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OPERATION RESEARCH I (120301451)

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TRAINING UNIT #4

4. OTHER INVENTORY CONTROL METHODS

Model II - Economic Order Quantity with Variable Demand

In this model formulation, all other assumptions remain the same as in the case of model I, except the condition of variable demand. In that case, we have to specify the time period for the demand.

By this assumption

$$Ordering\ Cost = \frac{\mathrm{D}}{\mathrm{Q}}\ C_o$$

$$Carrying\ Cost = \frac{\mathrm{Q}}{2}\ C_h\ T \quad \text{(Where T = Time period for the demand)}$$

$$Total\ inventory\ Cost = \frac{\mathrm{D}}{\mathrm{Q}}\ C_o + \frac{\mathrm{Q}}{2}\ C_h\ T$$

$$\text{And Q (EOQ)} = \sqrt{\frac{2DC_o}{T\ C_h}}$$

$$Total\ Optimal\ Inventory = \frac{\mathrm{D}}{\sqrt{\frac{2DC_o}{T\ C_h}}}\ C_o + \frac{\sqrt{\frac{2DC_o}{T\ C_h}}}{2}\ C_h\ T = \sqrt{\frac{2DC_oC_h}{T}}$$

Model III - Economic Order Quantity when Shortages are Permitted

In this case, the change from Model I is that inventory levels are allowed to go below zero level and the cost of shortage is directly proportionate to the number of units short. The figure below indicates the situation.

Fig. 14.3

Total inventory is Q, but it consists of Qo i.e., inventory with no shortage and s, the demand during shortage period. The cycle time t has been accordingly marked with consumption pattern as ABC and replenishment as CE and beyond.

In this case, Total Cost = Ordering Cost + Carrying Cost + Shortage Cost

= Co + Ch + Cs. (where Cs Shortage Cost)

Here Average Inventory $= \frac{Q_o}{2}$

And $Ordering\ Cost = \frac{D}{Q}\ C_o$

$Carrying\ Cost = \frac{Q_o}{2}\ t_2\ C_h$

$= \frac{Q_o}{2}\ \frac{Q_o}{Q}\ t\ C_h$

$= \frac{{Q_o}^2}{2\,Q}\ t\ C_h$

$Shortage\ Cost = \frac{s}{2}\ t_1\ C_s$

$= \frac{s}{2}\ \frac{s}{Q}\ t\ C_s$

$= \frac{s^2}{2\,Q}\ t\ C_h$

$Total\ inventory\ Cost = \frac{D}{Q}\ C_o + \frac{{Q_o}^2}{2\,Q}\ tC_h + \frac{s^2}{2\,Q}\ tC_s$ ...

And Q (EOQ) $= \sqrt{\left(\frac{2\,D\,C_o}{C_h}\ \frac{C_h+C_s}{C_s}\right)}$

Model IV - Economic Order Quantity with Gradual Replenishment

In this case, the replenishment of the inventory is not in one go, but gradual like the consumption, the rate of replenishment and consumption, though, may not be the same. This is a practical situation, because production consumes the inventory over a period of time and gradually. Hence stocking of inventory all at one time may not be a good policy. Gradual replenishment is much nearer the real-life requirement, though may not be good from vendor point of view. Such a situation of replenishment and consumption is given in the figure below.

Fig. 14.4

If Demand is D, which remains constant and uniform over a period of time, and replenishment is gradual as indicated above.

Let tp = production time

And rp = rate of production

Q = size of each production run per cycle

rd = demand rate

Then by normal convention of Co, Ch and D

$$\text{Q (EOQ)} = \sqrt{\frac{2DC_o}{C_h}\left(\frac{rp}{rp - rd}\right)}$$

and $$\text{tp} = \sqrt{\frac{2DC_o}{C_h.rp(rp-rd)}}$$

Total Cost at Minimum inventory

$$= \sqrt{2DC_oC_h\left(\frac{1 - rd}{rp}\right)}$$

4.1 SAFETY STOCK

In addition of the inventories required for normal functions of business, some inventories are needed to cater for either sudden spurt of demand or uncertainty of usage or replenishment rate. When lead times are uncertain, we smooth out the production or meeting the demand from the safety or Buffer stock. It can be understood from the figures given below:

Fig. 14.5

In order to work out the safety stock, we have to consider the effect of shortage, if the safety stock is not kept. The alternatives and the effect of shortage vary depending upon the situation. If items involved in the shortage are very critical for the operation, shortage cost can be very high. Loss of business or loss of credibility is high cost to pay for the shortages. Loosing the market share even temporarily can be very devastating at times, when it is difficult to regain it. Even to cater for loss of production due to interruption in supplies either due to natural calamities or human created obstructions such as strikes etc. the buffer stock or safety stock becomes essential. Hence variability of either demand or time, necessitates the stocks as safety stocks and can be worked out as follows :

Safety Stock = (Max. demand - Average demand during lead time x Lead time)

4.2 INVENTORY CONTROL METHODS

In any organisation, depending on the type of business, some inventory is maintained. When the number of items in inventory are large and large amount of money is needed to create such an inventory, it become the concern of management to have a proper control over its ordering, procurement, maintenance and consumption. Unless some effective method is evolved, the control process can be cumersome. The control is different for different type of inventory usage and can be classified as under.

1. The order quantity
2. The order frequency.
3. The time interval between successive reviews.

The most widely used method of inventory control is known as ABC analysis. It is often called as Always Better Control Analysis or Pareto Analysis. In the technique, the total inventory is categorised into three sub-heads and then proper attention is exercised for each sub-head.

A-B-C Analysis

In this analysis, the classification of existing inventory is based on annual consumption and the annual value of the items. Hence we obtain the quantity of inventory item consumed during the year and multiply it by the unit cost to obtain it annual usage cost. The items are then arranged in the descending

order of such annual usage cost. The analysis is carried out by drawing a graph based on the cumulative number of items and cumulative usage of consumption cost. Classification is done as follows.

Category	Percentage of items	Percentage of annual Consumption value
A	10-20	70-80
B	20-30	10-25
C	60-70	5-15

The classification is shown on the figure as follows :

Fig. 14.6

Onc; ABC classification has been achieved, the policy for control can be formulated as follows:

A-items: Very tight control, the items being of high value. This control need be exercised at a higher level of authority.

Inventory Control Methods

B-items : It requires moderate control by a person at middle level authority.

C-items : These being low value, but large number items, control can be exercised by grass-root level i.e., this control can be done by respective user departmental managers.

Other Inventory Control Methods

1. HML – The items are classified as per the unit price of items such as:

   H = High price

   M = Medium price

   L = Low price

2. VED – The classification is done based on the critically of items such as:

   V = Vital few

   E = Essential

   D = Desirable

3. FSN – Yet another control is exercised on items classifying them on the basis of consumption:

   F = Fast Moving items

   S = Slow moving items

   N = Non-moving items

4. SDE - This classification and control is resorted to on the basis of problem faced on their procurement such as:

   S = Scarce

D = Difficult

E = Easy to obtain

5. SOS - Here the control requirement is based on the periodicity of demand or nature of supplies:

   S = Seasonal

   OS = Off-seasonal

6. GOLF - The "classification is based on the source of the inventory:

   G = Government supply

   O = Ordinarily available

   L = Local availability

   F= Foreign source of supply

4.3 ZERO-INVENTORY SYSTEMS (ZIN)

At times inventory holding or carrying cost are very excessive or there may he space restrictions on holding the inventory. In such case, a concept of zero-inventory as adopted by Japanese may be worth following. In this case, we attempt to bring down the inventory to almost zero or totally eliminate the inventory. The method can be practiced by asking for the materials or the products from the vendors locally available, keeping quality requirement in mind.

Another related or associated concept practised by Japanese is JIT (Just-in-Time). The Kanban system developed and used by them is a step in this direction. In this case, inventory in raw materials are obtained only when required and that too just to cater for the days requirement. The material is delivered to the work centre, when it is required. Hence raw materials, work in process as well as Finished goods inventories are minimal. It is good concept to reduce waste and also to save on storage space and cost of accounting and maintaining the inventory. The system is becoming popular in all the countries including India.

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