CHAPTER FIVE

INVENTORY MANAGEMENT

5.1. DEFINITION OF INVENTORY MANAGEMENT

- Inventory management involves determining how much inventory to hold, when to place orders, and how many units to order.
- It is concerned with keeping enough inventories at hand to avoid running out of stock while at the same time maintain a small enough inventory balance to allow for a reasonable return on investment.
- Inventories are stock of the product a company is manufacturing for sale and components that make up the product.
- Inventories will have forms or types of, raw material inventory; work in process inventory, finished goods inventory.

5.2. MOTIVES FOR HOLDING INVENTORIES

There are three general motives for holding inventories:

1) **Transaction motive**: emphasis the need to maintain inventories to facilitate smooth production and sales operations.
2) **Precautionary motive**: required for holding of inventories to guard against the risk of unpredictable changes in demand and supply forces and other factors.
3) **Speculative motive**: influences the decision to increase or decrease inventory levels to take the advantage of price fluctuation.

OBJECTIVES OF INVENTORY MANAGEMENT

A) To maintain a large size of inventories of raw materials and work in process for efficient and smooth production and of finished goods for uninterrupted sales operations.

B) To maintain a minimum investment in inventories to maximize profitability.

Therefore, excessive and inadequate inventories are not desirable and the firm should avoid these two danger points. So, the objective of inventory management should be determine and maintain optimum level of inventory investment.

- ✓ The firm should avoid over and under inventories.

The danger of over investment (consequence)

- Unnecessary tied-up of the firms funds and lose of profit.
- Excessive carrying cost; cost of storage, handling, insurance, recording, and inspection etc.

- Excessive inventories carried for long-period increase the chance of lose of liquidity.

The danger (consequence) of under investment (inadequate)

- ❖ Production hold ups.
- ❖ Failure to meet delivery commitments.

Thus, the aim of inventory management:

- To avoid excessive and inadequate levels of inventories and to maintain adequate inventory for smooth production and sales operations.
- An efficient inventory management should;
- ✓ Ensure a continuous supply of raw materials to facilitate uninterrupted production.
- ✓ Maintain sufficient stocks of RMs in periods of short supply and anticipate price changes.
- ✓ Maintain sufficient stocks of finished goods inventory for smooth sales operations.

5.3. COSTS OF HOLDING INVENTORY (INVENTORY COSTS)

The twin goals of inventory management are:

1) To insure that inventories needed to sustain operations are available, but
2) To hold the costs of ordering and carrying inventories to the lowest possible level.

Generally, typical costs (relevant inventory management costs) are usually grouped in to three categories:

A. Carrying costs
B. Ordering costs
C. Stock-out costs (costs of running short)

A) Carrying costs: they are available and rise in direct proportion to the average size of the inventory.

They will generally increase in proportion to the average amount of inventory held.

Components of this cost include the following:

- ❖ Storage and handling costs.
- ❖ Obsolescence and deterioration costs.
- ❖ Insurance, taxes, depreciation, cost of capital tied up.

- If a firm sales “S” units per year, and if it places equal size orders “N” times per year, then S/N units will be purchased with each order. If the inventory is used evenly over the year, and if no safety stocks are carried, then the average inventory, “A” will be:

Average inventory = units per order = S/N ⟶ Equation 1

2 **2**

Example: If a firm sales 120, 000 units a year, with orders of 4, then the firm will order 30,000 units at a time, and its average inventory will:

Average inventory (AI) = S/N = 120,000/4 = **15,000** units

2 **2**

- Assume price (p) **=** birr 2 per unit**,** then average inventory value will be;

Average inventory value (AIV) = AI * price ⟹ 15,000 units *birr 2per unit **=**Birr **30,000**.

- If a firm has a cost of capital = 10%,

Cost of capital for one year = birr 30,000 * 10% = birr **3,000**; the firm incurs birr 3,000 in financing charges to carry the inventory for 1 year.

- Assume that each year, the firm incurs birr 2,000 of storage costs (space, utilities, securities, taxes, and so forth).

✓ Inventory insurance costs = birr 500.

✓ Depreciation and Obsolescence costs = birr 1,000.

- Total cost of carrying birr 30,000 average inventory is:

  Birr 3,000 + Birr 2,000 + Birr 500 + Birr 1,000 = Birr **6, 500,** and

- Annual percentage cost of carrying inventory = birr 6,500 = **21.7%**

  Birr 30,000

  Let say Annual percentage carrying cost = C, we can find total carrying cost as:

Total carrying cost (TCC) = percentage carrying cost * price per unit * Average inventory in units

Equation 2

Total carrying cost (TCC) = (C) X (P) X (AI)

= (0.217) X (birr 2) X (15,000 units) = Birr **6,500**.

B) Ordering costs: they may vary, dependent up on the type of item.

✓ They normally stated as birr per order.

✓ They decline with larger inventory holding.

✓ They increase in proportion with the number of orders placed and they include:

- Paper work costs of typing and dispatching an order.

- Follow up costs- includes the travel costs for purchases, follow-up, telephone, telex, and postal bills.
- Costs involved in receiving the order, inspection, checking, and handling to the stores.

Let F = fixed cost associated with ordering inventory (fixed cost per order);

N = number of orders;

- Total Ordering costs (TOC) = (F) *(N).

Equation 1 can be written as N = S/2AI

TOC = (F) * (N) = F (S/2AI) ⟶ Equation 3

Example: if FCs = birr 100, and S = 120,000 units, and AI = 15,000 units;

TOC = F (S/2AI) = birr 100 (120,000/2 * 15,000) = birr 100 * (4) = birr **400**.

✓ The more frequently inventory is acquired, the higher the firm's ordering costs.

C) Stock-out costs (costs of running short)

These costs are incurred when ever a business is unable to fill orders because the demand for an item is greater than the amount currently available in inventory.

They are the danger costs for the firm as delay of actual inventory usage.

These costs include: - loss of sales, loss of customer goodwill.

- Disruption of production schedules etc.

✓ Total inventory cost is equal to carrying costs plus ordering costs.

TIC = TCC + TOC $\boxed{TIC = (C)(P)(AI) + F(S/2AI)}$ ⟶ Equation 4

N.B. recognizing that the average inventory carried is AI = Q/2, or one half the size of each order quantity, Q, we may rewrite equation 4 as follows:

TIC = TCC + TOC = (C) (P) (Q/2) + (F) (S/Q) ⟶ Equation 5

5.3. INVENTORY CONTROL MODELS

- A number of inventory management or control models that can help in determining the optimum inventory level of each item are available. One of these models is Economic Order Quantity (EOQ) model.

Economic Order Quantity (EOQ) model

➢ It is a model for determining the order quantity that will minimize total inventory costs or it is the optimal or least cost, quantity of inventory that should be ordered.

Assumptions of EOQ

1) Annual demand or usage for a particular inventory item is known with certainty.

2) The Annual demand or usage is stationary or uniform throughout the year.

3) Orders to replenish the inventory item are filed instantaneously. I.e. the lead time is zero.

Lead time: is the time taken from ordering inventory to the supplier until the ordered inventory is received from the supplier.

Approaches in determining EOQ

☞ Three approaches may be used in determining EOQ,

A) Trial and error
B) The formula } approaches, but we concern the formula approach.
C) The graphic

The formula approach: it is an easy way to determine EOQ. But the trial and error approach is tedious to calculate (determine) EOQ.

TIC = TCC + TOC = (C) (P) (Q/2) + (F) (S/Q).

By using derivation, we can obtain;

$$EOQ = \sqrt{\frac{2(F)(S)}{(C)(P)}}$$ ——— Equation 1 Where,

EOQ = Economic Order Quantity, or the optimal quantity to be ordered each time an order is placed.

F = fixed costs of placing and receiving an order.

S = annual sales in units.

C = annual carrying cost expressed as %age of AI value.

P = purchase price the firm must pay per unit of inventory.

⊕ EOQ can also be written as; ——→ equation 2

$$EOQ = \sqrt{\frac{2(F)(S)}{C}}*$$ Where, C^* = the annual carrying cost per unit expressed.

Example: given

S = annual sales = 26,000 shirts per year.

C = percentage of carrying cost = 25% of inventory value.

P = purchase price per shirt = birr 4.29 per shirt.

F = fixed costs per order = birr 1,000.

Required: determine EOQ.

Solution: EOQ = $\sqrt{\frac{2(F)(S)}{(C)(P)}}$

$\iquest \sqrt{\frac{2(Birr\,1{,}000)(26{,}000)}{(0.25)(Birr\,4.92)}}$

EOQ = $\sqrt{42{,}276.423}$ = **6,500 Units/Shirts**.

With an EOQ = 6,500 shirts and annual usage of 26,000 shirts;

Order per year (N) = S/EOQ = 26,000/6,500 = **4 orders per year**.

Average Inventory = EOQ/2 = 6,500/2 = **3,250 Shirts**.

Or, Average Inventory =(S/N)/2 = EOQ/2 = (26,000/4)/2 = 3,250 Shirts.

Assuming the EOQ is ordered each time, we can find the total inventory costs (TIC) as;

TIC = TCC + TOC = (ACC) (P) (Q/2) + (F) (S/Q)

TIC = 0.25(Birr 4.92) (6,500/2) + (birr 1,000) (26,000/6,500)

= birr 4,000 + birr 4,000 = **birr 8,000**.

Annual Carrying Cost percentage = (TCC)/ (AI*P) $\iquest \frac{Br.4000}{3{,}250\,x\,4.92}$ = 0.25 =25%

Example: Osasco Company sells mattress through its department stores located in Addis Ababa. All inventories are maintained at the firm's centrally located warehouses. Annual demand for the standard –sized mattress is 3,600 units and is spread uniformly throughout the year. The cost of placing and receiving an order is birr 31.25. The inventory value is birr 50 per mattress. Osasco's annual carrying costs are 20% of inventory value (assume a 360 day year).

Required:

a) Determine the EOQ
b) Compute annual carrying costs
c) Compute annual ordering coasts
d) Total costs

Inventory reorder point: once the firm has calculated its EOQ, it must determine when to place orders. It is a level of inventory an order is placed. It is the point at which (level of inventory) new items must be ordered. It can be expressed as;

Inventory reorder point = lead time in days/weeks/months x daily demand or usage

Lead time- is the time needed to place and receive orders.

Daily demand or usage = annual demand /number of days in a year

Example: by referring Osasco Company mentioned above, assume Osasco Company knows that it requires 5 days to place and receive an inventory order. Its annual demand for the standard sized mattress is 3600 units and spread uniformly throughout the year.

- Thus, as soon as the company's inventory reaches……units of mattresses, an order will be placed for an amount equal to the EOQ (150 units). If the estimates of lead-time and daily usage are correct, the order will be received exactly when inventory level reaches to zero. However, demand fluctuates overtime due to seasonal and imprecise forecast of future demands. Similarly, lead-time is subject to uncertainty because of such factors as transportation delays, natural disasters etc. Under such conditions, the possibility of stock out exists. To minimize the stock outs and the associated stock out costs, most firms use an approach of adding a safety stock to their inventory.

Safety stock: it is an additional amount of inventory kept permanently at hand to absorb fluctuations in inventory usage and lead-time.it is maintained to meet unexpected high demand during the lead-time, unanticipated delays in the lead-time, or both.

Stock out = stock out units order per day/week X lead time

Example: by referring Osasco Company lead time (5 days) and the reasonable expected stock are 4 units, then

Quantity discount

The firm will save only the per unit purchase price, however, the firm will have to increase its order size more than the EOQ level to avail the quantity discount. This will reduce the number of orders and increase the average inventory holding.

Net return = resultant savings – additional carrying cost.

- If Net return is positive, the firm's order size should be equal to the quantity necessary to avail the discount.
- If Net return is negative, the firm's order size should be equal to EOQ level.

Example: EOQ = 300 units, and assume that the firm is offered 0.5% quantity discount on orders of 400 units or more. The net returns should be calculated for deciding whether the order size should be increased from 300 units to 400 units with annual requirement of 1,200 units, and ordering cost per order and carrying cost per unit is birr 37.5 and birr 1 respectively. Purchase price will be birr 50.

Solution: cash discount = discount rate x price x annual quantity requirement

= 0.5% x birr 50 x 1,200 = birr **300**.

The saving on ordering cost will be:

$$SOC = FC\left(\frac{A}{EOQ} - \frac{A}{Q}\right) = \text{BIRR } 37.5\left(\frac{1{,}200}{300} - \frac{1{,}200}{400}\right) = \text{Birr } 37.5(4\text{-}3) = \textbf{Birr 37.5}$$

The additional carrying cost = ½ CC (Q – EOQ) = ½ X Birr 1 (400 – 300) = **birr 50**.

Net return = cash discount + TOC – TCC

Net return = cash discount + savings on ordering cost – additional carrying costs

= Birr 300 + birr 37.5 – birr 50 = **birr 287.50**

- Since the net return is positive**,** the firm should have an order quantity of 400 units.

5.5. INVENTORY CONTROL SYSTEMS

Inventory management requires the establishment of an inventory control system. It ranges from simple to extensively complex, depending on the size of the firm and the nature of its inventory. The two simple control procedures that can be applied in manufacturing or retailing businesses are;

1) **The red line method**: it is an inventory control model(procedure) in which inventory items are stocked in a bin, a red line is drawn around the inside of the bin at the level of the reorder point, and the inventory clerk places an order when the red line shows.
2) **The two bin method**: it is an inventory control procedure in which an order is placed when one of two inventory-stocked bins is empty. When the working bin is empty, an order is placed and inventory is drawn from the second bin.

Inventory management also takes more complex systems of inventory control than the ones mentioned above. These are:

1) **Computerized inventory control system**

It is a system of inventory control in which a computer is used to determine reorder points and to adjust inventory balances.

2) **Just-in-time (JIT) system**: it is a system of inventory control in which a manufacturer coordinates production with suppliers so that raw materials or components arrive just as they are needed in the production process.
3) **Out-sourcing**: it is the practice of purchasing components rather than making them in house. though out sourcing was originally used to enable a firm obtain parts at lower cost than making them in-house, it would be more productive when combined with JIT system.