**UNIT V INVENTORY CONTROL AND RECENT TRENDS IN PPC**

Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures. Two bin system - Ordering cycle system-Determination of Economic order quantity and economic lot size.

## Inventory Control & Inventory control parameters

### Inventory:

- It is stock of an item or idle resource held for future use.
- It is a stock of physical assets having some economic value, which can be used at a later time to meet expected/unexpected demand.
- The amount of material, a company has in stock at a specific time is known as inventory or in terms of money it can be defined as the total capital investment over all the materials stocked in the company at any specific time
- Items waiting to be purchased or sold are considered to be in inventory.
- The primary factor in the reduction of inventory costs is deciding when to order, how much to order, and if back-ordering is permissible

### Types of inventory:

- raw material inventory
- work in process inventory
- finished goods inventory
- spare parts inventory
- office stationary

### Need of Inventories:

- To safe guard against the uncertainties in price fluctuations, supply conditions, demand conditions, lead times, transport contingencies etc.
- To reduce machine idle times by providing enough in-process inventories at appropriate locations.
- To take advantages of quantity discounts, economy of scale in transportation etc.
- To decouple operations i.e. to make one operation's supply independent of another's supply. This helps in minimizing the impact of break downs, shortages etc. on the performance of the downstream operations. Moreover operations can be scheduled independent of each other if operations are decoupled.
- To reduce the material handling cost of semi-finished products by moving them in large

quantities between operations.

- To reduce clerical cost associated with order preparation, order procurement etc.

**Functions of Inventories:**

The basic purpose of inventories is to balance supply and demand.

Inventory serves as a link between:

1. Supply and demand
2. Customer demand and finished goods
3. Finished goods and component availability.
4. Requirements for an operation and the output from the preceding operation.
5. Parts and materials to begin production and the suppliers of materials.

**Inventory Control**

- It may be defined as the scientific method 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 interruption production and sales.
- Inventory control involves decisions by management as to the source from which the inventory is to be procured and as to the quantity to be procured at the time
- According to the Merriam-Webster dictionary, **inventory control** can be defined as the "coordination and supervision of the supply, storage, distribution, and recording of materials to maintain quantities adequate for current customer needs without excessive supply or loss."
- When it comes to wholesalers and distributors of durable goods, inventory control can be further defined as the process employed to maximize a company's use of inventory. The goal of inventory control is to generate the maximum profit from the least amount of inventory investment without hindering customer satisfaction levels or order fill rates.

**Objectives of inventory control:**

- To ensure continuous supply of materials so that production should not suffer at any time.
- To maintain the overall investment in inventory at the lowest level, consistent with operating requirement
- To minimize the holding, replacement and shortage cost of inventories and maximize the efficiency in production and distribution.
- To keep inactive waste surplus scrap and obsolete items at the minimum level.
- To supply the product raw material to its users as per the requirements at right time

and at right price.

- To ensure timely action for replenishment
- To maintain timely record of inventories of all the items and to maintain the stock within the desired limits
- To avoid both over-stocking and under-stocking of inventory.

**Definitions of Terms:**

- **Procurement quantity**

  Is the order quantity, which in effect determines the frequency of ordering and is related directly to the maximum inventory level

- **Inventory (I):**
  - Stock held for the purpose of meeting a demand either internal or external to the organization.
- **Lead time (L):**
  - The time required to replenish an item of inventory by either purchasing from a vendor or manufacturing the item in-house.
- **Demand (D):**
  - The number of units of an inventory item required per unit of time.
- **Reorder point (r):**
  - The point at which an order must be placed for the procured quantity to arrive at the proper time or, for the manufacturing case, the finished product to begin flowing into inventory at the proper time.
- **Reorder quantity (Q):**
  - The quantity for which an order is placed when the reorder point is reached.
- **Demand during lead time (DL):**
  - This quantity is the product of lead time and demand. It represents the number of units that will be required to fulfill demand during the time that it takes to receive an order that has been placed with a vendor.
- **Replenishment rate (P):**
  - This quantity is the rate at which replenishment occurs when an order has been placed. For a purchase situation it is infinite (when an order arrives, in an instant the stock level rises from 0 to Q). For the manufacturing situation it is finite.
- **Shortage:**
  - The units of unsatisfied demand that occur when there is an out-of-stock situation.

**Inventory Costs**

In order to control inventories appropriately, one has to consider all cost elements that are associated with the inventories. There are four such cost elements, which do affect cost of inventory.

1. **Unit cost:**

   It is usually the purchase price of the item under consideration. If unit cost is related with the purchase quantity, it is called as discount price.

2. **Procurement costs:**

   This includes the cost of order preparation, tender placement, cost of postages, telephone costs, receiving costs, set up cost etc.

3. **Stock out costs:(Shortage cost):**

   Is the penalty incurred for being unable to meet a demand when it occurs? This cost does not depend on the source chosen to replenish the stock but is a function of the number of units short and the time duration involved

   This represents the cost of loss of demand due to shortage in supplies. This includes cost of loss of profit, loss of customer, loss of goodwill, penalty etc.

4. **Holding costs (Carrying costs):**

   Are incurred as a function of the quantity on hand and the time duration involved. Included in these costs are the real out-of-pocket costs, such as insurance, taxes, obsolescence, and warehouse rental and other space charges, and operating costs, such as light, heat, maintenance, and security. In addition, capital investment in inventories is unavailable for investment elsewhere.

   This represents the cost of maintaining inventories in the plant. It includes the cost of insurance, security, warehouse rent, taxes, interest on capital engaged, spoilage, breakage etc.

5. **Ordering cost**

   Is the cost incurred when an order is placed. It is composed of the cost of time, materials, and any expense of communication in placing an order.

6. **Setup cost:**

Is the cost incurred when a machine's tooling or jigs and fixtures must be changed to accommodate the production of a different part or product.

**Total annual inventory cost = Cost of items + Annual procurement cost + Annual carrying cost + Stock out cost**

**Variables in Inventory Models**

D = Total annual demand (in units) Q = Quantity ordered (in units)

Q* = Optimal order quantity (in units) R = Reorder point (in units)

R* = Optimal reorder point (in units) L = Lead time

S = Procurement cost (per order)

C = Cost of the individual item (cost per unit)

I = Carrying cost per unit carried (as a percentage of unit cost C) K = Stock out cost per unit out of stock

P = Production rate or delivery rate

dl = Demand per unit time during lead time

Dl = Total demand during lead time

TC = Total annual inventory costs

TC* = Minimum total annual inventory costs

Number of orders per year = =Annual Demand/Order Quantity=D/Q

Total procurement cost per year = S.D / Q

Total carrying cost per year = Carrying cost per unit * unit cost * average inventory per cycle

Cost of items per year = Annual demand * unit cost = D.C

Total annual inventory cost (TC) = D.C+ S.D/Q+I.C. Q/2

$$\text{Total cost} = \left(\begin{matrix}\text{Cost of}\\ \text{items}\end{matrix}\right) + \left(\begin{matrix}\text{Cost of}\\ \text{ordering}\end{matrix}\right) + \left(\begin{matrix}\text{Cost of holding}\\ \text{items in stock}\end{matrix}\right) + \left(\begin{matrix}\text{Cost of}\\ \text{shortage}\end{matrix}\right)$$

$$\textbf{Total annual inventory cost (TC)} = D.C + \frac{S.D}{Q} + \frac{I.C.Q}{2}$$

- The objective of inventory management team is to minimize the total annual inventory cost.
- A simplified graphical presentation in which cost of items, procurement cost and carrying cost are depicted is shown in Figure.

- It can be seen that large values of order quantity Q result in large carrying cost.
- Similarly, when order quantity Q is large, fewer orders will be placed and procurement cost will decrease accordingly.
- The total cost curve indicates that the minimum cost point lies at the intersection of carrying cost and procurement cost curves.

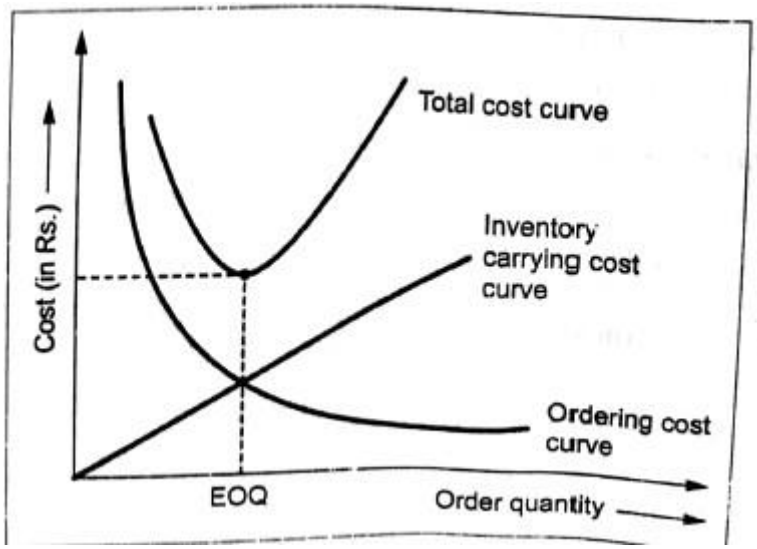



**Fig.3.6: Economic Order Quantity**

**Inventory Operating Doctrine:**

When managing inventories, operations manager has to make two important decisions

- When to reorder the stock (i.e. time to reorder or reorder point)
- How much stock to reorder (i. e. order quantity)

Reorder point is usually a predetermined inventory level, which signals the operations manager to start the procurement process for the next order. Order quantity is the order size.

**Types of Inventory Models**

**Deterministic models:**

- It assumes that quantities used in the determination of relationships for the model are all known.
- These quantities are such things as demand per unit of time, lead time for product arrival, and costs associated with such occurrences as a product shortage, the cost of holding the product in inventory, and that cost associated with placing an order for product.

**Constant demand:** Is one case that can be analyzed within the category of deterministic models. It represents very effectively the case for some components or parts in an inventory which are used in multiple parents, these multiple parent components having a composite demand which is fairly constant over time.

**Lumpy demand:** Is varying demand that occurs at irregular points in time.

- This type of demand is normally a dependent demand that is driven by an irregular production schedule affected by customer requirements.
- Although the same assumptions are made regarding the knowledge of r elated quantities, as in the constant demand case, this type of situation is analyzed separately under the topic of materials requirements planning (MRP). This separation of methodology is due to the different inputs to the modeling process in that the knowledge about demand is approached by different methods in the two cases.

**Probabilistic models:**

- Consider the same quantities as do the deterministic models but treat the quantities that are not cost related as random variables.
- The demand and lead time have their associated probability distributions. The added complexity of the probabilistic values requires that these models be analyzed by radically different methods.

**Inventory Modeling:**

This is a quantitative approach for deriving the minimum cost model for the inventory problem in hand.

- This model is applied when objective is to minimize the total annual cost of inventory in the organization.
- Economic order quantity is that size of the order which helps in attaining the above set objective.
- EOQ model is applicable under the following conditions.
    - Demand per year is deterministic in nature
    - Planning period is one year
    - Lead time is zero or constant and deterministic in nature
    - Replenishment of items is instantaneous

o Demand/consumption rate is uniform and known in advance

o No stock out condition exist in the organization

The total annual cost of the inventory (TC) is given by the following equation in EOQ model

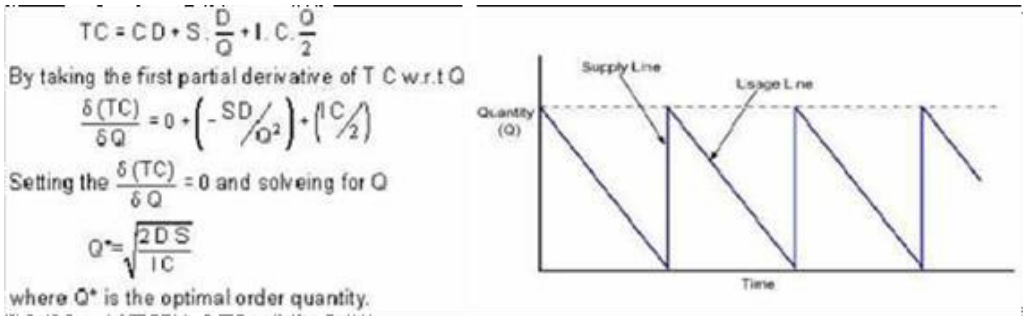
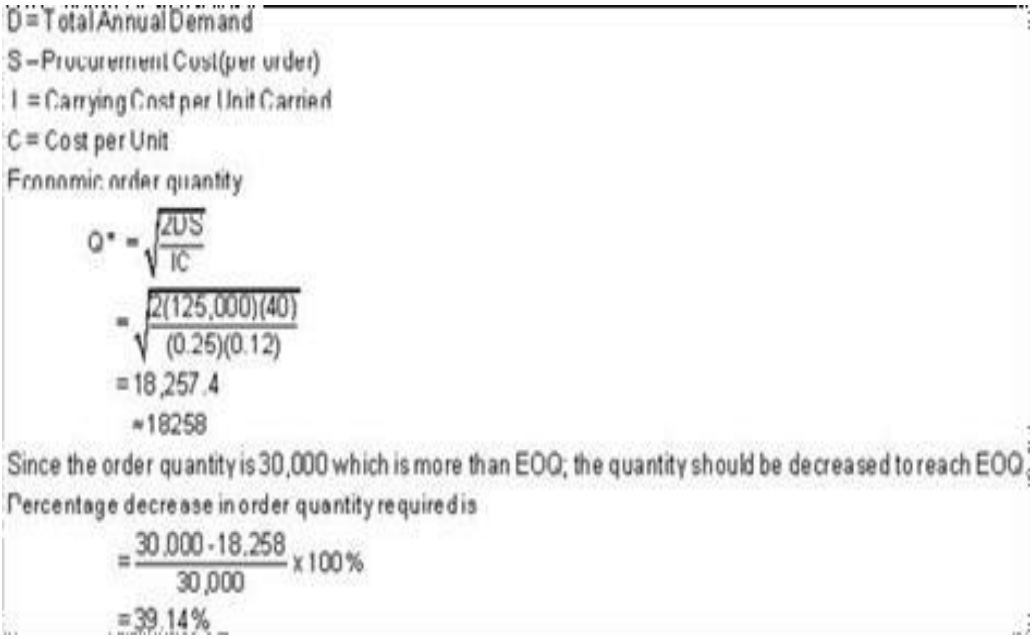



**Fig.3.7: Inventory Models**

**Example:** ABC manufacturers produces 1,25,000 oil seals each year to satisfy the requirement of their client. They order the metal for the bushing in lot of 30,000 units. It cost them $40 to place the order. The unit cost of bushing is $0.12 and the estimated carrying cost is 25% unit cost. Find out the economic order quantity? What percentage of increases or decrease in order quantity is required so that the ordered quantity is Economic order quantity?




Techniques of Inventory Control

There are a number of different techniques employed by wholesale distributors to ensure their inventory control is maximizing efficiency and profitability. Below are six key techniques of inventory control for wholesalers and distributors of durable goods:

1) Establishing Annual Stocking Policies

Management must decide the maximum and minimum level of stocks and supplies that need to be kept in the warehouse or across the network of warehouse locations. Management must also set optimized re-order levels, safety stock levels (below which supply must not be allowed to fall) and an average inventory level to ensure costs are contained.

2) Preparation of Inventory Budgets

Many organizations have an annual inventory budget and they are usually prepared well in advance before inventory is procured. Budgets should include the total cost of ownership to keep inventory on hand during that year's account period. This includes materials cost, fixed operational costs, carrying costs, logistics costs, redistribution costs and additional miscellaneous costs that contribute to the total costs of ownership.

3) Maintaining A Perpetual Inventory System

Also known as "the automatic inventory system", this method is designed to keep a constant track of the quantity and value of each stocked item. Many wholesale distributors leverage a combination of an Enterprise Resource Planning (ERP) or Warehouse Management System (WMS) in conjunction with an Inventory Optimization solution, such as EazyStock, to optimize inventory balances. Most ERP and WMS technologies struggle to keep costs low and service rates high, which is why optimization software can be so valuable to operations processes.

4) Inventory Turnover Ratio

This is a calculation used to determine how quickly inventory is used up or "turned over" in a given time period. The higher the ratio the shorter the shelf life of the inventory and typically leads to higher sales volume and profitability for companies with lower profit margins. Inventory turnover should be closely watched for every item in the warehouse. Over the course of the product's life cycle, demand will fluctuate and cause variability in the supply chain. Tracking demand patterns are one way to ensure product replenishment calculations are accurate and optimized.

5) Establishment of Optimized Purchasing Procedures

In order to ensure that inventory is under adequate control, management must adopt purchasing procedures that align with actual sales history and demand pattern data. All inventory items that have not had an inventory turnover or have not been sold within an

accounting period, typically 12 months, should be classified as obsolete stock and should be liquidated from inventory to eliminate unnecessary carrying costs. Any item with a declining customer demand should be flagged in the system and its safety stock level thresholds and re-order point counts should be downwardly adjusted to mitigate risk of obsolescence and cost.

6) ABC Analysis and ABC Classification

The fastest moving products in your inventory should be located closest to the shipping, staging, and receiving area in the lower-right of the diagram below. As the demand for each product decreases over time, products should be migrated backwards to free up space for items with higher inventory turnover or for new product introductions that have high demand. Since the majority of your picking activity is performed in a rather small area, your warehouse layout should be optimized to reduce time spent looking for product in the back of the warehouse.

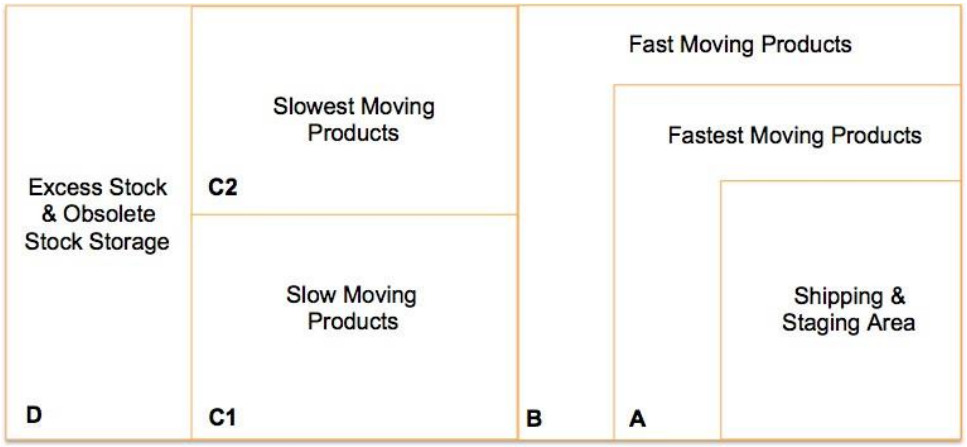



**Fig.3.8: Inventory model classification**

- **They experience stock outs of other products,** resulting in backorders, lost sales, and dissatisfied customers.
- **They have too much of some products** which leads to excess inventory which ties up working capital and profitability.
- **They have lost track of what is actually in inventory** because their legacy applications cannot effectively keep up with growing demand and the speed of business.

**They can't find material in their warehouse,** but they know the material is in the warehouse but warehouse management systems says they have product on hand.

With these common challenges come a few industry best practices that can eliminate, or at the very least, reduce the recurrence of these issues. Distributors that have committed to putting into place some of the following best practices on average report 30% reduction in costs associated with managing inventory.

**Optimization**

Here are 5 inventory optimization best practices to consider that will lead to a more optimized supply chain:

1) Categorize Your Inventory

This is similar to the ABC analysis practice where management categorizes its inventory according to its value and speed of turnover. Sales numbers and profitability margins are some of the ways stocks are valued. Inventory optimization software, such as EazyStock, can help inventory managers track an item's demand and lifecycle across 9 different demand patterns, from new to growing to decline, to ensure replenishment practices and customer demand are never out of step with each other.

2) Automate Demand Forecasting

The company's performance is often dependent on external conditions such as seasonal demand, market trends, economic conditions and other business trends that can cause unpredictable demand variability. Automated demand forecasting can be used to take the guesswork out of how much inventory should be carried for a given period. Automation dynamically calculates an inventory item's based demand according to historical sales data to ensure minimum and maximum order quantities are optimal.

3) Replenishment Automation

A centralized inventory management system coupled with inventory optimization software will enable a company to better track inventory levels and prepare for unexpected events. They can also avoid over stocking and under stocking situations as demand patterns can automatically override the replenishment parameters based on predetermined stocking policies and service level targets.

4) Continuous Process Improvement

Unless companies continuously monitor and analyze operational challenges, they may keep getting the same results, which include high operational costs, poor customer service levels and inefficient operations.

5) Invest into Inventory Optimization Technology

Most wholesalers and distributors rely on antiquated technology platforms such as ERP and WMS to drive their planning, forecasting and replenishment processes. Unfortunately, these

types of systems were not designed to optimize inventory levels. Companies looking to gain a step on the competition need to evaluate add-on systems that can support more lean operations and more efficient operations to save costs and increase service levels.

**Selective control systems:**

- Selective inventory control refers to the variation in method of control from item to item on some selective basis.

- The principle of selective inventory control recognizes that it is impossible to manage and control every item in inventory holdings, in the same way and still meet the objectives of
  - Bringing down the level of investment inn inventory
  - Avoid stock-out of critical items

- In this system the items are clustered into a few groups depending upon the selected criteria such as value, usage and frequency of consumptions

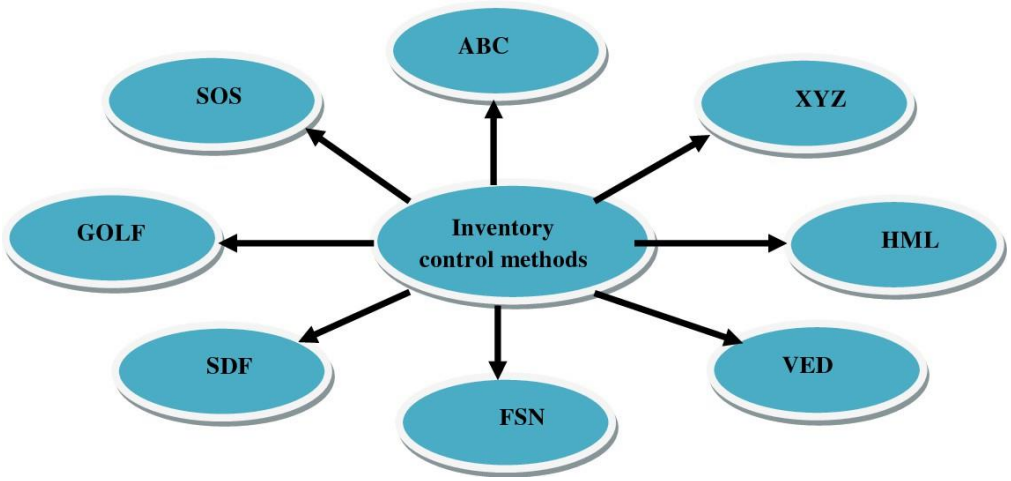



**Fig.3.9: Selective Inventory control technique**

**Table.3.1: Selective Inventory control models**

| S.No. | Techniques | Meaning | Criteria |
|---|---|---|---|
| 1. | ABC analysis | Always, Better, Control analysis | Annual usage value of items |
| 2. | VED analysis | Vital, Essential, Desirable analysis | Material criticality |
| 3. | HML analysis | High, Medium, Low analysis | Unit price of material |
| 4. | FSN analysis | Fast moving, Slow moving, Non-moving analysis | Issues from stores |
| 5. | SDE analysis | Scarce, Difficult, Easy to obtain analysis | Level of difficulty in the procurement of inventory |
| 6. | SOS analysis | Seasonal, Off-Seasonal analysis | Nature of the supplies |
| 7. | GOLF analysis | Government, Ordinary, Local, Foreign analysis | Source of the inventory |
| 8. | XYZ analysis | — | Inventory value of items used |
| 9. | Bar coding analysis | — | Use of bar codes |