INVENTORY MANAGEMENT

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INVENTORY MANAGEMENT

**Inventory** is a stock or store of goods. It includes raw materials or stock incoming suppliers.

**What to Inventory?**

(A) Raw materials and purchased parts  
(B) Partially completed goods  
(C) Finished-goods inventories or merchandise  
(D) Replacement parts, tools, and suppliers  
(E) Goods-in-transit to warehouses or Goods In progress

**Types of Demand:**

1) **Dependent Demand**  
These are items that are typically subassemblies or component parts that will be used in the production of a final or finished product. Subassemblies and component a part is derived from the number of finished units that will be produced. Example: Demand for wheels for new cars.

2) **Independent Demand**  
These are items that are the finished goods or other end items. These items are sold or at least shipped out rather than used in making another product.

**Functions of Inventory**

1. **To meet anticipated customer demand.** These inventories are referred to as anticipation stocks because they are held to satisfy planned or expected demand.

2. **To smooth production requirements.** Firms that experience seasonal patterns in demand often build up inventories during off-season to meet overly high requirements during certain seasonal periods. Companies that process fresh fruits and vegetable deal with seasonal inventories.

3. **To decouple operations.** The buffers permit other operations to continue temporarily while the problem is resolved. Firms have used buffers of raw materials to insulate production from disruptions in deliveries from suppliers, and finished goods inventory to buffer sales operations from manufacturing disruptions.

4. **To protect against stock-outs.** Delayed deliveries and unexpected increases in demand increase the risk of shortages. The risk of shortages can be reduced by holding safety stocks, which are stocks in excess of anticipated demand.

5. **To take advantage of order cycles.** Inventory storage enables a firm to buy and produce in economic lot sizes without having to try to match purchases or production with demand requirements in short run.

6. **To hedge against price increase.** The ability to store extra goods also allows a firm to take advantage of price discounts for large orders.

7. **To permit operations.** Production operations take a certain amount of time means that there will generally be some work-in-process inventory.
Inadequate control of inventories

Inadequate control of inventories can result into two categories:

1) Under stocking results in missed deliveries, lost sales, dissatisfied customers and production bottlenecks.
2) Overstocking unnecessarily ties up funds that might be more productive

Two Main Concerns of Inventory Management

First Concern Level of customer service to have the right goods, in sufficient quantities, in the right place, and at the right time, second Cost of ordering and carrying inventories.

Objectives of Inventory Management

To achieve satisfactory levels of customer service while keeping inventory costs within reasonable bounds. Specifically Decision maker tries to achieve a balance in stocking and Cost of ordering and carrying inventories.

Fundamental decision must be made related to the timing and size of orders

Requirements for Effective Inventory Management

To be effective, management must have the following:
1. A system to keep track of the inventory on the hand on order.
2. A reliable forecast of demand that includes an indication of possible forecast error.
3. Knowledge of lead times and lead time variability.
4. Reasonable estimates of inventory holding costs, ordering costs, and shortage costs.
5. A classification system for inventory items.

Inventory Counting Systems

1) Periodic System

This is a physical count of items in inventory is made at periodic intervals (e.g. weekly, monthly) in order to decide how much to order of each item. Major users: Supermarkets, discounts stores, and department stores.

Advantage

Orders for many items occur at the same time, which can result in economies in processing and shipping orders.

Disadvantages

a) Lack of control between reviews.
b) The need to protect against shortages between review periods by carrying extra stock.
c) The need to make a decision on order quantities at each review
2) **Perpetual Inventory System** (also known as a continual system)

This keeps track of removals from inventory on a continuous basis, so the system can provide information on the current level of inventory for each item.

**Advantages**

1. The control provided by the continuous monitoring of inventory withdrawals.
2. The fixed-order quantity; management can identify an economic order size.

**Disadvantage**

1. The added cost of record keeping.

**Two-bin-system method**

Is two containers of inventory; reorder when the first is empty. The advantage of this system is that there is no need to record each withdrawal from inventory; the disadvantage is that the reorder card may not be turned in for a variety of reasons.

**Tracking System**

**Universal Product Code (UPC)** bar code printed on a label that has information about the item to which it is attached. Bar coding represents an important development for other sectors of business besides retailing. In manufacturing, bar codes attached to parts, subassemblies, and finished goods greatly facilitate counting and monitoring activities.

**Demand Forecast and Lead time Information**

Managers need to know the extent to which demand and lead time might vary; the greater the potential variability, the greater the need for additional stock to reduce the risk of a shortage between deliveries.

**Lead time** is time interval between ordering and receiving the order.

**Inventory Cost (Three Basic Costs)**

1. **Holding or Carrying Cost** is the costs to carry an item in inventory for a length of time usually a year. Cost includes interest, insurance, taxes, depreciation, obsolescence, deterioration, spoilage, pilferage, breakage, etc.

2. **Ordering Cost** is cost of ordering and receiving inventory. These include determining how much is needed, preparing invoices, inspecting goods upon arrival for quality and quantity, and moving the goods to temporary storage.

3. **Storage Cost** is cost resulting when demand exceeds the supply of inventory on hand. These costs can include the opportunity cost of not making a sale, loss of customer goodwill, late charges, and similar costs.
Inventory Management Continue….

Classification System
An important aspect of inventory management is that items held in inventory are not of equal importance in terms of dollars invested, profit potential, sales or usage volume, or stock-out penalties. Example: A producer of electrical equipment might have electric generators, coils of wire, and miscellaneous nuts and bolts among the items carried in inventory. It would be unrealistic to devote equal attention to each of these items.

A-B-C Approach
A-B-C Approach classifies inventory items according to some measure of importance, usually annual dollar usage, and then allocates control efforts accordingly.

<table>
<thead>
<tr>
<th>Three Classes of Items Used:</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (very important)</td>
</tr>
<tr>
<td>B (moderately important)</td>
</tr>
<tr>
<td>C (least important)</td>
</tr>
</tbody>
</table>

The key questions concerning cycle counting for management are:
1. How much accuracy is needed?
2. When should cycle counting be performed?
3. Who should do it?

ECONOMIC ORDER QUANTITY MODELS

Economic Order Quantity (EOQ) is the order size that minimizes total cost. EOQ models identify the optimal order quantity in terms of minimizing the sum of certain annual costs that vary with order size.

Three (3) Order Size
1. The economic order quantity model.
2. The economic order quantity model with non instantaneous delivery.
3. The quantity discount model.

Inventory Cycles begins with the receipt of an order of Q units, which are withdrawn at instant rate over time. When the quantity on the hand is just sufficient to satisfy demand during lead time, an order for Q units is submitted to the supplier.
Developing EOQ Mathematical Model

Assumption of the Basic EOQ Model

1. Only one product is involved.
2. Annual demand requirements are known.
3. Demand is spread evenly throughout the year so that the demand rate is reasonably constant.
4. Lead time does not vary.
5. Each order is received in a single delivery.
6. There are quantity discounts.

**Holding Cost** (H) or carrying cost relate to having items in storage. Cost includes interest, insurance, tax, depreciation Obsolescence, deterioration, spoilage, breakage. Warehouse cost (heat, light, security and rent).

In EOQ Model Holding Cost is express in terms of unit, So:

Total holding Cost = Number of unit x quantity

**Ordering Costs** are the costs of ordering and receiving inventory. They are the cost that varies with the actual placement of an order such as shipping cost, preparing invoices, inspecting goods upon arrivals.

The ordering Cost express as Fixed dollars per order regardless of order size.

By merging the two Graphs we can notice that the minimum Inventory Cost is at the intersection point.

Total Cost = Holding Cost + Ordering Cost
Optimal Quantity = \[ EOQ = \sqrt{\frac{2 \times D \times S}{H}} \]

Annual Holding Cost = \[ \frac{Q}{2} \times H \]

Annual Carrying Cost = \[ \frac{D}{Q} \times S \]

Total annual Inventory Cost = \[ \frac{Q}{2} \times H + \frac{D}{Q} \times S \]

Length Of order Cycle = \[ \frac{Q}{D} \]

**Determinants of Reorder point quantity** *(when we have to reorder?)*

a) Rate of demand  

b) The lead time  

c) The extent of demand  

d) The degree of stock out risk acceptable to management

**Example**

SaveMart needs 1000 coffee makers per year. The cost of each coffee maker is $78. Ordering cost is $100 per order. Carrying cost is $20 of per unit cost. Lead time is 5 days. SaveMart is open 360 days/yr.

(A) What is EOQ Model?

(B) How many times per year does the store reorder?

(C) What is the length of order cycle?

(D) What is the total annual cost if the EOQ quantity is ordered?

**Answer**

(A) \[ EOQ = \sqrt{\frac{2 \times D \times S}{H}} = \sqrt{\frac{2 \times 1000 \times 100}{10}} = \frac{Q}{2} \times H = 100 \text{ units} \]

(B) Number of orders = \[ \frac{D}{Q} \times \frac{1000}{100} = 10 \text{ times} \]

(C) Cycle Length = \[ \frac{Q}{D} \times \frac{100}{1000} = 0.1 \text{ per year} = 0.1 \times 360 \text{ days/year} = 36 \text{ days} \]

(D) Total Annual Inventory Cost = \[ \frac{Q}{2} \times H + \frac{D}{Q} \times S = \frac{100}{2} \times 20 + \frac{1000}{100} \times 100 = 2000 \]
EOQ with Non instantaneous Replenishment (EPQ)

When a firm is both a producer and a user or deliveries are spread over time, inventories tend to build up gradually instead of instantaneously. If usage production (or delivery) rates are equal, there will be no inventory buildup since all output will be used immediately and the issue of lot size doesn’t come up. In the more typical case, the production or delivery rate exceeds the usage rate. In the production case, production occurs over only a portion of each cycle because the production rate is greater than the usage rate, and usage occurs over the entire cycle.

The economic Production Quantity = \( \sqrt{\frac{2DS}{H}} \cdot \frac{p}{p-u} \)

Total Inventory cost = Carrying cost + setup cost

\( TC_{\text{min}} = \frac{I_{\text{max}}}{2} \cdot H + \frac{D}{Q} \cdot S \)

Cycle Time = \( \frac{Q_p}{u} \) time between beginning of range

Run time = \( \frac{Q_p}{p} \) production phase of the cycle

Average inventory \( I_{\text{average}} = \frac{I_{\text{max}}}{2} \)

The maximum inventory level = \( \frac{Q_p}{p} \cdot (p - u) \)

Where

- \( P \) is Production or Delivery Rate
- \( U \) is usage rate
Example

A toy manufacturer uses 48,000 rubber wheels per year for its popular dump truck. The firm makes its own wheels, which it can produce at a rate of 800 per day. The toy trucks are assembled uniformly over entire year. Carrying cost is $1 per wheel a year. Setup cost of production run of wheels is $45. The firm operates 240 days per year. Determine the:

a) Optimal Run Size.
b) Minimum total annual cost for carrying and setup.
c) Cycle time for the optimum run size.
d) Run time.

Answer

D = 48,000 wheels per year
S= $45
H= $1 per wheel per year
P = 800 wheels per day
U = 48,000 wheel per 240 days or 200 wheels per day

a) \[ Q_p = \sqrt{\frac{2DS}{H}} \cdot \frac{p-u}{p-u} = \sqrt{\frac{2(48000)45}{1}} \cdot \frac{800}{800-200} = 2400 \text{ wheels} \]

b) \[ TC_{\text{min}} = \frac{I_{\text{max}}}{2}H + \frac{D}{Q}S \]

so we first must find \( I_{\text{max}} \)

The maximum inventory level = \( \frac{Q_p}{p}(p-u) = \frac{2400}{800} \cdot (800-200) = 1800 \text{ wheel} \)

So \[ TC_{\text{min}} = \frac{I_{\text{max}}}{2}H + \frac{D}{Q}S = \frac{1800}{2}(1) + \frac{4800}{200}(45) = 1800 \]

c) \[ \text{Cycle Time} = \frac{Q_p}{u} = \frac{2400}{200} = 12 \text{ days} \]

d) \[ \text{Run time} = \frac{Q_p}{p} = \frac{2400}{800} = 3 \text{ days} \]
**EOQ with Quantity Discount**

**Quantity Discounts** are price reductions for large orders offered to customers to induce them to buy in large quantities. If quantity discounts are offered, the customer must weigh the potential benefits of reduced purchase price and fewer orders that will result from buying in large quantities against the increase in carrying costs caused by higher average inventories.

\[ TC = \text{carrying cost} + \text{Ordering cost} + \text{Purchasing Cost} \]

\[ TC = \frac{Q}{2}H + \frac{D}{Q}S + PD. \quad \text{Where: } P = \text{Unit price} \]

**EXAMPLE**

The maintenance department of a large hospital uses about 180 cases of liquid cleanser annually. Ordering costs are $25, carrying costs are $5 per case a year, and the new schedule indicates that orders of less than 45 cases will cost $2.0 per case, 45 to 69 will cost $1.7 per case, more than 70 cases will cost $1.4 per case. Determine the optimal order quantity and total cost.

\[ EOQ = \sqrt{\frac{2 \times D \times S}{H}} = \sqrt{\frac{2 \times 180 \times 25}{5}} = 43 \text{ unit} \]

Total Cost = \[\frac{Q}{2}H + \frac{D}{Q}S = \frac{43}{2} \times 5 + \frac{180}{43} \times 25 + 2 \times 43 = 298.15 \]

If we order 45 unit we may get discount the price will be reduced from $2 to $1.7 and the total annual cost will be:

Total Annual Cost = \[\frac{Q}{2}H + \frac{D}{Q}S = \frac{45}{2} \times 5 + \frac{180}{45} \times 25 + 1.7 \times 45 = 289 \]

If we order 70 unit we may get further reduction as the price will be reduced from $1.7 to $1.4 the annual cost in this case would be:

Total Annual Cost = \[\frac{Q}{2}H + \frac{D}{Q}S = \frac{70}{2} \times 5 + \frac{180}{70} \times 25 + 1.4 \times 70 = 337.28 \]

We can note that at some range from 45 to 70 units annual cost will be appropriate even the EOQ state other range due to discount effect.
Problem#1

A local distributor for a national tires company expects to sell approximately 9600 steel belted radial tires of certain size and treated design next year. Annual carrying cost is $16 per tire and ordering cost is $75. The distributor operates 288 days a year.

(A) What is EOQ Model?
(B) How many times per year does the store reorder?
(C) What is the length of order cycle?
(D) What is the total annual cost if the EOQ quantity is ordered?

Problem#2

A large bakery buys flour in 25-pound bags. The bakery uses an average of 4,860 bags a year. Preparing an order and receiving a shipment of flour involves a cost of $10 per order. Annual carrying costs are $75 per bag.

(A) Determine the economic order quantity.
(B) What is the average number of bags on hand?
(C) How many orders per year will there be?
(D) Compute the total cost of ordering and carrying flour.
(E) If ordering costs were to increase by $1 per order, how much that would affect the minimum total annual cost?

Problem#3

A large law firm uses an average of 40 boxes of copier paper a day. The firm operates 260 days a year. Storage and handling costs for the paper are $30 a year per box, and its costs approximate $60 to order and receive a shipment of paper.

(A) What order size would minimize the sum of annual ordering and carrying costs?
(B) Compute the total annual cost using your order size from part a?
(C) Except for rounding, are annual ordering and carrying costs always equal at EOQ?
(D) The office manager is currently using an order size of 200 boxes. The partners of the firm expect the office to be managed "in a cost-efficient manner." Would you recommend that the office manages use the optimal order size instead of 200 boxes? Justify your answer.

Problem#4

Highland Electric Co. buys coal from Cedar Creek Coal Co. to generate electricity. CCCC can supply coal at the rate of 3,500 tons per day for $10.50 per ton. HEC uses the coal at a rate of 800 tons per day and operates 365 days per year. HEC’s annual carrying cost for coal is $2 per ton, and the ordering cost is $5,000.

a) What is the economical production lot size?
b) What is HEC’s maximum inventory level for coal?
c) What is Cycle time and run time for the optimum run size.
Problem#5

The friendly Sausage factory (FSF) can produce hot dogs at a rate of 5,000 units per day. FSF supplied hot dogs to local restaurant at a steady state rate of 250 per day. The cost to prepare equipment for producing hot dog is $66. Annual holding cost is 45 cents per hot dog. The factory operates 300 days a year. Find
a) The optimal run size.
b) The number of runs per year.
c) The length (in days) of a run.

Problem#6

A chemical firm produces sodium bisulphate in 100-pound bags. Demand for this product is 20 tons per day. The capacity for producing the product is 50 tons per day. Setup cost $100 and storage and handling cost are $5 per ton a year. The firm operates 200 days a year. (Note 1 ton = 2000 pounds)
a) How many bags per run are optimal?
b) What would the average inventory be for this lot size?
c) Determine the approximate length of a production run in days?
d) About how many runs per year would there be?
e) How much could the company save annually if the setup cost reduced to $25 per run?

Problem#7

A-1 Auto Parts has a regional tire warehouse in Atlanta. One popular tire, the XRX75, has estimated demand of 25,000 next year. It costs A-1 $100 to place an order for the tires, and the annual carrying cost is $30 per unit. The supplier quotes these prices for the tire:

<table>
<thead>
<tr>
<th>Number of boxes</th>
<th>Price per box</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 490</td>
<td>$ 21.60</td>
</tr>
<tr>
<td>500 to 999</td>
<td>$ 20.95</td>
</tr>
<tr>
<td>More than 1000</td>
<td>$ 20.90</td>
</tr>
</tbody>
</table>

Problem#8

A mail order house uses 18,000 boxes a year. Carrying cost are 60 percent of a box cost price and ordering cost are $96 per order. The following price schedule applied. Determine:-
a) The optimal order quantity?
b) The number of orders per year?

<table>
<thead>
<tr>
<th>Number of boxes</th>
<th>Price per box</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 to 1900</td>
<td>$ 1.25</td>
</tr>
<tr>
<td>2000 to 4999</td>
<td>$ 1.20</td>
</tr>
<tr>
<td>5000 to 9999</td>
<td>$ 1.15</td>
</tr>
<tr>
<td>10000 or more</td>
<td>$1.10</td>
</tr>
</tbody>
</table>