UNIT 7 MANAGEMENT OF INVENTORY

Objectives

The objectives of this unit are to:

- Explain importance of holding different components of inventory in manufacturing and distribution.
- Explain the need for investments in inventory.
- Define the inventory system and the costs associated with the inventory system.
- Explain inventory models that balance the cost and benefit of holding inventory under certainty and uncertainty.
- Explain inventory control methods to ensure continuous inventory control.
- Discuss some of the emerging ideas in inventory management.

Structure

7.1 INTRODUCTION

Three things will come to top of your mind when you think of a manufacturing unit - machines, men and materials. Men using machines and tools convert the materials into finished goods. The success of a business unit depends on the extent to which these are efficiently managed. In this unit, we will discuss how to manage the inventory, which consists of not only material but also work-in- progress and finished goods. The general concepts of management namely, planning, decision-making and controlling equally apply to inventory management. In fact, this is one area in which companies in the real life spend a lot of resources, both in terms of monetary value and

managers' time. Table-7.1 shows the investments in inventory in different companies and its value as a percentage of current assets.

Table 7.1: Top Companies in India by the Size of Inventory Holdings by the Financial Year 2020-21

(Rs. in Crore)

S. No.	Name of the Company	Inventory Holding	% of Current Assets
1.	IOC	78,188	83.8
2.	Reliance	37,437	79.4
3.	HPCL	28,592	80.1
4.	BPCL	26,757	64.3
5.	Macrotech Developers	23,762	96.8
6.	SAIL	19,508	71.4
7.	Hindustan Aeron	16,560	56.4
8.	Hindalco	15,989	85.9
9.	Jaypee Infra	11,720	95.8
10.	JSW Steel	10,692	41.5
11.	DLF	9,804	92.6
12.	ITC	9,471	60.9
13.	NTPC	9,179	36.4
14.	Tata Steel	8,604	60.9
15.	ONGC	8,474	51.1
16.	Titan Co.	7,984	90.8
17.	BHEL	7,191	40.1
18.	Prestige Estate	6,880	73.1
19.	Sobha	6,752	94.5
20.	MRPL	6,610	72.8
21.	Mazagon Dock	5,889	39.6
22.	PC Jeweller	5,794	50.4
23.	Vedanta	5,555	50.4
24.	Bharat Ele.	4,955	30.0
25.	Zee Entertain	4,944	67.4
26.	Aurobindo Pharma	4,841	43.4
27.	Jindal Steel	4,592	37.5
28.	Jai Prakash Associate	4,568	66.7
29.	Tata Motors	4,552	41.5
30.	TML – D	4,552	41.5
31.	Chennai Petro	4,509	95.7
32.	Kalyan Jeweller	4,388	82.9
33.	Puravankara	4,057	94.0

Source: BSE Data (www.moneycontrol.com/stocks/marketinfo/inventory/bse/index/html)

It is evident from the Table-7.1 that inventory is the major component of current assets. In majority of the companies, it is constituting as high as 90 per cent. The trend is that those companies in the business of Steel, Heavy Machinery, Infrastructure are having the large size of inventory with them. To name a few of them Macrotech Developers, Jaypee Infra, Sobha, Purevankara, DLF are in the list.

The value of inventory differs between industries because several factors like technology, nature of materials, production process, etc. determines the value of inventory. The composition of inventory is high in food and beverages because the technology is fairly simple and hence the requirement of fixed assets is low. The inventory requirement is high because of seasonal factor and the need for wider retail distribution network. For instance, if each shop in the country stores twenty pockets of *Maggi Noodles or Milkmaid,* think of the total volume of finished goods stored in millions of shops distributed all over the country. The composition of inventory is low in heavy industries or hi-tech industries because of high value of fixed assets. Another interesting finding is declining trend in the composition of inventories as a percentage of total assets during the period, which partly attributes to successful implementation of new techniques such as Materials Resource Planning (MRP) and Just-in-Time (JIT). We will discuss these issues later under the heading of emerging trends in inventory management.

There are few basic differences between managing inventory and other components of assets. Unlike machine and men, the inventories are continuously planned on day-to-day basis based on the customers' demand and production schedule. Frequent decision-making and continuous controlling are thus required. Unlike other components of current assets, there are number of people/ departments involved in managing the inventory. While stores department manages the materials and components, it is the production department's responsibility in managing work-in-progress. Finished goods are managed either by the warehouse or sales department.

In addition to the involvement of different divisions, each division requires input from others in planning and controlling the inventory. For instance, stores department, which manages the raw material, needs to closely interact with production-planning and purchase departments to manage the raw materials effectively. Again, the production-planning department needs input from marketing or sales department to plan for the production schedule. The complexity of managing inventory could be seen with diverse objectives pursued by each of these departments. Production planning department wants to ensure timely availability of material to allow smooth functioning of production flow and thus insists that materials are purchased or drawn in advance. On the other hand, material planning and stores department would like to procure the material only when it is required and thus reduce their stay in the stores. Similarly, marketing department wants to ensure adequate stocks with the retailers or dealers or distributors. They may also insist the company to produce more variety to fulfil different tastes of the customers and thus forcing the firm to increase the Quantity as well as the number of materials and components. The larger issue or strategic role of inventory management is to synchronise different objectives of the departments and efficiently manage the inventory.

Activity 7.1

i) How managing inventory is different from that of managing machines and men?

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ii) Explain the need for external input in the management of different components of inventory?

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iii) Visit any of the Manufacturing Unit nearby, and write down a brief on your observations relating to Inventory Management there.

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7.2 COMPONENTS OF INVENTORY

Inventory is an asset to the organisation like other components of current assets but the difference is, it can be seen and counted. It is also bit complex because there are different types of inventory, as well as different sizes, shapes, forms and substances. It is a group of assets with different characteristics. There are four major components of inventory namely raw materials, stores and spares, work-in-process and finished goods.

Raw materials: Raw materials are the input that are used in the manufacturing process to be converted to finished goods. Examples of raw materials are iron-ore, crude oil, salt, wood, etc. However, what is considered to be the finished goods for one firm could be the raw materials for the others. For example steel flat or tubes are finished goods for Tata Iron and Steel Company (TISCO) but the same is raw material for automobile companies such as Maruti Udyog or Hindustan Motors or machinery manufacturing companies such as BHEL or Thermax. Similarly, petrochemicals produces manufactured by Reliance Industries are used as raw materials by several detergent manufacturers, polyester textile units, tyres manufacturers, etc. Raw materials are not only important in the manufacturing process but also play a crucial role in deciding the location of

plant. Several cement factories are located close to areas where limestone and coal are available. Sugar factories are located close to sugarcane growing areas and power plants are located close to waterfalls (hydroelectric units) and coal belts.

Stores and Spare parts: Stores or otherwise called as purchased components are another important input in the manufacturing process. This is a major component of working capital for many assembly type of units. For instance, manufacturers of colour television such as Videocon or Sony, Samsung and LG buy components like picture tubes, printed circuit boards, tuner, speakers, etc., and assemble them. Many of the computer hardware companies would be using assemblers to assemble Computers to cut down the cost. Many companies are also trying to achieve a concept called lean organisation to meet competition and in this process out sourcing several items, which were internally manufactured. The concept of 'supply chain management' has, of late, emerged as the key practice in the efficient management of inventory and sales. We will discuss the same in detail later in this lesson.

Spare parts and tools are also accounted for as part of total inventory. But these do not directly contribute in the final output of the product but are necessary to support in the smooth flow of the production process. Often machinery suppliers, particularly for imported ones, send critical spare parts required for the machines in the event of breakdown. Tools like spare parts are primary equipments used in the machines or independently to produce a product. However, they are treated as inventory due to their short life and stored along with materials. As they are also issued and accounted like materials, they are treated as a part of inventory.

Work-in-process: These are items, which are partially assembled or processed. The complexity of production process and time required to complete production cycle determines the value of work-in-process. The value of work-in-process is high for the manufacturers of passenger aircraft or railway engines or heavy machinery because of complexity and long time required to complete a unit. The value of work-in- process is relatively low in pharmaceutical or paint companies since its primarily mixing of chemicals. To gain better understanding you may compare the production process in the construction of a steam or electric turbine and a dairy unit.

Finished goods: The last stage in the inventory processing is the finished goods. These are the final output in any manufacturing process and are ready to be sold to the customers. Why do firms keep finished goods in the factory or warehouse before they are sold to the customers? It is not necessary and firms can sell whatever they have produced immediately or can produce only to the extent demanded by the customers like Tata Power and NTPC, BHEL, which will have no finished goods. However, it is not practical for many other firms because of the nature of production process and consumption practices of the users.

For instance, Maruti Automobiles, Parrys Confectionary, Britania and Nestle, which manufacture many brands of toffees and biscuits cannot produce all of them on a daily basis to the expected consumption of their products. They

have to necessarily produce them in batches of few days or weeks requirements by using more or less same machines. Otherwise, the requirement of machinery will be huge and production becomes economically nonviable. They may also have to establish a large number of plants all over the country to meet the local demands. Finished goods may be relatively low for high value equipments like aircraft or ships, which are often manufactured on the basis of orders. It can be reduced for firms, which are supplying to industrial customers because firms can schedule their production according to the production schedule of customers. The finished goods component has to be necessarily high for firms that produce products like food products, consumer durable, etc., which are directly consumed by the public, and distribution network also need to be large.

Activity 7.2

i) List out the various components of inventory? Identify major raw materials, purchased components, finished goods for any one firm which is familiar to you.

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ii) List down a few reasons for the differences in the level of inventory values.

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7.3 NEED FOR INVENTORY

In the course of discussion on different components of inventory, we have indicated that some amount of inventory is necessary. However, holding excessive inventory will block the funds and costs more to the firm. There are several other associated costs of holding excessive inventory, which we will discuss later. How do managers assess the level of inventory? They need to first understand different needs of holding inventory and accordingly quantify its requirement. For instance, a television manufacturer can quantify the

finished goods inventory by identifying the number of dealers the firm has appointed and the minimum number of pieces of each brand that need to be stored with each dealer for the customers to come and see the product. The following are some of the primary reasons or the motives for holding inventories that applies to different components of inventory.

Transaction Motive: It is possible for a hotel to buy vegetables and other food ingredients required for the day and serve the food such that there is no inventory at the end of day. If you have kitchen garden in your house, you, your mother or sister or wife will be picking up the vegetables when it is required for cooking. It is bit difficult for other large-scale manufacturing units to synchronise the arrival of materials and their use. Inventory is also required to supply to dealers and retailers on continuous basis to meet demand. Thus, an important motive for holding inventory is to perform smooth transaction in the production process and serving the customers' demand. It makes production and delivery scheduling a lot more easier.

Precautionary Motive: There is a risk of planning inventory exactly to the requirement unless the supplier is next to your firm or the product or component is internally produced. If a firm buys material from outside, there are several factors that govern the smooth flow of completing the purchase orders. Similarly, there is also a risk that the plant suddenly breaks down and is not in a position to replenish the finished goods. Some amount of excess inventory, often called as buffer stock, is maintained as a precaution. The precautionary motive plays a vital role in decision making relating to spares and other critical items required for the production. Many of us carry Stepney (extra tyre) with our scooters and four wheelers as a precaution.

Speculative Motive: Though firms may not speculate in buying and selling raw materials, there is nothing wrong in exploiting the opportunity that arises occasionally due to uneven demand and supply. A refinery could buy or enter into a contract for the purchase of the crude oil when the price is cheap because of sudden increase in the supply of oil. We have mentioned earlier, textile companies find it useful to buy cotton when the prices are low since the price behaviour is volatile. It is true for most of the seasonal products. It is also possible to buy extra materials because the suppliers offer discount beyond certain quantity. Many of the Agro-based industries like Jute, Cotton, Sugar, Tobacco, confectionery have to buy their entire requirement as and when the crop is available. These units are forced to buy their requirements much in advance, though not for speculative purposes. Price fluctuations in Agricultural products are also very wide, making it necessary for these firms to buy at any price to remain in production. We often buy extra garments during clearance sale or festival period, when firms offer discount.

The above discussion presents general reasons for holding different types of inventory. Given below are a few specific reasons that apply to individual components of inventory.

Raw Materials and Stores

- To make production process easier
- To ensure price stability
- To hedge against supply shortages
- To take advantage of quantity discounts

Work-In-Process

- To achieve flexibility in manufacturing
- To ensure economies of production

Finished Goods

- To ensure smooth delivery schedule
- To provide immediate supply
- To achieve economies of scale
- To allow batch processing in a multiple product situation and optimize the utilization of machine and other resources

Though the above said factors could influence the firms in maintaining the inventories, each firm has its own policies in deciding the quantum of the inventory to be maintained. To understand the need for inventory one should understand the flow of the inventory components in the manufacturing process. Raw materials are needed as input in the initial stages of the manufacturing cycle. The raw material requirements vary as per the nature of the industry.

Similarly the companies have to maintain sufficient stockings of the finished goods as the output produced are not always sold at the factory gate. These goods have to be distributed when the goods are to reach the customers spread out geographically. This requires overcoming the challenges faced in the competitive world. When the firm defaults to supply the goods at the right time in the right place to the right customers, there is fear of losing the sales to the competitors.

In a similar way, inventory is required to maintain a balance between the investment in inventory and customer-service, in that lower the inventory, higher the stock-out and higher the inventory better the customer service. Inventory is also required to minimise the ordering costs and transportation costs by reducing frequent ordering and by moving materials in bulk respectively.

Activity 7.3

i) Why do the firms maintain inventory? Identify three best reasons for holding inventory by a company.

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ii) List any two speculative reasons for holding excess inventory.

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7.4 INVENTORY SYSTEM

An understanding of inventory system is essential before making any attempt to manage different components of inventory. A system in simple terms is defined as how things are organised together with their inter-relationships among different components of systems. We can define inventory system as the one, which consists of three components namely inventory customers, inventory storage points and inventory sources. Inventory customers are primary cause for investments in inventory. Inventory customers includes end-customers, marketing department or dealers, production centres and any one, who demands inventory to be stored for their ready consumption. The customers demand inventory because of their production process and consumption pattern. A firm, which is doing job orders, can purchase the required items after it receives the job order. On the other hand, sugar or power plant cannot buy their daily requirements on daily basis because the process is continuous and any delay in the arrival of material will force the unit to shut down. Similarly, industrial consumer would buy in quantities sufficient to ensure their production process to run smoothly whereas retail consumers will expect the shops to keep ready the stocks to allow them to buy whenever the product is required. For example, individuals buy soaps, detergents, toothpaste, health drinks and other consumables only for a month's requirement. An analysis of the inventory customers and their consumption behavior is essential for inventory management.

The second component of an inventory system is inventory storage or inventory stocking points. It might be a warehouse, a distribution centre, a storage bin or any other physical location where inventory is stored for a brief period of time. Stocking points are required because transportation in bulk quantity to these points is easy and cheaper and stocks are redistributed in smaller quantity to retail outlets. In the case of raw materials also convenience and low cost, require materials to be bought in bulk and stored inside the factory. Analysis of stocks in stores and removing transportation bottleneck are key to reduce the investments in stocks. The slow moving and non-moving items not only increase the cost of carrying the inventory but also incur an opportunity cost of denying storing space for fast moving items.

The last component of an inventory system is sources of inventory. It could be a supplier from whom the firm purchases materials or internal division from which the products are transferred. This factor affects inventory management in several ways. For instance, the number of inventory sources affects the decision on inventory holding. If an item is manufactured by several units and the quality is comparable, then lead time for procuring the material is low and the availability of material is high. On the other hand, if the number of suppliers is few or the quality is not consistent, the inventory holding is high. The production process of suppliers again determines their ability to supply in small quantity.

In inventory system, where the number of customers, stocking points and suppliers are few, the system is relatively easy to manage. Many companies are trying to achieve this by doing customer profit analysis, warehousing analysis and supply chain analysis. The system becomes complex to manage, if the number of customers, stocking points and sources increases. As the customer's demands are satisfied by supplying stocks from the stock points, the core issue of inventory management is how to replenish the stocking points from different sources in such a way as to minimise the total of all associated costs and thereby enhance the profitability of the organisation. The next issue before us is to understand the costs associated with inventory before attempting to reduce them.

Activity 7.4

i) How do you define an inventory system? List down three important components of inventory system.

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ii) List down few industries in which the demand for inventory is (a) continuous and (b) discrete.

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iii) List down any three ideas to make the inventory system simpler so that its management is easier?

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7.5 COSTS IN INVENTORY SYSTEM

Managing costs is one of the primary responsibilities of any manager. The focus is not to eliminate or minimise the cost but it is a comparison of cost and benefit. The focus is to minimise the cost per unit of benefit. Thus, modern inventory management shifted the focus from eliminating inventory to optimising the level of holding inventory. For instance, one of the key success factors in cotton spinning and textile units is buying quality cotton during the season, when the prices are cheap. In all industries, which are exposed to price volatility, inventory holding is essential. Thus, cost of holding inventory needs to be compared to the benefit before judging the level of holding. We will first list out different costs associated with inventory in this section before comparing the cost with the benefits.

There are five different costs to the firm that holds inventory. The first category of costs is the value of inventory itself. It is the purchase cost of inventory of materials and components. For internally manufactured parts or work-in-progress or finished goods, the cost associated with producing the product, includes cost of material, labour and other production overheads. The second component of inventory cost is cost of acquiring inventory. For materials and purchased parts or components, it is the cost of purchasing, freight, inspection, etc. This component of cost goes up when the materials are purchased in small lot because it requires frequent ordering, transportation, and inspection. The set-up costs can be viewed as cost of acquiring finished goods since in terms of behaviour it is similar to acquisition cost of raw material. If finished goods are produced in small quantity, then the number of set-ups increases causing more set-up costs.

The third cost of inventory, which is important among different components of costs, is cost of holding inventory. There are different items that go into this cost component, some of them are fixed in nature whereas many others are variable. The cost of maintaining and managing stores, warehouses and other storing facilities are part of cost of holding inventory. The losses such as spoilage, theft or obsolescence that might occur in holding the inventory are also included in the cost of holding inventory. The most important cost of holding inventory is interest or opportunity costs associated with locking of firm's funds for inventory. The cost of holding inventory declines if the materials are procured in small quantity because it reduces the level of inventory.

The fourth cost of inventory is invisible and hence often ignored in formal analysis. This relates to cost of inventory shortage. In many ways, this is the most difficult category to estimate even though it is a very important cost to the firm. Its difficulty is mainly due to changes in the magnitude of the costs in different situations. For instance, if a firm is unable to supply the goods in time, it may have different consequences. It is possible to supply the goods with a minor delay and the buyer would perfectly accept the delayed supply. In a different situation, the customer would refuse to take delivery because of delay and thus the firm will lose profit on this sale. If the customer decides not to buy the product henceforth from the firm, then it is a loss of customer, which takes away all potential profits of the future. In the worst scenario, the news spreads to others' and many customers move to other competitors. The cost of shortage relates to material and other components which are associated with stopping and starting the production. If the entire factory is shut down due to shortage of material, then cost is very high.

The last component of cost related to inventory is cost of managing the inventory system. The cost of developing inventory information system, computer hardware and software and people associated with managing the inventory system. The cost is high in a multi-product and multi-locational firm whereas is it is relatively low for a single product 'company produced' at a single location.

The above costs in inventory system can also be classified as follows:

- Cost directly proportional to amount of inventory held such as storage cost, financial cost of carrying inventory, etc.
- Cost not directly proportional to amount of inventory held, which can be again classified into the following two categories:
    - Cost directly proportional to the period of holding inventory such as spoilage, obsolescence, interest cost, etc.
    - Cost directly proportional to number of orders such as ordering cost, set-up cost, freight, payment process, etc.
- Stock out cost

The objective before us is to manage these components of inventory cost such that the value derived from inventory is maximised. The optimisation can be achieved with zero inventory or high inventory, ordering frequently and procuring from several sources or storing in bulk and taking huge or zero risk of stock-out position.

Activity 7.5

i) Explain different cost components of inventory in a manufacturing unit?

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ii) Give an example on the relevance of cost of shortage in inventory management.

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iii) List down fixed and variable components of costs of inventory. How do you use this information in managing inventory?

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7.6 OPTIMISING INVENTORY COST

Inventory holding is desirable because it meets several objectives and needs as described in Section 7.3. But excessive inventory is undesirable as it costs a lot to a firm. The issue before us is balancing the cost and benefit and get an optimum level of inventory holding. This optimisation is achieved in two stages. First, the optimum ordering level (also called the Reorder Level) is computed by using the time required to place the order and receive the goods and demand from production centres. Second, the optimum ordering quantity also known as the Reordering quantity or Economic Order Quantity (EOQ) is computed using inputs such as ordering cost and inventory carrying costs. In simple terms, two questions namely, (a) how much should be ordered and (b) when should the stocks be ordered? are to be answered.

The issue of quantity to be ordered is determined by two costs namely ordering cost and cost of carrying inventory, which are inversely related. If every time, the firm orders more quantity, it can definitely cut down the cost of ordering, but has to carry more inventory and thus incur more cost of carrying inventory. Frequent ordering increases the cost of ordering but reduces cost of holding inventory. How these two costs are balanced to achieve optimum ordering quantity? There are two ways by which this could be achieved. One is by determining the EOQ and the other is by adopting the trial and error approach. This can be worked out with simple examples. But we do this with certain assumptions that both the annual demand and the materials usage is known with certainty. Also, the carrying cost per unit and ordering cost per order are constant. We will list down the assumptions once again because we will be discussing different other models in Section 7.7 by removing some of these assumptions.

1) The annual demand is known with certainty.

2) The annual consumption is even throughout the period.
3) The material usage per unit is known with certainty, and is uniform throughout the years.
4) The carrying cost per unit and ordering cost per unit is constant regardless of the size of the order.
5) The carrying cost is at a fixed percentage on the average value of the inventory held.
6) Inventory orders can be replenished immediately.

Trial and Error Approach has intuitive appeal as this resolves the problem through logical steps. Let us work out this with a simple problem. For this we take following data into consideration:

Annual consumption forecasted (C) : 24,000 units

Purchase price per unit (P) : Rs.15.00

Cost per order (O) : Rs.45.00

Carrying cost (I) :10% on the purchase price.

There are number of alternatives available to the firm to manage the inventory cost. The firm may either purchase the entire lot in one order or it may purchase in small lots by making multiple orders. If the firm chooses to purchase the entire in one single lot of 24000 units, then an amount of Rs.180000{(24000+0)/ 2*15}is invested throughout the period. On the other hand, if the firm chooses to purchase each month by ordering twelve times of 2000 units, then the average investment in inventory is Rs. 15000{(2000 + 0) /2*15}. Investment values differ according to the size of order. If the firm has to decide whether to go for the single order or multiple order system, it depends on various factors like the scarcity of materials, the production cycle, the demand for the materials, the availability of the materials, suppliers and buyers bargaining power, etc. If the firm focuses on reduction in the investment in inventory, then the firm would favour multiple orders. To further substantiate this, we find the total carrying and ordering cost involved in the various alternatives. Table 7.3 gives the details.

Table 7.3: Total cost of various alternatives

No. of orders (C/Q)	1	2	3	4	6	10	12	20	24
Order Size (Q)	24000	12000	8000	6000	4000	2400	2000	1200	1000
Avg inv (Q/2)	12000	6000	4000	3000	2000	1200	1000	600	500
Carrying cost (A/Q*I)	18000	9000	6000	4500	3000	1800	1500	900	750
Ordering cost (A/Q*O)	45	90	135	180	270	450	540	900	1080
Total Cost	18045	9090	6135	4680	3270	2250	2040	1800	1830

We find that the total cost gets reduced upto a point when the inventory level reaches 1200 units (Rs. 1800) of order size and after which, the cost starts to increase. Hence we call this level as the optimum level. There is an alternative way to find precisely the optimum quantity to be ordered. The Economic Order Quantity model is discussed in the next section.

Economic Order Quantity (EOQ)

Since the trial and error approach involves too tedious calculation, one simple Method is the use of the formula for calculating the Economic Order Quantity. We will show the derivation of the model before applying it to our above Example. Let us first describe the variables used in the equation as follows:

Annual consumption forecasted	= C
Purchase price per unit	= P
Cost per order	= O
Carrying cost	= I
Quantity per order	= Q
Number of orders	= C/Q
Average Inventory carried	= Q/2

The total cost of inventory is equal to purchase value of inventory (C x P) plus cost of ordering (C/Q x O) plus cost of holding or carrying inventory (Q/2xI). That is,

$$TC = CP + (C/Q)\,O + (Q/2)\,I$$

To minimise the total cost of inventory, we need to take the first derivative of the equation with respect to Quantity and set it to zero and then check whether the second derivative is positive.

$$\frac{dTC}{dQ} = -OCQ^{-2} + I/2 = 0$$

$$OC/Q^2 = I/2$$

$$Q^2 I = 2OC$$

$$Q^2 = 2OC/I$$

$$Q \text{ or } EOQ = \sqrt{2OC/I}$$

The second derivative ($2OCQ^{-3}$) is greater than zero because all the elements are positive. Substituting the values of the previous problem in the above equation, we get

$$\sqrt{2 \times 45 \times 24000/1.5} = 1200 \text{ Units}$$

The relationship between order size and different component of cost is given in the following graph. The total cost is low at the intersection point of ordering cost and carrying cost. The order size at this intersection is economic order quantity.

7.6.1 Analysis of Quantity Discounts

There are occasions when a firm is able to take advantage of quantity discounts provided the order size reaches a certain level. It is possible to analyse and decide on such cases.

For instance, in the preceding example we found that the usage per year is 2000 units, the holding cost per unit per year is Rs.10 and the ordering cost is

Rs. 100, let us now consider what would be the solution if it was known that a quantity discount of 10% in price is available if the order size is raised to 250 units.

Whether or not the quantity discount should be availed of, depends on an assessment of the costs and benefits involved.

The savings resulting from the quantity discount = (Re.1) (0.10) (2000) = Rs.200.

The cost is the additional holding cost minus savings in ordering cost stemming from fewer orders being placed.

While the cost was cQ*/2 = 10 (200)/2 = Rs.1000

The cost would now be, $cQ^{\#}/2$ = 10 (250)/2 = Rs. 1250;

where, $Q^{\#}$ = New Order Size

There would be a difference of Rs.250

The savings in ordering cost can be arrived at as follows:

Total ordering cost when 200 units are ordered each time

= 2000 (100)/200) = 1000

Total ordering cost when 250 units are ordered each time

= 2000 (100)/250 = Rs.800

The saving in ordering cost would be Rs. 200.

Thus while the savings in ordering cost would be Rs.200, the escalation in holding cost would be Rs.250, that is to say that the net increase in cost would be Rs.50.

In this particular instance it would be advisable to avail of the quantity discount option because the saving of Rs.200 exceeds the net increase in cost of Rs.50

7.6.2 Buffer Stock Decision

As was noted earlier in this unit, most firms maintain some margin of safety or buffer stock. If they did not do so they would run the risk of being unable to meet the demand for an item of inventory at a particular point in time. The cost of incurring shortages is the opportunity cost that one must take into account. When finished goods are in short supply customers get irritated and a loss of business may result therefrom. When raw materials or in-transit inventories are in short supply, stoppage in production and resulting inefficiencies may crop up.

To decide on the level of buffer stock to be carried a firm must balance the cost of stock outs with the cost of carrying additional inventory. One can assess this balance if the probability distribution of future usage is known.

Suppose the usage of an inventory item over a week is expected to be as follows:

Usage (in Units)	Probability
50	0.04
100	0.08
150	0.20
200	0.36
250	0.20
300	0.08
350	0.04
	1.00

Let us also assume an economic order quantity of 200 units per week, steady usage, 200 units in hand at the beginning of the period and three days' lead time required to procure inventories. We may further assume that since this lead time is known with certainty, orders are placed on the fifth day for delivery on the eighth day or the first day of the next seven-day-week. Even if the firm carries no buffer stock there will be no stock outs as long as the usage is 200 units or less. When usage exceeds 200 units there will be stock outs. When we know the cost per unit of stock out we are in a position to calculate the expected cost of stock outs and compare this with the cost of carrying additional inventory. Naturally, the stock out cost includes the loss of profit arising from the order not being fulfilled, a valuation of the loss of business reputation and goodwill. Let us say we reckon that the stock out cost is Rs.6 per unit and the average carrying cost per week is Re.1 per unit then we are in a position to figure out the expected costs associated with various levels of safety stocks.

Safety Stock	Stock out	Stock out Cost (Rs.)	Probability	Expected Stock out Cost (Rs.)	Carrying Cost (Rs.)	Total Cost (Rs.)
150 Units	0	0	0	0	150	150
100 Units	50	300	0.04			
150 units	0	0	0	0	100	150
100 units	50	300	0.04	12	100	112
50 units	100	600	0.04	24		
	50	300	0.08	24	50	98
0 units	150	900	0.04	26		
	100	600	0.08	48		
	50	300	0.20	60	0	144

From the above table it can be clearly seen that the optimal safety stock is 50 units, since at that level the total cost is at its lowest.

However, some firms simply decide on a probability level of stock out acceptable to them and then decide on the level of safety stock. For example, if this firm had decided on accepting a probability of 10% stock out then it will maintain a safety stock of 50 units only. If, however, the firm wished to accept a probability of only 5% stock out, then it will maintain a safety stock of 100 units. When it maintains a safety stock of 100 units it will be able to meet all situations except the one where there is 4% probability of the usage being 350 units.

Activity 7.6

i) How do firms arrive at the optimum cost?

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ii) What are the major costs that are taken into consideration in optimising the inventory cost?

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7.6 SELECTIVE INVENTORY CONTROL MODELS

The economic order quantity ensures the cost of carrying inventory and cost of ordering inventory are balanced and an optimum cost level is reached. However, it fails to ensure stock-out situation and the cost associated with the stock-out situation. In other words, if there is any uncertainty in replenishing the stock, it will lead to stock-out situation. Thus, in addition to ordering quantity, the time at which the order is to be placed is worked out after taking the uncertainty of replenishing the stocks into consideration. The various stock-levels that are mostly fixed are as follows:

Stock-Levels

Re-order Level: The storekeeper starts to make the purchases when the inventory in stores reaches this level. The re-order level is fixed taking into consideration leadtime and unusual delays or interruptions. This is calculated as follows:

Re-order Level = Maximum consumption x Maximum Re-order Period.

Minimum Level: Inventories are not allowed to fall below this level. These are otherwise called as safety stocks in the event of emergency. If the inventory level falls below this level there is a greater chance of stock-out. This generally happens when the consumption increases the standard requirements. This is calculated as follows

Minimum Level = Re-order Level - (Normal consumption x Normal Re-order Period)

Maximum Level: This is considered to be the highest level beyond which holding of inventories implies blocking of funds unnecessarily. The good inventory control technique should keep a constant check to see that the inventory level does not rise beyond this level. The maximum level is fixed taking into consideration the Re-order quantity, carrying costs, and the availability of capital, government policy and the nature of the materials.

Maximum Level= Re-order Level + 0.5(Re-order quantity) –

(Minimum consumption x Minimum Re-order Period)

Danger Level: This level is fixed even below the minimum level as a disastrous signal when the inventory level touches this level. This has to be solved by exercising greater efforts in purchasing to bring the inventory to the required level.

Re-order Point: When the question of maintaining inventory at optimum cost is raised one should not only focus on how much to order but the firm should also concentrate on when the order has to be placed. Arriving at the re-order point solves this. This is the level at which the orders should be placed to replenish the inventory. It takes into consideration the lead-time required to receive the inventory and the average usage. This should be a level over and above the minimum level or safety stock. Re-order point is calculated as follows:

Re-order point = Safety stock + (Average consumption x lead time.)

The determination of economic order quantity and different order levels are basically a planning exercise. The inventory management does not end with planning and what is more important is its implementation and continuous control on inventory. The following techniques, which follow selective control, are useful to exercise control on inventory.

ABC Analysis

ABC works on the mechanism namely Always Better Control. Vilfredo Pareto, called nineteenth century Renaissance man, was the first to document the Management Principle for Materiality, which formed the basis of ABC analysis discussed here. As per Pareto, the ABC principle involves:

1) Classifying the inventory on the basis of importance on a relative basis to the total inventory value.

2) Establishing different management controls for different classification with the degree of control being commensurate with the importance of the classification.

3) Hence this follows the criteria of concentrating the attention on most critical items and pay less concern for less critical items, something equivalent to the management by exception rule one could have come across in the basic management textbooks. For this purpose the management have to be careful in classifying the inventories into high, moderate and less critical goods. How is this done? The usual methodology is to use the Rupee volume as the criteria to classify them into categories, but there are several other factors that determine the importance of the item. These include:

Annual Rupee volume of the items.

a. Unit cost
b. Scarcity of material used in producing an item.
c. Availability of resources, manpower and facilities to produce an item.
d. Lead-time.
e. Storage requirements for an item.
f. Pilferage risks, shelf life and other critical attributes.
g. Cost of stock-out.
h. Engineering design volatility

Using value of items as the basis for such classification, if on an average the 15% of the items account for nearly 65% of the total inventory value, this falls under the most critical category which is usually named as the 'A' category. Similarly if 30% of the items account for 25% of the total inventory value, this falls under the next category named as 'B' category. The balance 55% of the items that account for nearly 10% of the total inventory value fall under the least category named as 'C' category.

Control Levels: In the case of 'A' category item, close controls are required to avoid stock-out costs. Arranging the supply with large number of vendors rather than depending only on a few suppliers might do this. Stock levels as discussed above are strictly maintained. Moreover holding buffer stocks would be more useful in managing the stock-out. In the case of B category item the stock-out costs could be somewhere between moderate to low. Hence appropriate computer-based system, with periodic reviews by the management is utmost necessary. In addition buffer stocks could be adequate control mechanism. On the other hand, routine control is sufficient for stocks falling under the C category. Action is taken only if the stock level falls below the re-order point. A periodic review at longer interval may also be sufficient.

VED Analysis

VED stands for Vital, Essential and Desirable. This technique is primarily used for the control of the spare parts inventory. As the name goes the spare

parts are subdivided into vital, essential and desirable categories, based on their critical nature. The criticality is determined by the importance of its usage. If the event of stock-out in an item stops the production, then it is classified under the 'vital' category. Those spares the absence of which is not tolerated for even few hours or a day, the loss of, which is considerably high, falls under the 'essential' category. Desirable spares are those, the absence of which is not expected to create havoc for a week or so and necessarily would not result in the stoppage of the production. Hence one could find that the VED analysis adopts almost the similar mechanism of the ABC analysis in that the former is used for the control of spare parts.

F-S-N Analysis

Inventory items are also classified and controlled on the basis of fast-moving, slow-moving and non-moving items (F-S-N analysis). The non-moving items are critically examined for their needs and items, which are not critical, are disposed off in a suitable manner. They may be used in the production process with modifications or sold in the market. The order levels and economic order quantity for slow-moving items are reviewed to check, whether they can be further reduced without affecting the production process.

The above three analysis are not mutually exclusive and in fact, by combining the analyses, the management can get a better picture on the inventory. For example, items, which are fast-moving, vital and "A" class, may require very close monitoring because excess holding will cause additional cost and at the same time stock-out will also cause equal loss. Inventory policy can be designed by combining the three analyses.

Activity 7.7

i) How do you think the existence of an inventory control system in the organisation would help in the inventory management?

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ii) What is Economic Order Quantity?

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iii) What are the various aspects that are to be considered in fitting an inventory control system in any organisation?

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7.8 INVENTORY MANAGEMENT UNDER UNCERTAINTY

In our discussion on optimising inventory cost, we have discussed economic order quantity based on the assumption that the firm knows with certainty the demand for inventory and cost of ordering and carrying inventory. Since this certainty assumption may go wrong, we have developed different stock levels to handle stock-out situation caused by uneven demand for inventory and order processing time. In this section, we will discuss some of the new techniques in handling the uncertainty. First, we will define the problem of uncertainty in simple terms with an example. Suppose a television dealer expects the demand for the product in the next twelve months to be 12000 televisions. Based on the ordering cost and cost of carrying inventory, the dealer works out 2000 units as the economic order quantity with a reorder level of 500 units. The methodology given in Section 7.6 would be adequate to get these figures. Suppose the actual demand for televisions suddenly increases to 20,000 units. If the manufacturer is not in a position to accept the demand for additional televisions, the dealer has to forego the opportunity income. On the other hand, if the demand declines to 5,000, the dealer will be carrying excess stock for atleast certain part of the year. The issue is how to address this uncertainty in demand while deciding optimum level of inventory. We will discuss a few models available to address the issue.

Option Pricing Model: Option is a contract that gives the holder a right to acquire or sell certain things at a predetermined price without any obligation. This type of contract is prevalent in commodities and financial assets. Since it is one- sided contract that offers only a benefit, the valuation methodology needs to differ from conventional models of valuing contracts or assets. There are different models available to value options and discussion on these models are beyond the scope of this unit. The basic option pricing approach finds application in several financial management issues such as capital budgeting, capital structuring and dividend policy. The model is also useful to address the uncertainty problem of inventory management.

We will first explain an option type called **put option** and then show how it is similar to the situation we have described in television dealers example. A put option gives a right to the holder to sell an asset at a predetermined price. The holder of the option gains if the value of underlying asset goes down because the holder can buy the asset at a lower price and sell at a higher predetermined price. The holder is not going to sustain any additional loss if

the price of the asset goes up. Of course, the holder will incur a loss to the extent of initial price (called option premium) paid to the other party of the contract to accept the one-sided contract. Thus, the value of contract is inversely related to the price behaviour of underlying asset with a cap on maximum loss. With this brief on options, let us go back to the television dealer example and compare the condition with the option model.

If the dealer decides to acquire additional inventory under the expectation that the demand will go up, there is an additional cost of carrying the inventory. At the same time, the dealer has acquired the right to sell the product and realise the profit if the demand picks up. This is similar to acquiring a put option on financial assets or commodity by paying upfront premium. The variable, which determines the profit of the financial or commodity option is the price of the product and in the case of inventory option, it is the demand for the product. As the demand goes up, the dealer starts initially getting back the cost and if the demand still goes up, gets profit. On the other hand, if there is no change in the demand, the product stays more time before it finds a buyer and this cost is initially determined as the cost of buying the option. The issue before the dealer is whether this cost is worth to incur to get a potential future benefit. This is similar to whether it is worth to buy a put option at a given price considering the likely benefit the option offers to the holder. Of course, in the television example, the value of the option directly moves with the demand for the product unlike the inverse relationship between the price of the asset and put option benefit. To know whether it is worth to carry additional inventory by incurring a cost, the dealer has to get a distribution of demand with associated probability. The easiest methodology to decide on this issue is Binomial Option Pricing Model. If the option value is more than the cost of carrying the inventory, then the decision is in favour of holding larger inventory. The readers are advised to consult standard text books on option pricing models to know more about valuation of options.

Frederic C. Scherrhas explained the use of Black-Scholes Option Pricing Model to resolve inventory problem by relating the impact of various demand levels on stock prices of the company.

Risk-Adjusted Discounted Cash Flow (DCF) Model: The model requires the managers to convert the inventory problem into a capital budgeting problem. Once this is done, it is possible to apply all the techniques that are used for resolving uncertainty in capital budgeting decisions. We will continue the television dealer example to show the similarity between the inventory problem and capital budgeting decisions. Suppose the dealer decides to hold additional inventory on the expectation that the demand will be more than 1000 television per month. The additional inventory holding has a cost and this is similar to the cost incurred for the purchase of equipment in capital budgeting exercise. The only difference is the inventory holding cost (cash outflow) is spread overtime whereas in the case of purchase of equipment, it is normally incurred at the beginning of the project period. Of course, there are projects, where investment is spread over time. The project offers certain benefit/cash inflows over the years. The benefit of holding larger inventory is the additional profit if the demand picks up. It

may be a one-time benefit or spread over the period. If you think of oil-drilling as a project, you can see several common features between our inventory problem and oil-drilling project. In an oil-drilling project, the cash outflow is incurred over a period, till the pipes reach the oil-bed. Once the oil is struck, there is no major additional expense and oil starts pouring for certain period. The project gets cash inflow. The only uncertainty is when we are going to strike oil and how long the flow will be there. There is no other way except to develop a probability distribution of the time and oil reserve. In the same manner, the television dealer also needs to estimate the probability distribution of future demand. As we have converted our inventory problem into a normal capital budgeting problem, risk- adjusted DCF model can be applied to resolve the uncertainty.

The next step in the application of risk-adjusted DCF model is to measure the cash inflow (profit) under different demand levels. It is also useful to estimate the cash inflows values for different levels of inventory holding i.e. 1000 units, 1500 units, 2000 units, etc. The cash flows are multiplied by the respective probability values of demand forecast. The next step is to use the risk-adjusted discount rate (often, it is cost of capital of the firm derived using Capital Asset Pricing Model) to get the present value of cash inflows. The expected value of cash inflows is computed by summing up all the present values of cash flows for different demand levels. If we repeat this process for different inventory holdings, then we get a series of expected values of cash inflows for different inventory holdings. The optimum inventory holding is the one where the difference between the risk-adjusted expected value of cash inflows is greater than the risk-adjusted cash outflows (cost of holding inventory).

Dynamic Inventory Model: In the above two models, we have limited the scope of uncertainty to expected demand and also restricted the period of analysis. If we desire to include uncertainty associated with many inventory variables such as demand, delivery period, interest cost of holding inventory, storage cost, cost of stock out, etc., we need a complex optimisation model. It is possible to use **simulation technique** to include multiple variables, which are exposed to uncertainty. The model requires identification of uncertain variables, estimation of probabilities associated with different uncertain variables and how the variables together affect the cost and benefit of holding a particular level of inventory. For example, given a delivery period of 30 days, interest cost of 14%, demand of 1500 units per month, and storage cost of 2% per month, the impact of placing an order quantity of 2000 units with a reorder level of 500 units on the cost and benefit of holding inventory are to be estimated. With this set of information, it is possible to simulate a large number of trials using random numbers. The simulation will give expected profit or loss estimation for each order quantity and reorder level and you may select the combination, which offers maximum profit. The decision making is easier and to an extent reliable because each profit estimation is based on a large number of simulated trials.

Though we have used finished goods example to explain different models of uncertainty, it equally applies to raw materials as well as work-in-process. All the uncertain variables affecting inventory like demand from production

centre, interest cost, storage cost, ordering cost, stock out cost, etc. are common to other types of inventory.

Activity 7.8

i) Why do we need to consider uncertainty in inventory management?

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ii) How do you evaluate the decision of holding additional inventory in an uncertain environment?

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iii) List down the steps involved in conducting simulation exercise to deal with uncertainty.

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7.9 EMERGING TRENDS IN INVENTORY MANAGEMENT

So far, we have assumed that inventory holding is inescapable necessity and thus finding ways to optimise the inventory holding through several models. This very basic assumption is questioned that leads to several interesting alternative inventory management techniques. Two important reasons for holding raw materials are to avoid price fluctuations and ensure that the delay in the arrival of materials does not affect the production process. Alternative strategies to holding raw materials to mitigate the price volatility include entering into a long-term supply contract at a fixed price or taking up position in futures market. The objective of ensuring smooth production process can be achieved by dealing with multiple supply sources, built-in strict penalty clauses in the purchase orders to compensate the loss sustained for emergency buying and adopting just-in-time (JIT) system.

The reasons for holding inventory in the form of work-in-process are complex production process, economic batch processing upto a stage of production and insure against sudden breakdown in the manufacturing process. It is not possible to overcome all the technology related problems but attempt can be made to bring a new technology that speeds up the production process or changes the production process. Some of the components can be outsourced so that there is no need to produce the quantity in bulk to achieve economies of scale. Another Japanese technique called *Kanbans* is useful to cut down the work-in-process since under this system, a production department produces the required product only when demand is made by the user system. Investments in plant and machinery and improving maintenance system would take away the need for holding stocks against sudden breakdown.

Finished goods inventory is maintained to ensure immediate delivery of the product. It may be difficult to make customers wait or require them to give an advanced schedule of consumption for many consumer products. However, this can be attempted in industrial goods and high value consumer goods. For example, companies like BPL have a system of taking advance from the customers to supply television after certain period and customers are suitably compensated for waiting period. Promoting internet based ordering system would definitely give a lead time to the manufacturer and thus avoid holding finished goods inventory. Industrial customers can be motivated to enter into a long-term purchase order by offering discounts or better credit terms. It is possible to access the production schedule of the industrial customers on a continuous basis and produce accordingly. The concepts such as vendor development, supply chain, etc. are emerging techniques that allow exchange of information between the suppliers and users with an objective of bringing down overall cost of inventory and at the same time ensuring smooth production process.

Many of the concepts we have discussed so far are likely to become outdated soon if the current growth rate in the information technology is maintained. The expansion of internet services and e-commerce will definitely create a new business world in which we may not have shops or malls. Most of the agencies dealing between customers and producers may not exist. Producers may also offer product with individual preferences and bargain for a leadtime to deliver the product. Industrial marketing is also likely to see major changes and at some point of time JIT, Kanbans, supply-chain, vendor development, etc. will become basic techniques for businesses. A sure way of tackling uncertainty is free exchange of information on online basis, which is not only feasible but will also become a norm in the near future.

Activity 7.9

i) List down some of the alternatives to hold raw material inventory.

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7.9 SUMMARY

Inventory, which consists of raw materials, components and other consumables, work-in-process and finished goods, is an important component of current assets. There are several factors like nature of industry, availability of material, technology, business practices, price fluctuation, etc., that determine the amount of inventory holding. Some of the broad objectives of holding inventory are ensuring smooth production process, price stability and immediate delivery to customers.

The inventory holding is also affected by the demand of the customers of inventory, suppliers and storage facility. Since inventory is like any other form of assets, holding inventory has a cost. The cost includes opportunity cost of funds blocked in inventory, storage cost, stock out cost, etc. The benefits that come from holding inventory should exceed the cost to justify a particular level of inventory.

Inventory optimising techniques such as EOQ help us to balance the cost and benefit to achieve a desirable level of inventory. It is not adequate to just plan for inventory holding. They need to be periodically monitored or controlled. Techniques such as ABC or VED are useful for continuous monitoring of inventory. Inventory planning can be done taking into account the uncertainty associated with inventory variables. Models such as option pricing model, risk- adjusted DCF model and dynamic inventory model are useful to handle the problem of uncertainty.

Recent developments in the manufacturing system and adoption of techniques such as JIT, Kanban, vendor development and supply chain management have contributed a lot in improving inventory management. The information sharing within the organisation as well as with the suppliers and consumers has allowed firms to operate with lower inventory and at the same time ensuring several objectives of holding inventory. The future is still exciting because of development in information technology and spread of internet and e-commerce. These developments allow a direct interaction between customers and producers and also synchronise material buying, production and consumption.

7.11 KEY WORDS

Raw materials: These are inputs used in the manufacturing process.

Work-in-progress: Material in the pipe line

Finished Goods: Completed products, ready for sale.

Stores and Spares: Consumables and components used in the manufacturing process.

Transaction motive: Material kept for running the production process.

Precautionary motive: Material kept for meeting contingency requirements like Irregular supply, excess demand, etc.

Speculative motive: purchasing material to take advantage of rising prices.

Economic ordering quantity: optimum quantity which minimises the costs of inventory.

Buffer stock: also known as safety stock, which is maintained to meet contingent requirements for material.

Re-order level: The stock level at which a fresh order for stock is made. This is fixed taking into account leadtime and consumption.

Minimum Level: The stock level below which inventories are not allowed to deplete

Maximum Level: The stock level, which is the highest in terms of holding inventory

ABC Analysis: A method of classification of inventory items basing on their consumption value. It is technique of management by exception.

Option Pricing Model: A mechanism of price determination in contracts that give the holder a right to acquire or sell certain things at a predetermined price without any obligation.

Just-in-Time: is an inventory management technique which helps companies to align raw material supplies with production schedules.

Kanban: is a technique used to limit the pile up of excess inventory in the production process by putting quantity restrictions at each point.

7.12 SELF ASSESSMENT QUESTIONS

1) Why do firms hold inventory? Illustrate with Examples.

2) Explain different components of an inventory system? Why do the inventory components vary from firm to firm? Compare your company's inventory components with that of some other company but in a different industry?

3) How do the factors that govern the inventory requirement of a firm that manufactures goods for direct consumption differ from another firm, which manufactures intermediary goods for industrial consumption?

4) What are different costs associated with holing inventory? How are they related?

5) What is Economic Order Quantity? How is it useful for the firms in inventory management? Under what conditions, EOQ model fails to hold good?

6) Briefly discuss philosophy of different types of inventory control systems.

7) How does uncertainty affect inventory management? Explain different models of inventory management under the condition of uncertainty.

8) If a firm adopts world-class manufacturing system, how does it affect inventory management?

9) How JIT and Kanbans help to cut-down the inventory in work-in-process? Will it be possible to implement these techniques in Indian Environment?

10) Describe the kind of impact the developments in IT is likely to cause on the inventory management of your industry.

11) The contention is that the ABC analysis is no longer appropriate as the developments in the IT technology can maintain tight control on all items. Comment.

12) Do you think that the Japanese Inventory Management Techniques have any relevance to the Indian Environment?

13) Sun Corporation estimates the monthly requirements of one of its inventory items to be as 1800 units. The cost of processing the order per unit is Rs.10.00.

The supplier agrees to offer quantity discounts as follows-

Lot size (Units)	Discount (%)
Upto 400 units	0
401-600	6
601-800	9
801-1000	15
Above 1000	20

The lead-time for the supply is found to be 2 days and the company wishes to keep a safety stock equivalent of 50% of the usage in the lead-time.

a) Find EOQ assuming no discount being offered.

b) Calculate Re-order point (for convenience take one month as 30days).

c) Tabulate various costs incurred taking into account the discount offered for various order sizes of 1,2,3 to7 orders a month and indicate the EOQ.

11. The ABC Corporation carries Rs 25 million of inventory. The financial manager is considering whether to recommend a reduction in inventory and has estimated the impact of lowering inventory from Rs.25 million to Rs.23 million and to Rs. 21 million on costs and sales. The details are given below:

Costs/Inventory Level	Rs.25mn	Rs. 23mn	Rs. 21mn
Storage costs	7,50,000	7,25,000	7,10,000
Spoilage costs	4,00,000	3,75,000	3,67,000
Daily sales	1,20,000	1,19,000	1,14,500

The company earns a contribution margin of 10% on sales. Would it be profitable for the firm to reduce the inventory from Rs. 25mn to Rs 23mn or to Rs 21mn.? Work out the possibilities.

12. A manufacturer of cameras has forecasted the demand for a component as follows:

Month	1	2	3	4	5	6
Demand(units)	100	130	125	200	210	185
Month	7	8	9	10	11	12
Demand(units)	175	190	200	251	270	255

The ordering cost for the component is Rs.50.00 per order. Purchase price per unit is Rs. 5.00 for a lot size of less than 500 units and Rs. 4.80 for lot size of 500 or more units. The annual carrying cost per unit of inventory is expected to be 30 percent of the unit purchase price. The lead-time is expected to be one week. The entire order for the component is delivered at one time.

The department has three alternatives for ordering. The order quantity should be equal to – (a) one-month supply, (b) two-month supply, (c) three-month supply.

Which one of these proposals would you suggest being more economical on the basis of an annual cost comparison?

13. An engineering unit uses a component at a uniform rate of 900 units per week. Minimum inventory is 100 units. The cost of placing and receiving an order is Rs. 200. Purchase price per unit is Rs. 40 per unit. Carrying cost is 15% of the purchase price per unit. The lead-time is two weeks.

You are required:

a. To ascertain the value of the economic order quantity for the firm.

b. With the use of the data and calculated EOQ as above determine:

   xi. Reorder point.

   xii. Maximum inventory.

   xiii. Average inventory.

   xiv. Average number of orders per week.

   xv. Average order cost per week.

   xvi. Average carrying cost per week.

   xvii. Relevant total average cost per week.

   xviii. Relevant total average cost per year.

14. ABC company buys an item costing Rs.125 each in lots of 500 boxes which is a 3 months supply and the ordering cost is Rs.150. The inventory carrying cost is estimated to be 20% of unit value, what is the total annual cost of the existing inventory policy? How much money could be saved by employing EOQ model?

15. The experience of a firm being out of stock is summarized below:

Stock out (No. of units)	No. of times (%)
500	1
400	2
250	3
100	4
50	10
0	80

Stock out costs are estimated to be Rs. 40 per unit and carrying costs per unit is Rs. 20. Determine the optimum level of Inventory?

7.13 FURTHER READINGS

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