SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
SCHOOL OF MECHANICAL ENGINEERING

Subject Title: Resource Management Techniques **Subject Code: SPR1307**

Course: B.E (Common to all Engineering Branches)

UNIT – 4 INVENTORY CONTROL

INVENTORY CONTROL

Inventory may be defined a stock of goods, commodities or other economic resources that are stored or reserved for smooth and efficient running of business. The inventory may be kept in any one of the following forms:

1. Raw material
2. Work-in progress
3. Finished goods

If an order for a product is receive, we should have sufficient stock of materials required for manufacturing the item in order to avoid delay in production and supply. Also there should not be over stock of materials and goods as it involves storage cost and wastage in storing. Therefore inventory control is essential to promote business. Maintaining inventory helps to run the business smoothly and efficiently and also to provide adequate service to the customer. Inventory control is very useful to reduce the cost of transportation and storage.

A good inventory system, one has to address the following questions quantitatively and qualitatively.

- What to order?
- When to order?
- How much to order?
- How much to carry in an inventory?

Objectives of inventory management/Significance of inventory management

- To maintain continuity in production.
- To provide satisfactory service to customers.
- To bring administrative simplicity.
- To reduce risk.
- To eliminate wastage.
- To act as a cushion against high rate of usage.
- To avoid accumulation of inventory.
- To continue production even if there is a break down in few machinery.
- To ensure proper execution of policies.
- To take advantages of price fluctuations and buy economically.

Costs involved in inventory

1. Holding Cost (Carrying or Storage Cost):
   It is the cost associated with the carrying or holding the goods in stock. It includes storage cost, depreciation cost, rent for godown, interest on investment locked up, record keeping and administrative cost, taxes and insurance cost, deterioration cost, etc. It is denoted by 'C'.
2. Setup Cost/ Ordering Cost:
   Ordering cost is associated with cost of placing orders for procurement of material or finished goods from suppliers. It includes, cost of stationery, postage, telephones, travelling expenses, handling of materials, etc. (Purchase Model)Setup cost is associated with production. It includes, cost involved in setting up machines for production run. (Production Model). Both are denoted by 'S'.
3. Purchase Cost/Production Cost:
   When the organization purchases materials from other suppliers, the actual price paid for the material will be called the purchase cost.
   When the organization produces material in the factory, the cost incurred for production of material is called as production cost. Both are denoted by 'P'.
4. Shortage Cost:
   If the inventory on hand is not sufficient to meet the demand of materials or finished goods, then it results in shortage of supply. The cost may include loss of reputation, loss of customer, etc.
5. Total incremental cost = Holding Cost + Setup Cost/ Ordering Cost:
6. Total cost = Purchase Cost/Production Cost + Shortage Cost +Total incremental cost

Demand is one of the most important aspects of an inventory system.
Demand can be classified broadly into two categories:

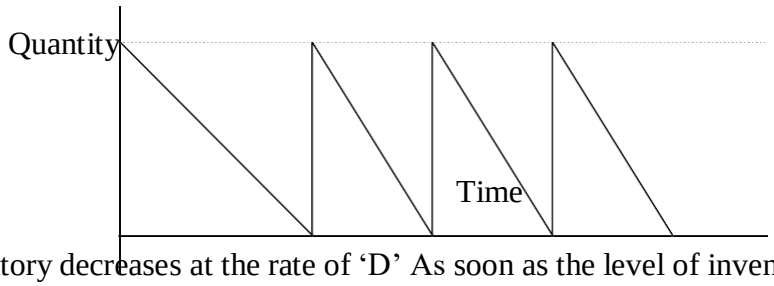
1. **Deterministic** i.e., a situation when the demand is known with certainty. And, deterministic demand can either be *static* (where demand remains constant over time) or it could be *dynamic* (where the demand, though known with certainty, may change with time).
2. **Probabilistic (Stochastic)** refers to situations when the demand is *random* and is governed by a *probability density function* or *probability mass function.* Probabilistic demand can also be of two types - *stationary*(in which the demand probability density function remains unchanged over time),and *non-stationary,* where the probability densities vary over time.

Deterministic Inventory Models
Model I: Purchasing model without shortages
Model II: Production model without shortages
Model III: Purchasing model with shortages
Model IV: Production model with shortages

Model I: Purchasing model without shortages
Assumptions

- Demand(D) per year is known and is uniform
- Ordering cost(S) per order remains constant

- Carrying cost(C) per unit remains constant
- Purchase price(P) per unit remains constant
- No Shortages are allowed. As soon as the level of inventory reaches zero, the inventory is replenished back.Lead time isZero

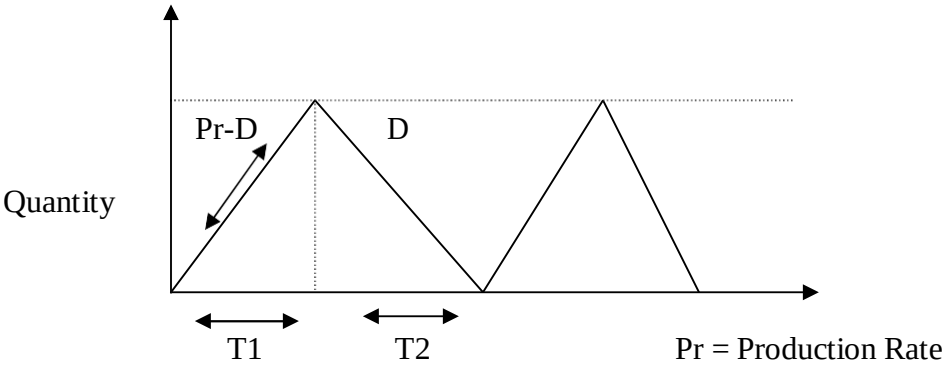


Inventory decreases at the rate of 'D' As soon as the level of inventory reaches zero, the inventory is replenished back

Model II: Production model without shortages

Assumptions

- Demand(D) per year is known and is uniform
- Setup cost (S) per production run remains constant
- Carrying cost(C) per unit remains constant
- Production cost per unit(P) per unit remains constant
- No Shortages are allowed. As soon as the level of inventory reaches zero , the inventory is replenished back.



Pr = Production Rate
D = Demand Rate

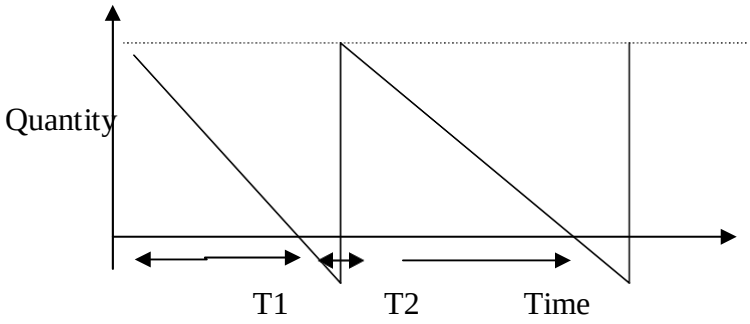
T1 is the time taken when manufacturing takes place at the rate of Pr and demand at the rate of D. So the stock is builtup at the rate of (Pr – D). During t2 there is no production only usage of stock. Hence, stock is decreased at the rate of 'D'. At the end of t2, stock will be nil.

Model III: Purchasing model with shortages

Assumptions

- Demand(D) per year is known and is uniform
- Ordering cost(S) per order remains constant
- Carrying cost(C) per unit remains constant

- Purchase price(P) per unit remains constant
- Shortages are allowed. As soon as the level of inventory reaches zero, the inventory is replenished back with lead time.
- Shortage cost (sh) per unit remains constant



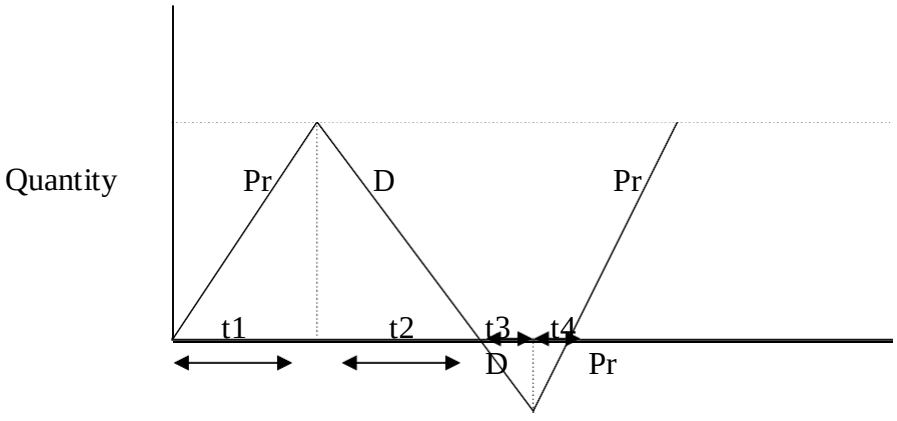
T1 is the time during which stock is nil.During T2 shortage occur and at the end of T2 stock is replenished back.

Model IV: Production model with shortages

Assumptions

Demand(D) per year is known and is uniform

- Setup cost (S) per production run remains constant
- Carrying cost(C) per unit remains constant
- Production cost per unit(P) per unit remains constant
- Shortages are allowed. As soon as the level of inventory reaches zero, the inventory is replenished back with lead time.
- Shortage cost (Sh) per unit remains constant



Time

T1 is the time taken when manufacturing takes place at the rate of Pr and demand at the rate of D. So the stock is built-up at the rate of (Pr – D). During t2 there is no production only usage of stock. Hence, stock is decreased at the rate of 'D'. At the end of t2, stock will be nil. During T3 shortage exists at the rate of 'D'. During T4 production begins stock builds and shortage decreases at the rate of 'Pr-D'

Inventory basic terminologies

- EOQ- Economic order quantity – The optimum order per order quantity for which total inventory cost is minimum.
- EBQ- Economic batch quantity – The optimum manufacturing quantity in one batch for which total inventory cost is minimum.
- Demand Rate – rate at which items are consumed
- Production rate- rate at which items are produced
- Stock replenishment rate
  - Finite rate – the inventory builds up slowly /step by step(production model)
  - Instantaneous rate – rate at which inventory builds up from minimum to maximum instantaneously (purchasing model)
- Lead time- Time taken by supplier to supply goods
- Lead time demand it is the demand for goods in the organization during lead time.
- Reorder level- the level between maximum and minimum inventory at which purchasing or manufacturing activities must start from replenishment.
  Reorder level = Buffer stock+ Lead time demand

- Buffer stock- to face the uncertainties in consumption rate and lead time , an extra stock is maintained. This is termed as buffer stock:
  Buffer stock = (Maximum Lead time – Average Lead time) x Demand per month

- Maximum Inventory Level: Maximum quantity that can be allowed in the stock:
  Maximum Inventory = EOQ + Buffer stock

- Minimum Inventory Level is the level that is expected to be available when thee supply is due: Minimum Inventory level = Buffer stock

- Average Inventory = (Minimum Inventory + Maximum Inventory)/2

- Order cycle is the period of time between two consecutive placements of orders.

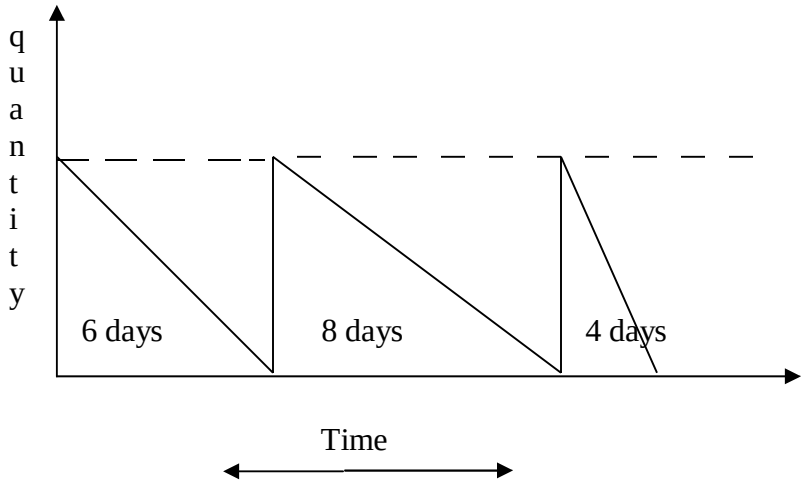
Inventory system followed in a organization:

- Q – System (fixed order quantity system)
- P - System (fixed period system)

Q – System

In a fixed order quantity system means every time an order is placed the quantity order is EOQ. In Q – System, the period between the orders is not constant:

Ex. 1st – 1 month – EOQ
2nd – 1 ½ month – EOQ
3rd- 2 month – EOQ
4th – 15 days - EOQ
Whenever the stock reaches reorder level, nest order is placed.



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  Maximum Inventory = EOQ + Buffer stock
- Minimum Inventory Level is the level that is expected to be available when thee supply is due:
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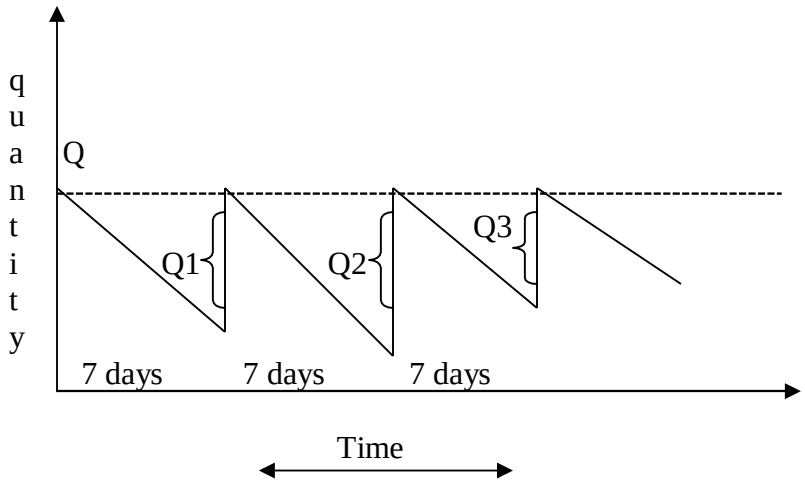
- Average Inventory = (Minimum Inventory + Maximum Inventory)/2

P – System
Time period between the orders is fixed; hence it is called as Fixed Period System. Period of order is fixed but the quantity will vary. Ex:
1st – 1 month – 1000 units
2nd – 1 month – 1200 units
3rd - 1 month – 950 units
A predetermined level of inventory is fixed and thee order quantity is determined by deducting the level of stock at the time review from P determine level of inventory.

Order quantity = Predetermined level of inventory – level of stock at the time of review



Inventory Selective Control Techniques

Every organization consumes several items of store. Since all the items are not of equal importance, a high degree control on inventories of each item is neither applicable nor useful. So it becomes necessary to classify items in group depending upon their utility importance. Such type of classification is name as the principle of selective control.

ABC Analysis (Always Better Control)

- A - High value items
- B - Moderate value items
- C - Low value items

ABC analysis is one of the methods for classification of materials. It is based on Parelo's law that a few high usage value items constitute a major part of the inventory while a large bulk of items constitute to very low usage value.

PROCEDURE FOR ABC ANALYSIS:

1. Note down the material code.
2. Note down the annual usage in terms of units.
3. Note down the price per unit.
4. Calculate the Annual usage value.

Annual usage value = Quantity used x Price per unit

5. Arrange the materials according to the value in descending order.
6. Find out the percentage contribution of each material to the total value.
7. Find out the percentage contribution of each material towards the total quantity.
8. Cumulate the % contribution towards value.
9. The classification is as follows.
   A = 80% contribution
   B = 15% contribution
   C = 5% contribution.

SIGNIFICANCE OF ABC ANALYSIS

ABC analysis is a very useful technique to classify the materials.

- The control procedure is based on which category the item belongs to.
  A = Tight control
  B = Moderate control
  C = Very little control.

- The inventory to be maintained is again based on the category
  A = Low Inventory
  B = Moderate Inventory
  C = High Inventory.

- The number of suppliers is also based on the category to which it belongs.
  A = Many suppliers
  B = Moderate No. of suppliers
  C = Few suppliers.

VEDAnalysis

- V Vital items
- E Essential items
- D Desirable or Durable items

HML Analysis

- High price items
- Moderate price items
- Low price items

FNSD Analysis

- F Fast Moving items
- N Normal Moving items
- S Slow Moving items
- D Dead items

Probabilistic Inventory Model.

One such model is fixed order quantity model (FOQ).

In this model,

1. The demand (D) is uncertain, you can estimate the demand through any one of the forecasting techniques and the probability of demand distribution is known.
2. Lead time (L) is uncertain, probability of lead time distribution is known.
3. Cost(C) all the costs are known.
   a. –Inventory holding costs C1
   b. –shortage cost C2
4. The optimum order level Z is determined by the following relationship

$$\sum_{d=0}^{z-1} p(d) < \frac{C2}{C1+C2} < \sum_{d=0}^{z} p(d)$$

Stock out Cost/Shortage cost

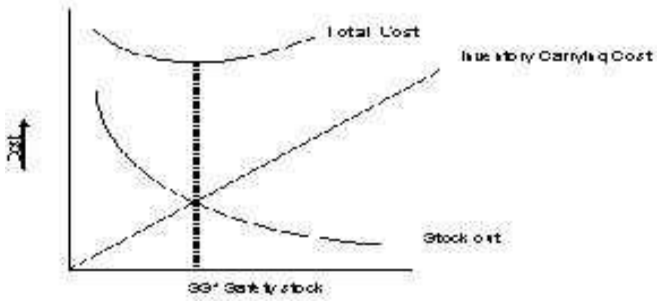
It is difficult to calculate stock out cost because it consists of components difficult to quantify so indirect way of handling stock out cost is through service levels. Service levels means ability of organization to meet the requirements of the customer as on when he demands for the product. It is measured in terms of percentage.

For example: if an organization maintains 90% service level, this means that 10% is "stock out" level. This way the stock out level is addressed.

Safety stock

It is the extra stock or buffer stock or minimum stock. This is kept to take care of fluctuations in demand and lead time.

If you maintain more safety stock, this helps in reducing the chances of being "stock out". But at the same time it increases the inventory carrying cost. Suppose the organization maintains less service level that results in more stock out cost but less inventory carrying cost. It requires a tradeoff between inventory carrying cost and stock out cost. This is explained through following Fig



Safety stock (S.S*) is to be stocked by the organization.

Working of fixed order quantity model

Fixed order quantity system is also known as continuous review system or perpetual inventory system or Q system.

In this system, the ordering quantity is constant. Time interval between the orders is the variable.

The system is said to be defined only when if the ordering quantity and time interval between the orders are specified. EOQ provides answer for ordering quantity.

Reorder level provides answers for time between orders.

The working and the fixed order quantity model is shown in the below Fig

Application of fixed order quantity system

1. It requires continuous monitoring of stock to know when the reorder point is reached.
2. This system could be recommended to" A" class because they are high consumption items. So we need to have fewer inventories. This system helps in keeping less inventory comparing to other inventory systems.

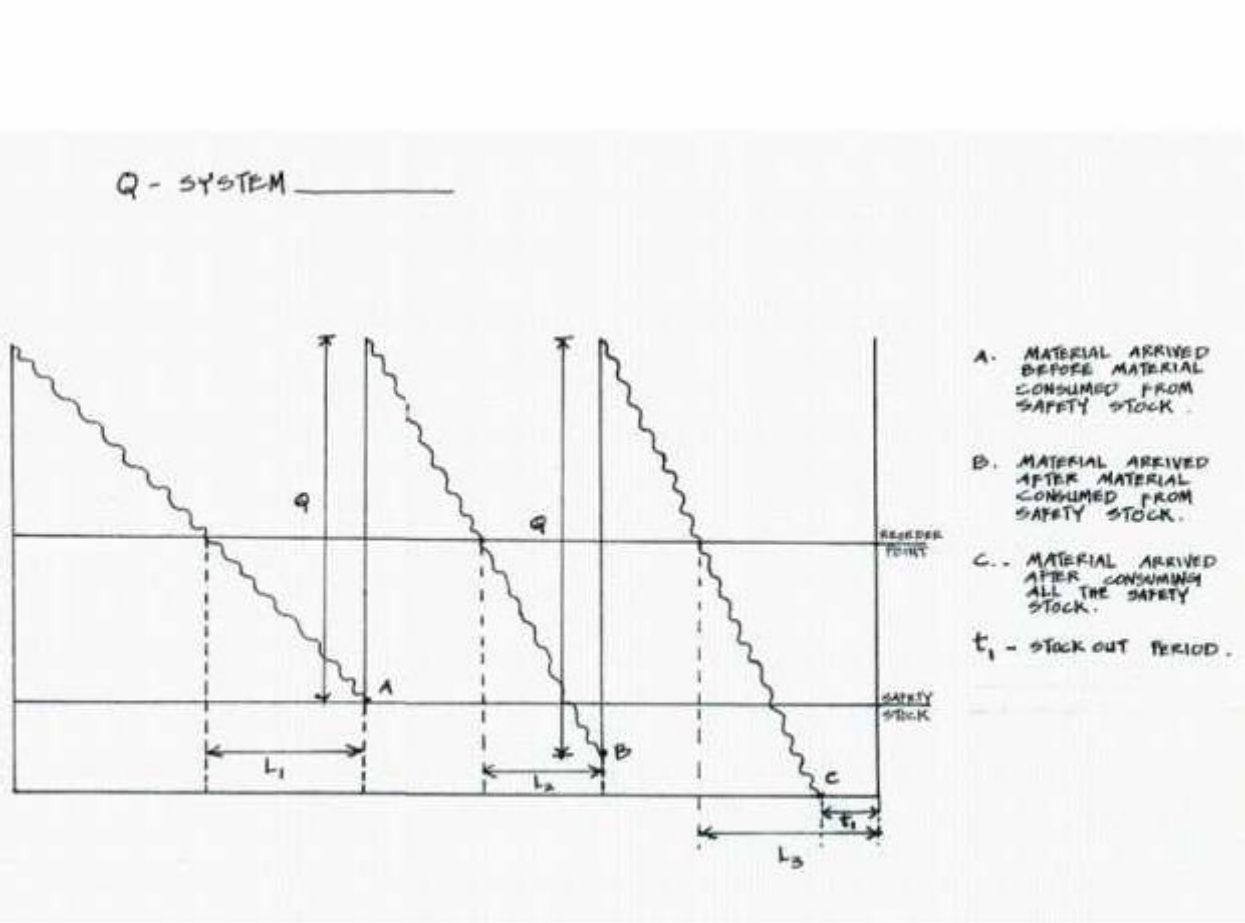
Advantages:

1. Since the ordering quantity is EOQ, comparatively it is meaningful. You need to have less safety stock. This model relatively insensitive to the forecast and the parameter changes.
2. Fast moving items get more attention because of more usage.

Weakness:

1. We can't club the order for items which are to be procured from one supplier to reduce the ordering cost.
2. There is more chance for high ordering cost and high transaction cost for the items, which follow different reorder level.
3. You can not avail supplier discount. While the reorder level fall in different time periods.

Figure –Fixed Order Quantity Model



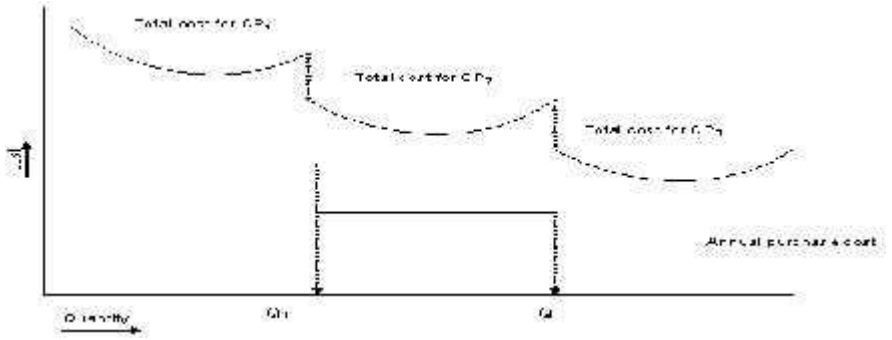
QUANTITY DISCOUNT MODEL

As it is mentioned already, the purchase cost becomes relevant with respect to the quantity of order only when the supplier offers discounts.

Discounts means if the ordering quantity exceeds particular limit supplier offers the quantity at lesser price per unit.

This is possible because the supplier produces more quantity. He could achieve the economy of scale the benefit achieved through economy of scale that he wants to pass it onto customer. This results in lesser price per unit if customer orders more quantity.

If you look at in terms of the customer's perspective customer has also to see that whether it is advisable to avail the discount offered, this is done through a trade off between his carrying inventory by the result of acquiring more quantity and the benefit achieved through purchase price. Suppose if the supplier offers discount schedule as follows,



If the ordering quantity is less than or equal to Q1 then purchase price is Cp1.

If the ordering quantity is more than Q1 and less than Q2 then purchase price is Cp2.

If the ordering quantity is greater than or equal to Q2 then purchase price is Cp3.

Then the curve you get cannot be a continuous total cost curve, because the annual purchase cost breaks at two places namely at Q1 and Q2.

STEPS TO FIND THE QUANTITY TO BE ORDERED

1. Find out EOQ for the all price break events. Start with lowest price
2. Find the feasible EOQ from the EOQ's we listed in step 1.
3. Find the total annual inventory cost using the formulae for feasible EOQ
   $\sqrt{[2DSC]}+D*P$
4. Find the total annual inventory cost for the quantity at which price break took place using the following formula.

Total annual inventory cost = TC= $(D/Q)*S + (Q/2)*C + D*P$

5. Compare the calculated cost in steps 3 and 4. Choose the particular quantity as ordered Quantity at which the total annual inventory cost is minimum.

SIMULATION

INTRODUCTION

There are certain real world problems which are very complicated in nature and it is not possible to construct mathematical models for them. Such problems can be solved by the method of simulation. Simulation is a representation of reality through the use of a model or other device, which will react in the similar manner as reality under a given set of conditions.

Analogue Simulation: Reality in physical form.
Computer simulation: Complex system in formulated into a mathematical model for which computer program are developed as problem is solved on high speed computers.

ADVANTAGES

- Simulation allows experimentation with a model of the real system rather than the actual operating system.
- Management can for see the difficulties and bottleneck.
- Relatively free from mathematics.
- Comparatively flexible.
- Easier to use than other techniques.
- Training the operating and personal staff.

LIMITATIONS

- Optimum result cannot be produced.
- Quantification of variable is not possible. (How many variable affecting the system).
- Difficult to make program because of difficult to know the interrelationship among many variables.
- Comparatively costlier and time consuming method.
- Too many tendencies to rely on the simulation model.

MONTE CARLO TECHNIQUE

a) Select the measure of effectiveness.
b) Decide the variables, which influence the measure of effectiveness significantly.
c) Determine the cumulative probability distribution of each variable.
d) Choose a set of random number. **Random Number** is a number in a sequence of numbers whose probability of occurrence is the same as that of any other member.
e) Consider each number as a decimal value of the cumulative probability distribution.
f) Insert the simulated value.
g) Repeat step (e) and f) until sample is large enough for the satisfaction of decision maker.

USES OF SIMULATION

When the characteristics such as uncertainty, complexity dynamic interaction between the decision and subsequent event and the need to develop a detailed procedure combine together in

one situation, it becomes too complex to be solved by any of the technique of mathematical programming. Under such situation the simulation is best technique to be used.

APPLICATIONS OF SIMULATION

- In industrial problems including the design of queuing system, inventory control, communication networks, chemical processes, nuclear reactors and scheduling of production processes.
- In business and economic problems including, price determination, forecasting etc.
- In social problems including population growth etc.
- In biomedical science such as fluid balance, brain activities etc.
- In the design of weapon system, war strategies and tactics.

QUESTION BANK

INVENTORY MANAGEMENT

INVENTORY MANAGEMENT
Deterministic cost Inventory Models
Model I: Purchasing model without shortages
(Demand rate Uniform, Production rate Infinite)

1. Find the economic order quantity and the number of orders if demand for the year is 2000 units. Ordering cost is Rs500 per order and the carrying cost for one unit per year is Rs2.50. calculate the Total Incremental Cost and Total cost if the purchase price of 1 unit is Rs25/-.

2. A manufacturing company uses an item at a constant rate of 4000 per year. Each unit costs Rs2. The company estimates that it will cost Rs50 to place an order and the carrying cost is 20% of stock value per year. Find economic order quantity and the Total Cost.

Model II: Production model without shortages
(Demand rate Uniform, Production rate finite)

3. A company needs 12000 units per year. The set up cost is Rs 400 per production run. Holding cost per unit per month is Rs15. The production cost is Rs4. The company can produce 2000 units per month. Find out the economic batch quantity, total incremental cost, total cost.

4. Demand = 2000 units/yr. The organization can produce @ 250 units per month. The set up cost is Rs1500/set up, running cost is 10% of average cost of the inventory pr year. If the organization incurs the cost of Rs100, determine how frequently the organization has to go for producing the required material.

Model III: Purchasing model with shortages

(Demand rate Uniform, Production rate Infinite, Shortages allowed)

5. The demand for an item is 20 units per month. The inventory carrying cost is Rs25 per item/month. The fixed cost (ordering cost) is Rs10 for each item a order is made. The purchase cost is Re.1 per item. The shortage cost is Rs15 per year. Determine how often a order should be made and what is the economic order quantity. Find the No. of orders, Total Incremental Cost and Total cost.

6. Demand = 9000 units. Cost of 1 procurement Rs100, holding cost – Rs2.40 per unit, shortage cost = Rs5 per unit. Find economic order quantity and how often should it be ordered. If price is Rs10 find Total Incremental Cost and Total Cost.

Model IV: Production model with shortages

(Demand rate Uniform, Production rate finite, Shortages allowed)

7. A company demands 12000 units per year. The set up cost is Rs 400 per production run. Holding cost per unit per month is Rs0.15. The shortage cost is Rs20 per year. The company can produce 2000 units per month. Find out the economic batch quantity, total incremental cost, total cost per year assuming cost of one unit is Rs 4.

8. The demand for an item in a company is 18,000 units per year, and the company can produce the item at a rate of 3000 per month. The cost of one set up is Rs.500 and the holding cost of one unit per month is 15 paise. The shortage cost of one unit is Rs.20 per month. Determine the optimum manufacturing quantity and the number of shortages. Also determine the manufacturing time and time between set-ups.

Buffer Stock - Deterministic Model

9. A Company uses annually 50,000 units, Each order costs Rs.45 and inventory carrying costs are .18 per unit. i) Find economic order quantity ii) If the company operates 250 days a year and the procurement lead time is 10 days and safety stock is 500 units, find reorder level, maximum, minimum and average inventory.

10. Annual Demand = 12000, Ordering cost = Rs 12, Carrying cost = 10% of inventory per unit cost per unit is Rs 10. The company operates for 250 days per year .The procurement lead time in the past is 10 days, 8 days, 12 days, 13 days and 7 days. find EOQ, Buffer stock reorder level, maximum, minimum and average inventory.

PROBABILISTIC INVENTORY MODEL

1. The probability distribution of the demand for certain items is as follows

Monthly sales	0	1	2	3	4	5	6
Probability	.01	.06	.25	.35	.20	.03	.10

The cost of carrying inventory is Rs 30 per unit per month and cost of unit short is Rs 70 per month. Determine the optimum stock level that would minimize the total expected cost.

2. A news paper boy buys paper for Rs 1.40 and sells them for Rs 2.45 .He cannot return unsold news papers .Daily Demand for the following distribution is as follows

Customers	25	26	27	28	29	30	31	32	33	34	35	36
Probability	.03	.05	.05	.10	.15	.15	.12	.10	.10	.07	.06	.02

If the days demand is independent of the previous day, how many papers he should order each day?

3. The probability distribution of the demand for certain items is as follows

Monthly sales	0	1	2	3	4	5	6
Probability	.02	.05	.30	.27	.20	.10	.06

The cost of carrying inventory is Rs 10 per unit per month .The current policy is to maintain a stock of 4 items at the beginning of each month. Determine the shortage cost per one unit for one time unit.

4. A company orders a new machine after certain fixed time. It is observed that one of the parts of the parts of the machine is very expensive if it is ordered without the machine. The cost of spare part when ordered with the machine is Rs 500 and the cost of down time of the machine and cost of arranging the new part is Rs10, 000. From the past records it is observed that spare parts required with probabilities mentioned below

Demand	0	1	2	3	4	5	6
Probability	.90	.05	.02	.01	.01	.01	0.00

Find the optimal no of spare parts which should be ordered along with the machine.

QUANTITY DISCOUNT MODEL

5. Find the optimal order quantity for a product for which price break up is as follows :

Quantity	**Unit Cost(Rs)**
$0 \leq Q1 < 50$	10
$50 \leq Q2 < 100$	9
$100 \leq Q3$	8

The monthly demand for the product is200 units, the cost of storage is 25%of the unit cost and ordering cost is Rs 20 per order.

6. Find the optimal order quantity for a product for which price break up is as follows :

Quantity	**Unit Cost(Rs)**
$0 \leq Q1 < 500$	10
$500 \leq Q2$	9.25

The monthly demand for the product is200 units, the cost of storage is 2%of the unit cost and ordering cost is Rs 350 per order.

SIMULATION

1. A bakery keeps stock of popular brand of cake. Daily demand based on past experience is given below:

Daily Demand	0	10	20	30	40	50
Probability		0.01	0.20	0.15	0.50	0.12	0.02

Using random numbers 25, 39, 65, 76, 12, 05, 73, 89, 19, 49 simulate the demand for the next 10 days.

2. A manufacturing company keeps stock of a special product. Previous experience indicates the daily demand as given below:

Daily Demand	5	10	15	20	25	30
Probability		0.01	0.20	0.15	0.50	0.12	0.02

Simulate the demand for the next 10 days. Also find the daily average demand for that product on the basis of simulated data.

3. A tourist car company finds that during the past 200 days the demand for the car has the following frequency distribution:

Trips per week	0	1	2	3	4	5
Frequency	16	24	30	60	40	30

Using random numbers, simulate the demand for a period of 10 weeks.

4. At a sales depot the arrival of customers and the service times follow the following probability distributions:

Arrival time (min)	**Probability**	**Service time (min)**	**Probability**
0.5	0.02	0.5	0.12
1.0	0.06	1.0	0.21
1.5	0.10	1.5	0.36
2.0	0.25	2.0	0.19
2.5	0.20	2.5	0.07
3.0	0.14	3.0	0.05
3.5	0.10		
4.0	0.07		
4.5	0.04		
5.0	0.02		

Estimate the average waiting time and percentage of idle time of the server by simulation, for 10 arrivals.

MODEL QUESTION PAPER

PART – A

1. Write short notes on i) Re-order level ii) Safety stock iii) Maximin criteria iv) Minimax criteria
2. List out the types of inventory models.
3. What do you mean by Buffer stock and write the formula to find buffer stock?
4. What is meant by re-order level?
5. Define a) EOQ b) EBQ c) Lead time d) Shortage cost.
6. List out the inventory selective control techniques.
7. State any two advantages of Simulation model.
8. What is Monte-Carlo method of Simulation?
9. What are the limitations of Simulation?
10. How simulation models are useful in managerial decision makig?

PART – B

11. From the following information calculate EOQ, frequency of orders, Number of orders, Total cost, and Total incremental cost:

    Annual Demand - 20000 units/yr
    Ordering cost – Rs.30 per order
    Carrying cost – 12.5% on inventory cost
    Purchase price – Rs.1.50 per unit per year

OR

12. A company orders a new machine after certain fixed time. It is observed that one of the parts of the parts of the machine is very expensive if it is ordered without the machine. The cost of spare part when ordered with the machine is Rs 500 and the cost of down time of the machine and cost of arranging the new part is Rs10, 000. From the past records it is observed that spare parts required with probabilities mentioned below

Demand	0	1	2	3	4	5	6
Probability	.90	.05	.02	.01	.01	.01	0.00

    Find the optimal no of spare parts which should be ordered along with the machine.

13. Find the optimal order quantity for a product for which price break up is as follows :

Quantity	Unit Cost(Rs)
$0 \leq Q1 < 100$	20
$100 \leq Q2$	19.25

    The monthly demand for the product is100 units, the cost of storage is 2%of the unit cost and ordering cost is Rs 250 per order.

OR

14. A news paper boy buys paper for 0.30p and sells them for 0.50p .He cannot return unsold news papers .Daily Demand for the following distribution is as follows

No. of copies sold	10	11	12	13	14
Probability		0.1	0.15	0.20	0.25	0.30

If the days demand is independent of the previous day, how many papers he should order each day?

15. A Company uses annually 15,000 units, Each order costs Rs.25 and inventory carrying costs are .9 per unit. i) Find economic order quantity ii) If the company operates 200 days a year and the procurement lead time is 15days and safety stock is 250 units, find reorder level, maximum, minimum and average inventory.

OR

16. A wholesale system dealer keeps stock of popular brand of computers. Daily demand based on past experience is given below:

Daily Demand	0	10	20	30	40	50
Probability	0.01	0.20	0.15	0.50	0.12	0.02

Using random numbers 52, 56, 77, 21, 14, 47, 23, 98, 09, 10 simulate the demand for the next 10 days.

17. The arrival of customers and the service distribution of the train are given in the following probability distributions:

Arrival time (min)	Probability	Service time (min)	Probability
0.5	0.02	0.5	0.12
1.0	0.06	1.0	0.22
1.5	0.10	1.5	0.34
2.0	0.20	2.0	0.19
2.5	0.20	2.5	0.17
3.0	0.14	3.0	0.08
3.5	0.10		
4.0	0.17		
4.5	0.14		
5.0	0.20		

Estimate the average waiting time and percentage of idle time of the server by simulation, for 10 arrivals.

OR

18. Find the optimal order quantity for a product for which price break up is as follows :

Quantity	Unit Cost(Rs)
$0 \leq Q1 < 25$	5
$25 \leq Q2 < 50$	4
$50 \leq Q3$	3

The monthly demand for the product is200 units, the cost of storage is 25%of the unit cost and ordering cost is Rs 20 per order.

19. The demand for an item in a company is 20,000 units per year, and the company can produce the item at a rate of 5000 per month. The cost of one set up is Rs.500 and the holding cost of one unit per month is 15 paise. The shortage cost of one unit is Rs.15 per month. Determine the optimum manufacturing quantity and the number of shortages. Also determine the manufacturing time and time between set-ups.

OR

20. A travels company finds that during the past 100 days the demand for the van has the following frequency distribution:

Trips per week	0	1	2	3	4	5
Frequency	8	12	15	30	20	15

Using random numbers, simulate the demand for a period of 10 weeks.