

## Quadrant II - Notes

Paper Code: COG140

Module Name: Economic Order Quantity

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### Economic Order Quantity (EOQ)

A decision about how much to order has great significance in inventory management. The quantity to be purchased should neither be small nor big because costs of buying and carrying materials are very high.

Economic order quantity is the size of the lot to be purchased which is economically viable. This is the quantity of materials which can be purchased at minimum costs. Generally, economic order quantity is the point at which inventory carrying costs are equal to order costs. In determining economic order quantity it is assumed that cost of a managing inventory is made of solely of two parts i.e. ordering costs and carrying costs.

**(A) Ordering Costs:** These are costs that are associated with the purchasing or ordering of materials. These costs include:

- (1) Inspection costs of incoming materials.
- (2) Cost of stationery, typing, postage, telephone charges etc.
- (3) Expenses incurred on transportation of goods purchased.

These costs are also know as buying costs and will arise only when some purchases are made.

**(B) Carrying Costs:** These are costs for holding the inventories. These costs will not be incurred if inventories are not carried. These costs include:

- (1) The cost of capital invested in inventories. An interest will be paid on the amount of capital locked up in inventories.
- (2) Cost of storage which could have been used for other purposes.
- (3) Insurance Cost
- (4) Cost of spoilage in handling of materials

**Assumptions of EOQ:** While calculating EOQ the following assumptions are made.

1. The supply of goods is satisfactory. The goods can be purchased whenever these are needed.
2. The quality to be purchased by the concern is certain.
3. The prices of goods are stable. It results to stabilise carrying costs.

Economic order quantity can be calculated with the help of the following formula:

where, A = Annual consumption in rupees.

S = Cost of placing an order.

I = Inventory carrying costs of one unit.

**Illustration 1:** The finance department of a Corporation provides the following information:

- (i) The carrying costs per unit of inventory are Rs. 10
- (ii) The fixed costs per order are Rs. 20]
- (iii) The number of units required is 30,000 per year.

Determine the economic order quantity (EOQ) total number of orders in a year and the time gap between orders.

**Solution: The economic order quantity may be found as follow**

$$A = 30,000$$

$$S = \text{Rs.}20$$

$$I = \text{Rs.}10$$

$$\text{Now, EOQ} = ( 2 \times 30,000 \times 20 ) / 10 )^{1/2} = 346 \text{ units}$$

So, the EOQ is 346 units and the number of orders in a year would be  $30,000/346 = 86.7$  or 87 orders. The time gap between two orders would be  $365/87 = 4.2$  or 4 days.

### Definition and explanation

**Economic order quantity (EOQ)** is the order size that minimizes the sum of ordering and holding costs related to raw materials or merchandise inventories. In other words, it is the optimal inventory size that should be ordered with the supplier to minimize the total annual inventory cost of the business. Other names used for economic order quantity are optimal order size and optimal order quantity.

The economic order quantity is computed by both manufacturing companies and merchandising companies. Manufacturing companies compute it to find the optimal order

size of raw materials inventory and merchandising companies compute it to find the optimal order size of ready to use merchandise inventory.

### **The ordering and holding costs**

The two significant factors that are considered while determining the economic order quantity (EOQ) for any business are the *ordering costs* and the *holding costs*.

A brief explanation of both the costs is given below:

#### **Ordering costs**

The **ordering costs** are the costs that are incurred every time an order for inventory is placed with the supplier. Examples of these costs include telephone charges, delivery charges, invoice verification expenses and payment processing expenses etc. The total ordering cost usually varies according to the frequency of placing orders. Mostly, it is directly proportional to the number of orders placed during the year which means If the number of orders placed during the year increases, the annual ordering cost will also increase and if, on the other hand, the number of orders placed during the year decreases, the annual ordering cost will also decrease.

#### **Holding costs**

The **holding costs** (also known as carrying costs) are the costs that are incurred to hold the inventory in a store or warehouse. Examples of costs associated with holding of inventory include occupancy of storage space, rent, shrinkage, deterioration, obsolescence, insurance and property tax etc. The total holding cost usually depends upon the size of the order placed for inventory. Mostly, the larger the order size, the higher the annual holding cost and vice versa. The total holding cost is some time expressed as a percentage of total investment in inventory.

***The economic order quantity is the level of quantity at which the combined ordering and holding cost is at the minimum level.***

**Relation between the ordering and holding cost:**

There is an inverse relationship between ordering cost and holding cost. Keeping the annual demand constant if for example the number of orders decreases, the ordering cost will also decrease but the holding cost will rise and vice versa.

Ordering costs and carrying costs are quite opposite to each other. If we need to minimize carrying costs we have to place small order which increases the ordering costs. If we want minimize our ordering costs we have to place few orders in a year and this requires placing large orders which in turn increases the total carrying costs for the period.

### **Economic order quantity formula**

The following formula is used to determine the economic order quantity (EOQ):

$$EOQ = \sqrt{\frac{2 \times D \times C_o}{C_h}}$$

*Where,*

- D = Demand per year
- C<sub>o</sub> = Cost per order
- C<sub>h</sub> = Cost of holding per unit of inventory

### **Example**

The material DX is used uniformly throughout the year. The data about annual requirement, ordering cost and holding cost of this material is given below:

- Annual requirement: 2,400 units
- Ordering cost: Rs.10 per order
- Holding cost: Rs.0.30 per unit

**Required:** Determine the economic order quantity (EOQ) of material DX using above data.

### **Solution**

The economic order quantity for material DX is 400 units. Now, we can compute the number of orders to be placed per year, annual ordering cost, annual holding cost and combined annual ordering and holding cost as follows:

### **Number of orders per year**

$$\begin{aligned} &= \text{Annual demand}/\text{EOQ} \\ &= 2,400 \text{ units}/400 \text{ units} \\ &= 6 \text{ orders per year} \end{aligned}$$

### **Ordering cost**

$$\begin{aligned} &= \text{Number of orders per year} \times \text{Cost per order} \\ &= 6 \text{ orders} \times \text{Rs.10} \\ &= \text{Rs.60} \end{aligned}$$

### **Holding cost**

$$\begin{aligned} &= \text{Average units} \times \text{Holding cost per unit} \\ &= (400/2) \times 0.3 \\ &= \text{Rs.60} \end{aligned}$$

### **Combined ordering and holding cost at economic order quantity (EOQ):**

$$\begin{aligned} &= \text{Ordering cost} + \text{Holding cost} \\ &= \text{Rs.60} + \text{Rs.60} \\ &= \text{Rs.120} \end{aligned}$$

*Notice that both ordering cost and holding cost are Rs.60 at economic order quantity. The holding cost and ordering cost at EOQ tend to be the same.*

### **Tabular determination of economic order quantity (EOQ)**

Under tabular approach of determining economic order quantity, the combined ordering and holding cost is computed at different number of orders and their respective order quantities. This approach is also known as trial and error approach of determining economic order quantity.

This approach is illustrated below using the same data as used in the above example:

\*Average units  $\times$  Holding cost per unit:  $1,200 \text{ units} \times 0.30 = \text{Rs.}360$

Notice that the quantity of 400 units with 6 annual orders and a combined ordering and holding cost of Rs.120 is the most economical quantity to order. Other order quantities that result in more or less than six orders per year are not so economical. For example, if only one order for the whole annual requirement of 2,400 units is placed, the combined ordering and holding cost comes to Rs.370 which is far higher than the cost at economic order quantity of 400 units.

The application of tabular approach is not common as it is more time consuming as compared to formula approach. Moreover, in some situations, it provides only an estimate of economic order quantity and is therefore not as accurate as the formula approach. If a question regarding economic order quantity is asked in the examination, the students should avoid using tabular (trial and error) approach; rather they should use the formula approach which is comparatively less time consuming and which also provides the most accurate answer.

## **Example 2**

The John Sports Inc. purchases tennis balls at Rs.20 per dozen from its suppliers. The John Sports will sell 34,300 dozens of tennis balls evenly throughout the year. The total cost to handle a purchase order is Rs.10. The insurance, property tax and rent for each dozen tennis balls in the average inventory is Rs.0.40. The company wants a 5% return on average inventory investment.

### **Required:**

1. Compute the economic order quantity.
2. Compute the total annual inventory expenses to sell 34,300 dozens of tennis balls if orders are placed according to economic order quantity computed in part 1.

### **Solution**

#### **1. Economic order quantity:**

$$*Rs.0.40 + (Rs.20 \times 5/100) = Rs.1.4$$

## 2. Total annual inventory expenses to sell 34,300 dozens of tennis balls:

$$\begin{aligned} &= \text{Annual ordering cost} + \text{Annual holding cost} \\ &= (\text{Number of orders} \times \text{Cost per order}) + (\text{Average units} \times \text{Holding cost per unit}) \\ &= (*49 \text{ orders} \times Rs.10) + [(700/2) \times 1.4] \\ &= Rs.490 + Rs.490 \\ &= Rs.980 \end{aligned}$$

$$*\text{Number of orders to be placed: } 34,300/700 = 49 \text{ orders}$$

### Underlying assumptions of economic order quantity (EOQ)

The computation of economic order quantity (EOQ) is based on the following assumptions:

1. The total number of units to be consumed during the period is known with certainty.
2. The total ordering cost remains constant throughout the period.
3. The inventory cost remains constant throughout the period.
4. There are no cash or quantity discounts available.
5. The whole quantity of ordered inventory is delivered in one batch.
6. The optimal quantity for each invariable or stock item is computed separately.
7. The lead time does not fluctuate and the order is received on time with the total order quantity.

The assumptions described above are also known as the limitations of economic order quantity (EOQ).

### PROBLEM 1:

Demand for the Child Cycle at Best Buy is 500 units per month. Best Buy incurs a fixed order placement, transportation, and receiving cost of Rs. 4,000 each time an order is placed. Each cycle costs Rs. 500 and the retailer has a holding cost of 20 percent. Evaluate the number of computers that the store manager should order in each replenishment lot?

**Solution:**

$$EOQ = \sqrt{\frac{2 * RU * OC}{UC * CC\%}}$$

$$EOQ = \sqrt{\frac{2 * 6,000 * 4,000}{500 * 20\%}}$$

$$EOQ = 693 \text{ Units}$$

**Example 2:**

ABC Ltd. uses EOQ logic to determine the order quantity for its various components and is planning its orders. The Annual consumption is 80,000 units, Cost to place one order is Rs. 1,200, Cost per unit is Rs. 50 and carrying cost is 6% of Unit cost. Find EOQ, No. of order per year, Ordering Cost and Carrying Cost and Total Cost of Inventory.

**Solution**

1. Economic Order Quantity

$$EOQ = \sqrt{\frac{2 * RU * OC}{UC * CC\%}}$$

$$EOQ = \sqrt{\frac{2 * 80,000 * 1,200}{50 * 6\%}}$$

$$EOQ = 8000 \text{ Units}$$

2. Number of Order Per Year

$$\text{No of order per year} = \text{Annual Requirements} / EOQ$$

$$\text{No of order per year} = 80,000 / 8,000$$

$$\text{No of order per year} = 10 \text{ Orders per year}$$

3. Ordering Cost

$$\text{Ordering Cost} = \text{Fixed ordering cost (F)} * \text{Number of Order per year N}$$

$$\text{Ordering Cost} = 1,200 * 10$$

$$\text{Ordering Cost} = 12,000 \text{ Rupees}$$

4. Carrying Cost

$$\text{Carrying Cost} = \text{Carrying Cost (C)} * EOQ/2$$

$$\text{Carrying Cost} = 50 * 0.06 * 8,000/2$$

$$\text{Carrying Cost} = 12,000 \text{ Rupees}$$

5. Total Inventory Cost

$$\text{Total Inventory Cost} = \text{Ordering cost} + \text{Carrying Cost}$$

$$\text{Total Inventory Cost} = 12,000 + 12,000$$

$$\text{Total Inventory Cost} = 24,000 \text{ Rupees}$$

**3:**

Goldmedal Corporation is trying to decide between two alternate Order Plans for its inventory of a certain item. Irrespective of the plan to be followed, demand for the item is

expected to be 1,000 units annually. Under Plan 1, order costs would be Rs. 40 per order and inventory holding costs would be Rs. 100 per unit per annum. Under Plan 2, order costs would be Rs. 30 per order and holding costs would be 20%. Unit Cost is Rs. 480.

i) Find out EOQ and Total Inventory Cost.

ii) Decide which plan would result in the lowest total inventory cost?

**Solution:**

**Plan 1<sup>st</sup>**

$$EOQ = \sqrt{\frac{2 * RU * OC}{UC * CC\%}}$$

$$EOQ = \sqrt{\frac{2 * 1,000 * 40}{100}}$$

$$EOQ = 28$$

*Total Inventory Cost = [Fixed ordering cost (F) \* Number of Order per year N] + [Carrying Cost (C) \* EOQ/2]*

*Total Inventory Cost = [40 \* 1,000/28] + [100 \* 28/2]*

*Total Inventory Cost = 1,440 + 1,400*

**Total Inventory Cost =Rs. 2,840**

**Plan 2<sup>nd</sup>**

$$EOQ = \sqrt{\frac{2 * RU * OC}{UC * CC\%}}$$

$$EOQ = \sqrt{\frac{2 * 1,000 * 30}{480 * 0.20}}$$

$$EOQ = 25$$

*Total Inventory Cost = [Fixed ordering cost (F) \* Number of Order per year N] + Carrying Cost (C) \* EOQ/2*

*Total Inventory Cost = [30 \* 1,000/25] + [480 \* 0.20 \* 25/2]*

*Total Inventory Cost = 1,200 + 1,200*

**Total Inventory Cost =Rs. 2,400**

*Plan 2<sup>nd</sup> is best*

4:

A local TV repairs shop uses 36,000 units of a part each year. It costs Rs. 20 to place and receive an order. The shop orders in lots of 400 units. It cost Rs. 4 to carry one unit per year of inventory. Calculate the following:

- Total annual cost before using EOQ policy
- Economic Order Quantity
- Total annual cost after using EOQ policy
- Amount saved by using EOQ policy

**Solution:** (1) Calculate total annual ordering cost

$$\text{Ordering Cost} = \text{Fixed ordering cost (F)} * \text{Number of Order per year N}$$

$$\text{Ordering Cost} = 20 * 36,000/400$$

$$\text{Ordering Cost} = \text{Rs. 1,800}$$

**Solution:** (2) Calculate total annual carrying cost

$$\text{Carrying Cost} = \text{Carrying Cost (C)} * \text{EOQ}/2$$

$$\text{Carrying Cost} = 4 * 400/2$$

$$\text{Carrying Cost} = \text{Rs. 800}$$

**Solution:** (3) Calculate total annual inventory cost

$$\text{Total Inventory Cost} = \text{Ordering cost} + \text{Carrying Cost}$$

$$\text{Total Inventory Cost} = 1,800 + 800$$

$$\text{Total Inventory Cost} = \text{Rs. 2,600}$$

**Solution:** (4) Calculate the Economic Order Quantity

$$EOQ = \sqrt{\frac{2 * RU * OC}{UC * CC\%}}$$

$$EOQ = \sqrt{\frac{2 * 36000 * 20}{4}}$$

$$EOQ = 600 \text{ Units}$$

**Solution:** (5) Calculate the total annual cost inventory cost using EOQ inventory Policy

$$\text{Total Inventory Cost} = [\text{Fixed ordering cost (F)} * \text{Number of Order per year N}] + \text{Carrying Cost (C)} * \text{EOQ}/2$$

$$\text{Total Inventory Cost} = [20 * 36,000/600] + [4 * 600/2]$$

$$\text{Total Inventory Cost} = 1,200 + 1,200$$

$$\text{Total Inventory Cost} = \text{Rs. 2,400}$$

**Solution:** (6) How much save using EOQ

$$\text{How much save using EOQ} = 2,600 - 2,400 = \text{Rs. 200}$$

**Solution:** (7) Compute ordering point assuming the lead time is 3 days

$$\text{Re-order level} = \text{Maximum consumption} * \text{Lead Time [maximum]}$$

$$100 * 3 = 300 \text{ per day}$$

**1.**