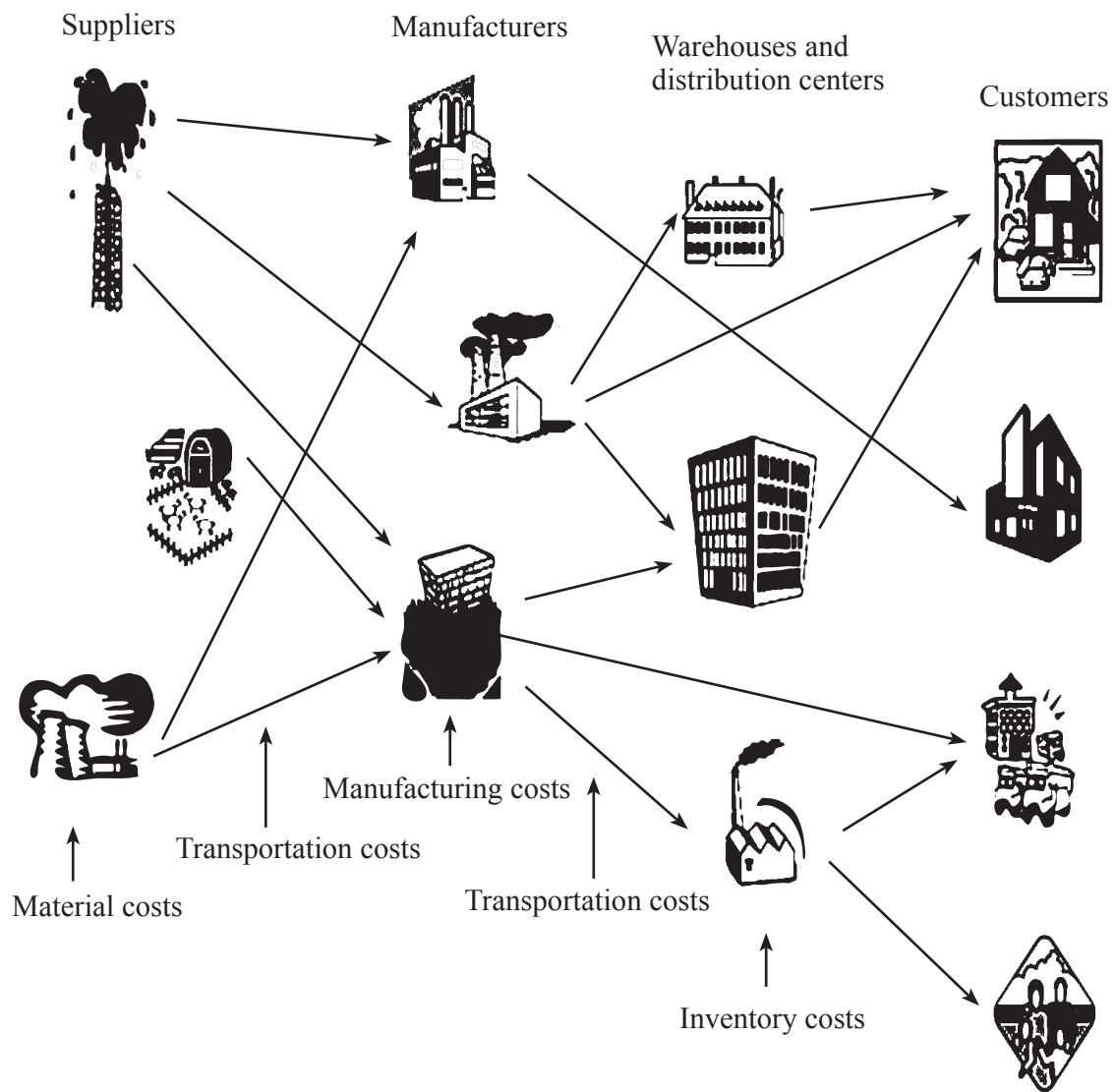


Fig. 4.2 A supply chain network

A supply chain has three key parts:

- **Supply**, which focuses on the raw materials supplied to manufacturing, including how, when, and from what location.
- **Manufacturing**, which focuses on converting these raw materials into finished products.
- **Distribution**, which focuses on ensuring that the products reach the consumers through an organised network of distributors, warehouses, and retailers.



Fig. 4.3 Key parts of supply chain

A supply chain encompasses all activities in fulfilling customer demands and requests.

In sophisticated supply chain systems, used products may re-enter the supply chain at any point where residual value is recyclable.

A supply chain strategy refers to how the supply chain should operate in order to compete in the market. The strategy evaluates the benefits and costs relating to the operation. The supply chain strategy focuses on the actual operations of the organisation and the supply chain that will be used to meet a specific goal. The supply chain integrates, coordinates and monitors the flow of materials, information, and funds.

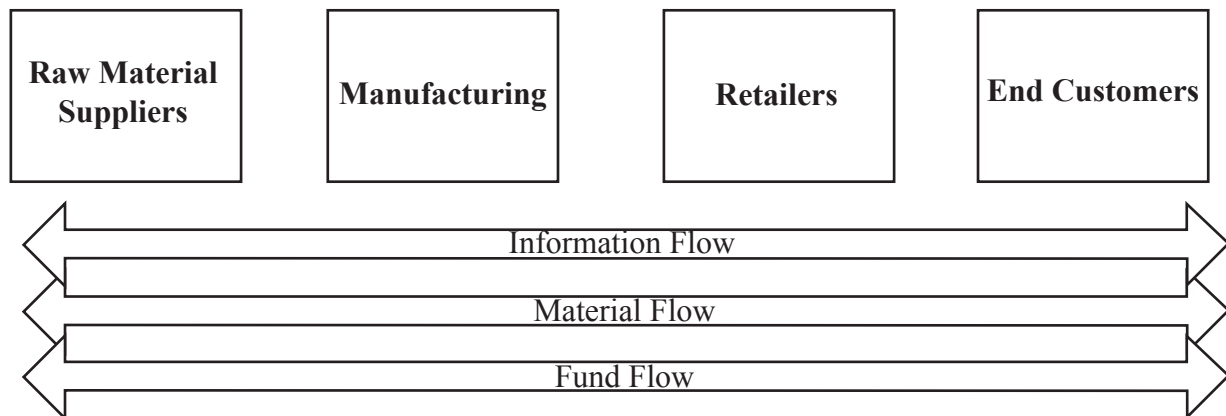


Fig. 4.4 Flows in a supply chain

(Source: <http://mdcegypt.com/Pages/Purchasing/Supply%20Chain/Introduction%20to%20Supply%20Chain%20Management/Introduction%20to%20Supply%20Chain%20Management.asp>)

4.3 Supply Chain Management

Supply chain management (SCM) is the oversight of materials, information, and finances distributed from supplier to consumer. The supply chain also includes all the necessary stops between the supplier and the consumer. Supply chain management involves coordinating this flow of materials within a company and to the end consumer.

The Council of Supply Chain Management Professionals defines supply chain management as follows: “Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities”. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies.

Supply chain management is an integrating function with primary responsibility for linking major business functions and business processes within and across companies into a cohesive and high-performing business model. It includes all of the logistics management activities noted above, as well as manufacturing operations, and it drives coordination of processes and activities with and across marketing, sales, product design, and finance and information technology. SCM is also called the art of management of providing the right product, at the right time, right place and at the right cost to the customer.

Supply chain management can be divided into three main flows:

- The **Product** flow includes moving goods from supplier to consumer, as well as dealing with customer service needs.
- The **Information** flow includes order information and delivery status.
- The **Financial** flow includes payment schedules, credit terms, and additional arrangements.

Supply chain management is a set of approaches utilised to efficiently integrate suppliers, manufacturers, warehouses, and stores, so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time, in order to minimise system-wide costs while satisfying service level requirements.

4.4 Objective of Supply Chain Management

- A supply chain is a global network of organisations that cooperate to improve the flows of material and information between suppliers and customers at the lowest cost and the highest speed. The final objective of a supply chain is customer satisfaction.
- The supply chain management takes into consideration every facility that has an impact on cost and plays a role in making the product match to customer requirements: from supplier and manufacturing facilities through warehouses and distribution centres to retailers and stores.
- The main purpose of the supply chain is to maximise overall value generated. Value is the difference between what the cost supply chain incurs and the worth end product has to the customer. Value of the commercial supply chain is correlated with its profitability generally known as supply chain surplus. For example: A customer purchase a personal computer from IBM at \$2,000, which indicates the revenue supply chain achieved. All the stages incur costs to make sure the efficient transfer of funds, information, storage of the product, transportation to the final consumer and so on. The difference between the supply chain cost and revenue generated from personal computer represent the supply chain surplus or profitability.
- Supply chain surplus can be defined as the total profit shared by all the stages and intermediaries of a supply chain. The greater the supply chain surplus the more successful is supply chain. But, Supply chain success is measured by its overall surplus not by the profit at each stage.
- The supply chain management has to be efficient and cost-effective across the entire system; from transportation and distribution to inventories of raw materials, work in process, and finished goods, are to be minimised. The emphasis is not on simply to minimise transportation cost or reducing inventories but, rather, on taking a systems approach to supply chain management.
- The objectives of supply chain management can be listed below:
 - Enhancing customer service
 - Expanding sales revenue
 - Reducing inventory cost
 - Improving on-time delivery
 - Reducing order to delivery cycle time
 - Reducing lead time
 - Reducing transportation cost
 - Reducing warehouse cost
 - Reducing supplier base
 - Expanding depth of distribution

4.5 Importance of Supply Chain Management

- The importance of supply chain management comes into picture if there is sharp focus on the loss due to the absence of an effective supply chain strategy and / or the benefit due to an effective supply chain for any firm.
- Basically, it refers that how good is the integration of supply chain that matters for any firm. The importance of having a robust supply chain management can be depicted from the following example:
 - Suppose, ABC is any company that manufactures the cycle chains for a cycle manufacturing company XYZ. Another company PQR manufactures bits used in the cycle chain manufactured by ABC. Now, in coming days, as per the market forecast, XYZ shall need 50,000 units of cycle chain, information that is not available with ABC. Accordingly, PQR also does not know how many bits to produce in order to meet ABC's requirement. The result would be either both ABC and PQR hold high safety stock inventory or

lose business respectively with XYZ and ABC. Now, if in this example showing only three supply chain partners, absence of a critical information among the partners, that is of production forecast at XYZ firm results into either a higher inventory level or loss of future business.

- The importance of supply chain management is to:
 - Reduce inventories along the chain
 - Share better information among the partners
 - Plan in consultation rather than in isolation

4.6 Activities of Supply Chain Management

There are three levels of activities of supply chain management that different parts of the company will focus on:

- **Strategic:** At this level, strategic decisions concerning the whole organisation, such as the size and location of manufacturing sites, partnerships with suppliers, products to be manufactured and sales markets are taken. Such decisions have a long-lasting effect on the firm. This includes decisions regarding product design, what to make internally and what to outsource, supplier selection, and strategic partnering and the flow of material through the logistics network.
- **Tactical:** Tactical decisions focus on adopting measures that will produce cost benefits such as using industry best practices, developing a purchasing strategy with favoured suppliers, working with logistics companies to develop cost effective transportation and developing warehouse strategies to reduce the cost of storing inventory. Such decisions are typically updated anywhere between once every quarter and once every year. These include purchasing and production decisions, inventory policies, and transportation strategies, including the frequency with which customers are visited.
- **Operational:** Decisions at this level affect how the products move along the supply chain. Operational decisions involve making schedule changes to production, purchasing agreements with suppliers, taking orders from customers and moving products in the warehouse. Such decisions refer to day-to-day decisions such as scheduling, lead time quotations, routing, and truck loading.

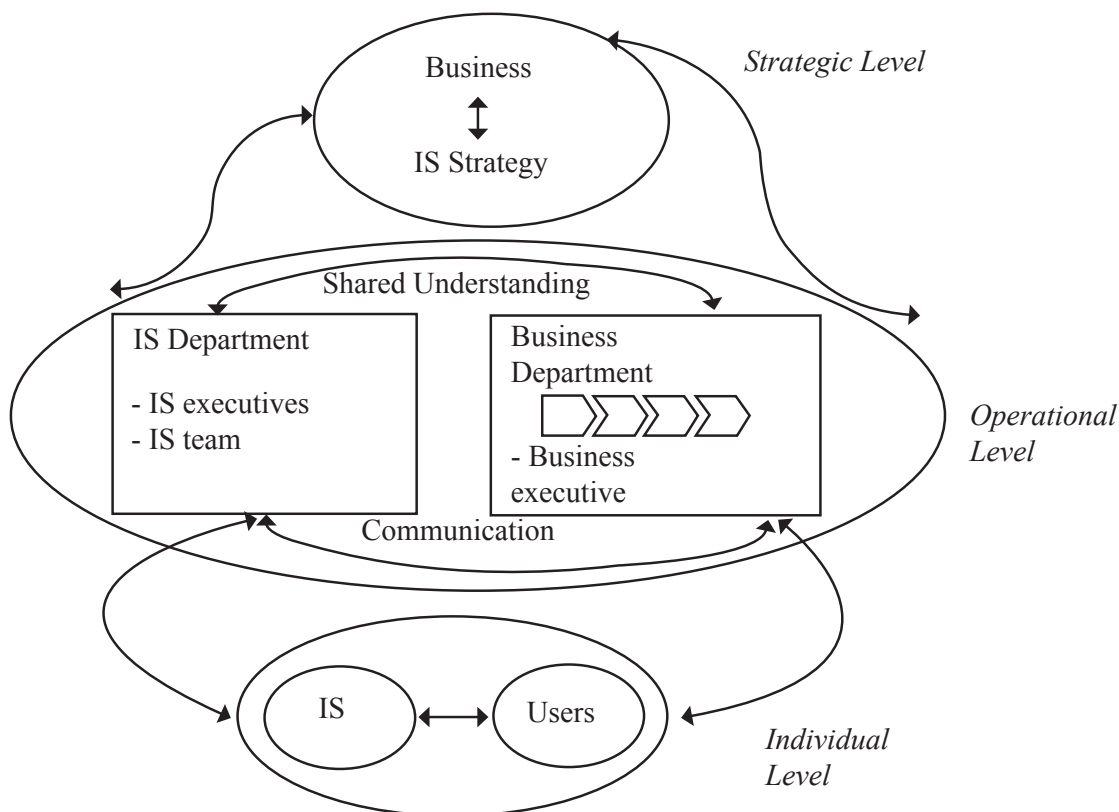


Fig. 4.5 Supply chain management activities

(Source: <http://businessitalignment.wordpress.com/page/2/>)

4.7 Decision Phases in a Supply Chain

Successful supply chain management requires many decisions relating to the flow of information, product, and funds. These decisions fall into three categories or phases, depending on the frequency of each decision and the time frame over which a decision phase has an impact. The design, planning, and operation of a supply chain have a strong impact on overall profitability and success.

Supply chain strategy or design

- During this phase, the supply chain is structured and configured.
- It is designed that, how resources will be allocated, and what processes each stage will perform.
- Strategic decisions made by companies include:
 - Location and capacities of production and warehouse facilities
 - Products to be manufactured or stored at various locations
 - Modes of transportation to be made available along different shipping legs
 - Type of information system to be utilised
- Supply chain design decisions are typically made for the long term (in years) and can be expensive to alter on short notice. Consequently, when a company makes these decisions, they must take into account uncertainty in anticipated market conditions over the next few years.

Supply chain planning

- During this phase, the time frame considered is a quarter to a year. It starts with a forecast of demand in the coming year.
- As a result, the supply chain's configuration determined in the strategic phase is fixed. The configuration establishes constraints within which planning must be done. Planning establishes parameters within which a supply chain will function over a specified period of time. Companies start the planning phase with a forecast for the coming year of demand in different markets.
- Planning decisions include those regarding markets to which a given production facility will supply and target production quantities at different locations.
- The companies must include uncertainty in demand, exchange rates, and competition over this time horizon in their decisions.
- Given a shorter time horizon and better forecasts than the design phase, companies in the planning phase try to incorporate any flexibility built into the supply chain in the design phase and exploit it to optimise performance.
- As a result, companies define a set of operating policies that govern short-term operations.
- Following are the planning decisions undertaken in supply chain:
 - Which markets will be supplied from which locations
 - Planned build-up of inventories
 - Subcontracting, backup locations
 - Inventory policies
 - Timing and size of market promotions

Supply chain operation

- The time horizon is weekly or daily, and during this phase companies make decisions regarding individual customer orders. At the operational level, supply chain configuration is considered fixed and planning policies are already defined.
- The goal of supply chain operations is to handle incoming customer orders in the best possible manner. During this phase, the following activities are undertaken:
 - Firms allocate inventory or production to individual orders

- Set a date that an order is to be filled
- Generate pick lists at a warehouse
- Allocate an order to a particular shipping mode and shipment
- Set delivery schedules of trucks
- Place replenishment orders
- There is less uncertainty about demand information because operational decisions are being made in the short term horizon (minutes, hours, or days). The goal during the operation phase is to exploit the reduction of uncertainty and optimise performance. The main aim here is to implement the operating policies as effectively as possible.

4.8 Process View of Supply Chain

The process view of supply chain can be categorised as:

- **Cycle view:** In this, processes in a supply chain are divided into a series of cycles, each performed at the interfaces between two successive supply chain stages.

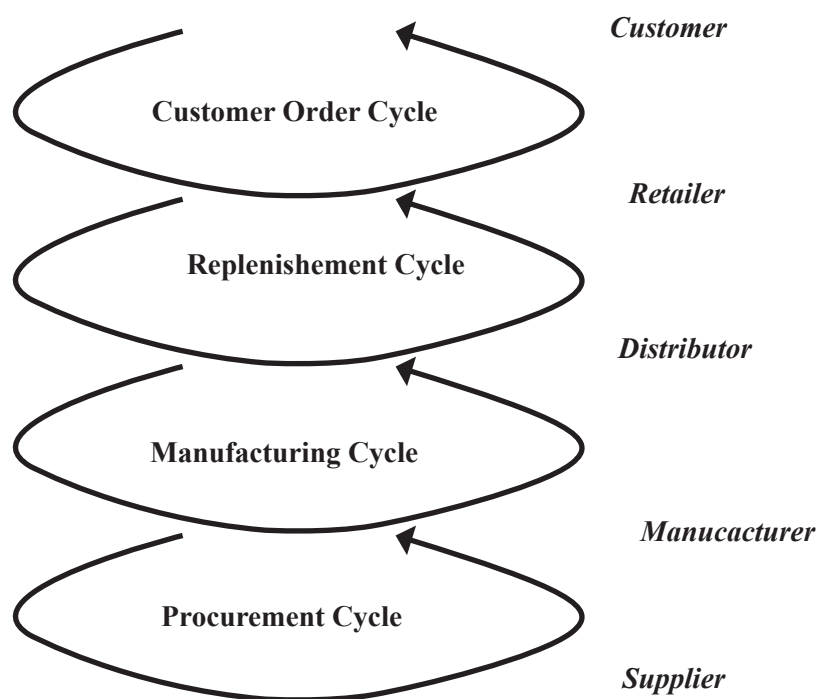


Fig. 4.6 Cycle view of supply chain

(Source: <http://iem.csu.edu.tw/member/huangck/images/%E4%BE%9B%E6%87%89%E9%8F%88%E7%AE%A1%E7%90%86/Ech01.pdf>)

Each cycle occurs at the interface between two successive stages

- Customer order cycle (customer-retailer)
- Replenishment cycle (retailer-distributor)
- Manufacturing cycle (distributor-manufacturer)
- Procurement cycle (manufacturer-supplier)
- Cycle view clearly defines processes involved and the owners of each process specify the roles and responsibilities of each member and the desired outcome of each process.

- **Push/pull view:** In this, processes in a supply chain are divided into two categories depending on whether they are executed in response to a customer order (pull) or in expectation of a customer order (push).

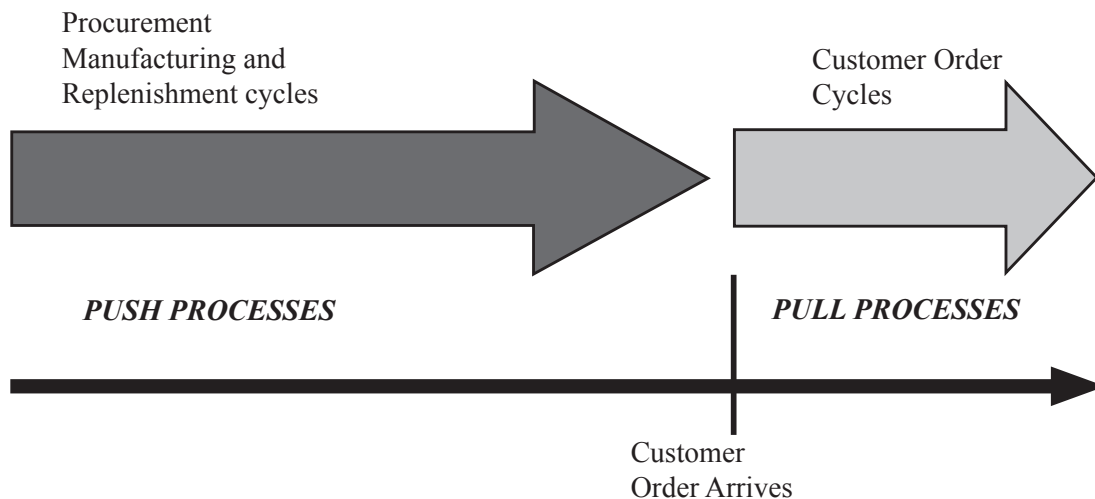


Fig. 4.7 Push/pull view of supply chain

- The flows in supply chains helps in:
 - Close connection between design and management of supply chain flows (product, information, and cash) and supply chain success.
 - Playing a significant role in the success or failure of a firm.

4.9 Linking Competitive(business) and Supply Chain Strategies

The competitive strategy defines the set of customer needs which a firm seeks to satisfy through its products and services. It includes low cost, rapid response, product differentiation etc. Supply chain strategy determines the nature of material procurement, transportation of materials, and manufacture of product or creation of service, distribution of product.

Consistency and support between supply chain strategy, competitive strategy, and other functional strategies is important.

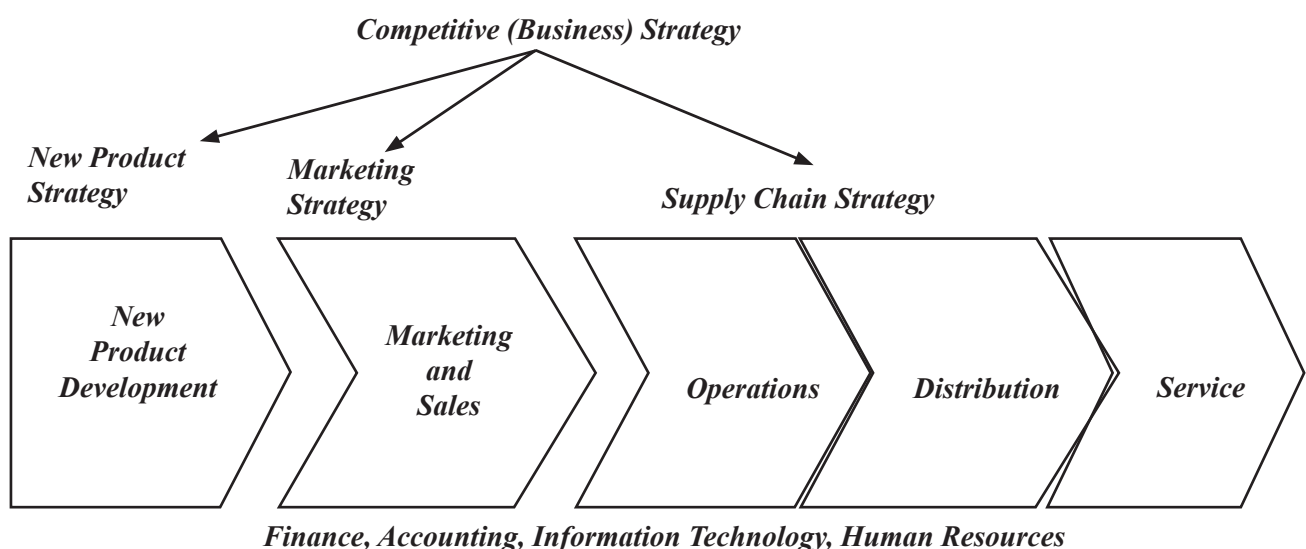


Fig. 4.8 Linking competitive (business) and supply chain strategies

(Source: http://www.clt.astate.edu/asyamil/SCM_Chopra/chopra3_ppt_ch02.ppt)

4.10 Supply Chain Drivers

Supply chain drivers determine the supply chain performance. For each driver, managers must make tradeoffs between efficiency (cost) and responsiveness. The drivers of supply chain include:

- **Inventory:** It consists of all raw materials; work in process, and finished goods within a supply chain. Inventory is maintained in the supply chain because of mismatches between supply and demand. Increasing inventory gives higher responsiveness but results in higher inventory carrying cost.
- **Transportation:** It involves moving inventory from one point in the supply chain to another point. A number of decisions have to be taken in designing a supply chain regarding transportation. The six basic modes of transportation are:
 - Air
 - Truck (road)
 - Rail
 - Ship
 - Pipeline
 - Electronic transportation (the newest mode for music, documents etc.)
- **Facilities:** A facility is a place where inventory is stored, manufactured or assembled. Hence facilities can be categorised into production facilities and storage facilities. The facilities related decisions involve location, capacity, manufacturing methodology or technology and warehousing methodology.
- **Information:** It consists of data and results of analysis regarding inventory, transportation, facilities, customer orders, customers, and funds. Good information drives good decisions.

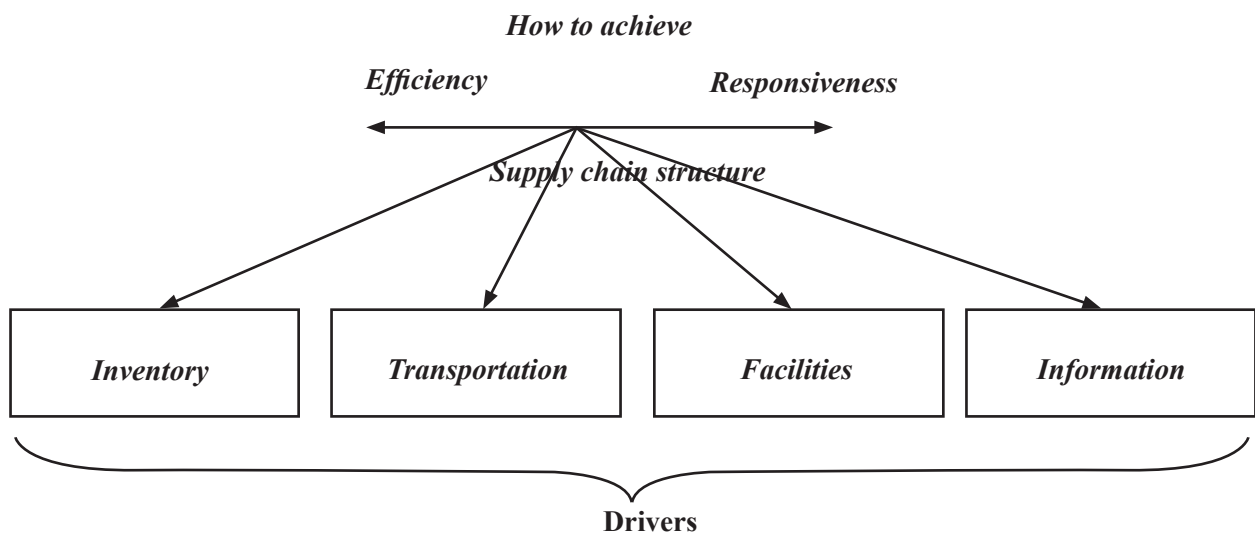


Fig. 4.9 Supply chain drivers

(Source: http://www.clt.astate.edu/asyamil/SCM_Chopra/chopra3_ppt_ch02.ppt)

4.11 Barriers of Supply Chain Management

The obstacles of supply chain management include:

- Lack of top management support
- Non-aligned strategic and operating philosophies
- Inability or unwillingness to share information
- Lack of trust among supply chain members
- Unwillingness to share risks and rewards
- Inflexible organisational systems and processes
- Cross-functional conflicts

- Inconsistent or inadequate performance measures
- Resistance to change
- Lack of training for new mindsets and skills

4.12 Scope of Supply Chain Activities

The scope of supply chain activities includes:

- Sourcing and procurement
- Production scheduling and manufacturing
- Order processing
- Inventory management
- Warehousing
- Customer service
- Distribution
- Reverse logistics

4.13 Marketing Mix Model

Marketing managers and strategists have used the 'Four P's' model of marketing mix to define their business strategy for product specification, delivery and promotion. The term "marketing mix" became popularised after Neil H. Borden published his 1964 article, *The Concept of the Marketing Mix*. Culliton described the marketing manager as a "mixer of ingredients". McCarthy proposed a Four P classification in 1960. These four P's are the parameters that the marketing manager can control, subject to the internal and external constraints of the marketing environment. The goal is to make decisions in the target market in order to generate a positive response.

Any organisation, before introducing its products or services into the market; conducts a market survey. The sequence of all 'P's as above is very much important in every stage of product life cycle. These four most important 'P's of marketing mix are generally accepted to be:

- **Price** (the amount a customer pays for the product)
- **Product** (specification and branding)
- **Promotion** (all of the communications that a marketer may use in the marketplace, advertising, public relations, personal selling and sales promotion.)
- **Place** (the location where a product can be purchased, distribution channel)



Fig. 4.10 Elements of marketing mix

(Source: http://www.designersplus.co.uk/unit1/elements_of_the_e_business_domain/level3.html)

The Marketspace Model (de Meyer *et al*) is a useful model that identifies three key features of e-business that are enabled through technology, as an extension of the traditional ‘4 P’s’ marketing model. Customer relationship is rightly placed at the centre, because the customer is uniquely identified. The on-line nature of the internet, relationships between organisations and customers are becoming more interactive.

Interactivity is the two-way exchange of information and ideas with the customer through an on-line interface, which enhances the richness of customer relationships and gives rise to new paradigms of product design and customer service, such as internet forums.

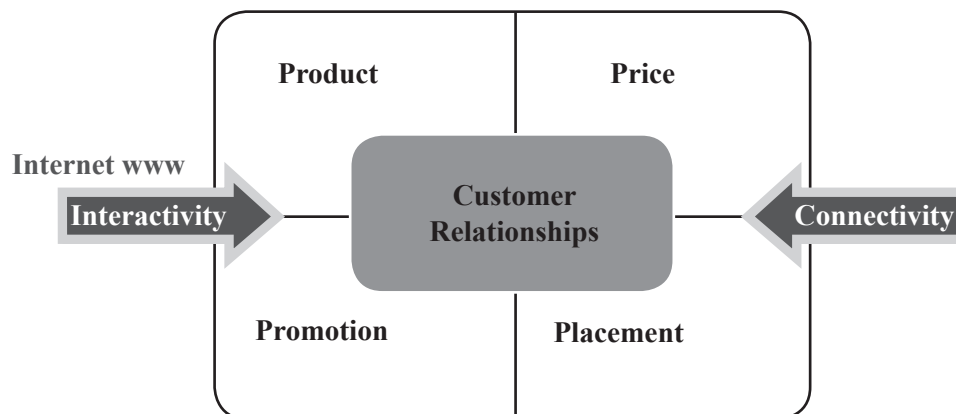


Fig. 4.11 Market space model

Summary

- The introduction of products with shorter life cycles and the heightened expectations of customers have forced business enterprises to invest in, and focus attention on, their supply chains.
- A supply chain is a network of retailers, distributors, transporters, storage facilities, and suppliers that participate in the production, delivery and sale of a product to the consumer.
- A supply chain strategy refers to how the supply chain should operate in order to compete in the market. The strategy evaluates the benefits and costs relating to the operation. The supply chain strategy focuses on the actual operations of the organisation and the supply chain that will be used to meet a specific goal.
- The supply chain integrates, coordinates and monitors the flow of materials, information, and funds.
- SCM is also called the art of management of providing the right product, at the right time, right place and at the right cost to the customer.
- The supply chain management takes into consideration every facility that has an impact on cost and plays a role in making the product match to customer requirements: from supplier and manufacturing facilities through warehouses and distribution centres to retailers and stores.
- Successful supply chain management requires many decisions relating to the flow of information, product, and funds. These decisions fall into three categories or phases, depending on the frequency of each decision and the time frame over which a decision phase has an impact. The design, planning, and operation of a supply chain have a strong impact on overall profitability and success.
- Planning decisions include those regarding markets to which a given production facility will supply and target production quantities at different locations.
- The competitive strategy defines the set of customer needs which a firm seeks to satisfy through its products and services. It includes low cost, rapid response, product differentiation and so on.
- Marketing managers and strategists have used the 'Four P's' model of marketing mix to define their business strategy for product specification, delivery and promotion.
- The Marketspace Model (de Meyer *et al*) is a useful model that identifies three key features of e-business that are enabled through technology, as an extension of the traditional '4 P's' marketing model.

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Self Assessment

1. A supply chain has _____ key parts.
 - a. two
 - b. three
 - c. four
 - d. five
2. _____ focuses on converting these raw materials into finished products.
 - a. Manufacturing
 - b. Distribution
 - c. Production
 - d. Supply chain
3. Which flow includes moving goods from supplier to consumer, as well as dealing with customer service needs?
 - a. Product flow
 - b. Information flow
 - c. Financial flow
 - d. Materials flow
4. What is the term given to the difference between what the cost supply chain incurs and the worth end product has to the customer?
 - a. Lead time
 - b. Sales revenue
 - c. Value
 - d. Supplier-base
5. Which decisions focus on adopting measures that will produce cost benefits such as using industry best practices?
 - a. Tactical decisions
 - b. Strategic decisions
 - c. Operational decisions
 - d. Supply chain design decisions
6. Supply chain design decisions are typically made for _____.
 - a. months
 - b. years
 - c. days
 - d. weeks
7. Which of the following statements is false?
 - a. Strategic decisions made by companies include location and capacities of production and warehouse facilities.
 - b. Operational decisions involve making schedule changes to production.
 - c. Tactical decisions focus on adopting measures that will produce cost benefits such as using industry best practices and developing a purchasing strategy with favoured suppliers.
 - d. Tactical decisions affect how the products move along the supply chain.

8. Which of the following statements is false?
- a. Cycle view clearly defines processes involved and the owners of each process specify the roles and responsibilities of each member and the desired outcome of each process.
 - b. The competitive strategy defines the set of customer needs which a firm seeks to satisfy through its products and services.
 - c. Increasing inventory gives lower responsiveness but results in higher inventory carrying cost.
 - d. Supply chain drivers determine the supply chain performance.
9. There are _____ P's' in the model of marketing mix used by marketing managers and strategists.
- a. five
 - b. two
 - c. four
 - d. three
10. _____ is the two-way exchange of information and ideas with the customer through an on-line interface.
- a. Interactivity
 - b. Customer relationship
 - c. Promotion
 - d. Internet

Chapter V

Design of Supply Chain and Planning Transportation Networks

Aim

The aim of this chapter is to:

- define supply chain and supply chain management
- explain the key parts and flows of supply chain
- elucidate the need of supply chain management

Objectives

The objectives of this chapter are to:

- describe the supply chain concept
- explain the decision phases in supply chain management
- discuss the marketing mix model

Learning outcome

At the end of this chapter, you will be able to:

- understand the barriers of supply chain management
- examine the strategies in supply chain management
- elucidate the supply chain drivers

5.1 Introduction

The supply chain network consists of suppliers, manufacturing centres, warehouses, distribution centres, and retail outlets, as well as raw materials, work-in-process inventory, and finished products that flow between the facilities. It is the collection of physical locations, transportation vehicles and supporting systems through which the products and services the firm markets are managed and ultimately delivered. All organisations have or can purchase the components to build a supply chain network.

Physical locations included in a supply chain network can be manufacturing plants, storage warehouses, major distribution centres, ports, etc. Transportation modes that operate within a supply chain network can include the many different types of trucks, trains, container ships or cargo planes. The many systems which can be utilised to manage and improve a supply chain network include order management systems, warehouse management system, transportation management systems, strategic logistics modelling, inventory management systems, replenishment systems, supply chain visibility, optimisation tools and more. Emerging technologies and standards are now making it possible to automate these supply chain networks in a real time mode making them more efficient than the simple traditional supply chain.

5.2 Role of Distribution Network

Distribution is the steps taken to move and store a product from the production stage to the customer stage in a supply chain. Distribution directly affects cost and the customer experience and therefore drives profitability. There is a system of intermediaries between the producer of goods and/or services and the final users. A strong and efficient distribution network is one of the most important assets a manufacturer can possess.

The distribution is one of the four elements of the marketing mix. The other three parts of the marketing mix are product, pricing, and promotion. Distribution is a key driver of the overall profitability of a company because it directly impacts both the supply chain costs and customer experience. Good distribution system serves the effectiveness of realising marketing strategy. This strategy is aimed at reaching certain levels of customer service.

Distribution process involves each intermediary passing the product down the chain to the next organisation, before it finally reaches the consumer or end-user. This process is known as the distribution chain or the channel. Each of the elements in these chains will have their own specific needs, which the producer must take into account, along with those of the all-important end-user.

A number of alternate channels of distribution may be available:

- **Distributor**, who sells to retailers
- **Retailer** (dealer), who sells to end customers
- **Advertisement** typically used for consumption goods

Distribution channels may not be restricted to physical products from producer to consumer in certain sectors. Both direct and indirect channels may be used. Hotels, for example, may sell their services directly or through travel agents, tour operators, airlines, tourist boards, centralised reservation systems, etc. There has been some sort of innovations in the distribution of services. For example, there has been an increase in franchising and in rental services. There has also been some evidence of service integration, with services linking together, particularly in the travel and tourism sectors. For example, links now exist between airlines, hotels and car rental services.

Supply chain distribution often introduces middlemen into the economic market. Historically, supply chains were primarily found in the manufacturing and production industries. These companies transform raw materials such as timber, minerals, steel, and fabric into valuable goods ready for use by consumers. Manufacturing and production companies may not have resources available for delivering products into retail stores where consumers can safely shop and purchase items, so they depend upon supply chain distribution to complete the process. There is an increasing number of complicated supply chains. So, the distribution network design plays a key role in controlling the cost of doing business.

The distribution network design involves:

- Locating production plants and distribution warehouses
- Determining the best strategy for distributing the product from the plants to the warehouses and from the warehouses to the customers

The aim is to select the optimum numbers, locations and capacities of plants and warehouses to open so that all customer demand is satisfied at minimum total costs of the distribution network (including transportation and production costs). Since, controlling of the cost of doing business is an important factor; it can put supply chain network optimisation goals ahead of competitors. The choice of distribution network can achieve supply chain objectives from low cost to high responsiveness.

5.3 Factors Influencing Distribution Network Design

At the highest level, performance of a distribution network should be evaluated along two dimensions:

- Customer needs that are met (influence the company's revenues)
- Cost of meeting customer needs (decide the profitability of the delivery network)

Elements of customer service influenced by network structure are:

- **Response time:** The time between when a customer places an order and receives delivery.
- **Product variety:** The number of different products / configurations that a customer desires from the distribution network.
- **Product availability:** The probability of having a product in stock when a customer order arrives.
- **Customer experience:** This includes the ease with which the customer can place and receive their order.
- **Order visibility:** The ability of the customer to track their order from placement to delivery.
- **Returnability:** The ease with which a customer can return unsatisfactory merchandise and the ability of the network to handle such returns.

Generally, a customer always wants the highest level of performance along with the above dimensions. However, in practice, this is not always the case. For example: customers ordering a book at Amazon.com are willing to wait longer than those that drive to a nearby store to get the same book. On the other hand, customers can find a far larger variety of books at Amazon compared to the nearby store.

There can be customers who can tolerate a large response time. The firms target these customers and require few locations that may be far from the customer. They focus on increasing the capacity of each location. On the other hand, firms that target customers who value short response times need to locate close to them. Such firms must have many facilities, with each location having a low capacity. Thus, a decrease in the response time which the customers desire, increases the number of facilities required in the networks. For example, ABC provides its customers with books on the same day but requires about 400 stores to achieve this goal for most of the country. Amazon, on the other hand, takes about a week to deliver a book to its customers, but only uses about 5 locations to store its books.

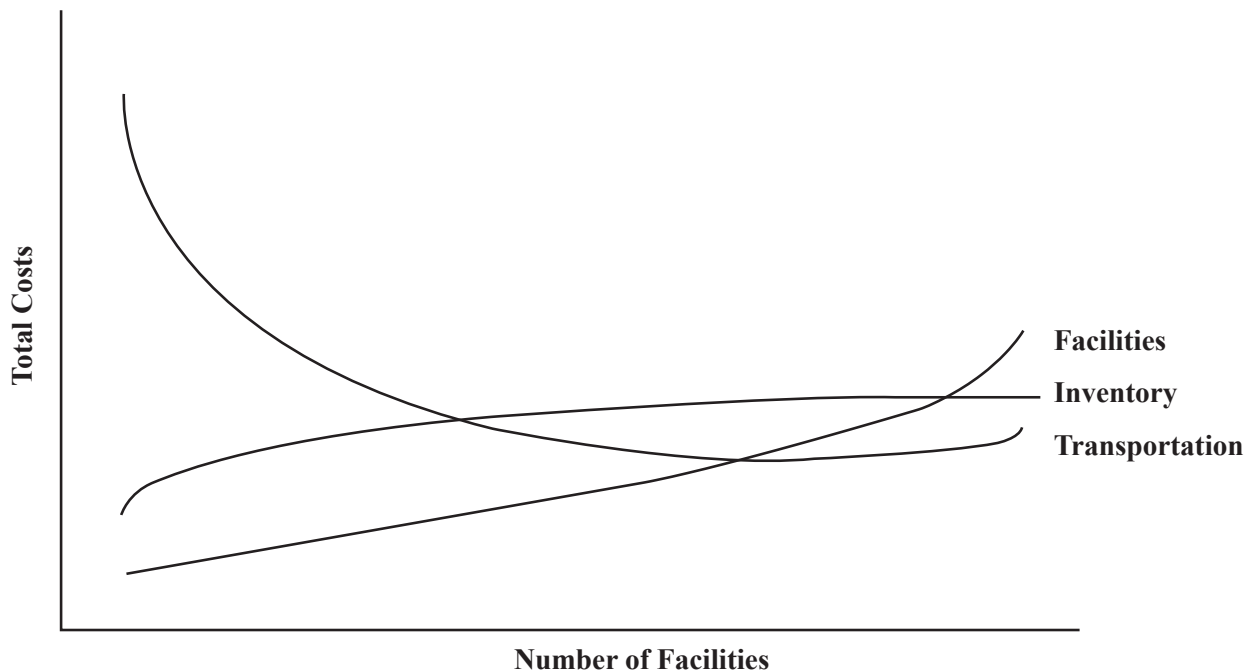


Fig. 5.1 Relationship between number of facilities and logistics cost

Changing the distribution network design affects the following supply chain costs:

- Inventories
- Transportation
- Facilities and handling
- Information

As the number of facilities in a supply chain increases, the inventory and resulting inventory costs also increase as shown in the above figure. As long as inbound transportation economies of scale are maintained, increasing the number of facilities decreases total transportation cost.

A distribution network with more than one warehouse allows reduction of transportation cost relative to a network with a single warehouse. Facility costs decrease as the number of facilities is reduced, because a consolidation of facilities allows a firm to exploit economies of scale. Total logistics costs are the sum of inventory, transportation, and facility costs for a supply chain network. Distribution network design options must therefore be compared according to their impact on customer service and the cost to provide this level of service.

5.4 Design Options for a Distribution Network

Distribution network design options must be compared according to their impact on customer service and the cost to provide this level of service. There are two key decisions while designing a distribution network:

- Will product be delivered to the customer location or picked up from a predetermined site?
- Will product flow through an intermediate location?

The distribution networks have their relative strengths and weaknesses. Based on the choices for the two decisions, there are five distinct distribution network designs that are classified as follows:

Manufacturer storage with direct shipping (Drop shipping)

The product is shipped directly from the manufacturer to the end customer, bypassing the retailer (who takes the order and initiates the delivery request). All inventories are stored at the manufacturer. Information flows from the customer, via the retailer, to the manufacturer, while product is shipped directly from the manufacturer to customers.

- The biggest advantage of drop shipping is the ability to centralise inventories at the manufacturer. A manufacturer can aggregate demand and provide a high level of product availability with lower levels of inventory than individual retailers.
- The benefits from such sort of centralisation are highest for high value, low volume items with unpredictable demand and vice versa. Thus, drop shipping would not offer a significant inventory advantage to an online grocer selling a staple item like detergent.
- Transportation costs are high with drop shipping because the average outbound distance to the end consumer is large and package carriers must be used to ship the product that have high shipping costs per unit compared to truckload carriers.
- With drop shipping, a customer order with items from several manufacturers will involve multiple shipments to the customer. This loss in aggregation in outbound transportation further increases cost.
- Supply chains save on the fixed cost of storage facilities when using drop shipping because all inventories are centralised at the manufacturer.
- There can be some savings of handling costs too because the transfer from manufacturer to retailer no longer occurs. Handling costs can be significantly reduced if the manufacturer has the capability to ship orders directly from the production line.
- A good information infrastructure is needed so that the retailer can provide product availability information to the customer even though the inventory is located at the manufacturer.
- The information infrastructure requirement is simpler for direct sellers like Dell because two stages (retailer and manufacturer) do not need to be integrated.
- Response times tend to be large when drop shipping is used because the order has to be transmitted from the retailer to the manufacturer and shipping distances are on average longer from the manufacturer's centralised site. Also, the response time need not be identical for every manufacturer that is part of a customer order.
- Manufacturer storage with drop shipping allows a high level of product variety to be made available to the customer.
- Drop shipping provides a good customer experience in the form of delivery to the customer location. The experience, however, suffers when a single order containing products from several manufacturers is delivered in partial shipments.

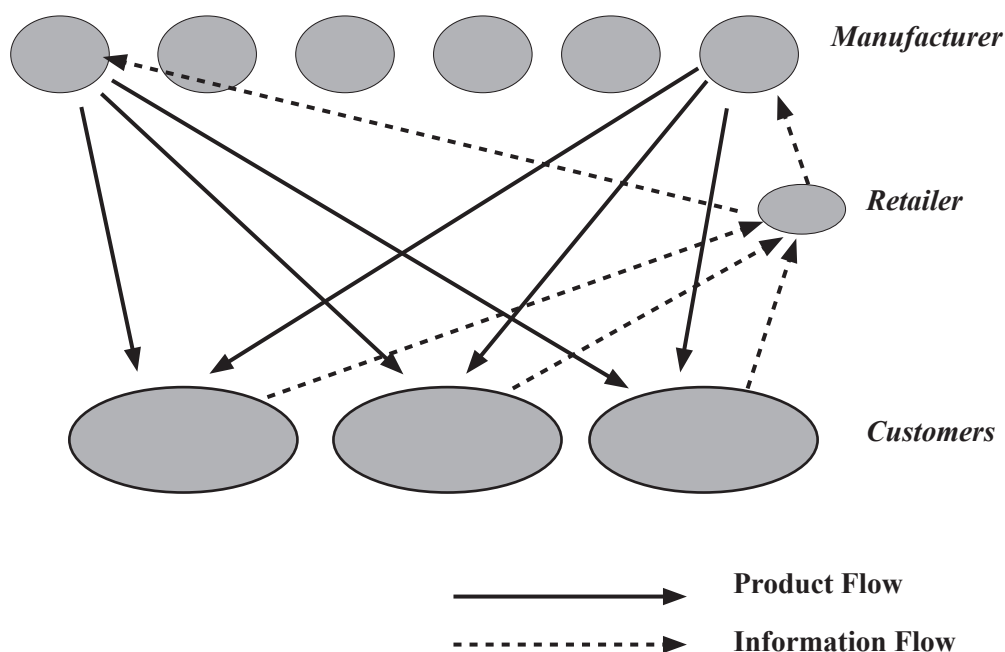
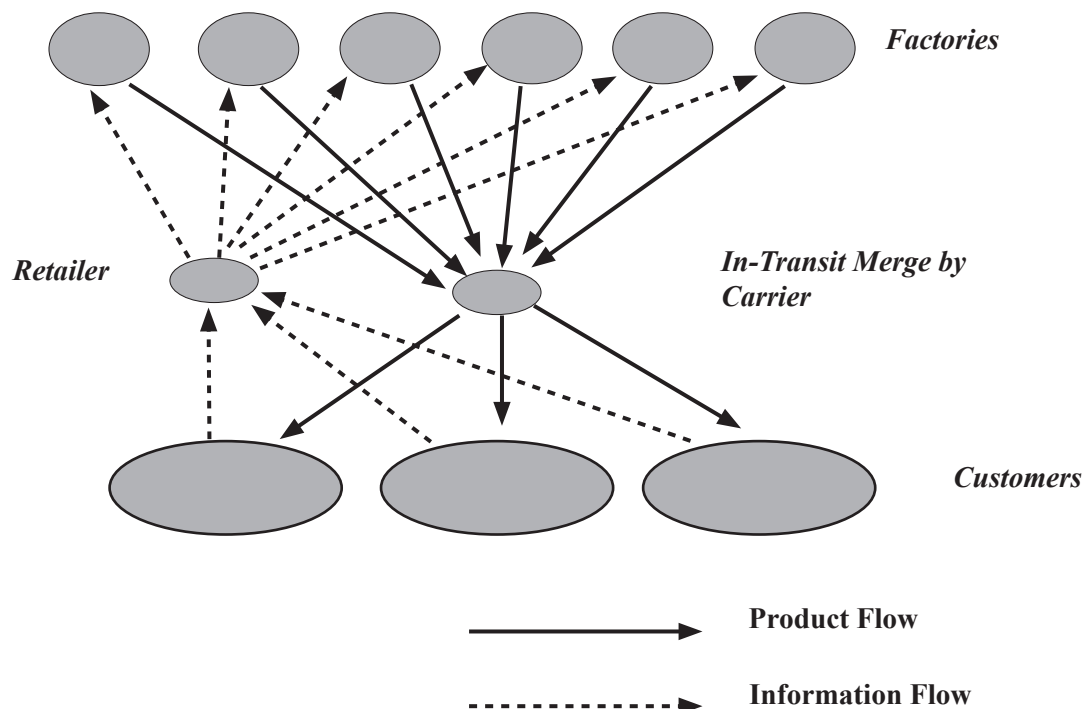


Fig. 5.2 Manufacturer storage with direct shipping

(Source: [http://www1.ximb.ac.in/users/fac/visiting/vfac.nsf/23e5e39594c064ee852564ae004fa010/89b99a7daf20080665257086002ecac4/\\$FILE/Facility%20Decisions%20and%20Network%20Design.ppt](http://www1.ximb.ac.in/users/fac/visiting/vfac.nsf/23e5e39594c064ee852564ae004fa010/89b99a7daf20080665257086002ecac4/$FILE/Facility%20Decisions%20and%20Network%20Design.ppt))

Manufacturer storage with direct shipping and in-transit merge

- Unlike drop shipping where each product in the order is sent directly from each manufacturer to the end customer, in-transit merge combines pieces of the order coming from different locations so that the customer gets a single delivery. Information and product flows for the in-transit merge network. For example, when a customer orders a PC from ABC along with a XYZ monitor, the package carrier picks up the PC at the ABC factory, the monitor at the XYZ factory and merges the two together at a hub before making a single delivery to the customer.
- The ability to aggregate inventories and postpone product customisation is a significant advantage of in-transit merge.
- As from above example, in-transit merge allows ABC and XYZ to aggregate all their inventories at the factory. This approach will have the greatest benefits for products with high value whose demand is hard to estimate.
- The transportation costs are lower than drop shipping because of the merge that takes place at the carrier hub prior to delivery to the customer.
- An order with products from many manufacturers thus requires only one delivery to the customer. Fewer deliveries save transportation cost and simplify receiving process.
- Overall supply chain facility and handling costs are somewhat higher than drop shipping.
- Sophisticated information infrastructure is needed to allow the in-transit merge.
- The information, operations at the retailer, manufacturers, and the carrier must be coordinated.
- Response times may be higher because of the need to perform the merge.
- Customer experience should be better than drop shipping because the customer receives only one delivery for their order instead of many partial shipments.
- The main advantage of in-transit merge over drop shipping is the lower transportation cost and improved customer experience.
- The major disadvantage is the additional effort during the merge.

**Fig. 5.3 Manufacturer storage with direct shipping and in-transit merge**

(Source: [http://www1.ximb.ac.in/users/fac/visiting/vfac.nsf/23e5e39594c064ee852564ae004fa010/89b99a7daf20080665257086002ecac4/\\$FILE/Facility%20Decisions%20and%20Network%20Design.ppt](http://www1.ximb.ac.in/users/fac/visiting/vfac.nsf/23e5e39594c064ee852564ae004fa010/89b99a7daf20080665257086002ecac4/$FILE/Facility%20Decisions%20and%20Network%20Design.ppt))

Distributor storage with package carrier delivery

- Under this option, inventory is not held by manufacturers at the factories but is held by distributors or retailers in intermediate warehouses and package carriers are used to transport products from the intermediate location to the final customer. Information and product flows when using distributor storage with delivery by a package carrier.
- Transportation costs are somewhat lower for distributor storage compared to manufacturer storage because an economic mode of transportation (example, truckload) can be employed for inbound shipments to the warehouse, which is closer to the customer.
- Unlike manufacturer storage where multiple shipments may need to go out for a single customer order with multiple items, distributor storage allows outbound orders to the customer to be bundled into a single shipment further reducing transportation cost.
- For faster moving items, transportation savings from distributor storage relative to manufacturer storage increase.
- Compared to manufacturer storage, facility costs are somewhat higher with distributor storage because of a lack of aggregation. From a facility cost perspective, distributor storage is not good for extremely slow moving items.
- The information infrastructure needed with distributor storage is significantly less complex than the manufacturer storage.
- Response time with distributor storage is better than with manufacturer storage because distributor warehouses are closer to customers and the entire order is aggregated at the warehouse on shipping.
- Distributor storage can handle somewhat lower variety than manufacturer storage.

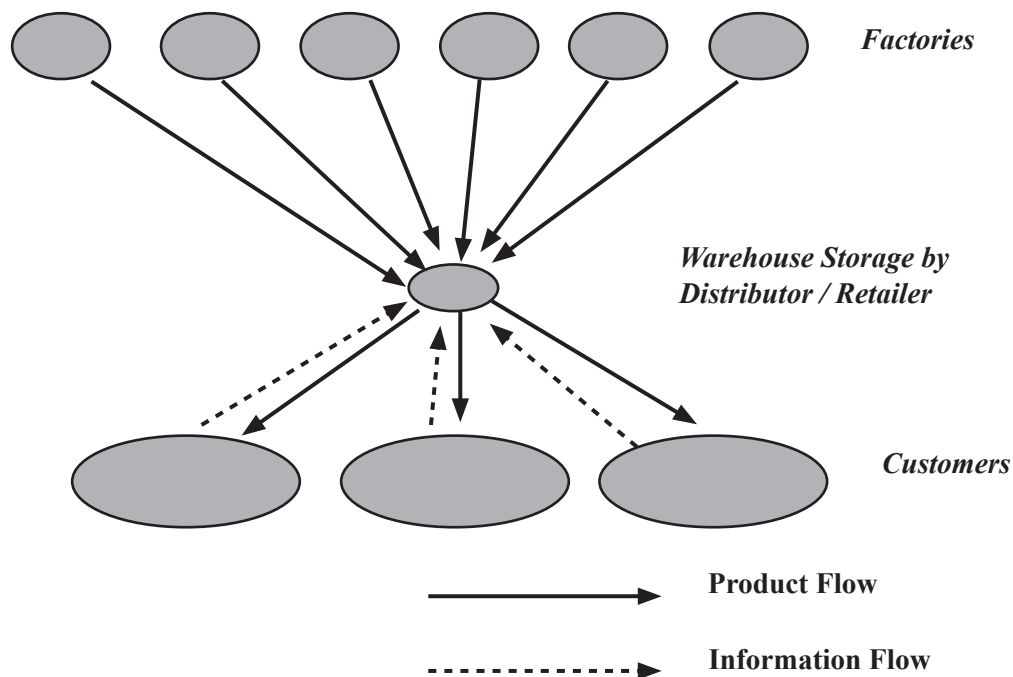


Fig. 5.4 Distributor storage with package carrier delivery

(Source: [http://www1.ximb.ac.in/users/fac/visiting/vfac.nsf/23e5e39594c064ee852564ae004fa010/89b99a7daf20080665257086002ecac4/\\$FILE/Facility%20Decisions%20and%20Network%20Design.ppt](http://www1.ximb.ac.in/users/fac/visiting/vfac.nsf/23e5e39594c064ee852564ae004fa010/89b99a7daf20080665257086002ecac4/$FILE/Facility%20Decisions%20and%20Network%20Design.ppt))

Distributor storage with last mile delivery

- Last mile delivery refers to the distributor / retailer delivering the product to the customer's home instead of using a package carrier. Peapod and Albertson's have used last mile delivery in the grocery industry. Unlike package carrier delivery, last mile delivery requires the distributor warehouse to be much closer to the customer, increasing the number of warehouses required.

- Distributor storage with last mile delivery requires higher levels of inventory because it has a lower level of aggregation.
- Transportation costs are highest using last mile delivery. This is because package carriers aggregate delivery across many retailers and are able to obtain better economies of scale than available to a distributor or retailer attempting last mile delivery.
- Last mile delivery is cheaper in dense cities.
- Transportation costs are reasonable for bulky products where the customer is willing to pay for home delivery. For example, home delivery for water and large bags of rice has proved quite successful in China, where the high population density has helped decrease delivery costs.
- Facility and processing costs are very high using this option given the large number of facilities required. For example, a grocery store doing last mile delivery performs all the processing until the product is delivered to the customer's home unlike a supermarket where there is much more customer participation.
- The information infrastructure with last mile delivery requires the additional capability of scheduling deliveries.
- Response times are faster than the use of package carriers.
- Product variety is generally lower than distributor storage with carrier delivery.

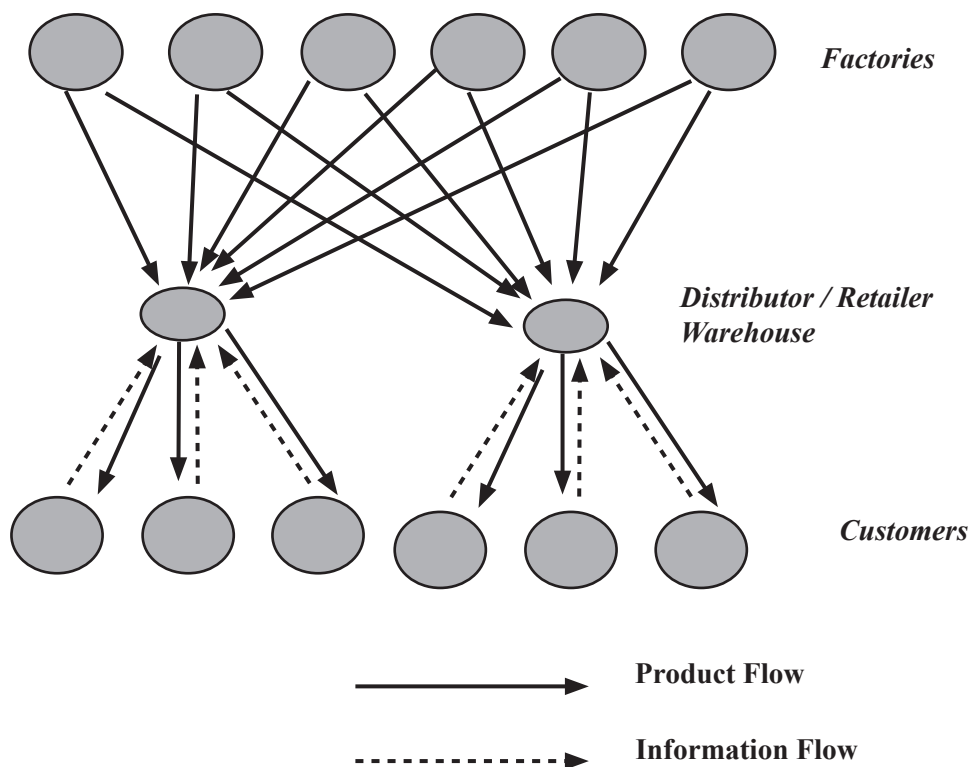


Fig. 5.5 Distributor storage with last mile delivery

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Manufacturer or distributor storage with costumer pickup

- In this approach, inventory is stored at the manufacturer or distributor warehouse but customers place their orders online or on the phone and then come to designate pickup points to collect their orders. Orders are shipped from the storage site to the pickup points as needed.
- Inventory costs using this approach can be kept low with either manufacturer or distributor storage to exploit aggregation.

- Transportation cost is lower than any solution using package carriers because significant aggregation is possible when delivering orders to a pickup site.
- Facility costs are high if new pickup sites have to be built.
- A significant information infrastructure is needed. A good coordination is needed between the retailer, the storage location, and the pickup location.
- The main advantage of a network with consumer pickup sites is that it can lower delivery cost, thus expanding the set of products sold as well as customers served online.
- The major hurdle is the increased handling cost at the pickup site.

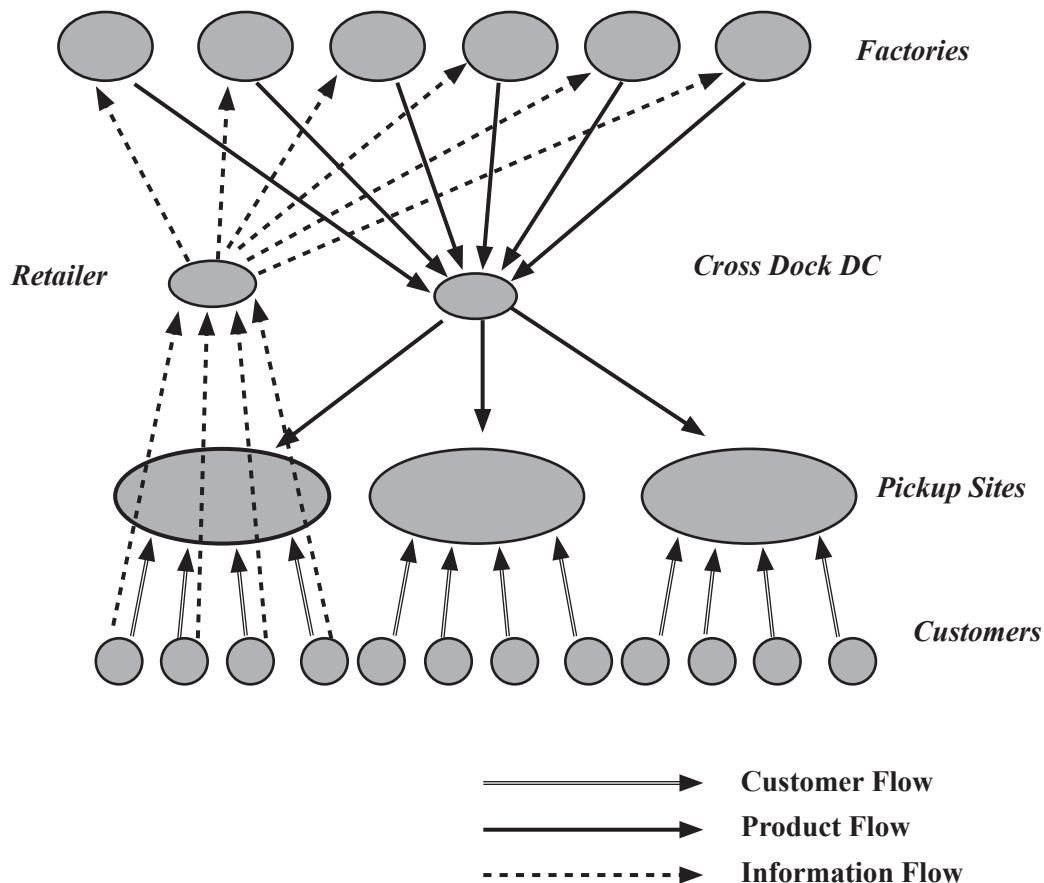


Fig. 5.6 Manufacturer or distributor storage with costumer pickup

(Source: [http://www1.ximb.ac.in/users/fac/visiting/vfac.nsf/23e5e39594c064ee852564ae004fa010/89b99a7daf20080665257086002ecac4/\\$FILE/Facility%20Decisions%20and%20Network%20Design.ppt](http://www1.ximb.ac.in/users/fac/visiting/vfac.nsf/23e5e39594c064ee852564ae004fa010/89b99a7daf20080665257086002ecac4/$FILE/Facility%20Decisions%20and%20Network%20Design.ppt))

5.5 E-business and its Impact

Electronic business is commonly referred as eBusiness or e-business, or an internet business, may be defined as the application of information and communication technologies in support of all the activities of business. E-business is a term used to describe businesses that run on the internet, or utilise internet technologies to improve the profitability of a business.

The entire process of setting up a website, helping the prospective customers navigate through the website, showing them the available products, offering discounts and vouchers and doing everything possible to encourage the prospective clients and converting them into customers, comes under the area of e-business.

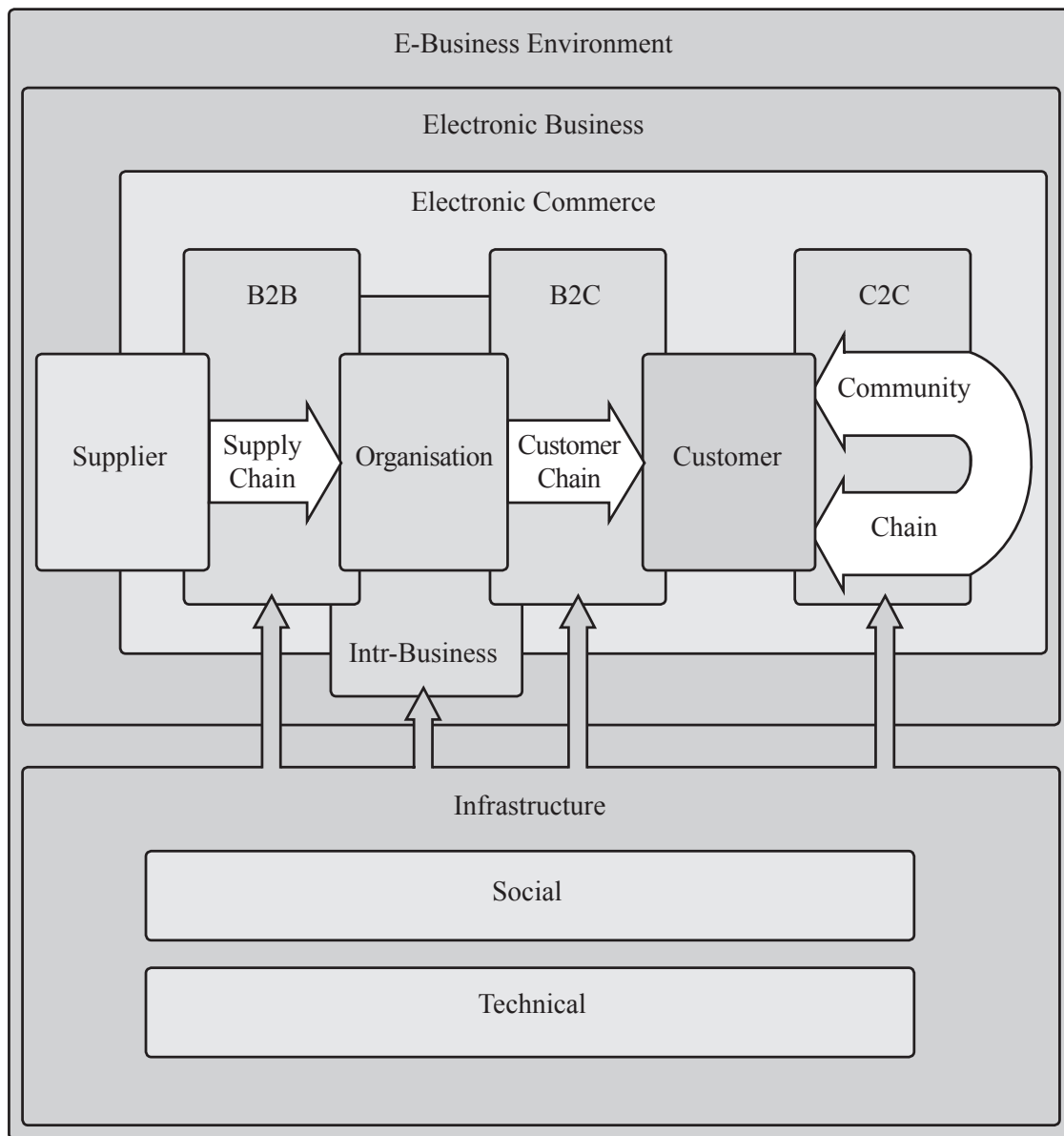


Fig. 5.7 Elements of e-business domain

(Source: http://www.designersplus.co.uk/unit1/elements_of_the_e_business_domain/level3.html)

By selling products and services online, an e-business is able to reach a wider consumer base. This function of eBusiness is referred to as ecommerce, and the terms are occasionally used interchangeably. E-business is a vast term encompassing the various business processes that aim to integrate the vendors or traders with the consumers and suppliers using the internet. E-commerce, on the other hand, is a subset of e-business and refers to online transactions that can be accounted for in monetary terms. For instance, accepting credit card payment for products sold to consumers or making payments for shopping online are examples of e-commerce. Thus, simply saying, e-commerce refers to the last stage of e-business which involves collecting payments for the goods sold by the business firm. Wherein, commerce constitutes the exchange of products and services between businesses and groups and individuals, electronic commerce focuses on the use of information and communication technologies to enable the external activities and relationships of the business with individuals, groups and other businesses. An eBusiness may also use the internet to acquire wholesale products or supplies for in-house production. This facet of eBusiness is sometimes referred to as e-procurement. Using email and private websites as a method for dispensing internal memos and white sheets is another use of the internet by e-business.

A central server or email list can serve as an efficient method for distributing necessary information. The trend continues with new technologies, such as internet-enabled cell phones and laptops. It can be used for buying and selling of products. The electronic chat is widely in use nowadays which saves time. The technical support operators can remotely access a customer's computer and assist them in correcting a problem. Organisations are finding that their ability to respond to unpredicted changes in the market is becoming a key factor in survival. The ability to adjust e-business processes to customer references (flexibility) has become a necessity for online systems.



Fig. 5.8 Areas of e-business
 (Source: <http://www.ipsrsolutions.com/ebusiness.htm>)

5.5.1 Advantages of E-Business

The advantages of e-business are described below:

Worldwide presence

This is the biggest advantage of conducting business online. A firm engaging in e-business can have a nationwide or a worldwide presence. There are many examples which had the advantage by the use of e-business. IBM was one of the first companies to use the term e-business for servicing customers and collaborating with business partners from all over the world. Dell Inc. is another success story which too had a blooming business selling personal computers throughout the United States, only via telephone and the internet till the year 2007. Hence, worldwide presence is ensured if companies rethink their business in terms of the Internet.

Cost effective marketing and promotions

Nowadays, the web is used to market products guarantees worldwide. Advertising techniques like pay per click advertising ensure that the advertiser only pays for the advertisements that are actually viewed. Affiliate marketing is a sort of marketing where customers are directed to a business portal because of the efforts of the affiliate who in turn receive a compensation for their efforts meeting with success. Affiliate marketing has helped both the business and the affiliates. The cost effective online advertising strategies are used in e-business.

Developing a competitive strategy

In order to ensure a competitive advantage, an effective strategy should be there to maintain the advantage and earn profits. It can be a cost strategy or a differentiation strategy. For example, till the year 2007, Dell Inc. was selling computers only via the internet and the phone. It adopted a differentiation strategy by selling its computers online and customising its laptops to suit the requirements of the clients. Thus, e-business resulted in Dell Inc. managing to capture a vast market using the differentiation strategy.

Better customer service

Customer services help in encouraging the customer to know more about the product or service. For example, on visiting a website, the customer is greeted by a pop-up chat window. Moreover, payments can be made online; home-delivery of products can be done.

5.5.2 Disadvantages of E-Business

The disadvantages of E-Business are described below:

Sectoral limitations

Lack of growth in some of the sectors can be on the account of product or sector limitations. For instance, food sector has not experienced growth of sales and revenue generation because of a number of practical reasons like food products being perishable items. Also, consumers do not look for food products on the internet since they prefer going to the supermarket to buy the necessary items as and when the need arises.

Costly e-business solutions for optimisation

Substantial resources are required for redefining product lines in order to sell online. Upgrading the computer systems, training personnel, and updating websites require substantial resources. Moreover, electronic data management and enterprise resource planning is necessary for ensuring optimal internal business processes.

From the above discussion, it is observed that the advantages clearly overshadow the disadvantages of e-business.

5.6 Distribution Networks in Practice

The ownership structure of the distribution network can have as big an impact as the type of distribution network. The choice of a distribution network has very long-term consequences. Consider whether an exclusive distribution strategy is advantageous.

Product, price and commoditisation criticality have an impact on the type of distribution system preferred by customers.

5.7 Distribution Network Design in the Supply Chain

The objective of strategic distribution network planning is to determine a plan that indicates the most economic way to ship and receive product while maintaining or increasing customer service requirements, i.e., to maximise profits and optimise service. Strategic distribution network planning typically answers the following:

- How many distribution centres should exist?
- Where should the distribution centre(s) be located?
- How much inventory should be stocked at each distribution centre?
- What customers should be serviced by each distribution centre?
- How should the customer 'order' from the distribution centre?

- How the distribution should centres 'order' from vendors?
- How frequently should shipments be made to each customer?
- What should the service levels be?
- What transportation methods should be utilised?
- How to measure the balance between logistic costs and customer service correlation?

5.8 Factors Affecting Network Design Decisions

Following are the factors that influence the decision of distribution network design:

Centralisation vs. Regionalisation

In distribution network planning, there is a well-established relationship between the number of distribution points, transportation costs and customer service targets. Graphically, the point at which these three entities merge is the optimum balance of facility and transportation costs to develop a low-cost, high service distribution network. As the distribution networks become more centralised, the internal support structures such as facility management, order entry, customer service and data processing also do the same. Degree of centralisation achieved determines the cost savings over decentralised networks. However, service levels, limitations on total facility size and risk mitigation must be factored into the decision.

Energy

Considerable shifts in the cost of energy (for example, electricity, fuel, etc.) can have an impact on operating costs and, as a result, on distribution. Distribution projects may fail once the cost of energy turns into an influencing factor, for example, energy-intensive facilities such as refrigerated warehouses. Thus, it is critical to work with all energy providers to determine the load that an operation would put on the local energy system and develop solutions that conserve energy while achieving goals. Some interesting energy solutions can be abatement programs (high power generator or solar power) to run normally on a reduced energy load or high-efficiency units.

Even if the transportation is handled via third party carriers, rising fuel costs make a very sensitive component of distribution costs. Some strategies to consider mitigating this can be cube out containers, transportation management systems, private fleet concerns and so on.

Flexibility

When designing a distribution facility, versatile equipment should be specified. In the beginning, the latest technology can make a good start but becomes a waste of money if it can't keep a pace with unpredictable events. Planning for probable or doubtful changes in the distribution profile should drive the warehouse design and equipment specifications.

For the majority of distribution operations, flexible equipment is the more practical choice.

Global marketplace

Preparedness is the critical element in a global marketplace. The supply chain is ever-changing and has a global impact that needs to be considered. This could be as minor as a domestic customer wanting direct shipments to an international location, or as major as an acquisition by a global company or addition of a key global account. Transportation systems should be designed with exports in mind. Proper customs documentation and international shipping paperwork should be done. Operations should be designed in a manner that product re-labelling or special packaging for international customers can be done easily. Facilities may be needed to accommodate inbound or outbound airfreight or ocean freight containers. Customer service functions may need to operate in 24-hour mode to assist customers in all time zones.

Government involvement

The involvement of government has an impact on distribution. The distribution system should be aware of legislation that involves their industry. Many decisions are made daily at a local, state, and federal level that impact distribution operations. Taxes, labor regulations, transportation restrictions and infrastructure decisions are continually up for review and discussion at every level of government.

Information systems

In today's e-world, timely and accurate information is needed. The days of daily distribution activity and nightly updates to financial systems are done. Today distribution execution systems must be:

- **Real-time:** Customer requirements are moving toward being able to instantly track an order through every step of the fulfilment process to delivery. The information is linked to internet where a customer can easily log in and see the exact status of their order. Real-time interfaces and host system updates enable the customer.
- **Paperless:** Language and educational barriers result in error-prone paper documents that are often misinterpreted, at best resulting in loss within the distribution operation or, worse still, lost customers due to fulfilment issues. The solution is paperless systems requiring operator validation.
- **Standardised:** Standardised, industry-tailored software is now the rule.

Modularity

As companies in the distribution space move, their business will typically jump to a new distributor or distributors. The ability to quickly take on significant business volumes dictates that modularity is a necessity for a thriving distribution organisation. Modularity must be evident in:

- **Assets:** Distribution assets must be modular, providing the ability to easily expand facilities, capacities and equipment to meet increasing demands and diverse products. Many companies design this into a facility.
- **Work assignments:** The workforce must be able to handle new work assignments and transfer knowledge to new employees effectively.
- **Labour management systems:** These systems must be able to handle the addition of new operations quickly and economically so that performance can be measured and costs can be kept under control.

Off-highway vehicles

In many countries, issues regarding the environment and air quality continue. These issues for stringent air-quality regulations will impact the warehouse. Electric vehicles will take over as the preferred models in the warehouse.

Pace

Access to a web site can now order product, specify their service requirements, pay for their order on-line, and track the order right to their doorstep. For distributors, this means that the pace of distribution must increase significantly to account for the reduced times, shorter product lives, increased inventory turnover and greater customer expectations that is considered standard in the modern business-to-business and business-to-consumer marketplace. For example, if a customer places an order today with next-day delivery, a company picks and ships the order the next day. This won't be competitive and the entire supply chain needs to keep pace, from vendor compliance to information and execution systems in order to support the new economy.

People

Team-based, participatory organisational culture and a total dedication to customer satisfaction are the components of success in supply chain distribution network. For example, employee celebration days, employee suggestion programs, revised organisational designs, compensation or incentive or bonus plans, and other processes that directly tie the distribution associate.

Price

The service and quality are key factors in selecting a distribution partner. Modern free enterprise demands efficient, effective and low-cost distribution. The goal of a successful distribution operation should be to operate within their core values at the lowest cost possible. The path to competitive pricing is to operate efficiently and flexibly at low cost.

Accountability

A successful distribution operation must have accountability. Accountability is made possible by effective leadership, clear communications and efficient systems and equipment to enable productive operations and a fulfilling work environment. Effective leadership make difficult decisions while maintaining the commitment of the organisation. Accountability requires establishing standards, identifying improvement opportunities and measuring performance.

Reverse logistics

The challenge is the question of handling the products that are coming back into the operation. The decision on whether to accept the product, whether a refused shipment, an authorised customer return, or an unexpected return must be planned for and communicated with the distribution operation.

Third party logistics

A growing number of companies are turning to third party logistics organisations to handle the customer fulfilment in the supply chain. Companies that are accustomed to true partnering with customers and suppliers have less trouble moving to the third party logistics and achieving the potential cost savings. The key steps are to conduct a complete search for the right third party logistics vendor, thoroughly review cost proposals and contracts to ensure there is financial benefit, and work with the third party logistics.

Variety

Special packaging, pricing, labelling and delivery requirements are becoming the norm and must be addressed in any distribution plan. These tasks should be designed into the operation.

Many companies invest large amounts of capital setting up specialised packing or value-added services to gain competitive advantages. Properly planned, these services can give profits, providing differentiation in a competitive marketplace.

5.9 Supply Chain Model

The supply chain models address both the upstream and downstream sides. The Supply-Chain Operations Reference model (SCOR) measures total supply chain performance. It is a process reference model for supply-chain management, spanning from the supplier's supplier to the customer's customer. It is the most widely used model. It includes delivery and order fulfilment performance, production flexibility, warranty and returns processing costs, inventory and asset turns, and other factors in evaluating the overall effective performance of a supply chain.

SCOR is based on five distinct management processes: Plan, Source, Make, Deliver, and Return.

- **Plan:** Processes that balance aggregate demand and supply to develop a course of action which best meets sourcing, production, and delivery requirements.
- **Source:** Processes that procure goods and services to meet planned or actual demand.
- **Make:** Processes that transform product to a finished state to meet planned or actual demand.
- **Deliver:** Processes that provide finished goods and services to meet planned or actual demand, typically including order management, transportation management, and distribution management.
- **Return:** Processes associated with returning or receiving returned products for any reason. These processes extend into post-delivery customer support.

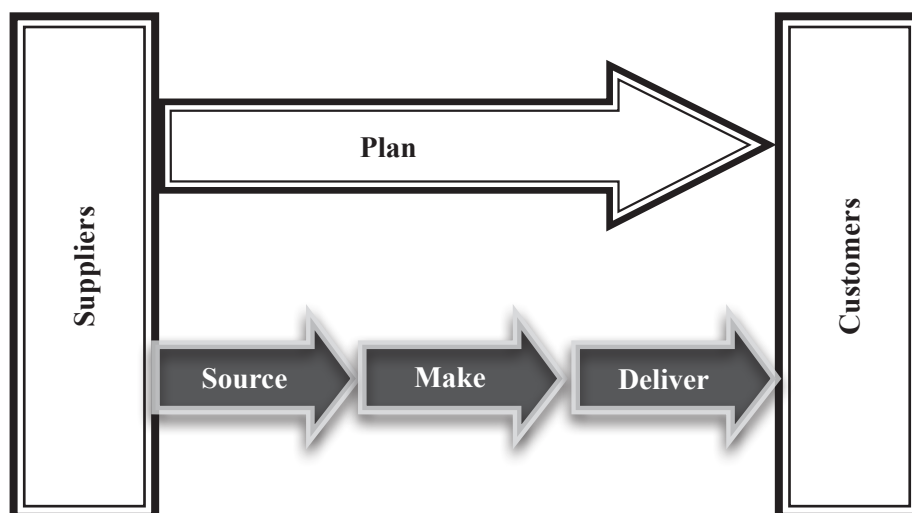


Fig. 5.9 Supply chain model

5.10 Transportation in Supply Chain

The importance of supply chain management has been growing in various areas because of the trend of nationalisation and globalisation in recent decades. For industries, it helps to optimise the existing production and distribution processes based on the same resources through management techniques for promoting the efficiency and competitiveness of enterprises. Transportation system is the key element in a supply chain. It joins the separated activities. Transportation occupies one-third of the amount in the supply chain costs and transportation systems influence the performance of supply chain system enormously. Transporting is required in the whole production procedures, from manufacturing to delivery to the final consumers and returns. A good coordination between each component can give the maximum benefits.

Transportation refers to the means of distributing goods, supplies, resources, information, people, and energy from the original point (beginning of supply chain) to the destination point (customer). It also involves handling, packaging, managing the time the goods are fetched and delivered, and maintaining coordination, especially when inter-modal or a combination of two or more transport modes is used.

An intelligent transportation system may be defined as a planned network of elements or physical components that play different roles in the transportation of goods, supplies, resources, information, people, and energy from one place to another. The elements or physical components of a transport system are referred as the facilities.

A transport system consists of:

- Fixed facilities
- Flow entities
- Control system

The fixed facilities are the physical components of the system that are fixed in space and constitute the network of links and nodes of the transportation system. For example, the links could be roadway or railway track and the nodes could be intersections, interchanges, transit terminals, harbours or airports.

Flow entities are the units that negotiate the fixed facilities. These include people, vehicles, container units, railroad cars, and so on. In the case of a road system, the fixed facilities accommodate a wide variety of vehicle types, ranging from bicycles to large tractor-trailer combinations.

The control system consists of vehicular control and flow control. Vehicular control refers to the technological way in which individual vehicles are guided on fixed facilities. Such controls can be manual or automated. The characteristics of the vehicle and the characteristics of the vehicular control system are considered by proper geometric design of fixed facilities. For example, in the case of highway facilities, where the vehicles are manually controlled, these include driver's characteristics, such as time a driver takes to perceive and react to various stimuli.

The flow control system consists of the means that permit the efficient and smooth operation of streams of vehicles and the reduction of conflicts between vehicles. This system includes various types of signing, marking, and signal systems and the underlying rules of operation. Civil engineering is the branch of engineering involving design of the fixed facilities. The design includes soil and foundation engineering design, structural engineering design, the design of drainage systems, and geometric design, which is concerned with the physical proportioning of the elements of fixed facilities.

The success of any supply chain is closely linked to the appropriate use of transportation. For example, Wal-Mart has effectively used a responsive transportation system to lower its overall costs. Wal-Mart use cross-docking process in which product is exchanged between trucks so that each truck going to a retail store has products from different suppliers.

There are two key players in any transportation that takes place within a supply chain: shipper and carrier.

- The shipper is that party that requires the movement of the product between two points in the supply chain.
- The carrier is the party that moves or transports the product. For e.g., when ABC uses uninterruptible power supply to the ship its computers from the factory to the customer, ABC is the shipper and uninterruptible power supply is the carrier.

The management of the supply chain requires a coordinated approach to manage all activities to provide the greatest value to the customer.

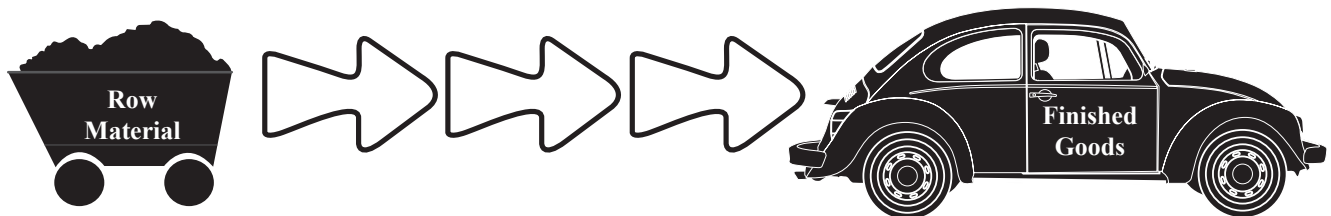


Fig. 5.10 Flow of product along the supply chain

(Source: http://www.marcbowles.com/courses/adv_dip/module4/module6/m6two.htm)

5.11 Importance of Transportation

The importance of transport has been enumerated below:

Basic service for increasing national income

As national income rises, infrastructure adopts to support changing patterns of demand, with the shares of power, transport and communication. Transport is one of the most important services within any country and a vital sector of growth.

Create new economic activity

Since, economic development in a country requires adequate and effective transport services; the degree to which transport creates new activity is a necessary condition within the economy. Transport is one of the essential elements of an integrated plan for area development.

Indicator of development

Existence of high quality transport network, availability of number of mechanised motor transport, adequate number of railway, air and shipping services as per the demand of the users are indicators of the development in any country. Effective transportation systems have been playing a vital role in the economic prosperity of a country.

Enlarge the trading activities

The industrially developed countries lay more emphasis on the development of trade. The search for an integrated system combines the merits of the individual transportation modes and eliminates the uneconomic and unproductive activities.

Promotes industrialisation

It increases wealth, promotes industrialisation and transforms the organisation of industry and raises the standard of living of the people.

5.12 Role of Transport in Supply Chain

Transport system provides the vital linkage between production and consumption. Development of transport infrastructure helps the globalisation of production process. Transport is essential in an economy because the demand and supply of goods does not reach equilibrium at any particular area or point of time. The need for dispatch of the goods arises as they are often produced in one place to be sold and consumed in another place. Thus, transport provides the vital link between the production and consumption point and the objective of production is not fulfilled till the commodity reaches the consumer. It forms an integral part of the production, distribution and marketing systems.

Transport infrastructure services are critical for diversification and modernisation of production and distribution process. Transport is the key factor to link dispersed areas. Transport increases the economic efficiency of resources. The economic efficiency of resources of various countries is increased with the growth of different mode of transportation. Transport reduces the cost of production and distribution by effective, planned, integrated and co-ordinated network. Developed or developing nations depend largely on transport development for better utilisation of resources. The adequacy of transport infrastructure is a key factor in the ability of countries to compete in international trade. Competition for new exports and location of global industries largely depends on the quality of transport infrastructure. Increased globalisation of world trade in many countries arouses not only from the liberalisation of trade policies but also from advances in transportation.

Transport helps to stabilise prices. Goods can be transported to places, where there is scarcity for it. By this the consumers can get their desired products or commodities at a reasonable price. Similarly, by transporting goods to the market, the producer gets fair price on their products.

Transport curbs monopoly of the trader. Facilities for quick transport of commodities from one place to another, restricts the traders to charge high price to the consumers. The demand for a product increases because of non-availability of a product in the market.

5.13 Transportation Modes in Supply Chain

Transport modes are the means to achieve mobility of supplies. They fall into one of three basic types, depending on what surface they are transported:

- land (road, rail and pipelines)
- water (shipping)
- air

Each mode is characterised by a set of technical, operational and commercial characteristics.

Road transportation

Road infrastructures are large consumers of space with the lowest level of physical constraints among transportation modes. Physiographical constraints are significant in road construction with substantial additional costs to overcome features such as rivers or rugged terrain.

Road transportation has an average operational flexibility as vehicles can serve several purposes. These systems have high maintenance costs, both for the vehicles and infrastructures. Rapid movements of cargo occur in small batches. With containerisation, road transportation has become a crucial link in cargo distribution. Trucks are used generally which lowers the cost and have good accessibility. The trucks are able to access many more locations than planes or railroads. Regional truck lines are excellent for small, frequent shipment and are most effective over short distances. But, the factors which lower the use of trucks are their speed, capacity and range.

Rail transportation

Railways have an average level of physical constraints linked to the types of locomotives. Heavy industries are traditionally linked with rail transport systems. The process of containerisation has improved the flexibility of rail transportation by linking it with road and maritime modes.

Rail is by far the land transportation mode offering the highest capacity of cargo carried. Gauges are often complicating the integration of rail systems worldwide. Railroads cost much less than other modes when shipping large quantities or bulky goods over long distances.

Trains run on a more consistent time schedule than trucks or airlines. They are often able to travel in weather that would slow or stop trucks and airplanes. Disadvantages include inflexibility, potential damage of goods and ineffectiveness with small shipments.

Pipelines

Pipeline routes are practically unlimited as they can be laid on land or under water. They are used for transport of homogenous materials. The costs are lower than other transportation modes. Pipeline construction costs vary according to the diameter and increase proportionally with the distance and with the viscosity of fluids. Pipeline terminals are very important since they correspond to refineries and harbours.

Pipelines are ideal for materials such as water, oil, and gas. Pipelines have high initial costs since they must be built but once they are constructed transportation costs are much lower than other modes. They are unable to transport a variety of materials.

Maritime transportation

Because of the physical properties of water such as buoyancy and limited friction, maritime transportation is the most effective mode to move large quantities of cargo over long distances. Main maritime routes are composed of oceans, coasts, seas, lakes, rivers and channels. However, due to the location of economic activities maritime circulation takes place on specific parts of the maritime space. The construction of channels and dredging are attempts to facilitate maritime circulation by reducing discontinuity. Comprehensive inland waterway systems are there.

Maritime transportation has high terminal costs, since port infrastructures are among the most expensive to build, maintain and improve and also high inventory costs. Maritime transportation is linked to heavy industries, such as steel and petrochemical facilities adjacent to port sites. Ships are one of the oldest methods of transporting goods and they are virtually the only way to transport large volumes of good over-seas. Although this method is slower than shipping by air, a ship can carry much more cargo than an airplane. Costs are reduced significantly by choosing ships over air transport.

Air transportation

Air is considered a premium mode of transportation because of the speed of delivery and the low impact on the cargo (items are less likely to be broken than those shipped by rail or truck). Airplanes are also able to cover much longer distances in a short time. Savings resulting in speed of delivery are greater than extra costs.

Air transport constraints can be the site, the climate, fog and aerial currents. For instance, a commercial plane needs about 3,300 meters of runway for landing and for take off. Air activities are linked to sectors like finance and tourism, which lean on the long distance mobility of people. The mode of transportation has been accommodating growing quantities of high value goods and is playing a growing role in global supply chain management.

Intermodal transportation

Intermodal transport refers to a variety of modes that is used in combination so that the respective advantages of each mode are better exploited. The intermodal transportation applies for passenger movements, such as the usage of the different, but interconnected modes of a public transit system. Containerisation has been a powerful vector of intermodal integration, enabling maritime and land transportation modes to more effectively interconnect.

Telecommunications

Telecommunications are structured networks with a practically unlimited capacity. They have very low constraints that include the physiographic and oceanic masses that may impair the setting of cables. They provide for the instantaneous movement of information.

Wave transmissions, because of their limited coverage, often require substations, such as for cellular phone networks. Satellites use a geostationary orbit which is getting crowded. High network costs and low distribution costs characterise many telecommunication networks.

5.14 Transportation Infrastructure and Policies

Infrastructures are the fixed installations that allow a vehicle to operate. It can consist of a way, terminal and facilities for parking and maintenance. For rail, pipeline, road and cable transport, the entire way the vehicle travels must be built up. The airway and seaway do not need to be built up. However, they require fixed infrastructure at terminals. Terminals such as airports, ports and stations, are locations where passengers and goods can be transferred from one vehicle or mode to another. The terminals for automobiles are parking lots, while buses and coaches can operate from simple stops. For goods, terminals act as trans-shipment points, though some cargo is transported directly from the point of production to the point of use.

The financing of infrastructure can either be public or private. Transport is a necessity for the public; roads, and in some countries railways and airports are funded through taxation. New infrastructure projects involve large spending, and are often financed through debt. Many infrastructure owners therefore impose usage fees, such as landing fees at airports, or toll plazas on roads. Independent of this, authorities impose taxes on the purchase or use of vehicles.

Transport policy

Transport Corporation of India Limited is the largest private sector integrated Logistics Company in India. Any transport policy should be able to ensure safe, affordable, quick, comfortable, reliable and sustainable access. Integrated land use and transport planning in all cities should be encouraged so that travel distances are minimised. The access of business to markets and the various factors of production should be improved. It should bring about a more equitable allocation of road space.

The transport infrastructure should favour the establishment of quality focused transport systems that are well integrated, providing seamless travel. Various mechanisms should be established for enhanced coordination in the planning and management of transport systems. There should be intelligent transport systems for traffic management and the use of cleaner technologies should be promoted.

5.15 Design Options for Transportation Network

In most cases, trucking or road freight provide the most flexible means of distribution of finished products to retail locations. The supply chain utilises several modes for transportation at various stages of the supply chain. Traditionally, marine transport has been the backbone of international trade. It remains the major mode of transport when the supply chain extends overseas.

In recent years there has been a tremendous growth in air freight and products with short shelf lives and high value are increasingly moving by air. One supply chain which is very much dependent on time definite air freight services is the high tech industry.

The use of a quick and reliable, time definite service as opposed to a long sea voyage should be readily apparent when the focus of modern supply chain management is considered. Whereas each mode has its specific cost and service attributes, the use of any or a particular combination is important and on the terms of contract between the supplier and the firm for transportation. The following questions related to transport in supply chain are:

- What are the transportation options?
- Which one to select? On what basis?

Direct shipping network

In this case, the manufacturer ships directly go from the manufacturing plant to the retailer without using a distribution centre or a warehouse. It reduces costs associated with warehousing or intermediate distribution centres. The time related to order processing is also reduced when goods are shipped directly to retail stores. This is a valid approach provided the supplier is able to respond quickly and cost effectively. Using less than truck load carrier, the cost and transit time both increase.

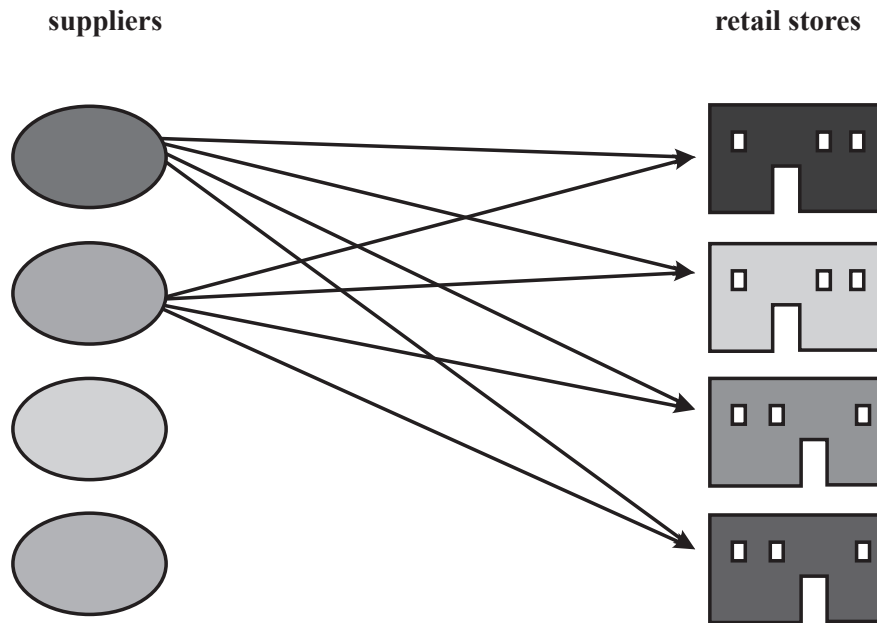


Fig. 5.11 Direct shipping network

(Source: http://www.marcbowles.com/courses/adv_dip/module4/module6/m6four1.htm)

Direct shipping with milk runs

A milk run is a route in which a truck delivers products from a supplier to a number of retail outlets. It reduces cost by eliminating the need for direct small shipments using less than truck load shipments. For example, Toyota uses milk runs both in Japan and in the USA to support its just-in-time manufacturing (Chopra & Meindl, 2001).

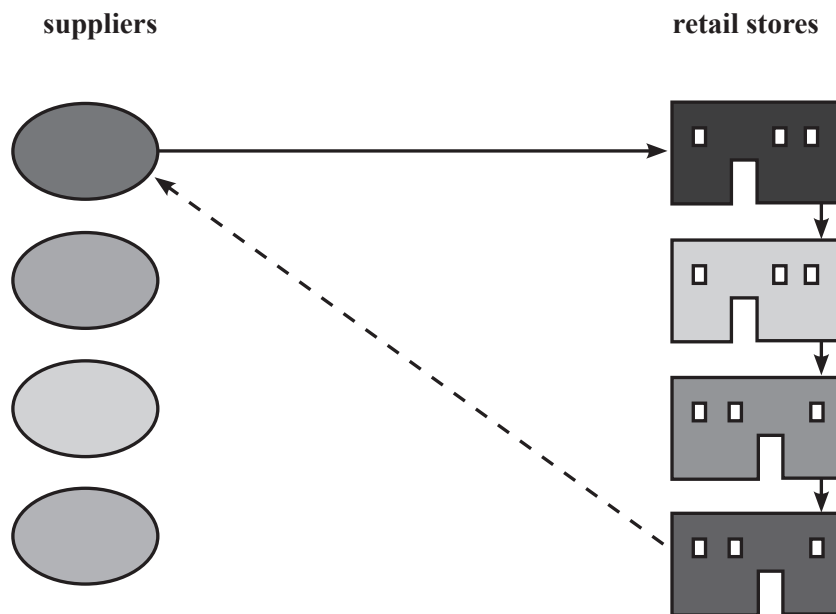


Fig. 5.12 Direct shipping network with milk runs

(Source: http://www.marcbowles.com/courses/adv_dip/module4/module6/m6four1.htm)

Shipments via central distribution network

Supplier does not send shipment to buyer location. The buyer divides location by geographic origin; a distribution centre is built for each region. Supplier sends their shipment directly to buyer location. The distribution centre is a layer between supplier and buyer location and can play two different roles: one is to store inventory and other to serve as a transfer location.

The trucks carry goods to the distribution centre, which is sorted and consolidated with other products and transferred to loading dock to load on a truck.

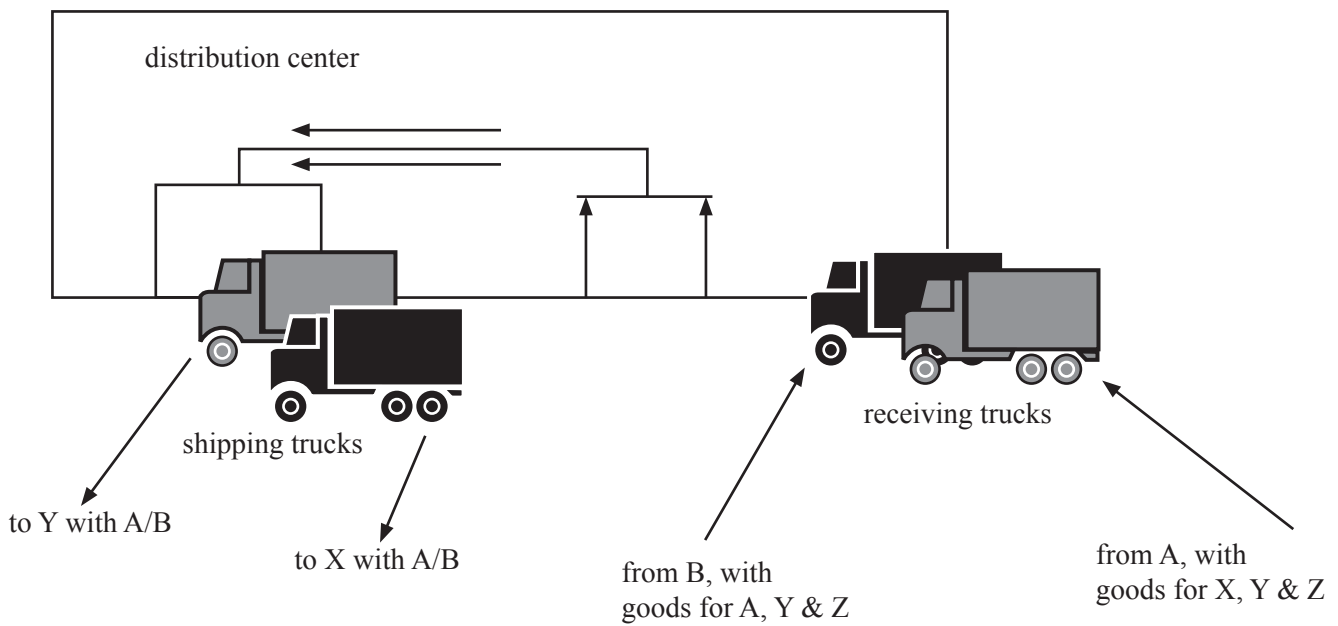


Fig. 5.13 Shipments via central distribution network

(Source: http://www.marcbowles.com/courses/adv_dip/module4/module6/m6four1.htm)

Shipping via DC using milk runs

Milk run can be used from a distribution centre if there are small lots to be delivered to each buyer.

Tailored network

The tailored network is the integration of supply chain services with the core product in order to give each customer a value added product which has been tailor made according to the requirement. Thus, it becomes a key differentiator of a product in an age of mass production when there is a very limited scope of differentiation among the core products themselves. It is the combination of options that reduces the cost and improves responsiveness of supply chain.

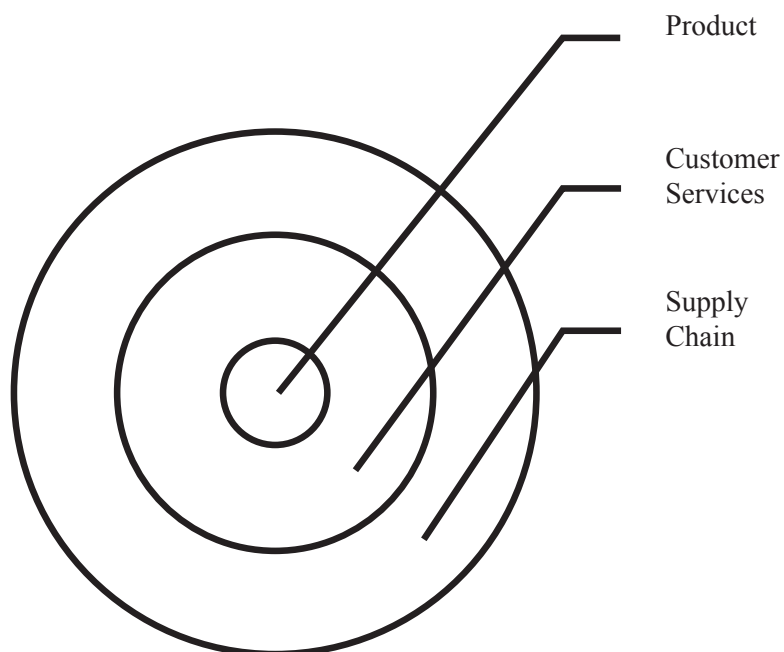


Fig. 5.14 A Tailored network

Tailored transportation

The use of different transportation networks and modes based on customer and product characteristics is tailored transportation. The factors affecting tailoring are:

- Customer distance and density
- Product demand and value
- Customer order size

5.16 Trade-off in Transportation Design

A trade-off implies a decision to be made with full comprehension of both the sides- up and down of a particular choice. Whatever decision is taken must be a trade-off that best meets the interest of the consumer whilst retaining profitability of the firm.

The design task is to trade-off the factors of decision making to meet the demands of the marketplace. All transportation modes have their pros and cons which make the decision of selecting the ideal transportation mode. Basically, the two major decisions a supply chain manager needs to make with respect to trade-offs in transportation are:

- Trading transportation costs over inventory costs and subsequently overall costs
- Trading transportation costs over inventory aggregation

Inventory aggregation decreases the supply chain costs if the product has a high value to weight ratio, high demand uncertainty and customer's orders are large and vice versa. The effect of a transportation mode on a supply chain aids in the decision making process; i.e., does one transportation mode make the supply chain more customer responsive than the other even though it is quite expensive, or is there a cheaper mode that responds a lot more slower to customer demands than another. The supply chain manager has to make the appropriate decision and it is most likely based on the following factors:

- Cost
- Ability to fill the transporting vehicle
- Protection of contents from theft, weather etc.
- Shipping time
- Availability of insurance on contents, delivery and other items and factors of importance
- Difficulty of arranging shipment like strict governmental regulations
- Delivery accommodation, for instance, how many other modes need to be employed apart from the primary mode to get products to the final consumer?
- Seasonal considerations like weather, flight delays in rainy seasons
- Size of the product to be shipped like cars, computer components
- Perishability of the product been shipped

5.17 Routing and Scheduling in Transportation

Routing and scheduling refers to the selection of customers visited by particular vehicle and the sequence in which they will be visited. Routing and scheduling must be done to reduce transportation cost and at the same time make deliveries in the earliest time possible and meet the promised level of customer responsiveness. The efficient mobility of goods is the optimal routing and scheduling.

The objective to minimise cost can be by:

- Decrease in number of vehicles
- Reducing total travelling distance and time
- Reduce service failures (delays)

Two basic approaches in routing and scheduling are:

Savings matrix method

The savings matrix method steps are:

- Identify the distance matrix
- Identify the savings matrix
- Assign customers to vehicles or routes
- Sequence customers within routes

From the figure below, it is clear that the visit starts and ends at the same destination AB. The savings (X, Y) is the distance saved in the trips. So, the trips are combined to make a single trip.

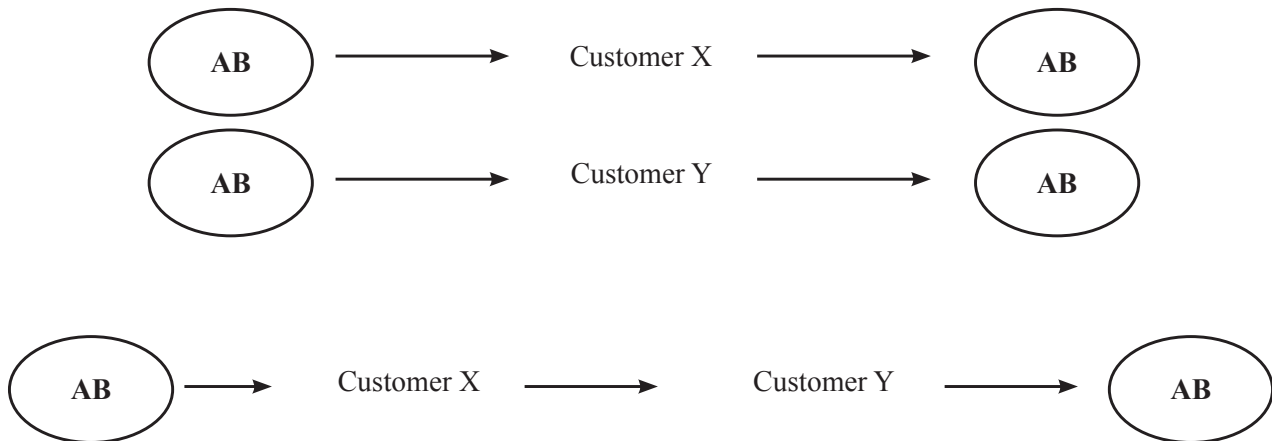


Fig. 5.15 Savings matrix method

Generalised assignment method

The generalised assignment method steps are:

- Assign seed points for each route
- Evaluate insertion cost for each customer
- Assign customers to routes
- Sequence customers within routes

5.18 Making Transportation Decisions in Practice

The following points should be considered while making any decisions related to transportation in supply chain:

- Alignment of transportation strategy with competitive strategy
- Consideration of both in-house and outsourced transportation
- Designing a transportation network that can handle e-commerce
- Use of technology to improve transportation performance
- Designing flexibility into the transportation network

Summary

- The supply chain network is the collection of physical locations, transportation vehicles and supporting systems through, which the products and services the firm markets are managed and ultimately delivered.
- Emerging technologies and standards are now making it possible to automate these supply chain networks in a real time mode making them more efficient than the simple traditional supply chain.
- The distribution is one of the four elements of the marketing mix. The other three parts of the marketing mix are product, pricing, and promotion.
- Distribution is a key driver of the overall profitability of a company because it directly impacts both the supply chain costs and customer experience.
- There is increasing number of complicated supply chains. So, the distribution network design plays a key role in controlling the cost of doing business.
- Since, controlling of the cost of doing business is an important factor; it can put supply chain network optimisation goals ahead of competitors. The choice of distribution network can achieve supply chain objectives from low cost to high responsiveness.
- Distribution network design options must be compared according to their impact on customer service and the cost to provide this level of service.
- Transportation costs are high with drop shipping because the average outbound distance to the end consumer is large and package carriers must be used to ship the product that have high shipping costs per unit compared to truckload carriers.
- Transportation system is the key element in a supply chain. It joins the separated activities. Transportation occupies one-third of the amount in the supply chain costs.
- The fixed facilities are the physical components of the system that are fixed in space and constitute the network of links and nodes of the transportation system.
- The success of any supply chain is closely linked to the appropriate use of transportation.
- There are two key players in any transportation that takes place within a supply chain namely shipper and carrier.
- The adequacy of transport infrastructure is a key factor in the ability of countries to compete in international trade. Competition for new exports and location of global industries largely depends on the quality of transport infrastructure.

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Self Assessment

1. Supply chain distribution often introduces _____ into the economic market.
 - a. common men
 - b. middlemen
 - c. suppliers
 - d. distributors
2. Which of these is not involved in the distribution network design?
 - a. Locating production plants and distribution warehouses
 - b. Determining the best strategy for distributing the product from the plants to the warehouses and from the warehouses to the customers
 - c. Controlling the cost of doing business
 - d. Achieve supply chain objectives from high cost to low responsiveness
3. _____ is the ability of the customer to track their order from placement to delivery.
 - a. Customer experience
 - b. Product availability
 - c. Order visibility
 - d. Product variety
4. A _____ always wants the highest level of performance along with the above dimensions.
 - a. supplier
 - b. customer
 - c. distributor
 - d. retailer
5. A decrease in the response time which the customers desire, increases the number of facilities required in the _____.
 - a. networks
 - b. distribution
 - c. supply chain
 - d. location
6. Which is the key element in a supply chain which joins the separated activities?
 - a. Infrastructure
 - b. Production
 - c. Transportation
 - d. Distribution
7. _____ is the branch of engineering involving design of the fixed facilities.
 - a. Civil engineering
 - b. Genetic engineering
 - c. Mechanical engineering
 - d. Software engineering

8. The _____ is that party, which requires the movement of the product between two points in the supply chain.
- shipper
 - carrier
 - distributor
 - consumer
9. As _____ rises, infrastructure adopts to support changing patterns of demand, with the shares of power, transport and communication.
- per capita income
 - national income
 - gross income
 - firm's income
10. Which of the following statement is false?
- Competition for new exports and location of global industries largely depends on the quality of transport infrastructure.
 - The adequacy of transport infrastructure is a key factor in the ability of countries to compete in international trade
 - Transport is the key factor to link dispersed areas.
 - Transport increases the social efficiency of resources.

Chapter VI

Sourcing and Pricing

Aim

The aim of this chapter is to:

- define sourcing and pricing
- explain the concept of in-house and outsource in supply chain
- describe the procurement process

Objectives

The objectives of this chapter are to:

- describe the concept of supplier selection and scoring
- explain the direct and indirect procurement
- illustrate the method of scoring and assessment of suppliers

Learning outcome

At the end of this chapter, you will be able to:

- understand the strategy of revenue management
- analyse the management of revenue for multiple customers
- state the benefits of outsourcing

6.1 Introduction

Sourcing strategy deals with planning, designing and building a reliable and competitive supplier base, determining the strategy for procurement, defining pricing strategies and supply chain requirements. The strategy involves confirming to the objectives of stake holders in operations, finance, marketing and distribution. Some supply chain managers favour “everyday low pricing” strategies to reduce demand distortion, improve customer service, and lower costs. Others apply “high-low pricing” strategies to clear slow moving items and build retail traffic, thereby increasing revenues.

6.2 Sourcing

Sourcing is an entire set of business processes required to purchase goods and services. Sourcing processes include:

- Supplier scoring and assessment
- Supplier selection and contract negotiation
- Design collaboration
- Procurement
- Sourcing planning and analysis

The most significant decision is either to outsource or perform in-house. In business, the term word sourcing refers to a number of procurement practices, aimed at finding, evaluating and engaging suppliers of goods and services. The methodology involved in procuring the necessary materials, supplies, and services necessary to sustain a supply chain system.

A thorough understanding of a company’s business strategy, the resources required to deliver that strategy, the market forces and the unique risks within the company associated with implementing specific approaches is essential for success. To ensure the achievement of desired results and continued alignment with business objectives, a periodic review of the sourcing strategy is needed.

The sourcing strategies used in supply chain management include:

- **Single sourcing:** Single sourcing is a method whereby a purchased part is supplied by only one supplier. A Just-in-time (JIT) manufacturer will frequently have only one supplier for a purchased part so that close relationships can be established with a less number of suppliers. These close relationships and mutual interdependence promote high quality, reliability, less time and cooperative action.
- **Multi-sourcing:** Multi-sourcing is a method whereby procurement of a good or service is from more than one independent supplier. It is used sometimes in a company to induce healthy competition between the suppliers in order to achieve higher quality and lower price.
- **Outsourcing:** Outsourcing is the process of having suppliers that provide goods and services previously provided internally. Outsourcing involves the replacement of internal capacity and production by that of the supplier. This third party can increase the supply chain surplus relative to performing the activity in house. Outsourcing makes the sense only if it increases the supply chain surplus without increasing the risks.
- **Insourcing:** Insourcing is the process where the goods or services are developed internally.

6.3 In-house and Outsource

Insourcing (or in-house, contracting in) is defined as the delegation of operations from production within a business to an internal but independent entity that specialises in that operation for example, either by hiring local subcontractors or building a facility.

Insourcing is a business decision made to maintain control of critical production or competencies. The independent entity is internal yet not a part of the organisation and will usually have a specialized team who will be proficient in the providing the required services. For example, Toshiba insourced with UPS (Unit Parcel Service) in a way that UPS now is in control of the supply chain for Toshiba. If a customer’s laptop at home needs repair, UPS will pick it up and fix it at the Toshiba/UPS Repair Centre and deliver it back to the customer. UPS is the in charge of delivering products for Toshiba.

Organisations sometimes take such business decisions because it enables them to maintain a better control of what they outsource. For example, organisations involved in production usually opt for insourcing in order to cut down the cost of labour and taxes. (e.g., American labour is often cheaper than European labour), transportation, etc. Since the year 2006, the trend towards insourcing has increased.

According to recent studies, there is more work insourced than outsourced in the U.S and U.K. These countries are currently the largest outsourcers in the world. The U.S and U.K outsource and insource work equally. Insourcing is loosely referred to in call centres that are doing the work of the outsourcing companies. Some of the companies that outsource include Dell, Wipro, and Symantec etc.

Outsourcing (or contracting out, sub-servicing) refers to the process of contracting to a third-party. Outsourcing involves the contracting out of a business function - commonly one previously performed in-house - to an external provider. The two organisations may enter into a contractual agreement involving an exchange of services and payments. For example, BMW outsourced with Boss Sound System in a way that Boss does all the music for the BMW cars. It is cheaper for BMW to make a deal with Boss sound system instead of opening a new factory to produce speakers and subwoofers. Boss is in charge of doing sound systems in BMW. The ability of businesses to outsource to suppliers outside the nation is referred to as off-shoring or offshore outsourcing.

Outsourcing has the following benefits:

- **Cost savings:** Outsourcing lowers the overall cost of the service to the business, involving reducing the scope, defining quality levels, re-pricing, re-negotiation, and cost re-structuring. Labour arbitrage is the access to lower cost economies through off-shoring, which has been generated by the wage gap between industrialised and developing nations.
- **Focus on core business:** Resources (for example, investment, people, and infrastructure) are focused on developing the core business. Organisations outsource their IT support to specialised IT services companies.
- **Cost restructuring:** Operations leverage is a measure that compares fixed costs to variable costs. Outsourcing changes the balance of this ratio by offering a move from fixed to variable cost and also by making variable costs more predictable.
- **Improve quality:** Contracting out the service with a new service level agreement achieves an improved quality.
- **Knowledge:** Outsourcing helps to access to intellectual property and wider experience and knowledge.
- **Contract:** Services are provided to a legally binding contract with financial penalties.
- **Operational expertise:** Access to operational best practice that would be too difficult or time consuming to develop in-house.
- **Access to talent:** Access to a larger talent pool and a sustainable source of skills, particularly in science and engineering.
- **Capacity management:** Services and technology where the risk in providing the excess capacity is borne by the supplier needs capacity management.
- **Catalyst for change:** Outsourcing can be used as a catalyst for major step change that cannot be achieved alone and the outsourcer becomes a change agent in the process.
- **Enhance capacity for innovation:** Companies increasingly use external knowledge service providers to supplement limited in-house capacity for product innovation.
- **Reduce time to market:** Outsourcing helps to accelerate the development or production of a product through the additional capability brought by the supplier.
- **Commodification:** Outsourcing enables to buy the product at the right price.
- **Risk management:** An outsourcer is better able to provide the mitigation of risks.
- **Tax benefit:** Countries offer tax incentives to move manufacturing operations to counter high corporate taxes within another country.

- **Scalability:** The outsourced company is prepared to manage a temporary or permanent increase or decrease in production.
- **Creating leisure time:** It optimises the work-leisure balance.

6.4 3PL and 4PL

Third-party logistics (3PL) involves using external organisations to execute logistics activities that have previously been performed within an organisation itself. The third-party logistics includes any form of outsourcing of logistics activities previously performed in-house. For example, a company with its own warehousing facilities employing external transportation. Third party logistics, 3PL provider performs one or more of the logistics activities relating to the flow of product, information and funds. Traditionally, 3PLs focused on specific functions such as transportation, warehousing and information technology.

Third parties increase the supply chain surplus effectively if they are able to aggregate supply chain assets to a higher level than a firm itself. It can be done by:

- Capacity aggregation
- Inventory aggregation
- Transportation aggregation by transportation intermediaries
- Transportation aggregation by storage intermediaries
- Warehousing aggregation
- Procurement aggregation
- Information aggregation
- Receivables aggregation
- Relationship aggregation
- Lower costs and higher quality

There can be following risks of using a third party logistics:

- Loss in continuation of process
- Underestimation of the cost of coordination
- Reduced customer supplier contact
- Loss of internal capability and growth in third party power
- Sensitive data and information leakage
- Ineffective contracts

A fourth-party logistics (4PL) targets management of the entire process, whereas a third party logistics (3PL) service provider targets a function. 4PL may be a general contractor who manages other 3PLs, truckers, forwarders and custom house agents. Outsourcing a noncore activity such as logistics does not guarantee any growth in SC surplus. The basic advantage that a 4PL may provide comes from greater visibility and coordination over the firm's supply chain, which requires sophisticated information technology which is both costly and needs expertise.

6.5 Benefits of Effective Sourcing Decisions

The benefits of the effective sourcing decisions are listed below:

- Better economies of scale can be achieved if orders are aggregated.
- More efficient procurement transactions can significantly reduce the overall cost of purchasing.
- Good procurement processes can facilitate coordination with suppliers.
- Design collaboration can result in products that are easier to manufacture and distribute, finally resulting in lower overall costs.
- Appropriate supplier contracts can allow for the risk sharing.
- By increasing competition through the use of auctions, the firms can achieve a lower purchase price.

6.6 Supplier Scoring and Assessment

Suppliers are an intrinsic part of the supply chain. Poor performance of the suppliers can hinder the business activities. Supplier performance should be compared on the basis of the supplier's impact on total cost.

There are factors besides purchase price that influence total cost are:

- Replenishment lead time
- On-time performance
- Supply flexibility
- Delivery frequency or minimum lot size
- Supply quality
- Inbound transportation cost
- Pricing terms
- Information coordination capability
- Design collaboration capability
- Exchange rates, taxes, duties
- Supplier viability

Supplier evaluation provides with an in-depth assessment of performance set against objective and detailed criteria.

6.6.1 Scoring Suppliers

The first part of supplier's evaluation process is the scoring of suppliers. Performance in terms of delivery, lead time, and the quality of items supplied, the price, service levels and so on can be done. It assesses all of the suppliers against the set standards.

Some scoring systems offer the opportunity to utilise weighting according to the importance of certain criteria. For example, if price is viewed as very important, then that will be given a greater importance than something viewed as less important, which could be invoicing procedures etc. Often there are various sub-divisions within any one measure. For example, the price of the product is not just about its cost. Other factors affecting price include the stability of the price, acceptability and accuracy of the invoicing procedures and notice given about any changes to the price etc. So there are other hidden factors that need to be taken into consideration.

6.6.2 Ranking Suppliers

The analysis is complete when the supplier is ranked after scoring. This provides the customer with a real insight into who is performing well, who is average and who is weak at the bottom of the association. The ability of ranking is that it can be used to share information with suppliers, so that those who are performing poorly can work towards improving their performance. Often details of other suppliers may not be shared, but individual suppliers will be furnished with details of their score and rank.

The ranked suppliers can be grouped (typically into A, B, C groups). Specific groups may then result in targeted action (often along the lines of develop, maintain or exit). A true picture finally emerges of the supplier performing well and the weakest link to some extent. The table below is the method for supplier's scoring and ranking.

Factors influencing total cost	Purchase				Production
	Price of	Inventory		Transportation	Introduction
	Component	Cycle	Safety	Cost	Time
Replenishment lead time			X		
On-time performance			X		
Supply flexibility			X		
Delivery frequency		X	X	X	
Supply quality	X		X		
Inbound transport cost				X	
Pricing terms	X	X			
Information coordination			X	X	
Design collaboration	X	X	X	X	X
Exchange rates and taxes	X				
Supplier viability			X		X

Table 6.1 Scoring and assessment of suppliers

6.7 Supplier Selection

The selection of the supplier can be performed through:

- **Offline competitive bids:** It is a transparent procurement method in which bids from competing contractors, suppliers, or vendors are invited by advertising the scope, specifications, and terms and conditions of the proposed contract as well as the criteria by which the bids will be evaluated. This aims at obtaining goods and services at the lowest prices by stimulating competition, and by preventing partiality.
- **Reverse auctions:** In a reverse auction, sellers compete to obtain business, and prices typically decrease over time. A reverse auction is a type of auction in which the roles of buyers and sellers are reversed. In an ordinary auction, buyers compete to obtain a good or service, and the price typically increases over time.
- **Direct negotiations:** Direct negotiations refer to exclusive negotiations between an agency and a supporter without first undergoing a genuine competitive process. Direct negotiations are sometimes referred to as directly sourced, single-invited or non-competed contracts.

Supplier evaluation is based on total cost of using a supplier and not just the purchase price. Buyers usually use a price-only auction.

Design collaboration

50-70 of the cost in a manufacturing is through procurement and 80% of the cost of a purchased part is fixed in the design phase. It is important to employ design for logistics and for manufacturability. Design collaboration with suppliers can result in reduced cost, improved quality, and decreased time to market. Throughout the supply chain, manufacturers must become effective design coordinators.

6.8 Procurement Process

Procurement is the acquisition of goods or commodities by a company, organisation, institution, or a person. Procurement in supply chain is the process in which the supplier sends product in response to orders placed by the buyer. The goal of such process is to enable orders to be placed and delivered on schedule at the lowest possible overall cost. Based on the consumption purposes of the acquired goods and services, procurement activities are often split into two distinct categories. The two categories are:

- **Direct procurement:** Involves the components used to make finished goods, coordination and visibility with supplier should be improved to focus on the direct materials
- **Indirect procurement:** Involves the goods used to support the operations of a firm, decreasing the transaction cost for each order should be the focus

	Direct procurement	Indirect procurement	
Features	Raw material and production goods	Maintenance, repair and operating supplies	Capital goods and services
Quantity	Large	Low	Low
frequency	High	Relatively high	Low
Value	Industry specific	Low	High
Nature	Operational	Tactical	Strategic
Examples	Crude oil in petroleum industry	Lubricants, spare parts	Machinery, computers

Table 6.2 Categories of procurement

6.9 Sourcing Planning and Analysis

The procurement spending and supplier performance should be periodically analysed by the firm and analysis must be as an input for future sourcing decisions and to ensure appropriate economies of scale. Supplier performance analysis should be used to differentiate the suppliers with complementary strengths:

- Cheaper but lower performing suppliers should be used to supply base demand
- Higher performing but more expensive suppliers should be used to buffer against variation in demand and supply from the other source

6.10 Pricing and Revenue Management for Multiple Customers

Pricing is one of the most important elements of the marketing mix, which generates a turnover for the organisation. The remaining 3P's are the variable cost for the organisation: costs to produce, design, distribute and promote a product. Price must support these elements of the mix. Pricing reflects the supply and demand relationship.

Pricing should take into account the following factors:

- Fixed and variable costs
- Competition
- Company objectives
- Proposed positioning strategies
- Target group and willingness to pay

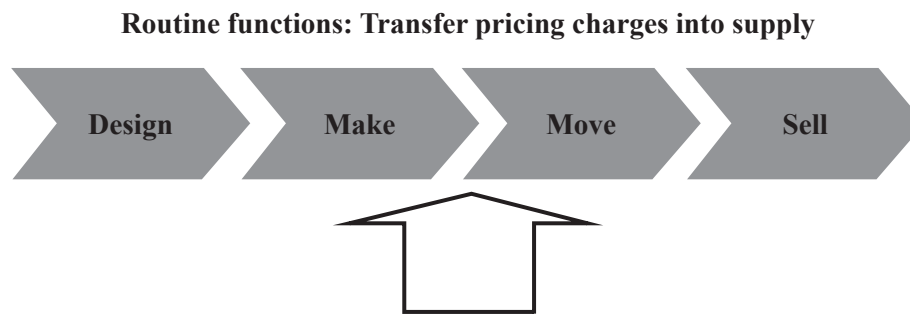


Fig. 6.1 Pricing charges into supply chain

Revenue Management encompasses a wide range of opportunities to increase revenue. It predicts consumer behaviour at the micro-market level and optimises product availability and price to maximise revenue growth. The primary aim is selling the right product to the right customer at the right time for the right price. The essence of this discipline is in understanding customer's perception of product value and accurately aligning product prices, placement and availability with each customer segment.

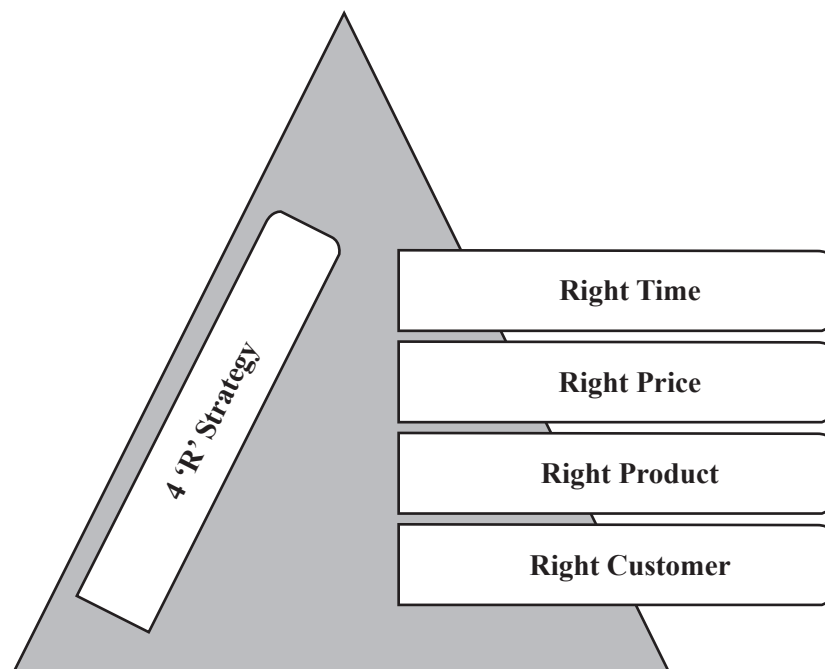


Fig. 6.2 The 4 “R” strategy of revenue management

The primary levels of revenue management are:

Pricing

Pricing involves redefining pricing strategy and developing disciplined pricing tactics. The value created for customers are anticipated and then specific prices to capture that value are set. A company may decide to price against their competitors or even their own products, but the most value comes from pricing strategies that closely follow market conditions and demand.

A pricing strategy dictates what a company wants to do; pricing tactics determine how a company actually captures the value. Price optimisation involves constantly optimising multiple variables such as price sensitivity, price ratios, and inventory to maximise revenues. A successful pricing strategy and pricing tactics can drastically improve a firm's profitability.

Inventory

The price or allocation of capacity is fixed in inventory management. Discount on products can increase volume that is by lowering prices on products, a company can overcome weak demand and gain market share, which ultimately increases revenue so long as each product sells for more than its marginal cost. When demand is strong for a product but the threat of cancellations looms (example, hotel rooms or airline seats), firms often overbook in order to maximise revenue from full capacity.

Marketing

Temporarily decreasing the price of their products, companies sell high volume of products. There should be a balance between volume growth and profitability. An effective promotion helps maximise revenue when there is uncertainty about the distribution of customer willingness to pay. When a company's products are sold in the form of long-term commitments, such as internet or telephone service, promotions help attract customers who will then commit to contracts and produce revenue over a long time horizon.

Channels

Different distribution channels may represent customers with different price sensitivities. For example, customers who shop online are usually more price sensitive than customers who shop in a physical store. Different channels often have different costs and margins associated with those channels. Multiple channels to retailers and distributors push more products without loss in quality.

6.11 Perishable Products and Seasonal Demand

Seasonal items like fruits, fish, winter cosmetics, fashion apparel, and so on, generally exhibits different demand patterns at various times during the season. Production and inventory planning must consider this property for cost effectiveness and optimisation of resources.

Economic order quantity, number of orders to be placed and/or the time to place each order should be checked due to four different types of problems that may be encountered in practice.

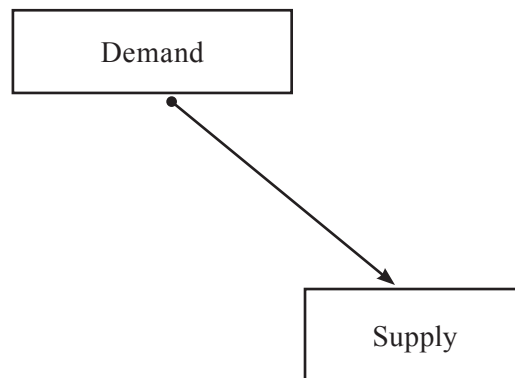


Fig. 6.3 Pegging in SCM

The first problem assumes a fixed planning horizon and perishable products such as Christmas trees or fashion merchandise whose value deteriorates as the item gets aged. Under constant demand assumption, solution for this type of problem is to capture the deterioration in value by increasing holding cost. Holding prices or exchange rates fixed over some time period is called pegging.

The second problem is similar to first, except that the demand is assumed to increase as time proceeds. The third problem allows a specific number of integer orders during the planning horizon. The fourth problem allows the ordering cost to increase as time progresses.

Warehousing refers to the activities involving storage of goods on a large-scale in a systematic and orderly manner and making them available conveniently when needed. It refers to holding or preserving goods in huge quantities from the time of their purchase or production till their actual use or sale. It creates time utility by bridging the time gap between production and consumption of goods.

Warehousing arises due to the following reasons:

- Seasonal production of goods
- Seasonal demand
- Large-scale production
- Quick supply
- Continuous production
- Price stabilisation

The functions of warehouses are:

- Storage of goods
- Protection of goods
- Risk bearing
- Financing

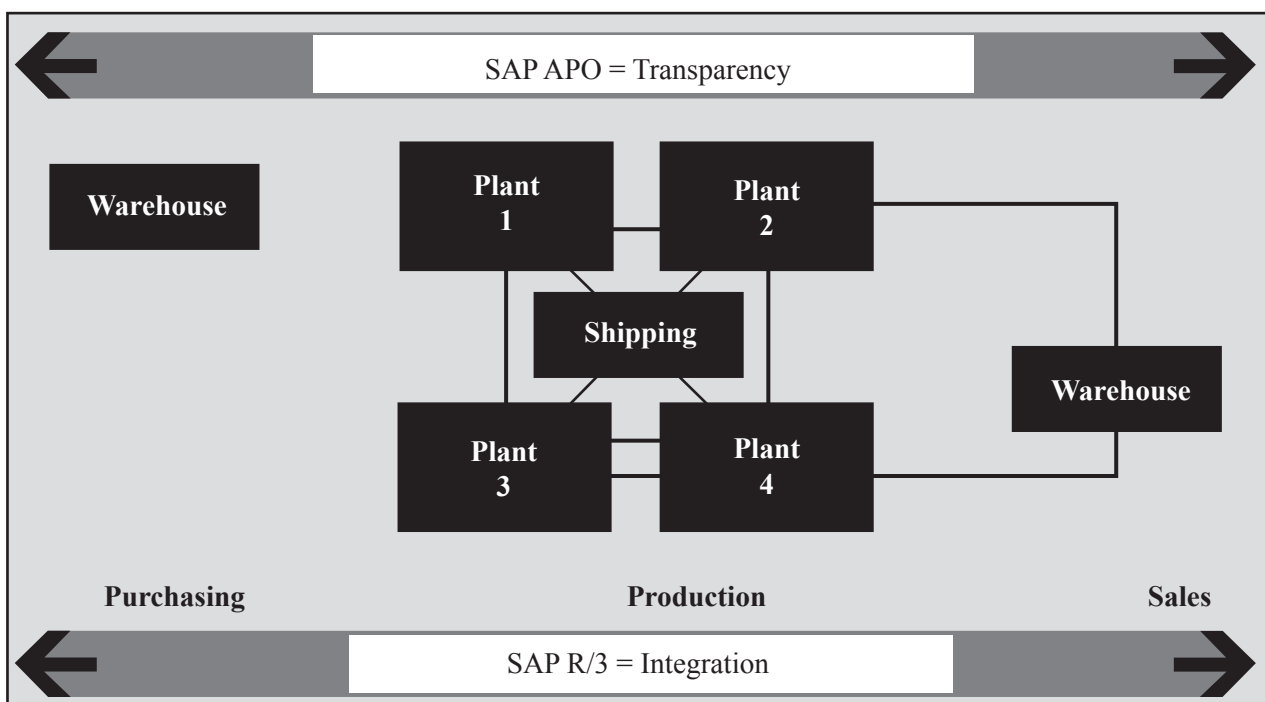


Fig. 6.4 Warehousing in SCM

(Source: <http://en.sap.info/product-clustering-provides-transparency/3264>)

Summary

- Sourcing strategy deals with planning, designing and building a reliable and competitive supplier base, determining the strategy for procurement, defining pricing strategies and supply chain requirements.
- Sourcing is the entire set of business processes required to purchase goods and services.
- A Just-in-time (JIT) manufacturer will frequently have only one supplier for a purchased part so that close relationships can be established with a less number of suppliers.
- Single sourcing is a method whereby procurement of a good or service is from more than one independent supplier. It is used sometimes in a company to induce healthy competition between the suppliers in order to achieve higher quality and lower price.
- Outsourcing involves the contracting out of a business function - commonly one previously performed in-house-to an external provider.
- Third-party logistics (3PL) involves using external organisations to execute logistics activities that have previously been performed within an organisation itself.
- The first part of supplier's evaluation process is the scoring of suppliers. Performance in terms of delivery, lead time, and the quality of items supplied, the price, service levels and so on can be done.
- Direct negotiations refer to exclusive negotiations between an agency and a supporter without first undergoing a genuine competitive process.
- Revenue management encompasses a wide range of opportunities to increase revenue. It predicts consumer behaviour at the micro-market level and optimises product availability and price to maximise revenue growth.
- Economic order quantity, number of orders to be placed and/or the time to place each order should be checked.

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Self Assessment

1. _____ is the entire set of business processes required to purchase goods and services.
 - a. Sourcing
 - b. Pricing
 - c. Assessment
 - d. Scoring
2. Which type of sourcing is the process of having suppliers that provide goods and services previously provided internally?
 - a. Outsourcing
 - b. Multisourcing
 - c. Single sourcing
 - d. Insourcing
3. _____ is the access to lower cost economies through off-shoring, which has generated by the wage gap between industrialised and developing nations.
 - a. Off-shoring
 - b. In-sourcing
 - c. Labour arbitrage
 - d. Outsourcing
4. Which is the quality that enables to buy the product at the right price?
 - a. Labour arbitrage
 - b. Scalability
 - c. Commodification
 - d. Outsourcing
5. Which of the following statements is false?
 - a. Suppliers are an intrinsic part of the supply chain. Poor performance of the suppliers can hinder the business activities.
 - b. Supplier performance should be compared on the basis of the supplier's impact on total cost.
 - c. Supplier evaluation provides with an in-depth assessment of performance set against objective and detailed criteria.
 - d. The first part of supplier's evaluation process is the ranking of suppliers.
6. Which of the following statements is false?
 - a. The price of the product is only about its cost.
 - b. Some scoring systems offer the opportunity to utilise weighting according to the importance of certain criteria.
 - c. In a reverse auction, sellers compete to obtain business, and prices typically decrease over time.
 - d. Direct negotiations are sometimes referred to as directly sourced, single-invited or non-competed contracts.

7. _____ usually use a price-only auction.
- Buyers
 - Sellers
 - Distributors
 - Retailers
8. What percentage of the cost of a purchased part is fixed in the design phase?
- 30
 - 50
 - 80
 - 90
9. _____ in supply chain is the process in which the supplier sends product in response to orders placed by the buyer.
- Procurement
 - Design collaboration
 - Sourcing
 - Pricing
10. _____ reflects the supply and demand relationship.
- Pricing
 - Sourcing
 - Competition
 - Fixed and variable costs

Chapter VII

Dimensions of Logistics

Aim

The aim of this chapter is to:

- define logistics
- explain the micro and macro dimension of logistics
- describe the value added role of logistics

Objectives

The objectives of this chapter are to:

- classify different logistics interfaces
- explain the activities of logistics
- enlist the approaches to analyse logistic systems

Learning outcome

At the end of this chapter, you will be able to:

- understand the logistic system analysis concept
- examine the factors affecting the cost and importance of logistics
- explain the dimensions of logistics

7.1 Introduction

Logistics in the 21st century touches every aspect of the company's daily operations and has grown into a business especially of its own. Strategic planning and resource management is a part of logistics management, but logistics is also about how companies go about their day and its impact. As a business specialty, the explosion of globalism has promulgated the practice of logistics. In the days of mostly domestic companies, shipping departments in most companies were run by an experienced shipping clerk. Since, there were only few people who could adequately understand how to get things done, it was a difficult task. Firms want their packages shipped and delivered on time.

Logistics is essential for the company's competitive strategy and survival. The buyer is not interested in the promises of the seller that he can supply goods at competitive price. If the supplier fails to meet the terms with the predetermined supply of period, the seller may not only get his sale amount back, but may also be legally penalised, if the sales contract specifies so. The better delivery schedule is a good promotional strategy when buyers are unwilling to invest in warehousing and keeping higher level of inventories. Similarly, better and timely delivery helps in getting repeat orders through the goodwill created.

Effective logistics system contributes immensely to the achievements of the business and marketing objectives of a firm. It creates time and place utilities in the products and thereby helps in maximising the value satisfaction to consumers. By ensuring quick deliveries in minimum time and cost, it relieves the customers of holding excess inventories. It also brings down the cost of carrying inventory, material handling, transportation and other related activities of distribution. In nutshell, an efficient system of physical distribution/logistics has a great potential for improving customer service and reducing costs.

7.2 Macro and Micro Dimension

The dimensions of logistics are categorised as:

- Macro dimension
- Micro dimension

7.2.1 Macro Dimension

The macro dimension of logistics are categorised as value added role and economic impacts.

Value-added role of logistics

The value-added role of logistics includes the form, place, time and possession utilities.

Form utility (what)

Logistics provides form utility through manufacturing or assembly operations. Logistics provides form utility through its impact on shipment size and packaging.

Place utility (where)

Logistics provides place utility by moving goods from production surplus points to points where demand exists. Reducing logistics costs expands market area for firm.

Time utility (when)

Logistics creates time utility by having goods and services available when demanded. Logistics creates time utility by inventory management, transportation management, and strategic location of goods and services.

Possession utility (why)

Created through the basic marketing activities related to the products and services promotion. These economic utilities are also referred to as the seven 'R's namely, Right product, Right quantity, Right condition, Right place, Right time, Right customer, and Right cost.

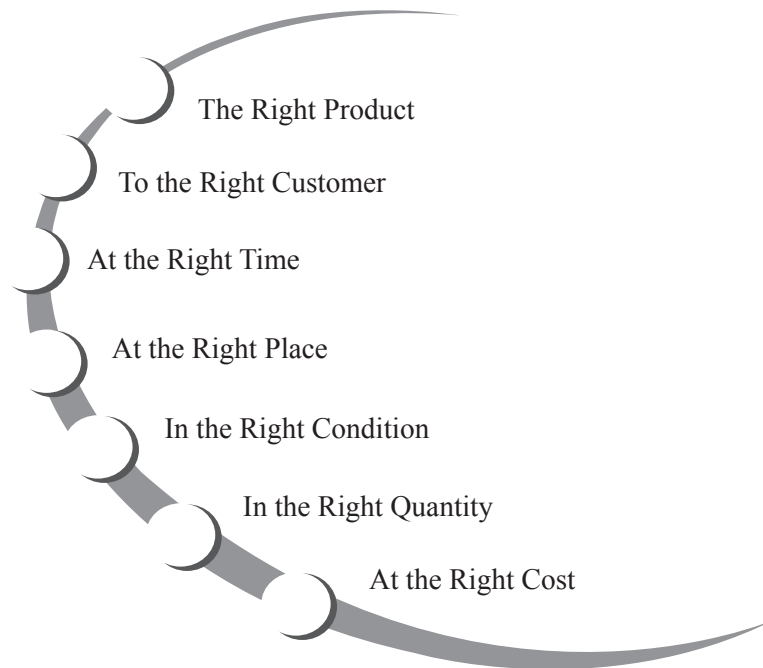


Fig. 7.1 Seven 'R's in supply chain

(Source: <http://www.careersinsupplychain.org/what-is-scm/7rights.asp>)

Economic impacts of logistics

The economic impacts of logistics include the economic development and specialisation, variety of goods, prices and land values.

Economic development and specialisation

For economic development, investment in transportation is an essential part. The extent of market can be determined by logistics.

Variety of goods

Logistics capabilities enable the ability to provide a wide variety of goods.

Prices

Logistics represents about 10% of gross domestic product. It also represents a much larger percentage of the value of many products and services.

Land values

If there is access to transportation service, it affects the economic potential of land.

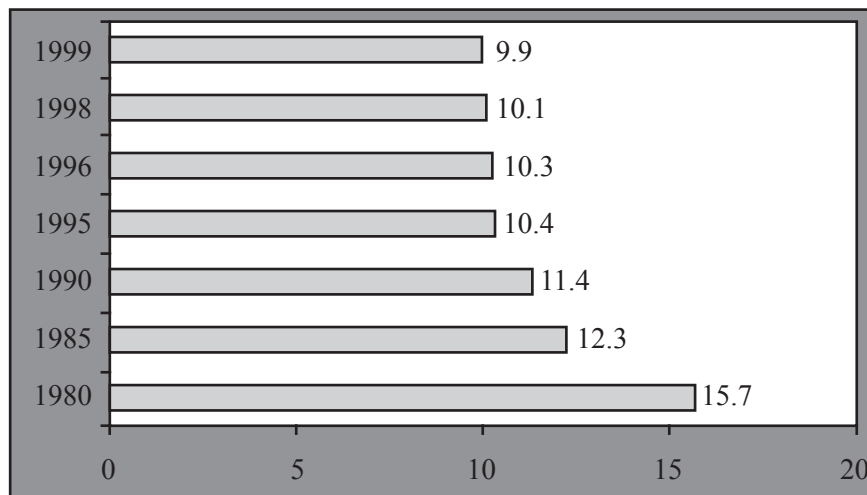


Fig. 7.2 Logistics costs as a percentage of GDP

(Source: http://www.swlearning.com/quant/coyle/seventh_edition/powerpoint/ch02.ppt)

As indicated in above figure, logistics costs as a percentage of gross domestic product (GDP) have declined from 16 percent in 1980, to under 10 percent in 1999. Early to mid-1970s saw the figure closer to 20 percent. This reflects a serious improvement in the efficiency of logistics systems.

7.2.2 Micro Dimensions

The micro dimensions of logistics are categorised as interfaces with operations or manufacturing and interfaces with marketing.

Logistics interfaces with operations/manufacturing

The logistics interfaces with operations or manufacturing include the length of production run, seasonal demand, supply-side interface and protective packaging.

Length of production run

Previously, the firms sought production economies by producing large volumes each time they had a production line setup or changeover. However, this led to very large inventory levels move to “pull” systems rather than “push” systems.

On markets the consumers usually “pulls” the goods or information they demand for their needs, while the offers or suppliers “pushes” them toward the consumers. The push strategy in marketing can be found in the communication (either interactive or non-interactive) between seller and buyer. For example, if the seller makes his promotion by television or radio, it’s not possible for the buyer to interact with. On the other hand, if the communication is made by phone or internet, the buyer has possibilities to interact with the seller.

In the first case information is just “pushed” toward the buyer, while in the second case it is possible for the buyer to demand the needed information according to his requirements.

In a “pull” system the consumer requests the product and “pulls” it through the delivery channel. For example, a mobile manufacturing company assembles parts to produce mobile phone. The process before production of the phone is push process but the process after production is pull process, as the manufacturer is predicting that the product will be accepted. As the customer orders for mobile phone it will become Pull Process.

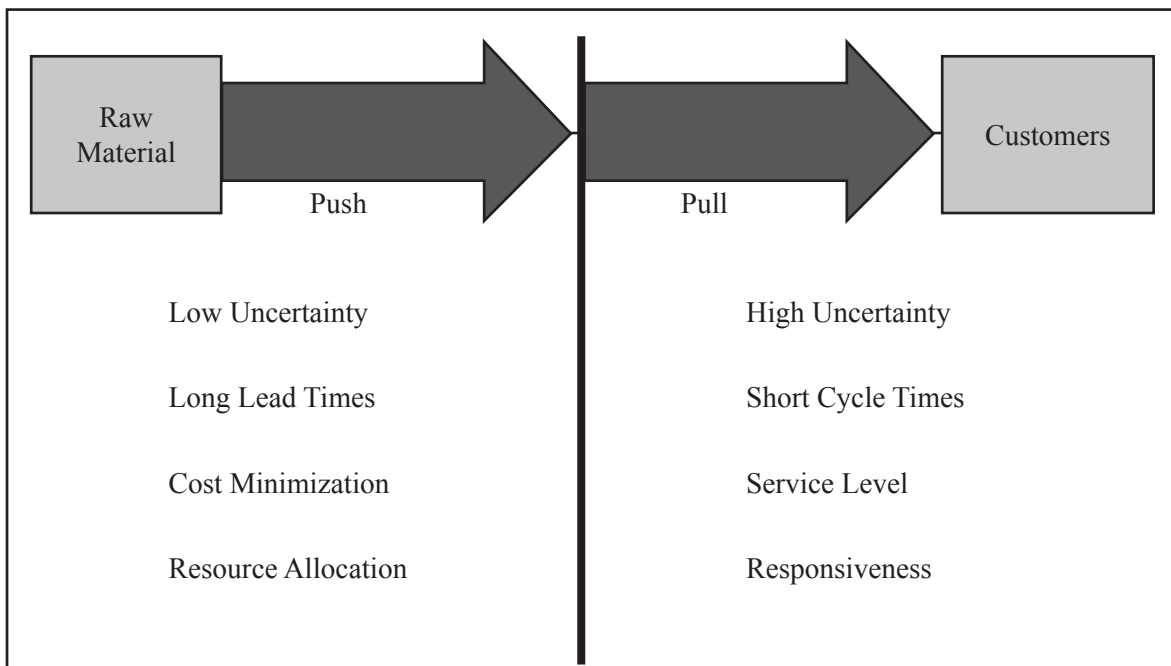


Fig. 7.3 Push and pull systems in supply chain

(Source: <http://www.personal.psu.edu/faculty/a/c/acc10/CHAP02.ppt>)

Seasonal demand

Build-up of seasonal inventories to meet demand and to smooth production

- Supply-side interface
 - materials management
 - supplier relations is critical to efficient production and logistics
 - logisticians involved in production scheduling
- Protective packaging
 - most firms consider this a logistics activity

Logistics interfaces with marketing

The logistics interfaces with marketing include the price, product, promotion, place and customer services.

- Price

The product pricing schedule is often tied to transportation pricing schedule (that is, price discounts occur for product given at volumes where transportation price discounts are present). The logistics costs must be included in the product price.
- Product

The size, shape, weight (density), packaging, and other physical characteristics affect logistics. For example, any product size and weight affects transportation and storage. Industrial packaging is done because of product protection and security
- Promotion

The promotion campaigns need to be coordinated with logistics staff.
- Place

The logistics interfaces with marketing also refer to the distribution channels decisions (example, sell through wholesalers or direct to retailers)

Customer service is the output of logistics. It depends upon following factors:

- Time
- Dependability
- Communications
- Convenience

7.3 Logistics Activities

The logistics activities are listed below:

- **Transportation** is the physical movement or flow of goods
 - Mode and transport service selection
 - Carrier routing
 - Vehicle scheduling
 - Equipment selection
 - Claims processing
- **Storage** includes inventory management and warehousing
 - Space determination
 - Stock layout and dock design
 - Warehouse configuration
 - Stock placement
- **Packaging** is affected by product and transportation
 - Design for handling
 - Storage
 - Protection from loss and damage
- **Materials handling** in movement, from, and within a warehouse
 - Equipment selection
 - Equipment replacement policies
 - Order picking policies
 - Stock storage and retrieval
- **Order fulfilment**: completing customer orders, affects lead time.
- **Forecasting**: predicting inventory necessary to fulfil customer demand.
- **Production planning**: product necessary to cover market.
- **Information maintenance**
 - Information collection, storage, and manipulation,
 - Data analysis
 - Control procedures
- **Purchasing**
 - Supply source selection
 - Purchase timing
 - Purchase quantities
- **Customer service**
- **Site location**
- **Inventory management**: raw material and finished goods
 - Stocking policies
 - Short-term sales forecasting

- Product mix at stocking points
- Number, size and location of stocking points
- Just in time, push and pull strategies

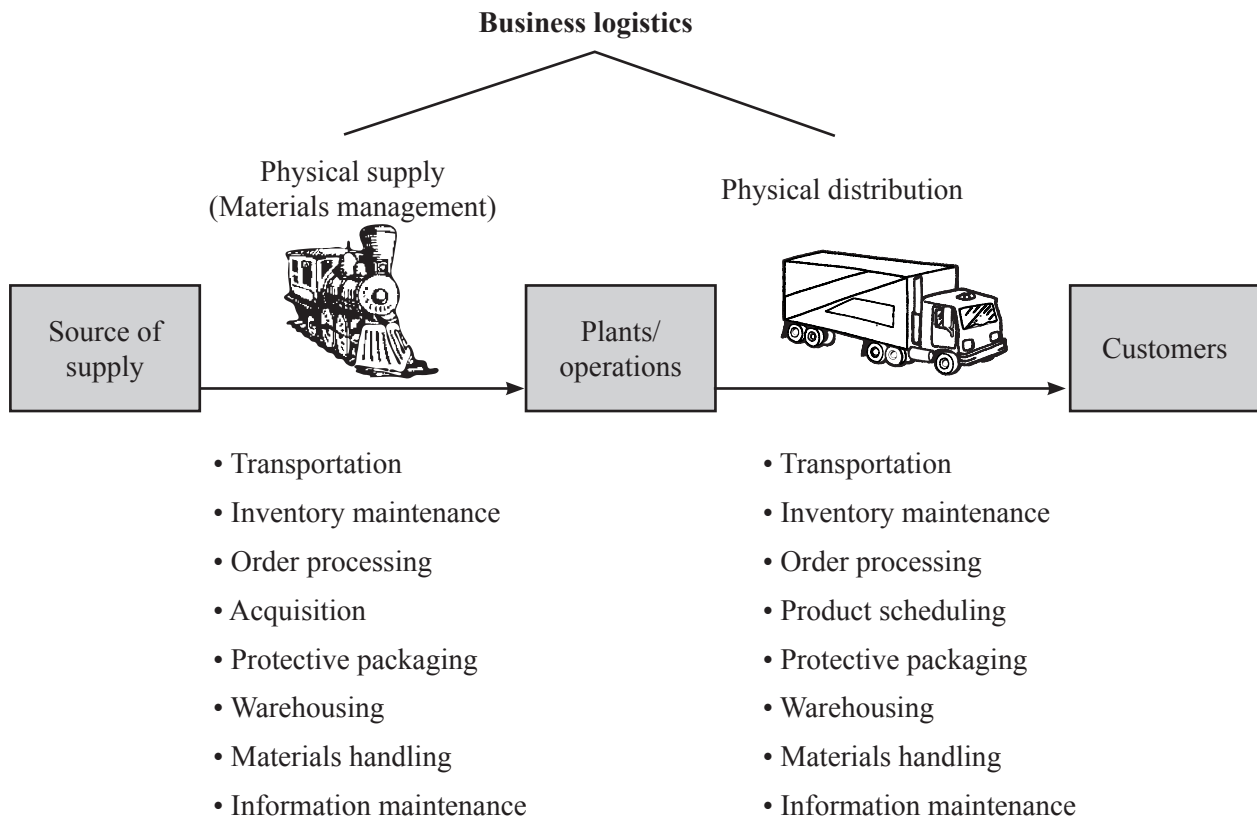


Fig. 7.4 Logistic activities

(Source: <http://info.cba.ksu.edu/ehie/faculty%20site%20templates/mangt%20662/sc-strategy&e-scm.ppt>)

- For example, every month the Toyota distribution moves more than 8 million parts and accessories. It is a 30 year old distribution network. This resulted in two distribution centres, one in California, another in Kentucky, feeding nine smaller distribution centres located around the country. Thus, the new network both improved customer service and lowered costs.

7.4 Approach to Analysing Logistics Systems

- Any system is a set of interacting elements, variables, parts or objects that are functionally related to one another and that form a coherent group. Logistics can be classified into:
 - Materials management (Inbound logistics)
 - Physical distribution (Outbound logistics)
- Inbound Logistics involves the processes from the purchase of raw material till it reaches manufacturing unit. The departments which are involved in-bound logistics are:
 - Purchasing department
 - Warehouse
 - Manufacturing unit
- Outbound Logistics delivers the finished goods or product to the customer as per their requirement. It is their responsibility to determine the shortest route through which transportation cost is the minimum.

- Usually the movement and storage of raw materials in a company is very different from the movement and storage of finished products. For example, a steel company may move required raw materials of iron ore and coal by large rail carload. Storage may require land where these items can be dumped and piled for future use. On the other hand, the finished steel will very often be moved by motor carrier, and the storage will require an enclosed facility for protection against the elements and, perhaps, elaborate materials handling equipment.

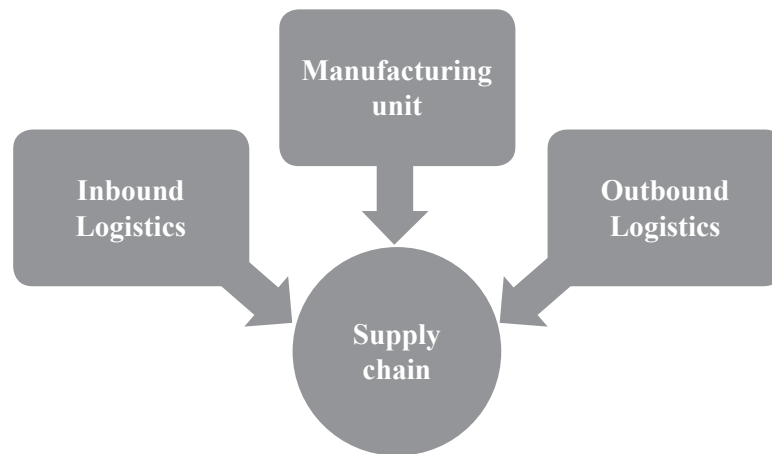


Fig. 7.5 Inbound and outbound logistics

- The movement and storage of raw materials is extremely different from the movement and storage of finished goods. This classification is very useful to logistics management.
- From the inbound and outbound requirements perspective, there are four different classifications of logistics system:
 - **Balanced system:** Companies receive supplies from various vendors in different locations and ship to various customers in different locations, for example; consumer products.
 - **Heavy inbound:** The process requires no warehousing, special transportation arrangements, or packaging. In contrast, the inbound side requires detailed scheduling, coordination, and planning to ensure that parts arrive in time. Aircraft companies use thousands of parts manufactured by hundreds of vendors to assemble and produce a finished airplane. Once the airplane is finished and tested, the company simply flies it to the customer e.g. aircraft, construction.
 - **Heavy outbound:** A wide variety of industrial and consumer products are produced that need storage, packaging, and transportation to the final customer. Therefore, in a company with heavy outbound, the physical distribution side of logistics system is more complex for example, chemicals companies like Dow.
 - **Reverse systems:** Some companies have reverse flows on the outbound side of their logistics systems. In the companies producing durable products that the customer may return for trade-in, for repairs, or for disposal. Companies that produce computers, telephone equipment, and copy machines have these characteristics. Increased concern with the environment will require more companies to develop reverse logistics systems to dispose of packaging materials on used products for example, returnable products.

Trade-offs

To make it easier to study cost trade-offs between the centres, logistics activities are treated as cost centres.

Cost Centers	Rail	Motor
Transportation	\$ 3.00	\$ 4.20
Inventory	5.00	3.75
Packaging	4.50	3.20
Warehousing	1.50	.75
Cost of Lost Sales	2.00	1.00
Total Cost	\$ 15.00	\$ 13.00

Table 7.1 Analysis of total logistics cost with a change to higher cost mode of transport

(Source: http://www.swlearning.com/quant/coyle/seventh_edition/powerpoint/ch02.ppt)

Cost Centers	System 1	System 2
	Three Warehouses	Five Warehouses
Transportation	\$ 850,000	\$ 500,000
Inventory	1,500,000	2,000,000
Warehousing	600,000	1,000,000
Cost of Lost Sales	350,000	100,000
Total Cost	\$ 3,300,000	\$ 3,600,000

Table 7.2 Analysis of total logistics cost with a change to more warehouses

(Source: http://www.swlearning.com/quant/coyle/seventh_edition/powerpoint/ch02.ppt)

Nodes versus links

Nodes are spatial points (warehouses, plants, and so on). Links are the transportation network (rail, motor, air, pipe and water).

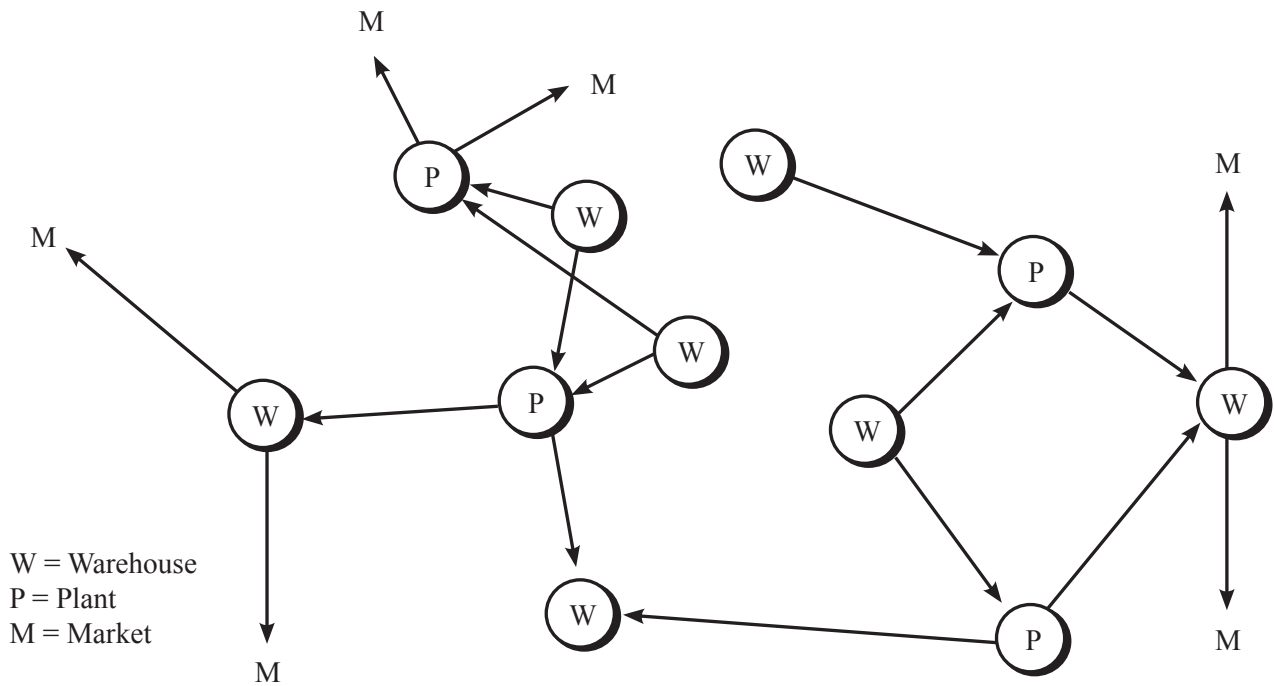


Fig. 7.6 Nodes and links in a logistics system

(Source: http://www.swlearning.com/quant/coyle/seventh_edition/powerpoint/ch02.ppt)

Logistics channel

The network of intermediaries involved in the logistics system.

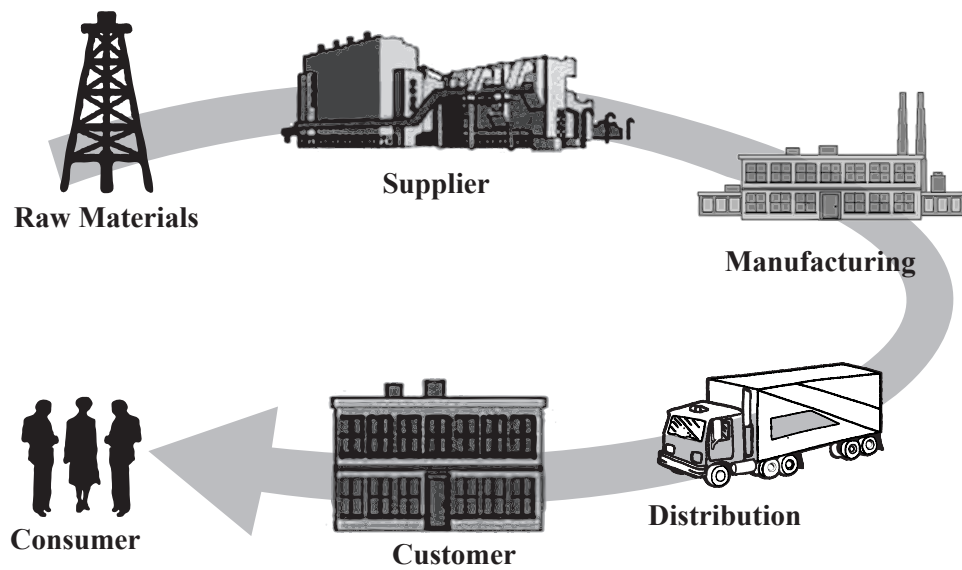


Fig. 7.7 A simple logistics channel

(Source: http://www.necareerguidance.com/category/sub_category.php?cat_id=111)

7.5 Logistics and Systems Analysis

The logistics and system analysis include:

Optimisation in supply chain

It is the application of processes and tools to ensure the optimal operation of a manufacturing and distribution supply chain. This includes the optimal placement of inventory within the supply chain, minimising operating costs (including manufacturing costs, transportation costs, and distribution costs). The logistics and system analysis is done in terms of cost and optimality.

Cost perspective

The most efficient systems are not always comprised of each system component operating at its lowest possible cost. The critical concern is to have the entire system operating at its lowest total cost.

Level of optimality

Logistics systems must work in harmony with marketing, finance, production, and so on. This may result in sub-optimal logistics performance.

7.6 Techniques of Logistics System Analysis

There are two techniques of total cost analysis for logistics systems.

Short-run/static analysis

The costs associated with various interrelated logistics activities such as transportation, warehousing, inventory, materials handling, and industrial packaging are calculated. This cost information for each system is developed and the one with the lowest overall cost within the constraints of the company's logistics area is found out. This method is also referred to as static analysis since it analyses costs associated with a logistics system's various components at one point in time or at one output level. This can be illustrated with the help of an example. ABC is a firm which uses first method in which all rail routes from the manufacturing plant and the associated plant warehouse to the customers.

At the plant warehouse, the chemicals are bagged and then shipped by rail to the customer. In another method, ABC uses the market oriented warehouse in which the goods would be shipped from the plant to the market warehouse and then packaged and sent to the customer. Thus, instead of shipping all goods by rail, the company would ship them by barge to the warehouse, taking advantage of low bulk rates. Then, after bagging, the chemicals would move by rail from the warehouse for shipping to the customer. Thus, the technique chooses the short run situation and selects the system with the lowest overall cost.

Plant Logistics Costs*	System 1	System 2
Packaging	\$ 500	\$ 0
Storage and handling	150	50
Inventory carrying	50	25
Administrative	75	25
Fixed cost	4,200	2,400
Transportation Costs*		
To market warehouse	0	150
To customer	800	100

Warehouse Costs*		
Packaging	0	500
Storage and handling	0	150
Inventory carrying	0	75
Administrative	0	75
Fixed cost	0	2,400
Total cost*	\$ 5,775	\$5,950
*In thousands of dollars.		

Table 7.3 Static analysis of C & B chemical company (50,000 pounds of output)
 (Source: http://www.swlearning.com/quant/coyle/seventh_edition/powerpoint/ch02.ppt)

Long-run/dynamic analysis

This is a mathematical method to calculate the point of equality between the two systems. For example, suppose there are two systems 1 and 2, equal at about 70,500 pounds of output. If a graph is used to determine the equality point, the accuracy is difficult. The equation for a straight line ($y = a + bx$) is considered in mathematical solution, where

- “a” = fixed costs
- “b” = variable cost per unit
- “x” = output level

Since, the two systems are equal at some point, the two equations are set up as equal and the cost information is used to solve these equations. Known is the fact that at approximately 70,500 pounds, the two systems are equal, and a point of indifference is seen between the two systems.

System 1

If, Total cost = fixed cost + variable cost/unit \times number of units

Then, $y = 4,200 + 0.0315x$ ----- equation 1

System 2

$y = 4,800 + 0.0230x$ -----equation 2

Trade-off point

$4,800 + 0.0230x = 4,200 + 0.0315x$ (equation 1 = equation 2)

$600 = 0.0085x$

$x = 70,588$ pounds

7.7 Factors Affecting the Cost and Importance of Logistics

The factors affecting the cost and importance of logistics are:

- Competition via customer service is an important factor affecting logistics.
 - The shorter the order cycle, less inventory is required.

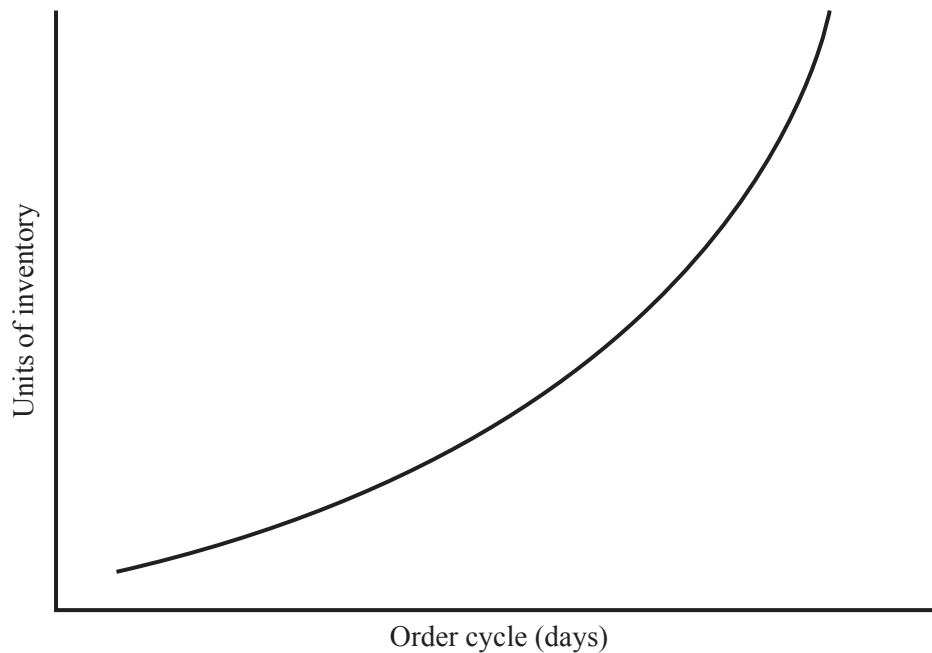


Fig. 7.8 Relationship between required inventory and order cycle length

(Source: http://www.swlearning.com/quant/coyle/seventh_edition/powerpoint/ch02.ppt)

- The more substitutable product, the higher customer service level is required.
- Increase in inventory, reduces cost of lost sales.

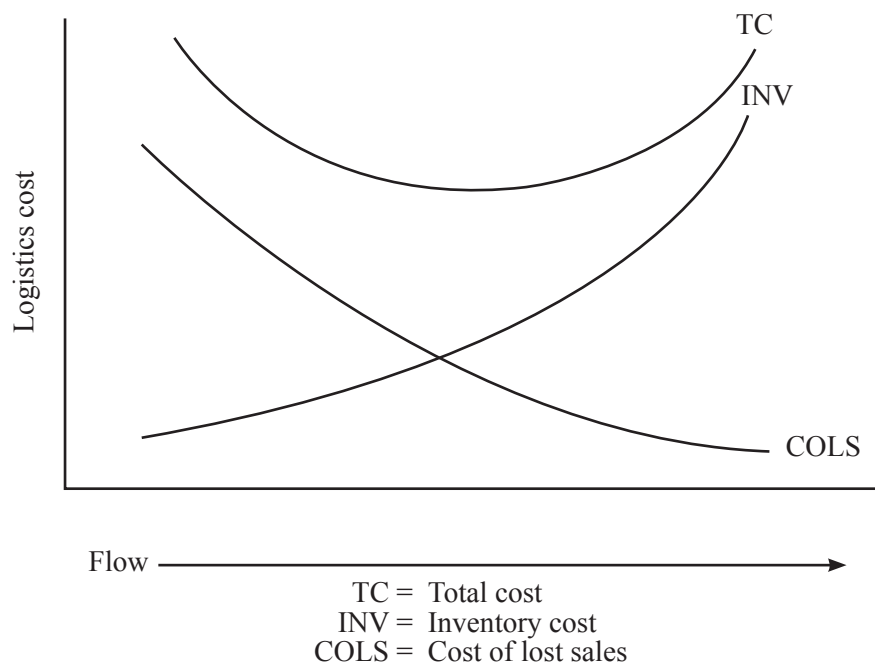


Fig. 7.9 Relationship of the cost of lost sales to inventory cost

(Source: http://www.swlearning.com/quant/coyle/seventh_edition/powerpoint/ch02.ppt)

- Increased transportation costs, reduces cost of lost sales.
- The final product also affects the logistics.
- As the dollar value goes up, cost of warehousing, transportation and inventory increases.

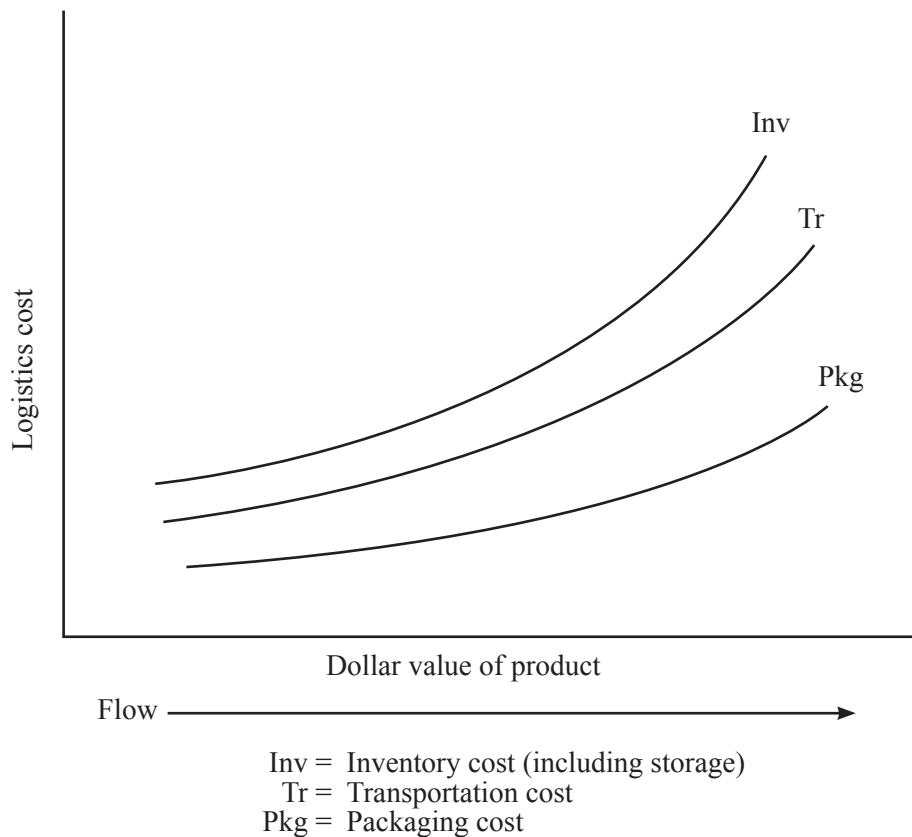


Fig. 7.10 Relationship of product dollar value to various logistics costs

(Source: http://www.swlearning.com/quant/coyle/seventh_edition/powerpoint/ch02.ppt)

The higher the density, there is more efficient use of warehouse and transportation space. If the risk of damage is greater, the transportation and warehousing cost is higher. Special handling requirements, spatial relationships and distance are other factors affecting the cost and importance of logistics.

Summary

- Effective logistics system contributes immensely to the achievements of the business and marketing objectives of a firm.
- An efficient system of physical distribution/logistics has a great potential for improving customer service and reducing costs.
- The macro dimension of logistics are categorised as value added role and economic impacts.
- On markets the consumers usually “pulls” the goods or information they demand for their needs, while the offers or suppliers “pushes” them toward the consumers.
- The logistics interfaces with marketing include the price, product, promotion, place and customer services.
- Static analysis method analyses costs associated with a logistics system’s various components at one point in time or at one output level.
- Some companies have reverse flows on the outbound side of their logistics systems.
- Companies that produce computers, telephone equipment, and copy machines have these characteristics. Increased concern with the environment will require more companies to develop reverse logistics systems to dispose off packaging materials on used products, for example, returnable products.
- Optimisation in supply chain is the application of processes and tools to ensure the optimal operation of a manufacturing and distribution supply chain. This includes the optimal placement of inventory within the supply chain, minimising operating costs (including manufacturing costs, transportation costs, and distribution costs).
- The higher the density, there is more efficient use of warehouse and transportation space. If the risk of damage is greater, the transportation and warehousing cost is higher.
- Special handling requirements, spatial relationships and distance are other factors affecting the cost and importance of logistics.

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- Rushton A., Croucher P., Baker P., 2006. *The handbook of logistics and distribution management*, Kogan Page Publishers, 3rd ed., p.612.

Self Assessment

1. _____ in supply chain is the application of processes and tools to ensure the optimal operation of a manufacturing and distribution supply chain.
 - a. Optimisation
 - b. Forecasting
 - c. Collaboration
 - d. Planning
2. In _____, companies receive supplies from various vendors in different locations and ship to various customers in different locations.
 - a. heavy inbound
 - b. balanced system
 - c. heavy outbound
 - d. reverse systems
3. To make it easier to study cost trade-offs between the centres, logistics activities are treated as _____.
 - a. distribution centres
 - b. links
 - c. cost-centres
 - d. nodes
4. Which are the spatial points in logistics system?
 - a. Links
 - b. Stocks
 - c. Nodes
 - d. Channels
5. _____ involves predicting inventory necessary to fulfill customer demand.
 - a. Forecasting
 - b. Planning
 - c. Collaboration
 - d. Order fulfilment
6. Which of these is not a factor of customer service?
 - a. Time
 - b. Promotion
 - c. Dependability
 - d. Communications
7. Which of the following statements is false?
 - a. The logistics activities include transportation, warehousing, inventory, materials handling, and industrial packaging.
 - b. Order fulfilment in supply chain is the application of processes and tools to ensure the optimal operation of a manufacturing and distribution supply chain.
 - c. The most efficient systems are not always comprised of each system component operating at its lowest possible cost.
 - d. Logistics systems must work in harmony with marketing, finance, production, etc.

8. Which of the following statements is false?
- a. The logistics interfaces with marketing also refers to the distribution channels decisions (example, sell through wholesalers or direct to retailers).
 - b. The promotion campaigns need to be coordinated with logistics staff.
 - c. The logistics costs should never be included in the product price.
 - d. Industrial packaging is done because of product protection and security.
9. Logistics represents about _____ of gross domestic product.
- a. 10%
 - b. 90%
 - c. 2%
 - d. 19%
10. The extent of market can be determined by_____.
- a. production costs
 - b. logistics
 - c. stock-outs
 - d. demand

Chapter VIII

Demand Management and Customer Service

Aim

The aim of this chapter is to:

- define demand management
- explain the importance of customer service in competitive market
- discuss the concept of collaborative planning, forecasting and replenishment

Objectives

The objectives of this chapter are to:

- describe the concept of forecasting error
- explain the forecasts that may be needed in demand management
- state different steps in demand management

Learning outcome

At the end of this chapter, you will be able to:

- understand the supply and demand relationship
- explain different channels of distribution of goods
- describe the effective demand management

8.1 Introduction

A market is a group of buyers and sellers of a particular product or service. Supply and demand is the most useful model for a competitive market, and shows how buyers and sellers interact in market. Whatever be the reasons, one element that is always present is price. If the price is too low, sellers will not sell. If the price is too high, buyers will not buy. Prices play a crucial role in our economic system. Demand management activities in any global supply chain consist of three activities: demand management, demand planning, and sales forecasting management. The Law of Demand states that “Quantity demanded varies inversely with (in the opposite direction to) changes in price”. Thus, buyers will purchase more of an item at a lower price and less at a higher price.

8.2 Outbound to Customer Logistics Systems

To increase levels of customer service, significant emphasis is placed on outbound-to-customer logistics systems. These systems refer to the set of processes, systems and capabilities that enhance the firm’s ability to serve its customers. This involves the study of physical distribution, logistics and supply chain management.

8.3 Supply and Demand Relationship

Demand refers to how much (quantity) of a product or service is desired by buyers. The quantity demanded is the amount of a product, people are willing to buy at a certain price; the relationship between price and quantity demanded is known as the demand relationship.

Supply represents how much the market can offer. The quantity supplied refers to the amount of a certain good, the producers are willing to supply when receiving a certain price. The correlation between price and how much of a good or service is supplied to the market is known as the supply relationship. Price, therefore, is a reflection of supply and demand.

The determinants of supply are:

- Production costs
- The technology used in production
- The price of related goods
- Firm’s expectations about future prices
- Number of suppliers

The determinants of demand are:

- Income
- Tastes and preferences
- Prices of related goods and services
- Buyer’s expectations about future prices
- Number of buyers
- Supply and demand determines price in a market

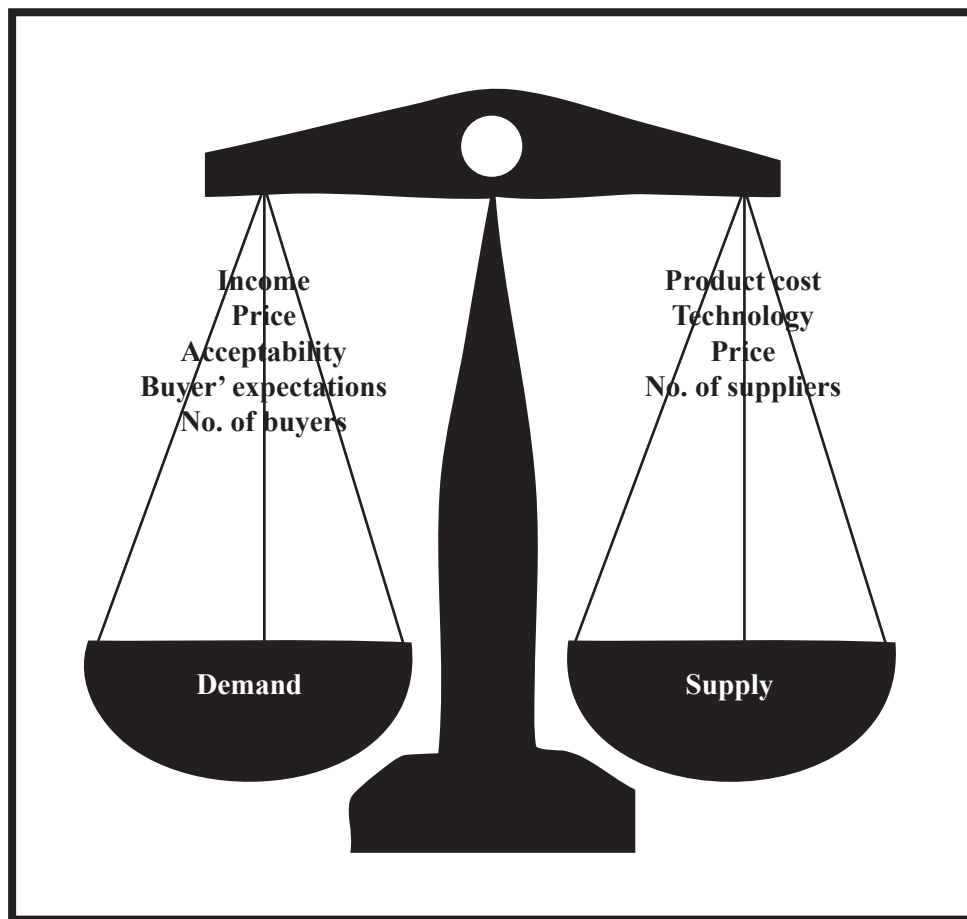


Fig. 8.1 Supply and demand balance

(Source: <http://www.therealestatefoundation.com/real-estate-investment-economics/low-prices-and-high-housing-inventory-profit-potential-or-losing-proposition/>)

In a competitive market, the unit price for a particular good varies until it settles at a point where the quantity demanded by consumers (at current price) will equal the quantity supplied by producers (at current price), resulting in an economic equilibrium of price and quantity.

The four basic laws of supply and demand are:

- If demand increases and supply remains unchanged, then it leads to higher equilibrium price and quantity.
- If demand decreases and supply remains unchanged, then it leads to lower equilibrium price and quantity.
- If supply increases and demand remains unchanged, then it leads to lower equilibrium price and higher quantity.
- If supply decreases and demand remains unchanged, then it leads to higher price and lower quantity.

8.4 Graphical Representation of Supply and Demand Relationship

The supply-demand model represents the determination of the price of a particular good and the quantity of that good which is traded. The standard graphical representation, usually credited to Alfred Marshall, has price on the vertical axis and quantity on the horizontal axis.

When supply and demand are equal (that is, when the supply function and demand function intersect) the economy is said to be at equilibrium. At this point of equilibrium, the allocation of goods is at its most efficient because the amount of goods being supplied is exactly the same as the amount of goods being demanded. Thus, everyone (individuals, firms, or countries) is satisfied with the current economic condition. At the given price, suppliers are selling all the goods that they have produced and consumers are getting all the goods that they are demanding.

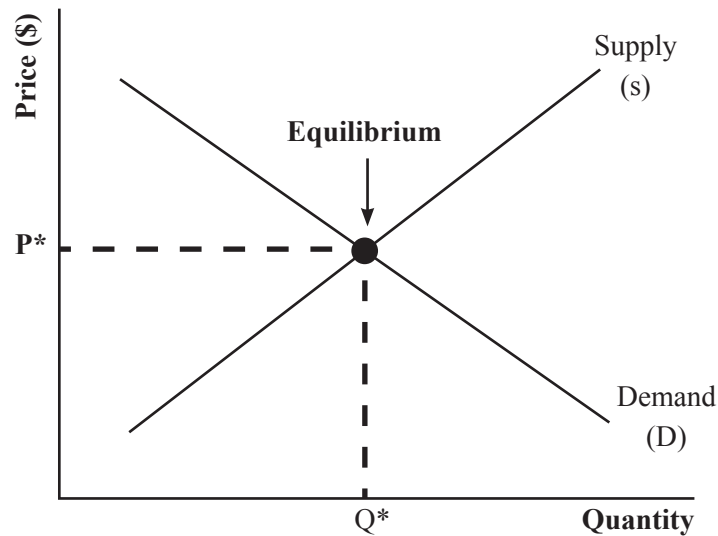


Fig. 8.2 Supply and demand equilibrium

(Source: <http://www.investopedia.com/university/economics/economics3.asp>)

Changes in supply and demand can be short run or long run in nature. Weather tends to influence market prices generally in the short run. Changes in consumer preferences can have either a short run or long run effect on prices depending upon the goods or services. They are categorised based on importance of product that is, luxuries or necessities. A luxury good may enjoy a short term shift in demand due to changing styles or appeal while necessities tend to have stable or long run demand curves.

Another major factor influencing market prices is technology. A major effect of technology in agriculture is to shift out the supply curve rapidly by reducing the costs of production on a per unit basis. Here is an example to illustrate the law of supply and demand. For a particular Saturday night, the willingness of particular restaurants to supply a nice dinner for two and the willingness of couples to dine out is observed, depending on the price of the dinner. There are five restaurants, each with a seating capacity of 30 couples. One restaurant is willing to supply a nice dinner for \$15 a couple, but the others require higher prices. If the price were \$15, everyone would show up at the one restaurant, so that it would have a very long line. Only 30 lucky couples would get to eat. There are 250 couples willing to go out for dinner, if the price were as low as \$12 a couple. Twenty couples would be willing to pay as much as \$80, but everyone else requires lower prices. Here is the whole picture.

Price of Dinner for Two	Supply offered by Restaurants	Demand from Consumers
\$12	0	250
\$15	\$30	200
\$25	\$60	140
\$35	\$60	60
\$45	\$90	50
\$65	\$120	40
\$80	\$150	20

Table 8.1 Demand fluctuations based on price and supply

The price P of a product is determined by a balance between production at each price (supply S) and the desires of those with purchasing power at each price (demand D). The diagram shows a positive shift in demand from $D1$ to $D2$, resulting in an increase in price (P) and quantity sold (Q) of the product.

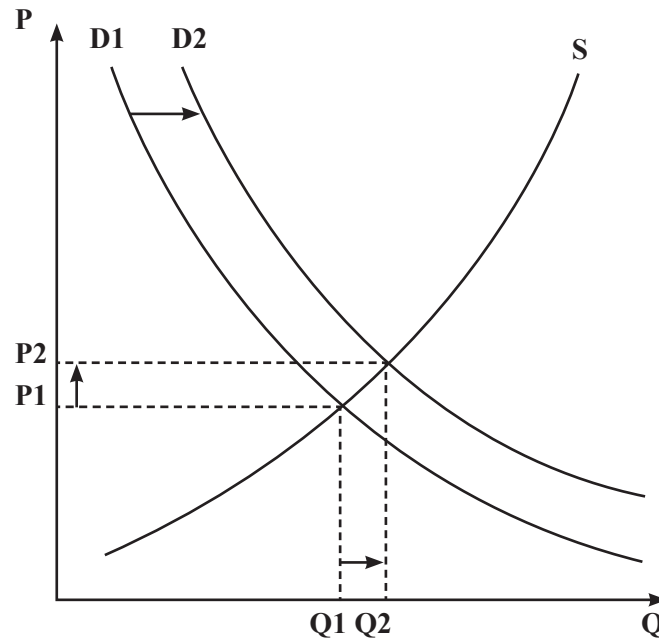


Fig. 8.3 Shift in demand

(Source: <http://sustainabilitynz.blogspot.com/2009/05/economicssupply-and-demand.html>)

8.5 Demand Management

Demand management is the supply chain management process that balances the customer's requirements with the capabilities of the supply chain. Managing supply with demand factors are essential using the right process, forecasting and executing the plan with minimal disruptions. It includes synchronising supply and demand, increasing flexibility and reducing variability.

Demand chain management is the management of upstream and downstream relationships between suppliers and customers to deliver the best value to the customer at the least cost to the demand chain as a whole. The organisation's supply chain processes are managed to deliver best value according to the demand of the customers. Successful demand management requires not only to provide more customer services, but also to provide:

- Effective service outcomes to meet identified community needs
- Assess if this need is changing
- To respond appropriately and within the available resources

Demand management is a key element of reform in the resource planning and management process. Demand can be managed in a variety of ways:

- Reduction in need for the service. For example, actions to raise awareness of the benefits of pregnant women taking foliate will reduce the need for medical and social support for children with neural tube defects.
- Alteration of ways to meet the needs to reduce pressure on available resources. For example, trialling different accommodation alternatives to reduce the demand for individual accommodation units.
- Education and awareness of consumers to limit consumption. For example, educating water users to save water during droughts has led to significant reduction in demand.

- Mechanisms of pricing. For example, charging consumers a truer price for water encourages more responsible use and may reduce the demand.
- Service delivery levels revision. For example, the threshold at which benefits become available or the level at which benefits are provided will be changed.
- Imposing legal penalty. For example, fines can be imposed for use of fixed sprinklers during the evening to reduce demand for additional reservoir pumping capacity.

8.5.1 The Demand Management Process

Demand management involves a number of key steps within the characteristic phases of any strategic management process which are, preparation, analysis, planning and implementation. The preparation phase involves gaining a proper understanding of your clients together with establishing the true costs of providing service. This provides the basic information for the analysis and planning phase in which the demand is clearly identified and a response to its management formulated.

In the implementation phase, a plan is prepared documenting the process stages including procedures for implementation, monitoring and evaluation of the defined Demand Management response. The benefits of demand management can be summarised as improving value for money spent on services through:

- More efficient allocation of resources to programs and projects of greatest need
- Reduced waste and misuse of resources by reducing the provision of unnecessary services by communicating (through charges, education or other means) the true cost of the service
- Deferred capital and recurrent expenditures by reducing excessive consumption
- Greater client participation and control over the cost of the service

For example, the Sydney harbour tunnel has reduced traffic delays and travel times. It has also provided the opportunity to dedicate one lane of the Harbour Bridge for buses. In the long term, the resulting shorter bus travel times will encourage public transport reducing the demand for further car crossings.

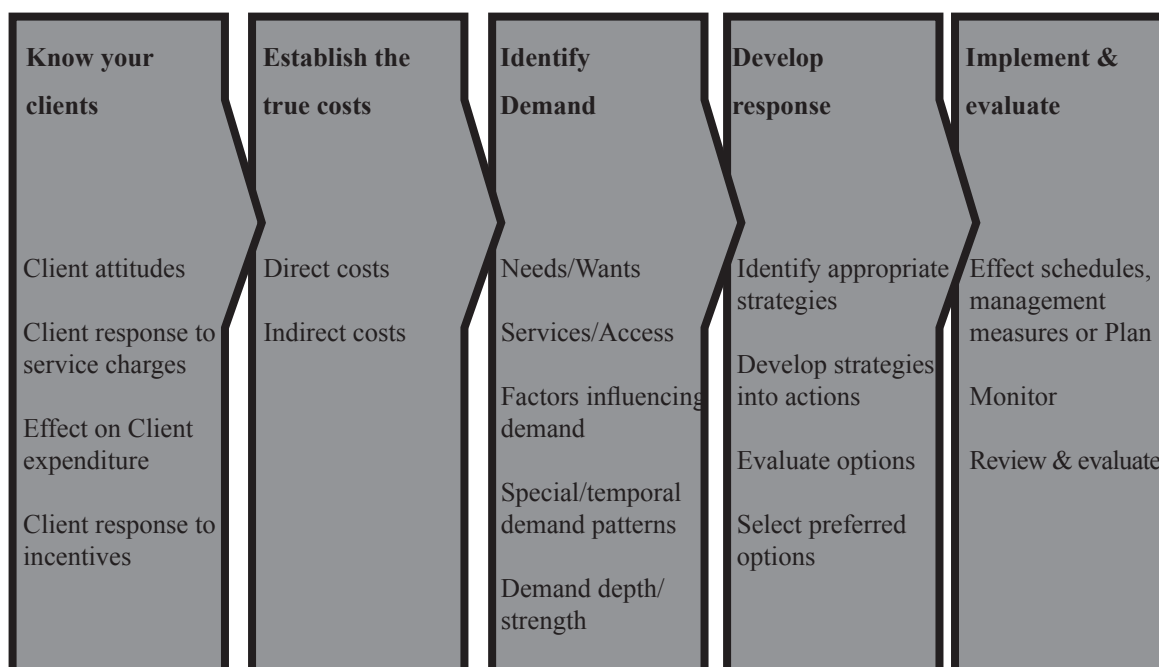


Fig. 8.4 Demand management process

(Source: http://www.treasury.nsw.gov.au/__data/assets/pdf_file/0003/5097/demand_management.pdf)

8.6 Demand Forecasting

Forecasting the future is a critical element of management decision making. The final effectiveness of any decision depends upon the consequence of events following this decision. Demand forecasting is the area of predictive analytics dedicated to understanding consumer demand for goods or services.

If the suppliers know how demand will fluctuate, they can keep the right amount of stock on hand. There can be two consequences. If demand is underestimated, sales can be lost due to the lack of supply of goods. If demand is overestimated, the supplier is left with a surplus that can also be a financial drain. Demand forecasting involves techniques including both informal methods, such as educated guesses, and quantitative methods, such as the use of historical sales data or current data from test markets. Demand forecasting may be used in making pricing decisions, in assessing future capacity requirements, or in making decisions on whether to enter a new market.

Necessity for forecasting demand

The need for demand forecast is due to stock and market response effects.

Stock effects

Stock effects are those effects that inventory levels have on sales. Stock-outs are the extreme cases where the demand coming into store is not converted to sales due to a lack of availability. Demand is also untapped when sales for an item are decreased due to a poor display location, or because the desired sizes are no longer available. For example, in fashion retailing, once the stock level of a particular sweater falls to the point where standard sizes are no longer available, sales of that item are diminished.

Market response effect

Market response effects are those effects of market events that are within and beyond a retailer's control. Demand for an item will likely rise if a competitor increases the price or if the item is promoted regularly. The resulting sales a change in demand as a result of consumers responding to stimuli that potentially drive additional sales. These forces need to be factored into planning and managed within the demand forecast.

8.7 Demand Planning

Demand planning improves the accuracy of forecasts. The goal of demand planning is to improve production scheduling or inventory stocks, where each party in the supply chain does some processing on the demand signal. A demand plan starts with a statistical forecast and adds intelligence through consensus management of the demand information process to develop an accurate demand forecast.

8.8 Demand Forecasting Error

Forecasting error is defined by The Association for Operations Management (APICS) as “the difference between actual and forecast demand, stated as an absolute value or as a percentage.” Forecast error is a point of reference of the variance between demand that was projected and actual demand that subsequently occurred.

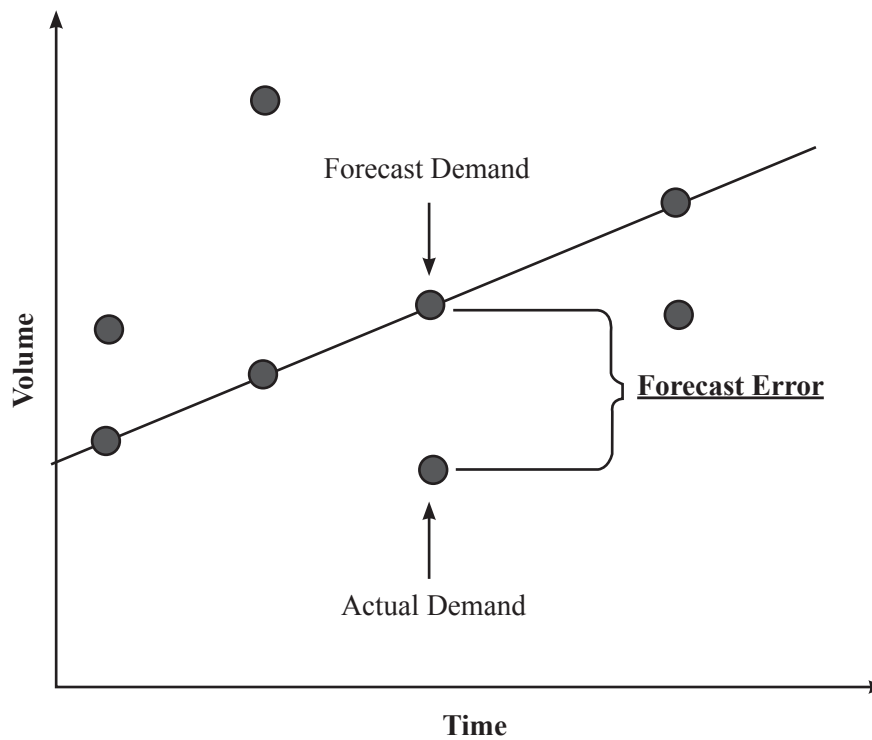


Fig. 8.5 Demand forecasting error

(Source: [http://www.sdcexec.com/web/online/Demand-Management-Trends/Forecast-Fit-vs-Forecast-Error--Clarifying-the-Concepts--Understanding-the-Value/22\\$9933](http://www.sdcexec.com/web/online/Demand-Management-Trends/Forecast-Fit-vs-Forecast-Error--Clarifying-the-Concepts--Understanding-the-Value/22$9933))

8.9 CPFR

Collaborative Planning, Forecasting and Replenishment (CPFR) is a concept that aims to enhance supply chain integration by supporting and assisting joint practices. CPFR was launched in 1995 by Wal-Mart with the pharmaceutical group Warner Lambert. It seeks cooperative management of inventory through joint visibility and replenishment of products throughout the supply chain. Planning and satisfying customer demands occur through a supportive system of shared information between suppliers and retailers. Continuous updating of inventory and upcoming requirements is possible, making the end-to-end supply chain process more efficient.

The CPFR process is divided into four steps:

- **Strategy and planning:** The ground rules for the collaborative relationship are established. Collaboration arrangement is the process of setting the business goals for the relationship, defining the scope of collaboration and assigning roles, responsibilities, checkpoints and growth procedures. The joint business plan identifies the significant events that affect supply and demand in the planning period, such as promotions, inventory policy changes, store openings or closings, and product introductions.
- **Demand and supply management:** Sales forecasting projects consumer demand at the point of sale. Order planning or forecasting determines future product ordering and delivery requirements based upon the sales forecast, inventory positions and transit lead times.
- **Execution:** Order generation includes transitions forecasts to firm demand. Order fulfilment is the process of producing, shipping, delivering, and stocking products for consumer purchase. The sales transactions are recorded and payments are made.
- **Analysis:** Monitor planning and execution activities for exception conditions that is exceptions management. Aggregate results are calculated. The active monitoring of planning and operations and performance assessment are the tasks included. For continuously improved results, plans are analysed.

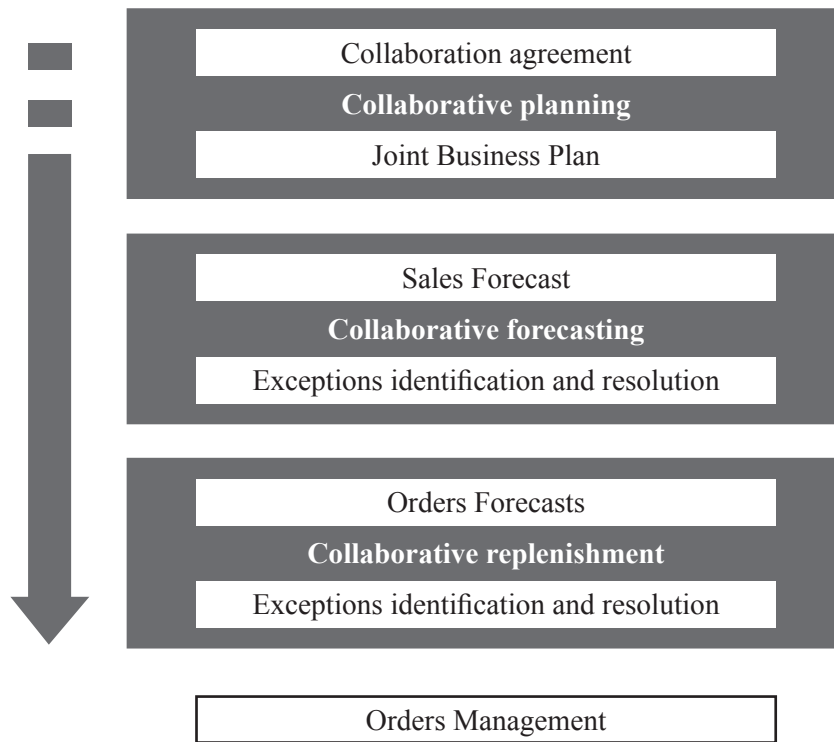


Fig. 8.6 Collaborative planning, forecasting and replenishment process

(Source: <http://www.free-logistics.com/index.php/Spec-Sheets/Forecasts-Supply-and-Inventory/CPFR-Collaborative-Planning-Forecasting-and-Replenishment.html>)

8.10 Customer Service

Customer service is the provision of service to customers before, during and after a purchase. According to Turban *et al.* (2002), “Customer service is a series of activities designed to enhance the level of customer satisfaction, that is, the feeling that a product or service has met the customer expectation.”

Customer service is an integral part of a company’s customer value proposition. Good customer service is the lifeblood of any business. It can bring back the customers. The importance of customer service varies by product, industry and customer. Customer service can be illustrated with the help of an example, such as defective or broken products can be exchanged, often only with a receipt and within a specified time frame. Retail stores often have a desk or counters devoted to dealing with returns, exchanges and complaints, or perform related functions at the point of sale.

Customer service plays an important role to generate income and revenue of an organisation. A customer service experience can change the entire perception a customer has of the organisation. Customer relationship management (CRM) is a widely-implemented strategy for managing a company’s interactions with customers, clients and sales prospects. It involves using technology to organise, automate, and synchronise business processes such as sales activities, marketing, customer service and technical support. The overall goals are to:

- Find, attract and win new clients
- Take care and retain those clients that the company already has
- Persuade former clients back
- Reduce the costs of marketing and client service

Thus, the use of a CRM system grants several advantages to a company:

- Quality and efficiency
- Decreased costs
- Decision support
- Enterprise agility

The high-quality customer service in the help desk is provided which requires much more than just technical troubleshooting skills. Employees must have excellent listening and communication skills, telephone skills, writing skills and they must be able to solve and prevent problems in the help desk. They should have the ability to handle difficult customers and minimise stress during the workday besides increasing the level of customer service they provide. These soft skills are often more important in ensuring a high level of customer satisfaction.

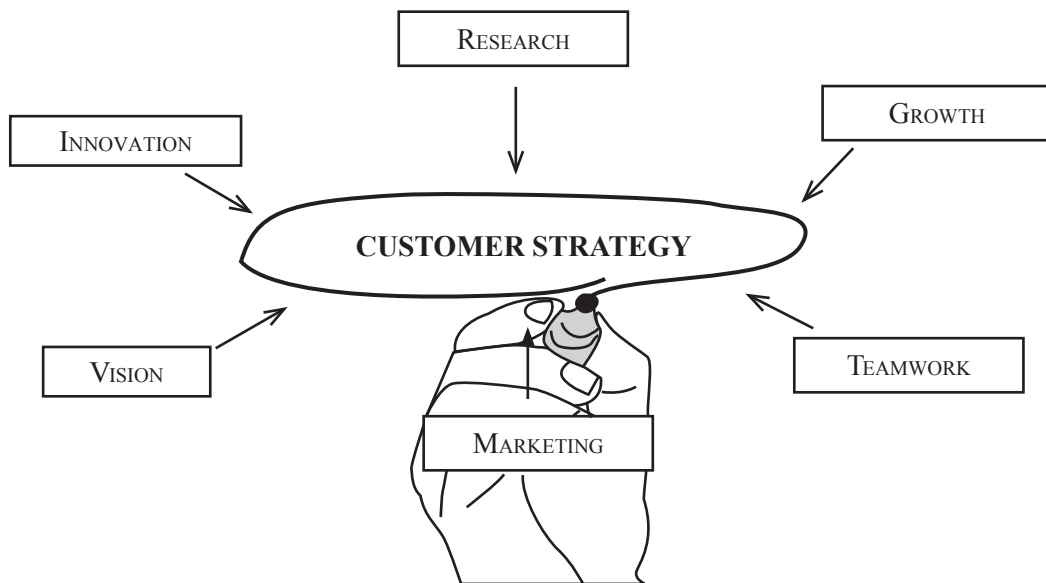


Fig. 8.7 Customer service strategy

(Source: <http://www.nlighten.co.za/customer-service-strategy/>)

8.11 Cost of Stock-Outs

Stock-out is a situation where the demand or requirement for an item cannot be fulfilled from the current (on hand) inventory. Stock-out costs are the costs associated with being unable to draw on a stock of raw material, work-in-progress or finished goods inventory (loss of sales, profits and goodwill, production dislocation). The cost of a stock out is a critical to the implementation of any retail inventory model. Unless these costs are known, retailers cannot balance the costs (and risk) of holding inventory with the inevitable profits when an item is out of stock.

8.12 Channels of Distribution

Product distribution is one of the four elements of the marketing mix. Distribution in supply chain management refers to the distribution of goods from one business to another. It can be factory to supplier, supplier to retailer, or retailer to end customer. Distribution channel is the path through which the goods and services flow in a direction. Each of the intermediaries is passing the product down the chain to the next organisation, before it finally reaches the consumer or end-user. Each of the elements in these distribution chains will have their own specific needs, which the producer must take into account, along with those of the all-important end-user.

A distribution channel can be as short as being direct from the vendor to the consumer or may include several interconnected (usually independent but mutually dependent) intermediaries such as wholesalers, distributors, agents, retailers. Each intermediary receives the item at one pricing point and moves it to the next higher pricing point until it reaches the final buyer.

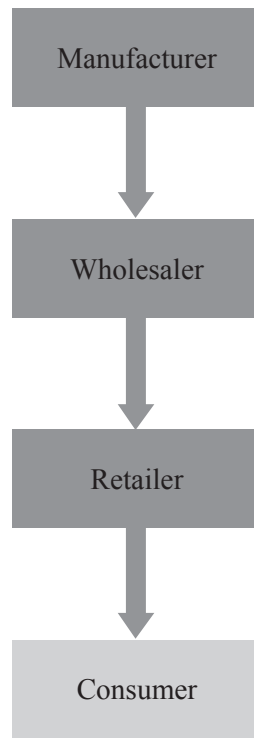


Fig. 8.8 Channels of distribution

(Source: <http://www.mbaknol.com/marketing-management/concept-of-distribution-channels-in-marketing/>)

Therefore, the channel serves to bridge the gap between the point of production and the point of consumption thereby creating time, place and possession utilities. A channel of distribution consists of three types of flows:

- Downward flow of goods from producers to consumers
- Upward flow of cash payments for goods from consumers to producers
- Flow of marketing information in both downward and upward direction i.e.,
 - Flow of information on new products, new uses of existing products, etc from producers to consumers
 - Flow of information in the form of feedback on the wants, suggestions, complaints, etc. From consumers to producers

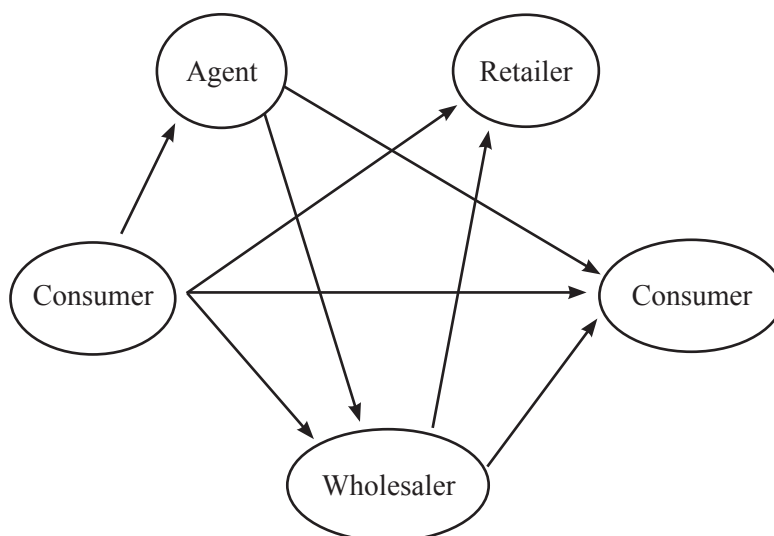


Fig. 8.9 Distribution network

(Source: <http://www.nios.ac.in/Secbuscour/20.pdf>)

Summary

- The Law of Demand states that “Quantity demanded varies inversely with (in the opposite direction to) changes in price”. Thus, buyers will purchase more of an item at a lower price and less at a higher price.
- Demand refers to how much (quantity) of a product or service is desired by buyers. The quantity demanded is the amount of a product, people are willing to buy at a certain price; the relationship between price and quantity demanded is known as the demand relationship.
- Demand management is the supply chain management process that balances the customers’ requirements with the capabilities of the supply chain.
- Managing supply with demand factors are essential using the right process, forecasting and executing the plan with minimal disruptions. It includes synchronising supply and demand, increasing flexibility and reducing variability.
- Demand chain management is the management of upstream and downstream relationships between suppliers and customers to deliver the best value to the customer at the least cost to the demand chain as a whole.
- In a competitive market, the unit price for a particular good varies until it settles at a point where the quantity demanded by consumers (at current price) will equal the quantity supplied by producers (at current price), resulting in an economic equilibrium of price and quantity.
- Demand for an item will likely rise if a competitor increases the price or if the item is promoted regularly. The resulting sales a change in demand as a result of consumers responding to stimuli that potentially drive additional sales. These forces need to be factored into planning and managed within the demand forecast.
- Demand forecasting is the area of predictive analytics dedicated to understanding consumer demand for goods or services.
- A distribution channel can be as short as being direct from the vendor to the consumer or may include several inter-connected (usually independent but mutually dependent) intermediaries such as wholesalers, distributors, agents, retailers.

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Self Assessment

1. The law of demand states that “Quantity demanded varies inversely with (in the opposite direction to) changes in _____.
 - a. price
 - b. quality
 - c. supply
 - d. income
2. Which of these is not the determinant of demand?
 - a. Income
 - b. Tastes and preferences
 - c. Prices of related goods and services
 - d. Production costs
3. Which of these is not the determinant of supply?
 - a. The price of related goods
 - b. Firm’s expectations about future prices
 - c. Income
 - d. Number of suppliers
4. Which of the following statements is false?
 - a. If demand increases and supply remains unchanged, then it leads to higher equilibrium price and quantity.
 - b. If demand decreases and supply changes, then it leads to lower equilibrium price and quantity.
 - c. If supply increases and demand remains unchanged, then it leads to lower equilibrium price and higher quantity.
 - d. If supply decreases and demand remains unchanged, then it leads to higher price and lower quantity.
5. The standard graphical representation, usually credited to _____, has price on the vertical axis and quantity on the horizontal axis.
 - a. Ling Li
 - b. John T. Mentzer
 - c. Alfred Marshall
 - d. C. Crum
6. A channel of distribution consists of _____ types of flows.
 - a. two
 - b. three
 - c. four
 - d. six
7. _____ is a situation where the demand cannot be fulfilled from the current (on hand) inventory.
 - a. Stock-out
 - b. Collaboration
 - c. Stock costs
 - d. Forecasting error

8. Which of these play an important role to generate income and revenue of an organisation?
- a. Demand management
 - b. Revenue management
 - c. Demand forecasting
 - d. Customer service
9. _____ includes transitions forecasts to firm demand.
- a. Order fulfilment
 - b. Order generation
 - c. Demand planning
 - d. Joint business plan
10. Who launched CPFR in 1995?
- a. APICS
 - b. Hewlett-Packard
 - c. Wal-Mart
 - d. Procter & Gamble

Case Study I

Port Centric warehousing strategy for a Leading Indian Logistics Service Provider

We created a port centric warehousing strategy to position our client a leading player in end-to-end 3PL space and achieve a revenue target of INR500 crores in 5 years from warehousing. The estimated payback period on the investment is 4.5 years.

Background

- The client is leading freight forwarding and contract logistics service provider in India.
- They have industry level expertise in Freight forwarding, project logistics and customs clearance.

Business Scenario

- The client is looking to become a globally renowned end-to-end logistics service provider and supply chain partner.
- The client wants to invest in value added port centric warehousing, which complements its existing freight forwarding business, and which is also an important component of its end-to-end value proposition.
- A strong India growth rate has also created unforeseen opportunity in port centric warehousing that needs to be addressed.

Our Solution

- We adopted a systematic and methodical approach to address the opportunity
 - Customer Need Identification,
 - Industry Opportunity identification,
 - Current state of the market,
 - Competition Landscape,
 - Aqua's positioning and value proposition
- A detailed warehousing locational strategy, target industries and services and rollout plan was created.

Benefits

- Value based warehousing strategy defined, and implementation plan was created.
- ROI assessment helped in justification of business and investment plan - 10 year NPV of 496 crore, Payback Period of 4.5 year.

(Source: Aqua MCG, Case studies: Port Centric warehousing strategy for a Leading Indian Logistics Service Provider [Online] Available at: <<http://www.aquamcg.com/DesktopModules/ListingOfEvents/UploadFile/warehousing-strategy-for-Indian-Logistics-Service-Provider.PDF>>. [Accessed 2 January 2012].)

Questions

1. What is the future plans of the client of the company mentioned in the above case study?

Answer

The client is looking to become a globally renowned end-to-end logistics service provider and supply chain partner.

The client wants to invest in value added port centric warehousing, which complements its existing freight forwarding business, and which is also an important component of its end-to-end value proposition.

A strong India growth rate has also created unforeseen opportunity in port centric warehousing that needs to be addressed.

2. For fulfilling the future plans of the clients, what is the solution provides?

Answer

We adopted a systematic and methodical approach to address the opportunity

- Customer Need Identification,
- Industry Opportunity identification,
- Current state of the market,
- Competition Landscape,
- Aqua's positioning and value proposition 6. Investment and ROI assessment

A detailed warehousing locational strategy, target industries and services and rollout plan was created.

3. What is the background of the client mentioned in the above case study?

Answer

The client is leading freight forwarding and contract logistics service provider in India.

They have industry level expertise in Freight forwarding, project logistics and customs clearance.

Case Study II

McDonald's Food Chain

McDonald's is a fast food chain with restaurants all over the world. It serves burgers and other fast food. It remains consistent in terms of cost and quality of burgers. To meet such high standards, it was essential to have an excellent supply chain management system.

McDonald's was started as a drive-in restaurant by two brothers, Richard and Maurice McDonald in California, US in the year 1937. The business, which was generating \$200,000 per annum in the 1940s, got a further boost with the emergence of a revolutionary concept called 'self-service.' Prices were kept low. Speed, service and cleanliness became the critical success factors of the business. By mid-1950s, the restaurant's revenues had reached \$350,000. As a result, franchisees started showing interest. However, the franchising system failed because the McDonald brothers observed very transparent business practices. As a consequence, imitators copied their business practices and emerged as competitors.

In 1996, when McDonald's entered India, Mumbai-based Radhakrishna Foodland Private Limited (RFPL) was chosen as a distribution agent who would act as a hub for all its vendors. RFPL stored the products in controlled conditions in Mumbai and New Delhi and supplied them to McDonald's outlets on a daily basis. By transporting the semi-finished products at a particular temperature, the cold chain ensured freshness and adequate moisture content of the food. The specially designed trucks maintained the temperature in the storage chamber throughout the journey. From its experience in other countries, McDonald's was aware that supply chain management was undoubtedly the most important factor for running its restaurants successfully.

In India as in other parts of the world, McDonald's had a very well orchestrated supply chain, called the 'cold chain'. Around the world (including India), approx. 85% of McDonald's restaurants were owned and operated by independent franchisees. Yet, McDonald's was able to run by outsourcing nine different ingredients used in making a burger from over 35 suppliers spread all over India through a massive value chain. McDonald's sourced its ingredients from all parts of India. For example, the iceberg lettuce was specially developed for India using a new culture farming technique.

Thus, US-based fast food giant, McDonald's success in India had been built on four pillars: limited menu, fresh food, fast service and affordable price. Intense competition and demands for a wider menu drive-through and sit-down meals - encouraged the fast food giant to customise product variety without hampering the efficacy of its supply chain.

(Source: Jaipur Institute of Management, Lucknow., 2010. McDonalds: Supply Chain Management [Online] Available at: <<http://www.scribd.com/doc/28339073/mc-donalds-supply-chain-management>> [Accessed 2nd January 2012].)

Questions

1. What business strategies were used in McDonald's food supply chain?
2. What was the role of outsourcing in SCM?
3. How McDonald's continues to be the fast food giant?

Case Study III

Dell's Direct Selling Model

US based computer hardware manufacturer Dell Inc. (Dell) aims to integrate its supply chain and achieve higher efficiency and quality. It is a leading direct computer systems manufacturing company. Earlier, all Dell's factories had been managed regionally, and procurement functioned as a separate division. Dell had been the top PC manufacturer till the second quarter of 2006. But in the third quarter of 2006, HP overtook Dell for worldwide PC shipments.

To rank first among PC manufacturers, Dell used direct selling method. The Dell's direct selling model had the idea of selling computers directly to the consumer eliminating the need for middlemen and distributors. Dell sold its computer systems directly to end customers, bypassing distributors and retailers (resellers). Thus, Dell's supply chain consisted of only three stages: the suppliers, the manufacturer (Dell), and end users.

By selling PCs directly to the consumers, the company was better able to understand the needs of its customers. Its direct contact with customers allowed it to identify market segments, analyse the requirements and profitability of each segment and develop more accurate demand forecasts. . The company's procurement decisions were based on four criteria - quality, cost, delivery and technology.

The first computer Turbo PC was introduced in 1985. The launch was advertised in computer magazines and sold directly to customers. Dell also began employing computer literate sales personnel to guide consumers in their choice of systems. Each system was assembled according to the preferences of the customers. This option helped customers to get computers at a price lower than other brands.

Dell matched supply and demand because its customers ordered the computer configurations over the phone or online. Dell received orders via the telephone, internet, e-mail, etc. With advancement in technologies, the choices available for the consumers also widened. Customers could use Dell's website www.dell.com, to configure their customised computer and place an order for it and choose from a variety of products ranging from desktops, notebooks, servers, printers, etc. The website catered to different segments of customers like individuals, home office customers, small businesses, medium businesses, large businesses and public sector customers like Government departments, educational institutions and healthcare institutions. Thus, it got popular amongst all.

Dell's strategy was to provide customised, low cost, and quality computers delivered on time. Dell reduced the cost of intermediaries that would otherwise add up to the total cost of PC for the customer. The time on processing orders was saved that other companies normally incur in their sales and distribution system. Moreover, the company got a clearer indication of market trends. This helped to plan for future besides better managing its supply chain.

It was also able to get the customers requirements regarding software to be loaded. Dell loaded the ordered software in its plant itself before dispatching it. By eliminating the need of a PC support engineer to load software, the customers gained both in time and cost. Dell collaborated closely with its suppliers in order to manage its operations with low inventory levels.

Demand forecasting with 75% accuracy was done as it maintained a database to track the purchasing patterns of corporate customers and their budget cycles. It also maintained a similar database for individual customers in order to cater to their future requirements for PCs. The changing demand patterns were communicated to the major suppliers frequently.

Questions

1. How direct contact with the customers helped Dell to rank first among PC manufacturers?
2. Dell has always use innovative information technology tools to supplement its supply chain. In a few words, explain how the use of IT tools has benefited Dell.
3. Which databases were created in order to cater to the customer's future requirements for PCs?

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Self Assessment Answers

Chapter I

1. c
2. d
3. a
4. d
5. c
6. c
7. a
8. d
9. a
10. d

Chapter II

1. b
2. a
3. a
4. d
5. b
6. c
7. a
8. d
9. a
10. a

Chapter III

1. a
2. a
3. a
4. d
5. b
6. c
7. a
8. a
9. d
10. b

Chapter IV

1. b
2. a
3. a
4. c
5. a
6. b
7. d
8. c
9. c
10. a

Chapter V

1. b
2. d
3. c
4. b
5. a
6. c
7. a
8. a
9. b
10. d

Chapter VI

1. a
2. a
3. c
4. c
5. d
6. a
7. a
8. c
9. a
10. a

Chapter VII

1. a
2. b
3. c
4. c
5. a
6. b
7. b
8. c
9. a
10. b

Chapter VIII

1. a
2. d
3. c
4. b
5. c
6. b
7. a
8. d
9. b
10. c