

# Inventory Theory

## Introduction

The word 'inventory' means simply a stock of idle resources of any kind having an economic value. In other words, inventory means a physical stock of goods, which is kept in hand for smooth and efficient running of an organization. It may consist of raw materials, work-in-progress, spare parts/consumables, finished goods, human resources such as unutilized labor, financial resources such as working capital, etc. It is not necessary that an organization has all these inventory classes but whatever may be the inventory items, they need efficient management as generally a substantial amount of money is invested in them. The basic inventory decisions include: **1) *How much to order?* 2) *When to order?* 3) *How much safety stock should be kept?*** The problems faced by different organizations have necessitated the use of scientific techniques in the management of inventories known as inventory control. Inventory control is concerned with the acquisition, storage, and handling of inventories so that the inventory is available whenever needed and the associated total cost is minimized.

## Reasons for Carrying Inventory

Inventories are carried by organizations because of the following major reasons:

- 1. Improve customer service-** An inventory policy is designed to respond to individual customer's or organization's request for products and services.
- 2. Reduce costs-** Inventory holding or carrying costs are the expenses that are incurred for storage of items. However, holding inventory items in the warehouse can indirectly reduce operating costs such as loss of goodwill and/or loss of potential sale due to shortage of items. It may also encourage economies of production by allowing larger, longer and more production runs.
- 3. Maintenance of operational capability-** Inventories of raw materials and work-in-progress items act as buffer between successive production stages so that downtime in one stage does not affect the entire production process.
- 4. Irregular supply and demand-** Inventories provide protection against irregular supply and demand; an unexpected change in production and delivery schedule of a product or a service can adversely affect operating costs and customer service level.

5. **Quantity discount-** Large size orders help to take advantage of price-quantity discount. However, such an advantage must keep a balance between the storage cost and costs due to obsolescence, damage, theft, insurance, etc.
6. **Avoiding stock outs (shortages)-** Under situations like, labor strikes, natural disasters, variations in demand and delays in supplies, etc., inventories act as buffer against stock out as well as loss of goodwill.

## **Costs Associated with Inventories**

Various costs associated with inventory control are often classified as follows:

1. ***Purchase (or production) cost:*** It is the cost at which an item is purchased, or if an item is produced.
2. ***Carrying (or holding) cost:*** The cost associated with maintaining inventory is known as holding cost. It is directly proportional to the quantity kept in stock and the time for which an item is held in stock. It includes handling cost, maintenance cost, depreciation, insurance, warehouse rent, taxes, etc.
3. ***Shortage (or stock out) cost:*** It is the cost which arises due to running out of stock. It includes the cost of production stoppage, loss of goodwill, loss of profitability, special orders at higher price, overtime/idle time payments, loss of opportunity to sell, etc.
4. ***Ordering (or set up) cost:*** The cost incurred in replenishing the inventory is known as ordering cost. It includes all the costs relating to administration (such as salaries of the persons working for purchasing, telephone calls, computer costs, postage, etc.), transportation, receiving and inspection of goods, processing payments, etc. If a firm produces its own goods instead of purchasing the same from an outside source, then it is the cost of resetting the equipment for production.

## **Basic Terminologies**

The followings are some basic terminologies which are used in inventory theory:

### **1. Demand**

It is an effective desire which is related to particular time, price, and quantity. The demand pattern of a commodity may be either deterministic or probabilistic. In case of deterministic demand, the quantities needed in future are known with certainty. This can be fixed (static) or can vary (dynamic) from time to time. On the contrary, probabilistic demand is uncertain over a certain period of time but its pattern can be described by a known probability distribution.

## **2. Ordering cycle**

An ordering cycle is defined as the time period between two successive replenishments. The order may be placed on the basis of the following two types of inventory review systems:

- *Continuous review*: In this case, the inventory level is monitored continuously until a specified point (known as reorder point) is reached. At this point, a new order is placed.
- *Periodic review*: In this case, the orders are placed at equally spaced intervals of time. The quantity ordered each time depends on the available inventory level at the time of review.

## **3. Planning period**

This is also known as time horizon over which the inventory level is to be controlled. This can be finite or infinite depending on the nature of demand.

## **4. Lead time or delivery lag**

The time gap between the moment of placing an order and actually receiving it is referred to as lead time. Lead time can be deterministic (constant or variable) or probabilistic.

## **5. Buffer (or safety) stock**

Normally, demand and lead time are uncertain and cannot be predetermined completely. So, to absorb the variation in demand and supply, some extra stock is kept. This extra stock is known as buffer stock.

## **6. Re-order level**

The level between maximum and minimum stocks at which purchasing activity must start for replenishment is known as re-order level.

# **Economic Order Quantity (EOQ)**

The concept of economic ordering quantity (EOQ) was first developed by F. Harris in 1916. The concept is as follows: Management of inventory is confronted with a set of opposing costs. As the lot size increases, the carrying cost increases while the ordering cost decreases. On the other hand, as the lot size decreases, the carrying cost decreases but the ordering cost increases. The two opposite costs can be shown graphically by plotting them against the order size as shown in Fig. 1.1 below:

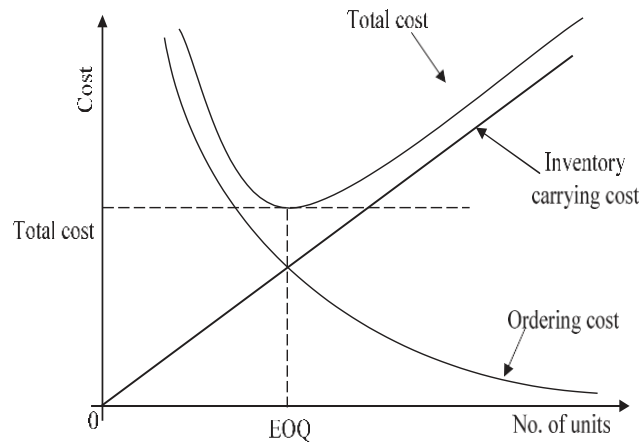


Fig. 1.1: Graph of EOQ

Economic ordering quantity (EOQ) is that size of order which minimizes the average total cost of carrying inventory and ordering under the assumed conditions of certainty and the total demand during a given period of time is known.

## List of Symbols

The following symbols are used in connection with the inventory model:

- $c$  = purchase (or manufacturing) cost of an item
- $c_1$  = holding cost per quantity unit per unit time
- $c_2$  = shortage cost per quantity unit per unit item
- $c_3$  = ordering (set up) cost per order (set up)
- $R$  = demand rate
- $P$  = production rate
- $t$  = scheduling period which is variable
- $t_p$  = prescribe scheduling period
- $D$  = total demand or annual demand
- $q$  = lot (order) size
- $L$  = lead time
- $x$  = random demand
- $f(x)$  = probability density function for demand  $x$ .
- $z$  = order level