

UNIT-III

Materials Management: Inventory Control, Inventory costs, Basic EOQ model, Model with Price breaks, ABC analysis, FSN Analysis, VED Analysis.

Total Quality Management:

Importance of quality, Difference between Inspection and Quality control, Components of total quality, Quality Function Deployment

Introduction to Supply Chain Management:

Definition, scope of SCM, Drivers of SCM, Advantages, limitations

Inventory Control

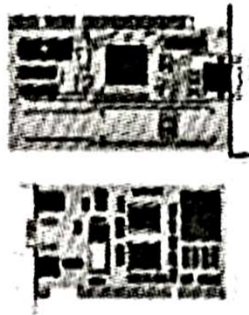
- **Inventory** generally refers to the materials in stock.
- It is also called the **idle resource** of an enterprise.
- Inventories represent those items which are either **stocked for sale** or they are **in the process of manufacturing** or they are in the form of **materials which are yet to be utilized**.



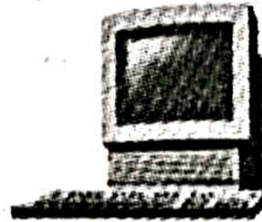
Raw
materials



Components



Work-in-progress



Finished
goods



Distribution
inventory



Maintenance,
repair & operating
supplies

REASONS FOR KEEPING INVENTORIES

1. To stabilise production:

The demand for an item fluctuates because of the number of factors, *e.g.*,
seasonality, production schedule, global incidents, temporary shortage, etc.

2. To take advantage of price discounts:

Usually the manufacturers offer discount for bulk buying and to gain this price advantage the materials are bought in bulk even though it is not required immediately.

3. To meet the demand during the replenishment period:

The lead time for procurement of materials depends upon many factors like location of the source, demand supply condition, delays in supply etc..

4. To prevent loss of orders (sales):

In this competitive scenario, one has to meet the delivery schedules at 100 per cent service level, means they cannot afford to miss the delivery schedule which may result in loss of sales.

5. To keep pace with changing market conditions:

The organizations have to anticipate the changing market, sentiments and they have to stock materials in anticipation of non-availability of materials or sudden increase in prices.

6. Suppliers minimum quantity condition, seasonal availability of materials or sudden increase in prices.

INVENTORY CONTROL

Inventory control is a planned approach of determining **what to order**, **when to order** and **how much to order** and **how much to stock** so that costs associated with buying and storing are optimal without interrupting production and sales.

Inventory control basically deals with two problems,

- (i) When should an order be placed? (Order level)**
- (ii) How much should be ordered? (Order quantity)**

OBJECTIVES OF INVENTORY CONTROL

1. To ensure adequate supply of products to customer and **avoid shortages** as far as possible.
2. To make sure that the financial investment in inventories is minimum (*i.e., to see that **the working capital** is blocked to the minimum possible extent*).
3. To **efficiently purchase, store, consume and accounting**
4. To maintain timely record of inventories of all the items and to **maintain** the stock **within the desired limits**.
5. To ensure timely action for **replenishment**.
6. To provide **a reserve stock** for variations in **lead times** of delivery of materials.
7. To provide a scientific base for both **short-term and long-term planning** of materials.

INVENTORY COSTS

1. Purchase (or production) Cost:

- The value of an item is its unit purchasing (production) cost.
- This cost becomes significant when availing the price discounts.
- This cost is expressed as Rs/unit.

2. Capital Cost:

- The amount invested in an item, (capital cost) is an amount of capital not available for other purchases.
- If the money were invested somewhere else, a return on the investment is expected.

3. Ordering Cost:

- It is also known by the name **procurement cost** or **replenishment cost** or **acquisition cost**.
- Cost of ordering is the amount of money expended to get an item into inventory.
- This takes into account all the costs incurred from calling the quotations to the point at which the items are taken to stock.

There are two types of costs **i. Fixed costs and ii. variable costs.**

- Fixed costs do not depend on the number of orders whereas variable costs change with respect to the number of orders placed.

- The salaries and wages of permanent employees involved in purchase function and control of inventory, purchasing, incoming inspection, accounting for purchase orders constitute the major part of the fixed costs.
- The cost of placing an order varies from one organisation to another. They are generally classified under the following heads:

(i) Purchasing: The clerical and administrative cost associated with the purchasing, the cost of requisitioning material, placing the order, follow-up, receiving and evaluating quotations.

(ii) Inspection: The cost of checking material after they are received by the supplier for quantity and quality and maintaining records of the receipts.

(iii) Accounting: The cost of checking supply against each order, making payments and maintaining records of purchases.

(iv) Transportation costs.

4. Inventory Carrying Costs (Holding Costs):

These are the costs associated with holding a given level of inventory on hand and this cost vary in direct proportion to the amount of holding and period of holding the stock in stores.

The holding costs include:

- (i) Storage costs (rent, heating, lighting, etc.).
- (ii) Handling costs: Costs associated with moving the items such as cost of labour, equipment for handling.
- (iii) Depreciation, taxes and insurance .
- (iv) Costs on record keeping.
- (v) Product deterioration and obsolescence.
- (vi) Spoilage, breakage and loss due to perishable nature

5. Shortage Cost:

When there is a demand for the product and the item needed is not in stock, then we incur a shortage cost or cost associated with stock out.

The shortage costs include:

- (i) Backorder costs.
- (ii) Loss of future sales;
- (iii) Loss of customer goodwill.
- (iv) Extra cost associated with urgent, small quantity ordering costs.
- (v) Loss of profit contribution by lost sales revenue.

INVENTORY CONTROL-TERMINOLOGY

1. **Demand:** It is the number of items (products) required per unit of time. The demand may be either deterministic or probabilistic in nature.
2. **Order Cycle:** The time period between two successive orders is called order cycle.
3. **Lead Time:** The length of time between placing an order and receipt of items is called lead time.
4. **Safety Stock:** It is also called buffer stock or minimum stock. It is the stock or inventory needed to account for delays in materials supply and to account for sudden increase in demand due to rush orders.

5. Inventory Turnover: If the company maintains inventories equal to 3 months consumption. It means that inventory turnover is 4 times a year, *i.e., the entire* inventory is used up and replaced 4 times a year.

6. Re-order Level (ROL): It is the point at which the replenishment action is initiated. When the stock level reaches R.O.L., the order is placed for the item.

7. Re-order Quantity: This is the quantity of material (items) to be ordered at the reorder level. Normally this quantity equals the economic order quantity (EOQ).

INVENTORY COST RELATIONSHIPS

There are two major costs associated with inventory.

- i. Procurement cost (ordering cost)
- ii. Inventory carrying cost.

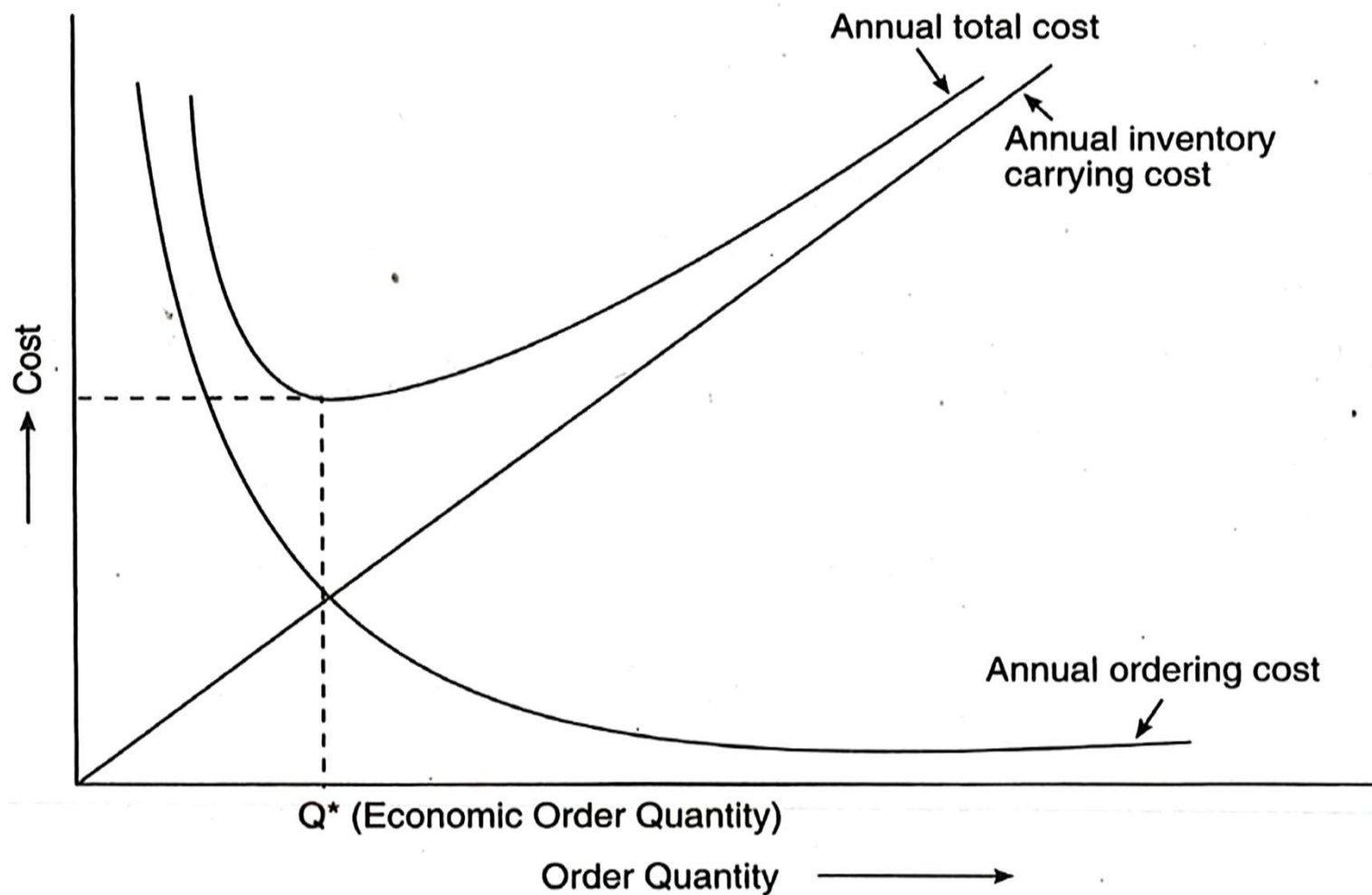
- Annual **procurement cost** varies with the number of orders.
- This implies that the procurement cost will be high, if the item is procured frequently in small lots.
- The procurement cost is expressed as Rs/Order.

- The annual inventory **carrying cost** (Product of average inventory x Carrying cost) is directly proportional to the quantity in stock.
- The inventory carrying cost decreases, if the quantity ordered per order is small.

The two costs are opposite to each other.

The right quantity to be ordered is one that strikes a balance between the two opposing costs.

This quantity is referred to as "**Economic order quantity**" (EOQ).



INVENTORY MODELS

One of the basic problem of inventory management is to find out the **order quantity** so that it is most economical from overall operational point of view.

Here the problem lies in minimising the two conflicting costs, *i.e.*, **ordering cost and inventory carrying cost**.

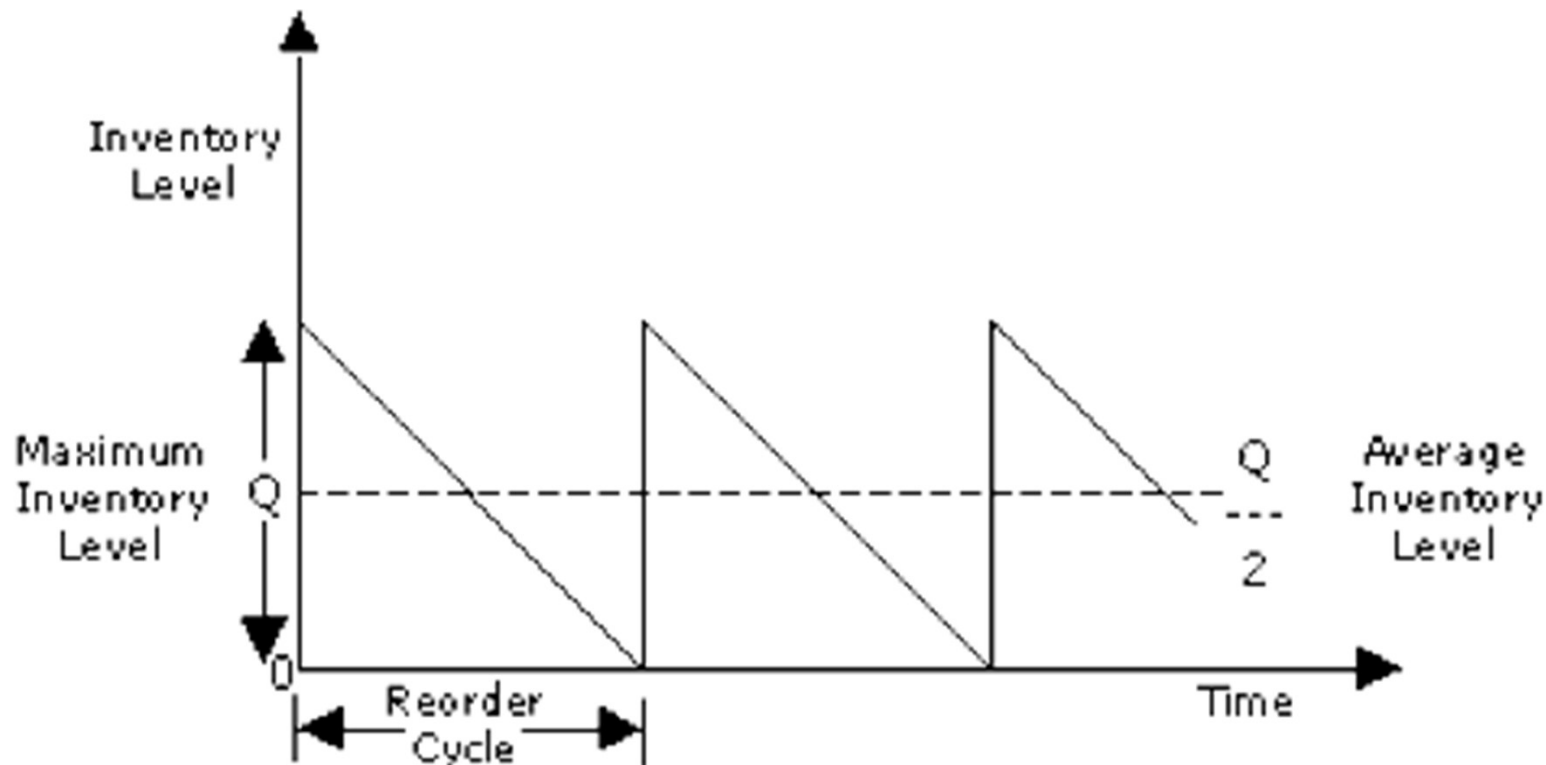
Inventory models helps to find out the order quantity which minimises the total costs (sum of ordering costs and inventory carrying costs).

ECONOMIC ORDER QUANTITY WITH INSTANTANEOUS STOCK REPLENISHMENT (BASIC INVENTORY MODEL)

Assumptions

1. Demand is deterministic, constant and it is known.
2. Stock replenishment is instantaneous (lead time is zero)
3. Price of the materials is fixed (quantity discounts are not allowed)
4. Ordering cost does not vary with order quantity.

Graphical representation of the model is shown in Fig.



D: Annual demand

H: Holding cost per unit

S: Ordering or set-up cost per order

Q: Batch size

Annual ordering cost = No. of orders x Ordering cost/order

$$= (D/Q) * S$$

If annual demand of an item is 1000 units and manager orders 100 units per order.

Thus he/she has to place an order 10 times.

Thus (D/Q) represents number of orders.

Annual inventory carrying cost = Average Inventory x inventory carrying cost.
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Between time period of start and end of cycle (time period t) on an average at any particular point, $Q/2$ units are being held up in inventory

$$= (Q/2) * H$$

As total cost is a combination of two types of cost so:

Total cost = Annual holding cost + Annual ordering cost

$$TC = (Q/2) * H + (D/Q) * S$$

To find minimum possible cost the above equation is differentiated w.r.t. Q and simple minima calculus is applied to find out batch size Q^* which would be

$$Q^* = \sqrt{(2DS/H)}$$

This formula of Q would provide manager the most optimum batch size that should be ordered with minimum total annual cost

Example 1:

Yellow press buys paper in 1500 pound rolls for textbook printing. Annual demand is 2500 rolls. The cost per roll is Rs.800 and annual holding cost is 1.5% of the cost. Each order costs Rs.50. How many rolls should Yellow press order at a time? What would be the total cost of keeping that many rolls?

Annual demand $D = 2500$

Holding cost, $H = 0.015 * 800 = \text{Rs.}12$

Ordering cost, $S = \text{Rs. } 50$

Number of rolls to be ordered:

$$Q = \sqrt{2DS/H}$$

$$Q = \sqrt{2 * 2500 * 50 / 12}$$

$$= 144.3 \text{ units} = \mathbf{144 \text{ units}}$$

Total annual cost would be:

$$TC = (Q/2) * H + (D/Q) * S$$

$$= (144/2) * 12 + (2500/144) * 50$$

$$= 864 + 868.055$$

$$= \mathbf{1732.05}$$

Example 2:

A firm buys 400 units of tapes per month for use in production content. The ordering cost is Rs.12.50. Holding cost is Rs.0.12 per tape. How many tapes should company order at a time? What is the time between orders?

Solution:

$$\text{Annual demand } D = 400 \times 12 = 4800$$

$$\text{Ordering cost } S = \text{Rs. } 12.50$$

$$\text{Holding cost } H = \text{Rs. } 0.12$$

$$\text{Thus, } Q = \sqrt{(2 \times 4800 \times 12.50 / 0.12)}$$

$$= 1000 \text{ units}$$

Order cycle or Time between orders (TBO).

$$\text{Number of times ordered per year} = 4800 / 1000 = 4.8$$

$$\text{Order cycle} = 12 \text{ months} / 4.8 = 2.5 \text{ months}$$

Example 3

Demand per week is 18 units. Price per unit is Rs.60. Holding cost = 25% of price of product. Cost of placing an order = Rs.45.

- (a) How many units should be ordered per batch?
- (b) If in addition to batch size as computed in (a) is 390 units and another batch is 468 units then which batch should be ordered? Also calculate TBO/order cycle for each batch size.

Solution:

(a) $D = 18 * 52 = 936$ units

$$H = 0.25 * 60 = \text{Rs.}15$$

$$S = \text{Rs.} 45$$

Batch size $Q = \sqrt{2DS/H}$

$$Q = \sqrt{2 * 936 * 45 / 15}$$

$$= 75 \text{ units}$$

(b) To decide which batch size is most optimum find Total cost for each batch size

$$\begin{aligned}\text{Total cost (when } Q = 75 \text{ units)} &= (Q/2) * H + (D/Q) * S \\ &= (75/2) * 15 + (936/75) * 45 \\ &= 562.5 + 561.6 \\ &= \mathbf{1124.1}\end{aligned}$$

$$\begin{aligned}\text{TBO/ Order cycle} &= \mathbf{Q/D} \\ &= 75/18 \\ &= 4.16 \text{ weeks}\end{aligned}$$

$$\begin{aligned}\text{Total cost (when } Q = 390 \text{ units)} &= (Q/2) * H + (D/Q) * S \\ &= (390/2) * 15 + (936/390) * 45 \\ &= \mathbf{3033}\end{aligned}$$

$$\begin{aligned}\text{TBO/Order cycle} &= \mathbf{Q/D} \\ &= 390/18 \\ &= 21.66 \text{ weeks}\end{aligned}$$

$$\begin{aligned}\text{Total cost (when } Q = 468 \text{ units)} &= (Q/2) * H + (D/Q) * S \\ &= (468/2) * 15 + (936/468) * 45 \\ &= \mathbf{3600}\end{aligned}$$

$$\begin{aligned}\text{TBO/Order cycle} &= \mathbf{Q/D} \\ &= 468/18 \\ &= 26 \text{ weeks}\end{aligned}$$

This implies that with increase in batch size total annual cost keeps on increasing, so it would be preferable to have a batch size of 75 units.

INVENTORY MODEL WITH PRICE BREAKS (DISCOUNTS)

When items are bought in large quantities, the supplier often gives discounts.

However, if the material is purchased to take advantage of discount, the average inventory level and so the inventory carrying costs will increase

Benefits for the purchaser from large orders are, lower cost per unit, lower shipping and the transportation cost, reduction in ordering costs due to less number of orders.

These benefits are to be compared with the increase in carrying costs. As the order size increases, more space should be provided to stock the items.

A decision is, therefore, to be taken whether the buyer should stick to economic order quantity or increase the same to take advantage that, at large quantities, the production costs per piece are lower

Price-discount Model

Let D - be the annual consumption. (Demand)

C_1 - is the price per unit. (Basic price)

C_2 - is the discounted price per unit.

C_o - is the ordering cost.

I - is inventory carrying cost expressed as a percentage of average inventory investment.

Q_B - The price break quantity. (Quantity at which the price changes).

Procedure (Decision Rules)

Calculate Q_2 (Economic order Qty. at discounted price (C_2))

$$Q_2 = \sqrt{\frac{2DC_o}{C_2I}}$$

Compare Q_2 with Q_B (Price break quantity)

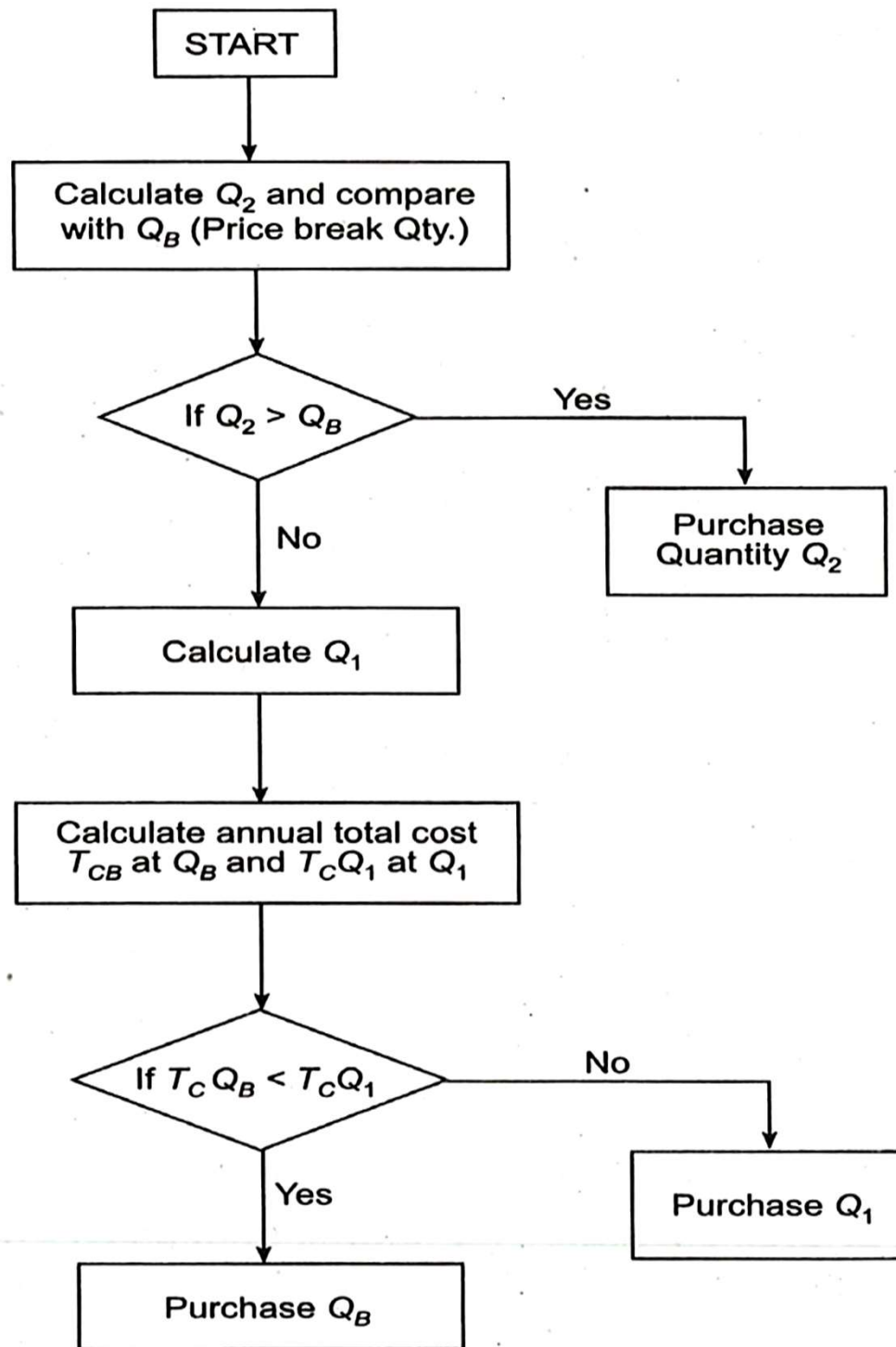
Case I

If $Q_2 > Q_B$, then order quantity Q_2

Case II

If $Q_2 < Q_B$,

1. Compute Q_1 (economic order quantity at basic price C_1)
2. Calculate annual total cost at Q_1 and Q_B .
3. If total cost TC at $Q_B < TC$ at Q_1 select Q_B , otherwise purchase Q_1 .



Flow-chart for price discount model.

SELECTIVE CONTROL OF INVENTORY

Selective control refers to the variation in method of control from item to item on some selective basis. There are many criteria used for this purpose. They are based on

- i. The cost of the product/item
- ii. Lead time
- iii. Usage rate
- iv. Procurement difficulties, criticality, frequency of usage

The items are categorised in a few groups depending upon the selected criteria such as value, usage and frequency of consumption.

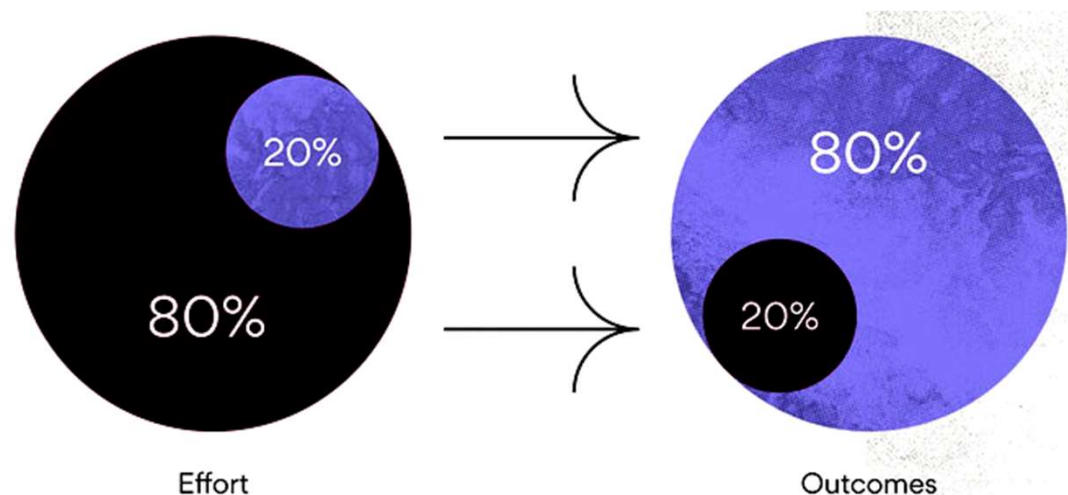
Such grouping helps the organisation for scientific inventory control.

Various types of inventory classifications

<i>Classification</i>	<i>Criteria</i>
1. <u>A.B.C. Analysis</u>	Annual usage value of items
2. <u>V.E.D. Analysis (Vital, Essential, Desirable)</u>	Criticality of the item (material criticality)
3. S.D.E. Analysis (Scarce, Difficult, Easy)	Procurement difficulties
4. H.M.L. Analysis (High, Low, Medium)	Unit price of the material (it does not depend upon consumption)
5. <u>F.S.N. Analysis (Fast, Slow, Non-moving)</u>	Issues from stores
6. S.O.S. (Seasonal, Off Seasonal)	Seasonality of items
7. X.Y.Z. Analysis	Inventory value of items used
8. G.O.L.F. (Govt., Ordinary, Local, Foreign)	Source of material

ABC analysis

- The inventory of an industrial organization generally consists of thousands of items with varying prices, usage rate and lead time.
- It is neither desirable nor possible to pay equal attention to all the items.
- ABC analysis is a basic analytical tool which enables management to concentrate its efforts where results will be greater.*
- The Pareto principle** (20/80) of cause and effect is a useful concept in business where it can be used to solve majority of production, quality and inventory problems.
- The concept applied to inventory control is called as *ABC analysis*.



- Statistics reveal that just a few items account for bulk of annual consumption of the materials.
- These few items are called *A class items which hold key to business*.
- *The other items known as B and C which are numerous in number but their contribution is less significant.*
- *ABC analysis thus tends to segregate the items into three categories A, B and C on the basis of their annual usage.*
- The categorization is made to pay right attention and control demanded by items.

(i) A class items:

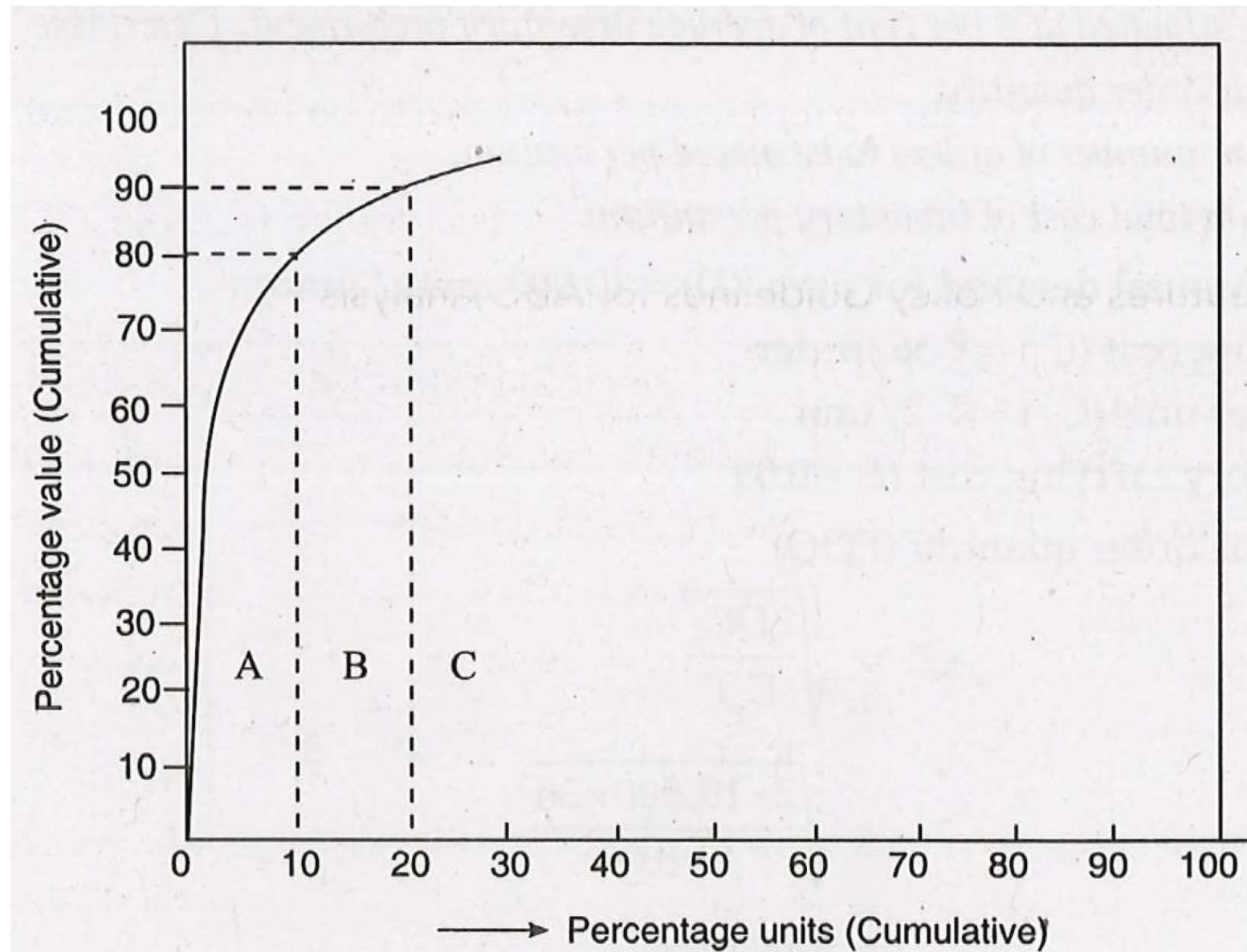
- These items hardly constitute 5-10 per cent of the total items and account for 70-75 per cent of the total money spent on inventories.
- These items require rigid and strict control and need to be stocked in smaller quantities. These items are to be procured frequently and each time less quantity is procured. The inventory of A class items is kept at minimum.

(ii) B class items:

- These items are generally 10-15 per cent of total items and represent 10-15 per cent of the total expenditure on materials.
- These are intermediate items. The control on these items should be intermediate between A and C items.

(iii) C class items:

- These are about 70-80 per cent in number and constitute only 5-10 per cent total expenditure on materials.
- These items being less expensive does not require strict control. These are ordered in bulk as against infrequent ordering of A class items.



ABC analysis.

Advantages of ABC Analysis

This approach helps the manager to exercise selective control and focus his attention only on a few items.

By exercising strict control on *A class items*, *the materials manager is able to show the results* within a short period of time.

It results in reduced clerical costs, saves time and effort and results in better planning and control and increased inventory turnover.

ABC analysis, thus, tries to focus and direct the effort based on the merit of the items and, thus, becomes an effective management control tool.

Limitations of ABC Analysis

ABC analysis is a fundamental tool for exercising selective control over numerous inventory items but in present form does not permit precise consideration of all relevant problems of inventory management.

ABC analysis is not one time exercise and items are to be reviewed and re-categorized periodically.

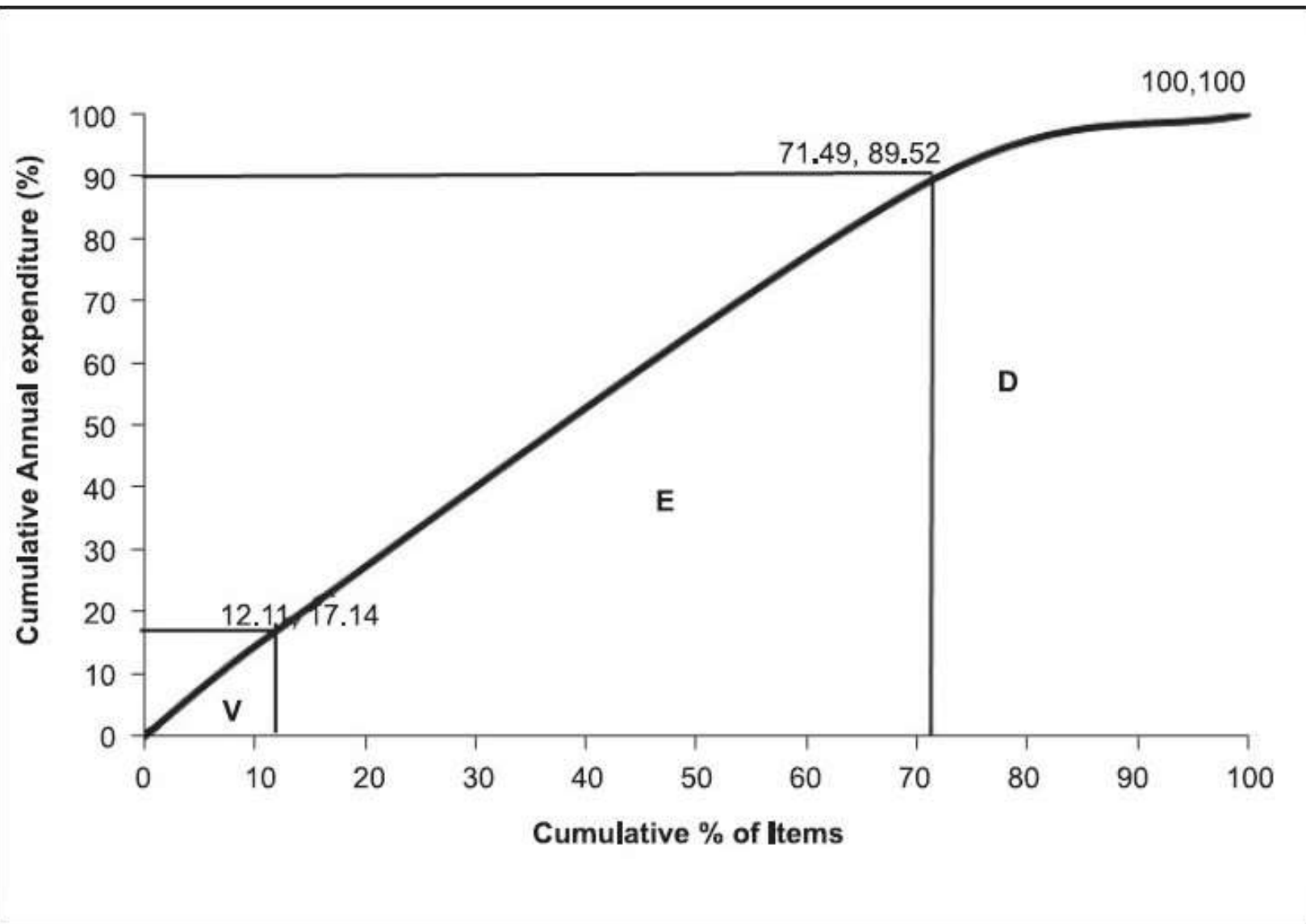
<i>A Class (High Value)</i>	<i>B Class (Moderate Value)</i>	<i>C Class (Low Value)</i>
1. Tight control on stock levels	Moderate control	Less control
2. Low safety stock	Medium safety stock	Large safety stock
3. Ordered frequently	Less frequently	Bulk ordering
4. Individual posting in stores	Individual posting	Collective postings
5. Continuous check on schedules and revision when called for	Broad check on schedule revisions	Hardly any check required
6. Weekly control statements	Monthly control reports	Quarterly control reports
7. Procured from multiple sources	Two or more reliable sources	Two reliable sources for each item
8. Minimise waste, obsolete and surplus	Quarterly control over waste	Annual review regarding waste
9. Continuous effort to reduce lead time	Moderate efforts	Minimum efforts

Procedure for making ABC Analysis

1. Calculate the total inventory value for each item held in inventory by multiplying the number of units used in a year by its unit price.
2. Tabulate these items in descending order of their values placing first the item having the highest total value and so on
3. Prepare a table showing item No., unit cost, annual units consumed and annual rupee value of units used.
4. Compute the running total item by item for the items and also for rupee value of consumption.
5. Compute the cumulative percentage for the item count and cumulative annual usage value.
6. Classify the items as per the norms for ABC items.
7. The cumulative percentages are represented graphically

V.E.D. analysis

- This analysis represents classification of items based on criticality.
- The analysis classifies the items into three groups called **vital, essential and desirable**.
- **Vital** items are those items the unavailability of which will stop the production.
- **Essential** items are those items whose stock out costs are very high.
- **Desirable** items will not cause any immediate production stoppages and their stock out costs are nominal.
- This analysis is mainly carried out to identify critical items.
- The service level for each item may be determined and the inventory can be planned accordingly.



FSN analysis

- All the items in the inventory are not required at the same frequency.
- Some are required regularly, some occasionally and some very rarely.
- FSN analysis classifies items into **fast moving, slow moving and non-moving**.

Fast Moving – Items which are frequently issued from inventory which are more than once for a specific time period

Slow Moving – Items which are less frequently issued which might be once in a specific time period

Non-Moving – Items which are not issued from the inventory at all in a specific time period

- The FSN classification system is extremely helpful in distributing spare parts which are kept near the dispensing area having items which belong to the fast-moving category.
- The items which fall into the non-moving category can be discontinued if the further scope of use is not expected.
- Companies in production for a longer period hold a specific percentage of non-moving spare parts which are usually disposed at regular intervals.
- Selling the spare parts or reusing the same can be again in the capital which can be used for other uses.

