



**Subject: Production and Operation Management**  
**Module 02**  
**CHAPTER 01**  
**FACILITY LOCATION PLANNING**

❖ **INTRODUCTION**

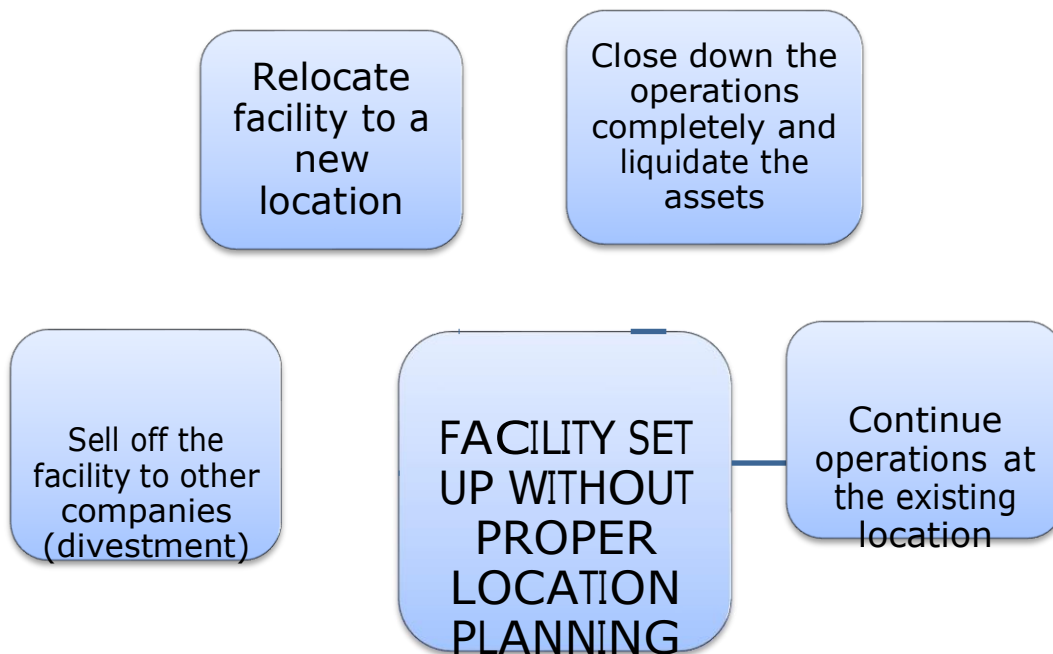
- A facility is an establishment of an organization through which the organization operates such as:
  - Manufacturing unit
  - Warehouse
  - Office
  - Showroom
  - Others like packaging
- A factory or a plant is the manufacturing facility of a company.
- A warehouse is the storage facility of a manufacturing or distribution company.
- The offices of a service sector company.
- Such as a courier company, bank, or an insurance company are its facilities.
- The facility location design is very important for big business houses as well as new entrepreneurs.
- Wrong location of the facility may lead to a failure of the complete project.
- Site selection is an important activity which decides the fate of the business.
- A good location may reduce cost of production and distribution.
- Locating a business involves a large, relatively permanent investment.
- If the site selection is not proper installation will go waste.
- The site for the factory should be selected very carefully.
- While selecting a Site...



It is necessary to consider technical, commercial and financial aspects then select a site that may provide maximum advantages.

## ❖ LOCATION PLANNING

- **Location** refers to the geographical position of an object, person or place.
- **Location Planning** refers to all the activities involved in determining & selecting the most suitable location and utilizing its benefits in an efficient manner.
- There are a number of problems to deal with if a wrong or improper facility location is been selected as follows:





### ❖ There Are Various Steps to Be Followed in Proper Facility Location Planning:

- Generate the list of alternative location options for the facility
- Find out factors relevant to facility being planned
  - Screen better location option location rating analysis
  - Screen better location option even analysis
    - Apply Simple Median model
    - Apply Centre of Gravity model
    - Apply Transportation model
    - Apply Ardalan Heuristic
- Best location chosen

### ❖ Operations Strategies for Multiple Facilities

- There are three strategies for the organizations to have more than one facility for pursuing their operations:
  1. Separate Facilities for Different Products/Services
  2. Separate Facilities to Serve Different Geographical Areas
  3. Separate Facilities for Different Processes

#### 1. Separate Facilities for Different Products/Services

- Companies which are into diversified product/service ranges prefer to have separate facilities.
- Each facility takes care of the entire population total geographical area for a particular product/service.
- Bring about economies of scale.



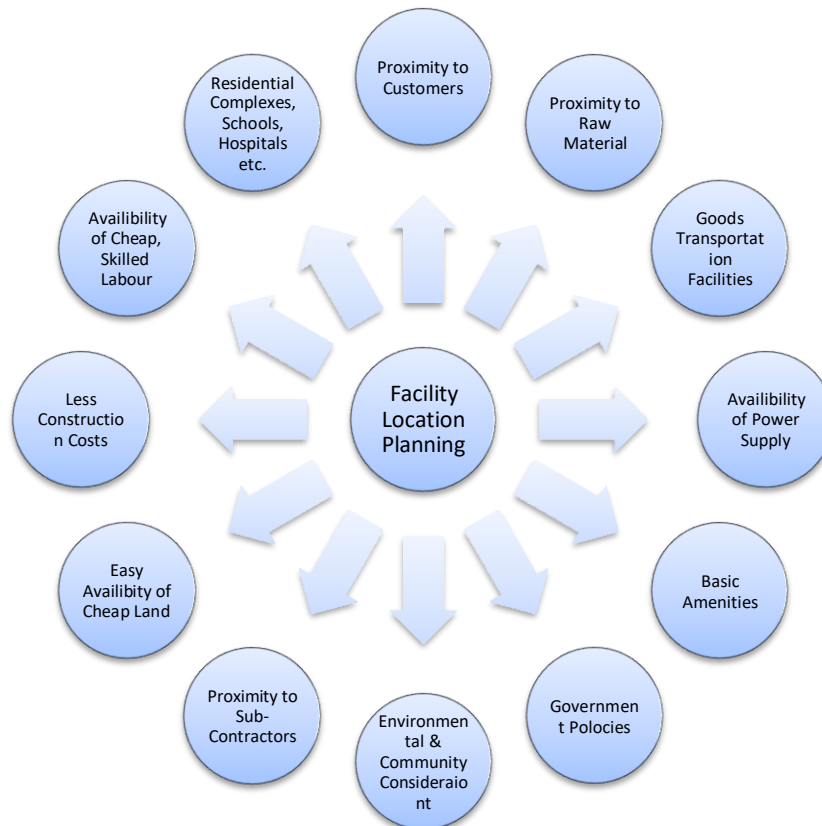
## 2. Separate Facilities to Serve Different Geographical Areas

- Plants scattered all over the country, which cater to different regions/ geographical areas.
- This strategy reduces the overall transportation costs and the lead time for supplying goods in the market.
- Prompt actions can be taken to deal with sudden changes in demand.

## 3. Separate Facilities for Different Processes

- Many organizations have their different facilities for their manufacturing process. i.e. from raw material storage to packaging.

## ❖ FACTORS AFFECTING FACILITY LOCATION PLANNING





### **1. Proximity to Customers (Markets):**

- This reduces the cost of transportation
- The product competes well with the competitors and allows companies to meet any sudden spurt in demand
- The response time to such demand is of prime importance for service sector which organizes their facility in high population zones so they are able to serve a large number of customers

### **2. Proximity to Raw Material:**

- Raw material gets available at cheaper rate because of negligible transportation costs
- Also, it becomes easier to control its quality

### **3. Good Transportation Facilities:**

- Regions near metro cities have the advantage of good transportation facilities, as they have good rail, air, water, and road transportation networks.

### **4. Availability of Power Supply:**

- Uninterrupted power supply is a basic requirement of most industries
- Some factories have to set up their own captive power plants if located in areas power problems

### **5. Basic Amenities:**

- The area for location of the plants should have water supply lines managed by the local municipal corporation
- Roads up to the factory premises are desirable
- Other amenities desired are sanitation facilities such as sewer line, drainage systems etc.



## 6. Government Policies:

- Local taxation policies and various promotional efforts help in increasing the industrial activity in the region
- ‘No sales tax regions’ and, therefore we find that most of the companies have their offices/ warehouses located there
- Many state governments promote industrial activities in their regions by creating Industry Development Zones

## 7. Environmental and Community Consideration:

- Many state governments have strict environmental policies in place, which have to be followed by the industries operating there
- The people residing in the area should not be against the idea of having a plant in their region as the effluents from a factory spoil the natural environment of the region

## 8. Proximity to Sub-Contractors:

- The presence of small ancillary units manufacturing small components/sub-assemblies is important for any new factory
- supplying the components required by new plant for starting its production process

## 9. Easy Availability of Cheap Land:

- Land is the basic necessity for the construction of new plant
- Regions such as UP, Bihar, and Orissa may be lucrative for big companies because of this
- Still, because of many other factors, companies prefer costly land.



## 10. Less Construction Costs:

- Construction costs of a plant may be low a particular place due to cheap labor available there, construction material may also be cheaper.

## 11. Availability of Cheap, Skillful and Efficient Labor:

- Multinational companies prefer China over India to set up their global sourcing bases because the labor in China has become more skillful and efficient as a result of increased industrial activity in the past few decades.

## 12. Residential Complexes, Schools, Hospitals, Clubs, etc.:

- Usually new factories are given land in remote villages by the state government
- Under such situation, companies have to create these facilities on their own
- The TISCO factories at Jamshedpur is the first example of this kind in India, where the company has created all such facilities for its Employees.

## ❖ FACTOR AND LOCATION RATINGS

- The factors affecting the facility location decision discussed earlier are all important for any type of industry.
- At the same time, the importance of each of these factors may vary for different types of plants.
- According to the requirements of a new plant, a set of these factors is considered.
- These **factors are rated from 1 to 5** to indicate the **importance** attached to them.
- The rating of **5** is given to the **most important** factor and rating of **1** is given to the **least important** one.
- These are called **factor ratings**.
- Let us consider three location options for a new leather goods manufacturing



facility being commissioned by a company.

- These location options are, say, Unnao- near Kanpur, Noida, and Gorakhpur
- There are various factors considered important for a leather goods manufacturing facility and their factor rating given in the following table:

FACTOR	FACTOR RATINGS
Close proximity to markets	3
Close proximity to raw material (leather)	5
Transportation facilities	4
Basic amenities	2
Acceptance of a leather factory by the local people	4
Availability of cheap land	3
Low construction cost	1
Easy availability of cheap and skillful/efficient labor	3

- Now with respect to each of the three locations, let us give each of these factors another rating, called the **location rating**, according to the benefits a particular location option offers.
- Location ratings vary from **1 to 10** is given to the most beneficial factor at that particular location.
- Similarly, a rating of **1** is given to the **least beneficial factor** at that location
- The following table gives the location ratings for the leather goods manufacturing facility:

FACTOR	FACTOR RATINGS	LOCATION RATINGS		
		Unnao	Noida	Gorakhpur
Close proximity to markets	3	4	6	3
Close proximity to raw material (leather)	5	10	5	4
Transportation facilities	4	9	10	5
Basic amenities	2	6	7	6





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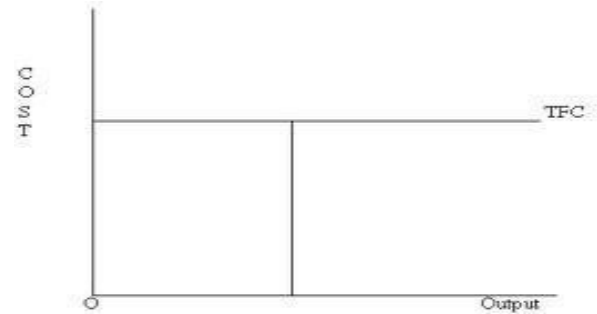
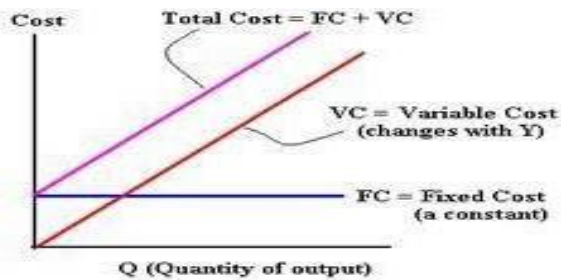
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Acceptance of a leather factory by the local people	4	8	3	7
Availability of cheap land	3	7	2	8
Low construction cost	1	5	1	6
Easy availability of cheap and skillful/efficient labor	3	3	8	4

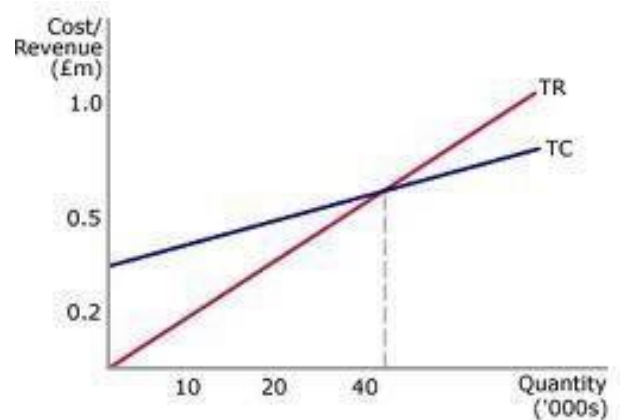
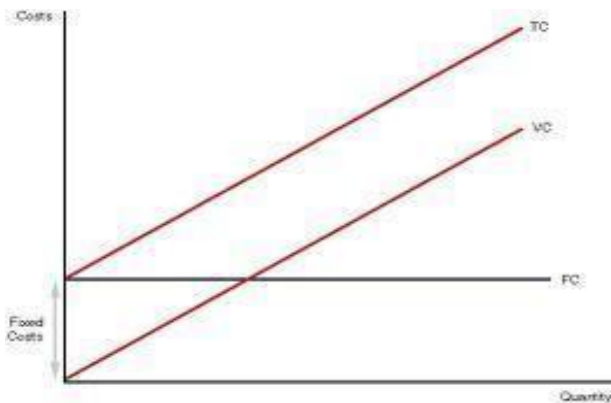
## ❖ BREAKEVEN ANALYSIS FOR FACILITY LOCATION PLANNING

- The conversion process from inputs to outputs involves two types of costs namely, the fixed cost and the variable cost
- Fixed costs are the capital expenditure
- These costs remain constant irrespective of the volume of production



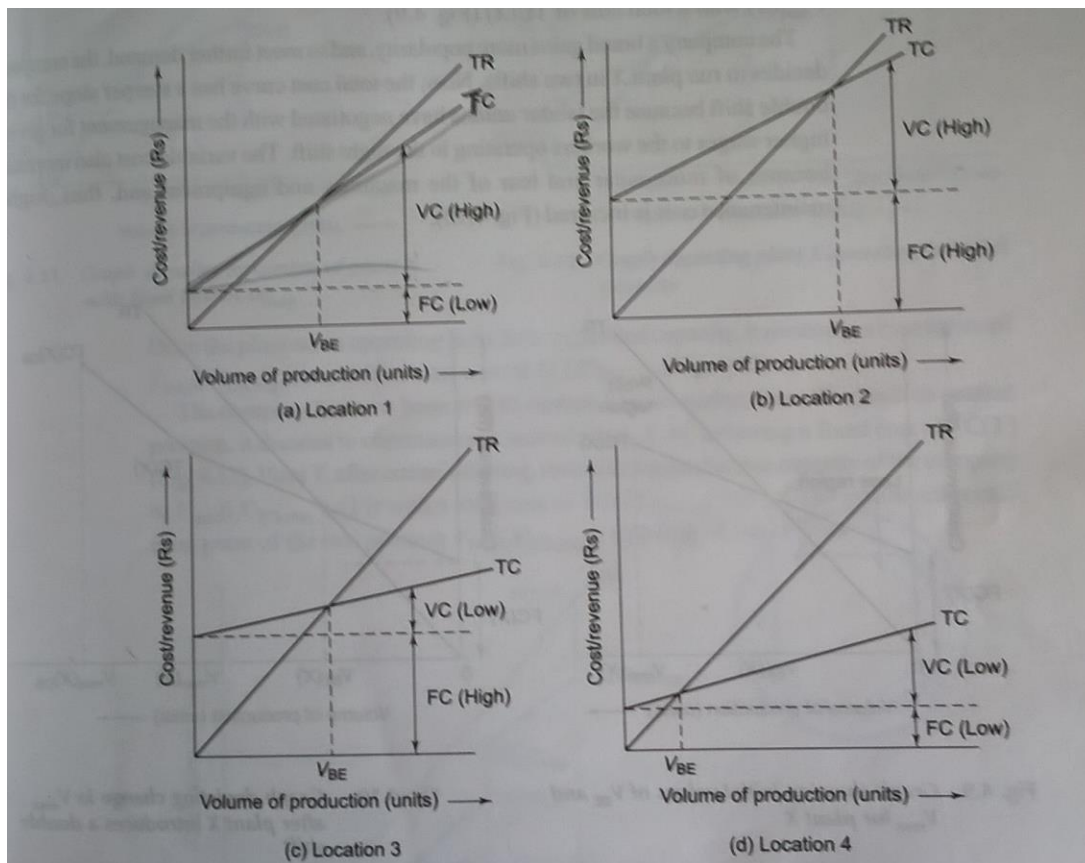
- Variable cost is cost of labor, raw material cost etc.
- As volume of production increases, variable costs also increase.
- When it is added to FC, we get the amount of TC

$$TC = FC + VC$$





- Here the regions show that the region where TR is more than TC is the region profit, while the region where TR is less than TC is the region of loss
- The point at which TR=TC is the breakeven volume  $V_{BE}$ , it represents the volume of output at which there is no profit and no loss
- All the expenses incurred are completely covered by the revenue generated
- In a facility location planning, a location at which the breakeven volume is lower is preferred
- The FC & VC may be different at different location options and hence, these options may have different values of  $V_{BE}$
- Let us have a look at different location options
- As we discussed earlier, BEP analysis is more suitable for screening the better location options rather than for selecting the best one





### ✓ EXAMPLE 1

- Triveni Steels (P) Ltd., is planning to start a new factory for manufacturing Steel Utensils. There are three location options for the company, namely Bokaro, Jamshedpur, and Bhilai.

DATA	BOKARO	JAMSHEDPUR	BHILAI
FC	8.15m	7.377m	7.903m
VC	500 per unit	580 per unit	490 per unit
INITIAL CAPACITY	75%	75%	75%

- The capacity of 10,000 units and in the initial years it will operate at the 75% capacity.

### ✓ EXAMPLE 2

- Sigma Instruments (P) Ltd is considering three locations for its new factory-
- Faridabad, Kolkata and New Delhi. The estimated costs for the locations are as below

	FARIDABAD	KOLKATA	NEW DELHI
Transportation Cost- Rs/Unit	10	20	9
Cost of Materials- Rs/Unit	120	110	100
Taxes- Rs/Year	40,000	35,000	45,000
Cost of Construction- Rs	5m	4m	4.7m
Electricity- Rs/Year	22,000	15,000	25,000
Labor- Rs/Unit	26	21	23

- The company has financed the construction cost of the factory by a loan from the state bank of India at 15% per annum. Find the economically best location option for the production of 5000 – 10000 units



- The total cost associated with a given volume of output is equal to the sum of fixed cost and variable cost  **$TC=FC+VC$**
- **$VC= Q*v$**  where v is variable cost per unit
- Revenue per unit is assumed to be the same regardless of quantity of output
- Total revenue associated with a given quantity of output Q is,  **$TR=R*Q$**
- According to the volume of breakeven profit or loss would be the result
- Total profit can be identified by  **$P = TR-TC$**   
 **$= R*Q - (FC +v*Q)$**
- Rearranging them we have  **$P = Q(R-v)-FC$**
- The difference between revenue per unit and variable cost per unit, R-v, is known as the **contribution margin**
- The required volume, Q, needed for total revenue to equal total cost. This is the **Break-Even Point,  $Q_{BEP} = FC/ R-v$**

#### ❖ SIMPLE MEDIAN MODEL

- This model is used for the final selection of the **best location option**.
- Transportation cost is a major consideration in facility location planning, this model helps to locate a new facility such that the **total transportation cost is the minimum**.
- The model is very simple in application, the term median refers to statistical median of the load to be transported between the existing facility and the new facility.
- The model has a simplifying assumption that the loads can be travelled only in two directions namely, **x axes and y axes**.
- The existing facilities may be factories, warehouses, or markets of the company, the company wants to know where to locate the new plant.



FACILITY	COORDINATE LOCATION (x, y)	COST(C) OF MOVING 1 UNIT BY UNIT DISTANCE (Rs)	ANNUAL LOAD (L) (Units)
Bareilly	(10, 80)	10	452
Shahjahanpur	(30,60)	10	678
Gonda	(80,50)	10	483
Kanpur	(50,10)	10	711
Sultanpur	(80,10)	10	539
			<b>2863</b>

- **Step 1: Find the median load**

- Add the annual loads given for all the existing facilities. The sum is 2863 units. This is an odd number. The median value will be  $(n+1)/2$  item
- i.e.  $2863+1/2 = 1432$  units

- **Step 2: Find the x-coordinate of the new plant**

- Move from the extreme left towards right along the positive x-axis. In our example we come across Bareilly first, its annual loads capacity is 452 which does not include our median load capacity
- So, we move further to right and we come across Shahjahanpur,
- Assume that loads 453-1130 are moved between Shahjahanpur and NP. This range does not include the median load 1432
- We move again towards right and come across Kanpur. Assume that loads, 1131-1842 are moved between Kanpur and the NP
- This range includes the median load 1432
- Therefore, the x-coordinate of the new plant is same as the x-coordinate of Kanpur, i.e. 50
- $X_0=50$



- **Step 3: Find the y- coordinate of the new plant**

- Move from bottom along the positive y-axis
- We come first across Kanpur and Sultanpur simultaneously
- Assume that loads 1-1250 have to be moved between Kanpur and NP, and Sultanpur and NP
- This range does not include the median load 1432, therefore we move upward and come across Gonda, suppose that 1251-1733 are moved between Gonda and the NP
- This range includes the median load, therefore, the y-coordinate of Gonda, i.e., 50
- Now the route to be followed between say the NP and Bareilly is represented by a line the distance between the two is...
- $|x - x| + |y - y|$
- $= |50 - 10| + |80 - 50|$
- $= 70$
- Same way the distance between all other facilities can be found out.

- ❖ **CENTER OF GRAVITY METHOD**

- It is also called centroid method. The center of gravity method is also simple in approach.
- The coordinates of the new plant  $(x_0, y_0)$  according to this model,
- $X_0 = \frac{\sum x_i L_i}{\sum L_i}$                        $y_0 = \frac{\sum y_i L_i}{\sum L_i}$
- $X_i, Y_i$  are the coordinates of existing facilities and  $L_i$  represents the loads to be transported between existing facilities and new facility
- The  $(x_0, y_0)$  co-ordinates of new plant can be identified by taking weighted average of the x, y coordinates of all the existing facilities.



- The loads  $L_i$  to be carried between existing facilities and new plant are the weights used in this calculation.

## ❖ TRANSPORTATION MODEL

- Under this model varying demands are considered and is correlated with capacity so as to reduce the transportation cost.
- The cost of transportation involved in transporting raw material and the finished goods.
- Evaluation of location is based on the cost of material to the market and same receiving the same from the warehousing.
- Mileage Tyres Ltd has four production facilities located at Chennai, Ahmadabad, Bhopal, and Lucknow. The company has three major sources of raw material for its plants at New Delhi, Kolkata, and Bhubaneshwar. It wants a fourth source of raw material and has identified two options – Bangalore and Mumbai. Both these suppliers can supply a maximum of 2000 units of raw material per year.
- The company has prepared two tables showing annual requirement of plants and annual capacity of raw material supplied.
- One table includes Bangalore as a raw material supplier, another includes Mumbai as a raw material supplier.
- The data in the table shows cost of transportation of a unit load of raw material from raw material supplier to plant.





**Transportation Cost (in rupees per unit load) (BANGALORE as one the supplier)**

Destination Sources	Chennai	Ahmadabad	Bhopal	Lucknow	Availability
New Delhi	500	300	400	150	3500
Kolkata	700	600	300	450	1000
Bhubaneswar	100	600	250	550	4500
<b>Bangalore</b>	<b>200</b>	<b>700</b>	<b>400</b>	<b>750</b>	<b>2000</b>
Requirement	2500	1500	3000	4000	11000

**Transportation Cost (in rupees per unit load) (MUMBAI as one the supplier)**

Destination Sources	Chennai	Ahmadabad	Bhopal	Lucknow	Availability
	500	300	400	150	3500
Kolkata	700	600	300	450	1000
Bhubaneswar	100	600	250	550	4500
<b>Mumbai</b>	<b>550</b>	<b>200</b>	<b>250</b>	<b>650</b>	<b>2000</b>
Requirement	2500	1500	3000	4000	11000



## CHAPTER 02

### FACILITY LAYOUT PLANNING

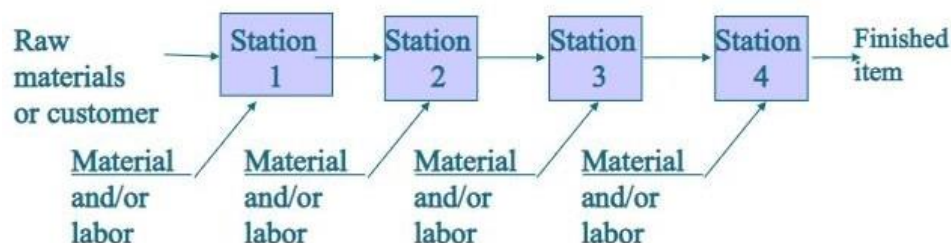
- It is the physical location of the various departments/units of the facility within the premises of the facility.
- Departments may be located based on some considerations such as less walking distance, logical sequence of the procedure, or any special requirements of the product.
- There are four types of basic layouts: product, process, fixed-position, and cellular layout.

#### ✓ PRODUCT LAYOUT

- Product Layout is also referred as ‘Single Line Layout’, ‘Line Processing Layout’, ‘Flow Line Layout’, or ‘Layout for Serialized Manufacture’.
- This type of layout provides arrangement of equipment in order to represent their sequential role in process of manufacturing.

#### ✓ A FLOW LINE FOR PRODUCT/SERVICE

##### ➤ FLOW SHOP/ASSEMBLY LINE WORK FLOW





- It is suitable when a product is having standard features is to be produced in large volume.
- The production process involves repetitive tasks to be performed for items arranged in sequence.
- Specialized machines and equipment are arranged one after another in the order of sequence required in the process.
- This production line is called **Assembly Line**.
- The assembly line has moving platform or conveyer which moves at a regular interval of time.
- The basic structure of products to be manufactured the raw form are placed on the conveyer at equal distance from each other.
- Across the conveyer there are work stations with required machines, equipment, components, tools, and workers to perform the assembling tasks on the basic structure of the product.

#### ✓ **ADVANTAGES**

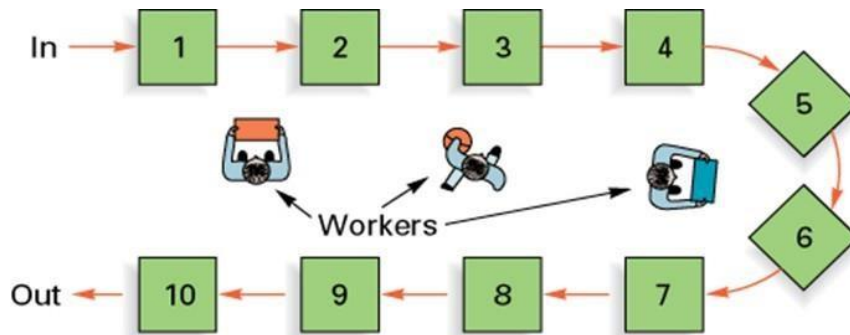
- Easier material handling & less inventory costs
- Less supervision & labor training costs
- High output rate that results into low cost of item per unit
- High efficiency of labor & equipment
- No need of routing or scheduling once the line is operational

#### ✓ **DISADVANTAGES**

- Monotonous repetitive tasks lead to frustration for workers
- Breakdown of a machine or high absenteeism of workers leads to halt
- Inflexible to design changes in product or process
- Maintenance cost is fairly high

## ➤ U-SHAPED ASSEMBLY LINE

- U-shaped assembly line is useful particularly when there is a single worker in the line taking care of all the work stations.
- The U shape of the line reduces the walking distance of the worker by almost half.
- The U-shaped line is being successfully used by Matusushita Electric Co. of Japan by using a single worker in such line.



- The closeness of the work station allows workers to help a fellow worker catch up, especially one working on the station just opposite.
- This increases teamwork among workers.
- At the same time, many work stations close to each other may result in conversations, noise etc., resulting in distraction from work.
- The U-shaped line reduces material handling as the entry and exit points of the material on the line are nearby.
- A trolley which brings the raw material for the line may take back the finished goods in a single round.

## ✓ ADVANTAGES

- More compact, Increased communication, Facilitating team work, minimize the material handling



## ✓ PROCESS LAYOUT

- In a process layout, general - purpose machines are arranged in no particular sequence, as the processing requirements and sequence are different for the various types of products to be manufactured.
- In a production set-up, such a layout is also called a machine shop or job shop.
- A good example of a process layout can be seen at any Maruti Service Station. Here, separate departments with general-purpose machines are assigned for dent corrections, painting, wheel alignment, oil replacement, engine correction, electrical check-up, interiors, washing, cleaning, etc.
- Different Maruti cars have different service requirements, thus taken to different departments according to schedule decided up on by the supervisor.
- Process layout is particularly suitable when different products are produced in lots or batches.
- This is called **Intermittent Manufacturing**.

## ✓ ADVANTAGES

- Maintenance cost is low
- The system is more flexible to design changes
- Break down of machines does not lead to a halt in production
- The system promotes creativity of workers due to variety of tasks

## ✓ DISADVANTAGES

- Material handling is time-consuming
- Work-in-process inventory is usually high
- A low output rate and high cost per unit
- Routing and scheduling are tedious
- High cost of supervision because of special treatment to every product being processed



## ✓ FIXED POSITION LAYOUT

- In this layout, the product is very bulky, heavy, large, or has a fixed position.
- Thus, machines, equipment, raw materials, workers, etc. have to be taken to the site of the product.
- The important aspect is the placement of all these things inside or around the product so that no overcrowding takes place.
- Equipment, raw materials, and worker teams are brought to the site according to a time schedule for better utilization of the space available.

## ✓ ADVANTAGES

- Saves time and money, as site of the key product is permanent.
- Job design and sequence of working activity can be changeable.
- Possible to accomplish number of orders concurrently, even at various stages.

## ✓ DISADVANTAGES

- A lot of space needed for storage of equipment and materials at site.
- Cost of equipment handling will be high.
- Chances of misunderstanding and inconsistency amongst various groups.

## ✓ CELLULAR LAYOUT & GROUP TECHNOLOGY

- We have seen that both product and process layouts have their advantages and disadvantages.
- Product layout is desirable by most organizations, but the low volume and the variety of their products does not warrant it.
- Therefore, they have no choice but to go on process layout.
- Product layout and process layout represent the two extremes of layout techniques.
- An intermittent manufacturing of a high variety of products with the advantages of a product layout.
- Let us take up an example to understand cellular layout.
- The following figure shows the typical process layout of a factory which has six departments, namely, lathe, foundry, fitting, drilling, welding, and paint.
- Each of these department has a general-purpose machine required for processing products manufactured by the factory.
- Following graph shows how different products are routed through different departments according to their differing processing requirements.

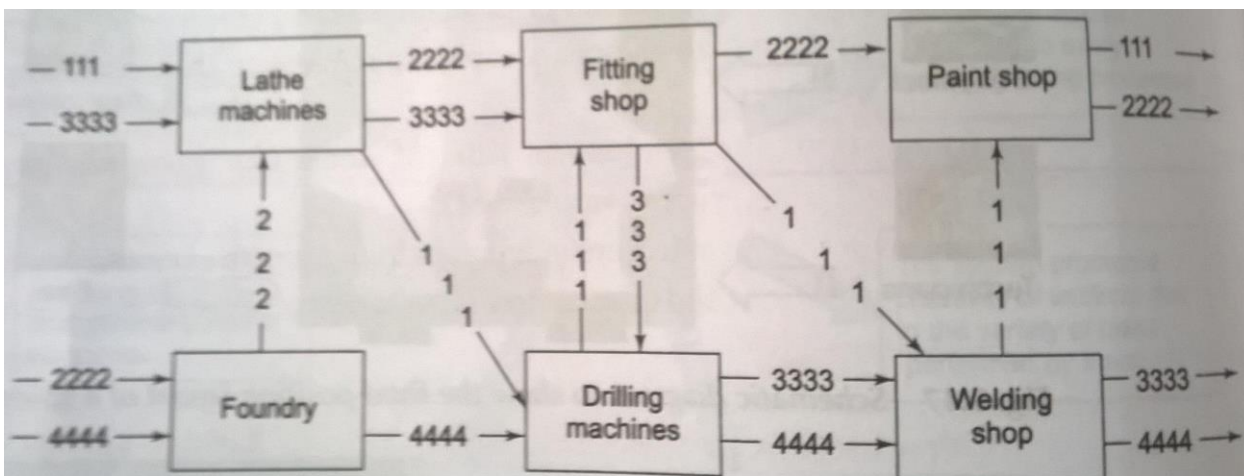
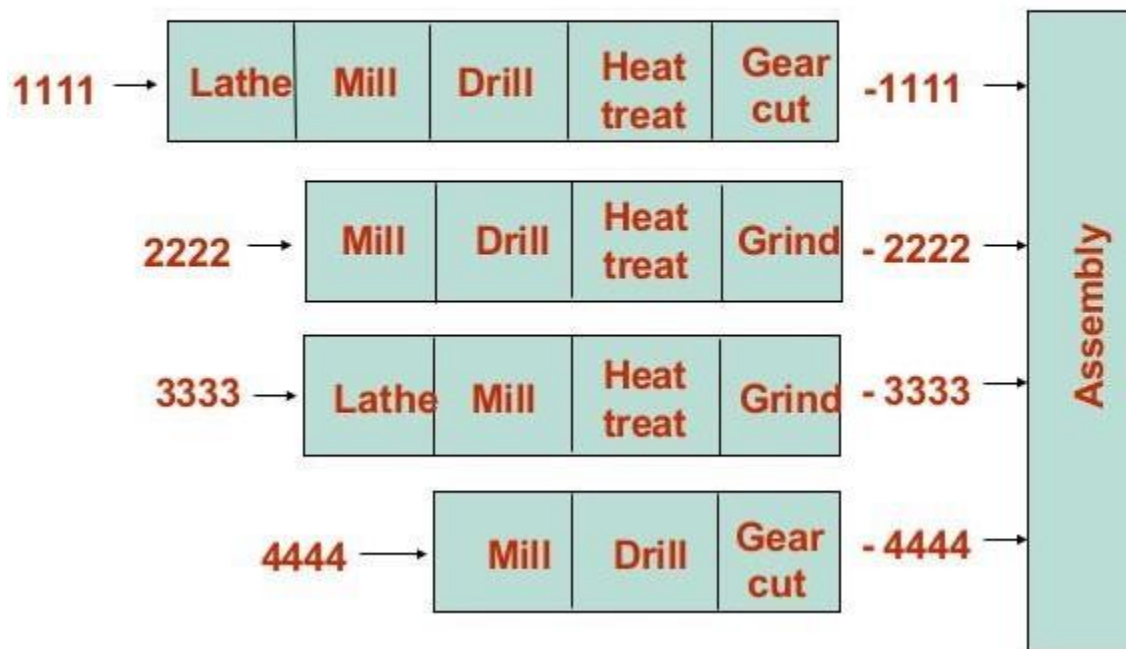


Fig. 5.18 Typical process layout of a factory



## Cellular Manufacturing Layout



- In a cellular layout of the same factory, groups of items with similar processing requirements are identified, and separate manufacturing cells are formed for each group, which contain the required machines in the desired sequence.
- There is no conveyor or mechanized moving platform in the cells to carry items from one machine to the other, as in the product layout.
- The identification of similar groups of items is an important aspect of cellular layout and is called group technology.
- In Group Technology, groups of items can be formed either according to similarities in their design or according to similarities in their manufacturing process.
- Before switching over to a cellular layout from a process layout, the production manager must do proper cost and time comparisons to derive the maximum advantages of cellular manufacturing.





## ✓ **ADVANTAGES**

- Less inventory in work in progress
- Produce variety of products
- Rush order can be produced
- Saves process time

## ✓ **DISADVANTAGES**

- High cost
- Not suitable for large number of products
- Not suitable for diversified product portfolio
- Lower utilization of equipment

## ✓ **FACTORS AFFECTING LAYOUT PLANNING**

- Product and material specification
- Location and site of the plant
- Manufacturing process
- Material handling
- Storage of in process inventory
- Working condition
- Disposal of waste and dangerous gases
- Flexibility

## ✓ **IMPORTANCE OF FACILITY LAYOUT**

- Overall manufacturing cost is likely to be reduced
- Efficient use of available space.
- Optimum utilization of various inputs, including manpower
- Speed of order execution become faster
- number of accidents reduced due to safety aspects
- High productivity can be achieved

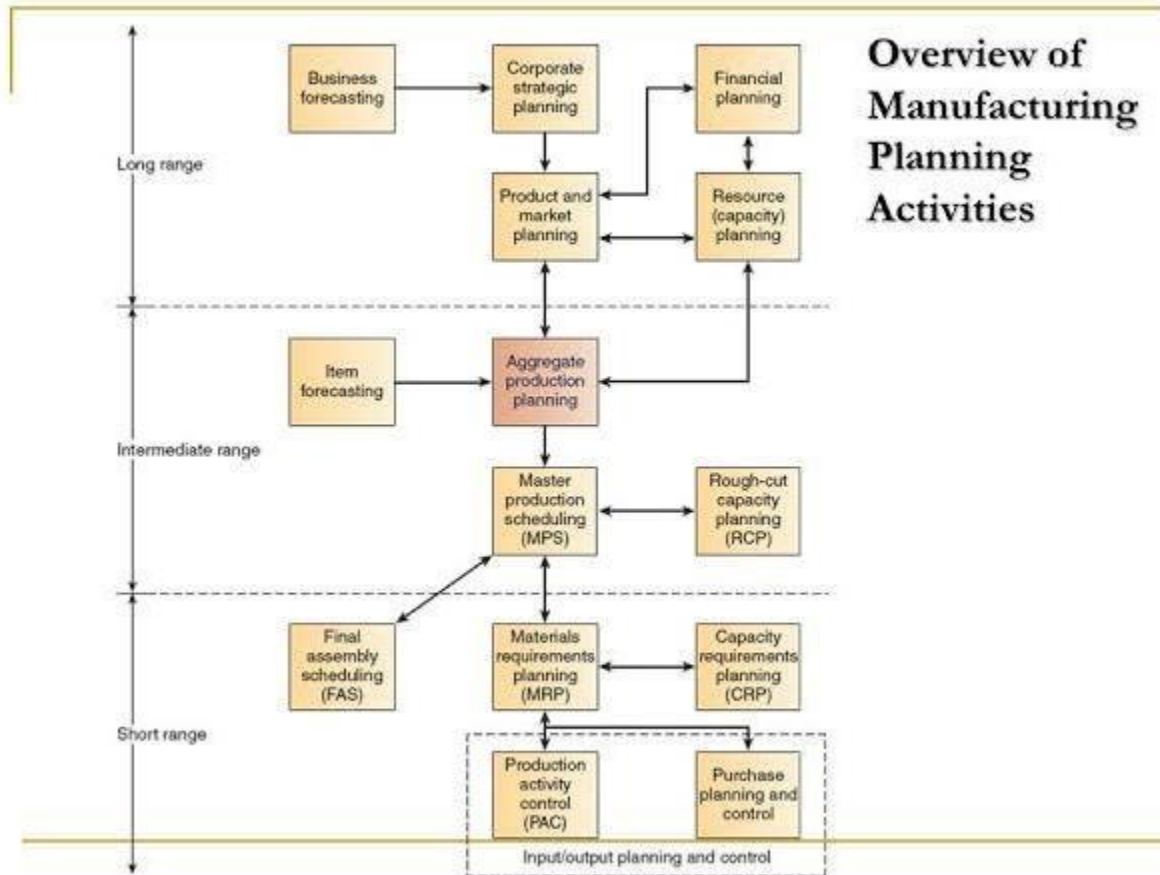


## CHAPTER 03

### AGGREGATE PRODUCTION PLANNING

#### ✓ INTRODUCTION

- Aggregate Production Planning is planning the number of units of the product to be produced on a weekly or monthly basis for the coming 6-18 months.
- This plan should be in line with the overall business plan of the company.
- Aggregate means complete or total. Hence this plan includes all the various models of the product and gives the complete picture of the future production requirements.
- Aggregate planning is the process of developing, analyzing and maintaining a preliminary, approximate schedule of the overall operations of an organization.
- **It is based up on the demand forecasts provided by the marketing department.**
- Aggregate planning is needed to **minimize the various types of costs** related to unplanned production
- Unplanned production leads to high costs **such as hiring and laying-off costs of workers, overtime costs, inventory costs, etc.**, but also to shortages of the product.



## Overview of Manufacturing Planning Activities

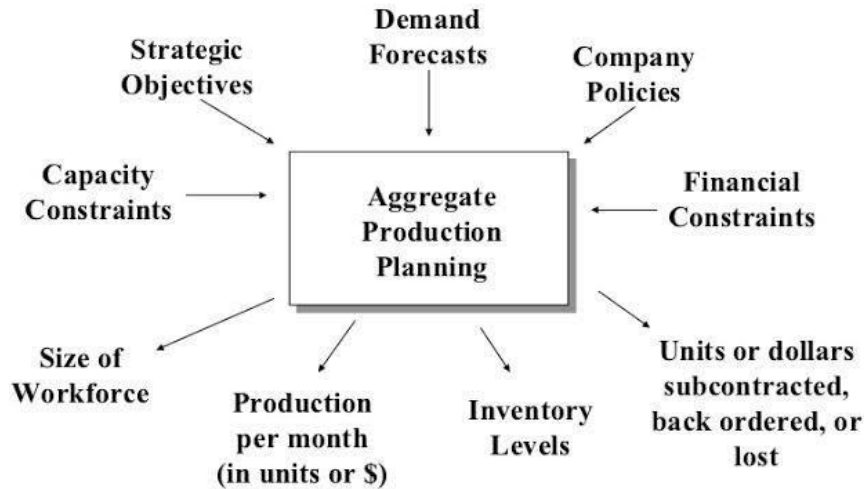
- A shortage or stock out is most harmful to the company, as it results in loss of goodwill on the part of the customers.
- The aggregate plan generally contains targeted sales forecasts, production levels, inventory levels.
- This schedule is intended to satisfy the demand forecast at a minimum cost.

### IT IS AN OPERATIONAL ACTIVITY WHICH...

- does an aggregate plan for the production process, in advance of 6 to 18 months,
- to give an idea to management as to what quantity of materials and other resources are to be procured and when,
- so that the total cost of operations is kept to the minimum, over that period.



## Inputs and Outputs to Aggregate Production Planning



- Let us take up an example to understand the relationship between the aggregate plan and the costs involved as the time horizon of the demand forecasts provided by the marketing department is broadened.
- Rajasthan saris are 100% export oriented.
- 5000 million turn over at Jetpur based plant.
- Export saris to European countries.
- In last week of October, sales agency forecast 2000 saris for November.
- In last week of November, agency provide 3000 saris for December sales.
- In October, 25 workers are there in factory. Each worker can produce 100 saris per month.
- Salary to worker is Rs. 4000 per month.
- Estimated cost of hiring a worker is Rs. 500.
- The company has to give 20% of salary as laying off cost to worker.
- Inventory cost is Rs. 10 per sari, per month.



## ✓ OBJECTIVES

- To minimize total cost over the planning horizon
- To minimize inventory investment
- To minimize changes in workforce levels
- To minimize changes in production rates
- To maximize utilization of plant and equipment

## ❖ AGGREGATE PRODUCTION PLANNING STRATEGIES

- The basic production planning strategies are based up on three variables. Work force size, utilization of workers and inventory size.
- In each one of these strategies, one variable is varied and other two are kept constant.
- The following are three basic production planning strategies:

### 1. Level Output Rate

- The inventory size is varied keeping the workforce size and utilization of work force constant.
- The number of workers is kept constant throughout the time period under consideration.
- During months of low demand, the excess units produced over demand are accumulated inventory.
- During the months of high demand, the units required over the units produced are taken from the inventory.



- The advantage of this plan is that the cost of hiring and training new workers is zero.
- Also, the cost of laying off workers is zero, as the workforce size is constant.
- The employee morale is high due to its large security.
- During periods of low demand, there is a high inventory cost due to its large size.

## 2. Chase Plan

- The workforce size is varied according to demand, keeping the utilization of workers and inventory size constant.
- During months of low demand, the workforce size is decreased and the extra workers are laid-off.
- Similarly, during months of high demand, more workers are hired.
- The hiring and laying-off cost are substantial in this plan.
- The worker's morale is also low due to a sense of insecurity.
- The production of items is in tune with the demand requirements, thus the inventory is almost negligible, so inventory cost is also negligible.
- During the months of heavy demand, overtime may be required on the part of workers, for which the company incurs overtime costs.

## 3. Varying Utilization Plan

- The utilization of workers is varied keeping the workforce size and inventory size constant.
- The number of workers is kept constant in this plan.
- During the months of low demand, the workers produce less so as to match the demand and they have a lot of idle time.



- On the other hand, during the months of high demand, the excess units required over regular production are produced by overtime on the part of workers.
- The idle time on the part of workers during the months of low demand is a loss to the company, which pays full wages to its employees.
- On the other hand, the company incurs overtime costs during periods of high demand.
- Overtime is usually expensive compared to the regular wages given to the workers and also leads to less efficiency on the part of workers and more accidents due to lack of concentration.
- Still the company saves on inventory costs, which are almost negligible, in this plan.
- These basic planning strategies should preferably not be used in isolation from each other, as each one of these has typical draw backs.

### ❖ DISAGGREGATING THE AGGREGATE PLAN

- The aggregate plan gives information about production requirements in general terms, as it includes different models of the product in the number of units to be produced.
- No specific information is given by the aggregate plan as to how many units of different models of the product are to be produced.
- Different models of the product may, in general, require common parts and components, but some parts may be specific to the models.
- Some models may also require specific labor skills for their processing.
- Thus, for material and labor planning of different models, information about what quantity of different models is to be produced is required.
- The aggregate plan is an intermediate planning stage and in the next stage the aggregate plan is to be disaggregated (broken down into parts) to include information about the different models of the product to be produced.



## ❖ MASTER PLAN

- A master schedule is the result of the disaggregation of an aggregate plan.
- The master schedule shows the quantity and timing of specific end items for a time horizon often spanning six to eight weeks.
- In a master schedule, the time horizon is divided into many time periods usually expressed in weeks.
- The time periods in a master schedule called time buckets may not be equal throughout the time horizon considered.
- The master schedule is more and more tentative for the distant future than in the near future.
- There is no upper limit on the duration of the time horizon for a master schedule, but there is a lower limit.
- The duration of the time horizon has to cover at least the cumulative lead time of production of end items.
- For example, if the production of an end item requires three days of procurement of raw materials, four days for manufacturing components, two days for putting together sub-assemblies, and one day for the final assembly, the cumulative lead time will be 10 days.
- Thus, the master schedule must cover a time horizon of 10 days.
- The aggregate plan covers a duration between 6-18 months, while the master schedule covers a few weeks to two or three months.
- Thus, the aggregate plan is disaggregated in phases or parts into the master schedule.
- The master schedule may be revised on a monthly basis in order to accommodate any changes in the actual demand being experienced compared to the demand forecast.





## ❖ ROUGH CUT CAPACITY PLANNING

- The initial master schedule is tentative in nature, as in reality capacity of the production system may not be able to support its practical implementation.
- Thus, the initial master schedule must be run through the MRP (Material Requirement Planning) system as a trial to check whether sufficient production capacities, such as machines, equipment, labor, warehouse, capacities at the supplier's end etc., exist or not.
- If the available capacities are not sufficient to support the master schedule, either the schedule can be revised to match the production capacities, or the production capacities expanded.
- For example, the workers may be required to do overtime, or the number of production shifts may be increased.
- Subcontracting some of the work to outside vendors is another means of temporary satisfying the master schedule requirements.
- This process of checking the feasibility of the master schedule with respect to available capacity is called rough-cut capacity planning.

## ❖ MASTER PRODUCTION SCHEDULE

- The master schedule provides details about the quantities and delivery timings of a product, but not the production plan.
- For example, if according to the master schedule, 1,200 cars of a particular model are to be delivered to the customer in week 1 and 1,000 cars of the model are already in the inventory, then only 200 units have to be produced in this week.



- 
- On the other hand, if there are 1,500 units of this model of the car in the inventory, there may be no requirement of any production in this week.
- The MPS gives details about the quantities and timing of the planned production of a product. It is derived from the master schedule by taking into account the inventory status of the product in a given time period.

### ❖ AVAILABLE TO PROMISE INVENTORY

- It is necessary for sales personnel to know how many units of the product at maximum they can commit to customers in a given time period.
- Available-to-promise inventory gives them this information.

### ❖ TIME FENCES

- The MPS cannot be changed near the actual production time.
- If changes are made at this stage, the whole exercise of a production planning will become useless.
- Therefore, production managers set various time fences to regulate changes in the MPS.
- For example, three-time fences may be fixed at time intervals of one, two and three months.
- Before three months of the actual production time, any changes in the MPS may be made.
- Between two and three months, product models may be substituted, provided the required components are available.



- Between the time fences of one month and two months, changes are avoided, but minor ones may still be permitted.
- The last fence of one month before actual production takes place is strictly frozen, i.e. no changes are allowed during this time.

## ❖ COST OF AGGREGATE PRODUCTION PLANNING

- Hiring and Laying off costs
- Inventory carrying cost
- Backorder cost
- Using over time and under time cost
- Basic production cost



## CHAPTER 04

### MATERIAL REQUIREMENT PLANNING (MRP)

#### ❖ INTRODUCTION

- A finished product is made up of many items called sub-assemblies. This sub-assemblies are made by joining various components together.
- Therefore, demand for this component are called **dependent demand**.
- Moreover, material requirement planning (MRP) is used for planning of future requirement of dependent demand.

#### ❖ DEFINITION

- “MRP constitute a set of techniques that use bill of material, inventory data, and master production schedule to calculate the requirement of material.”
- According to definition...
  1. Number of items already in inventory is called inventory status or inventory data.
  2. Number of finished goods to be produced in near future using these items is called Master production schedule.
  3. Number of units of items required for manufacturing a single unit of finished goods is called bill of material.



## ❖ INPUTS IN MRP

### 1. Bills of Materials:

- It is a document which tells us about an item's product structure, showing the sequence in which components/subassemblies are assembled and their required numbers.
- It also contains detail about the workstations at which the item is assembled.

### 2. Master Production Schedule:

- Aggregate production plan tells us about number of units that is to be produced in coming 6-18 weeks.
- MPS is extension of APP. It tells number of units of different models to be manufactured on weekly or monthly basis.

### 3. Inventory Status:

- It gives status of the inventory of an item at present, or in a given interval of time in the coming future.

## ❖ OUTPUTS IN MRP

### 1. Planned Orders Report:

- It gives information planned orders to be released on some future date or during a given interval of time.
- This report is also helpful in preparing for fund required for payment to supplier in future according to dates and order size.



## 2. Order Release Report:

- It gives information about order to be released on present date.
- It helps purchase manager to release purchase order to the supplier and also keep track of the purchase order that have to be sent on a particular day.

## 3. Order Change Report:

- Open order are those orders which have been placed in past and the suppliers of the item is preparing for these supplies to be made to the company.
- During the lead time the MPS of the company may fluctuate.
- According to that suppliers are told to either cancel the orders placed earlier by the company or postponed for some time.
- The order changes report gives the purchase manager all such changes with information about all such changes to be made in the open order with the suppliers.

### ❖ BENEFITS OF MRP

- Reduces work in progress
- Priority benefits
- Proper use of capacity
- Reduces lead time
- Increase in productivity
- Helps and better customer services

### ❖ LIMITATIONS OF MRP

- Causes inaccuracy in MPS
- Depends on data
- Requires disciplines for maintain correct stock records, reporting completed orders and jobs, ensure reporting of all relevant events



## CHAPTER 04

### INVENTORY MANAGEMENT AND PRODUCTION CONTROL

#### ❖ INTRODUCTION

- The need for inventory. It also provides a cushion for future price fluctuations.
- The purpose of inventory management is to ensure availability of materials in sufficient quantity as and when required and also to minimize investment in inventories.

#### ❖ MEANING AND NATURE OF INVENTORY

- The dictionary meaning of inventory is “stock of goods, or a list of goods”. The work “Inventory” is understood differently by various authors, in accounting language it may mean stock of finished goods only.
- In a manufacturing concern, it may...
  - a. Raw Material:** The quantity of raw materials required will be determined by the rate of consumption and the time required for replenishing the supplies. The factors like the availability of raw materials and government regulations, etc. too affect the stock of raw materials.
  - b. Work-in-Progress:** The work-in-progress is that stage of stocks which are in between raw materials and finished goods. The greater the time taken in manufacturing; the more will be the amount of work in progress.



- c. **Consumables:** These materials do not directly enter production but they act as catalyst, etc. There can be instances where these materials may account for much value than the raw materials. The fuel oil may form a substantial part of cost.
- d. **Finished Goods:** These are the goods which are ready for the consumers. The stock of finished goods provides a buffer between production and market. The purpose of maintaining inventory is to ensure proper supply of goods to consumers. In some concerns the production is undertaken on order basis, in these concerns there will not be a need for finished goods. The need for finished goods inventory will be more when production is undertaken in general without waiting for specific orders.
- e. **Spares:** Spares also form a part of inventory. Some industries like transport will require more spares than the other concerns. The costly spare parts like engines, maintenance spares etc. are not discarded after use, rather they are kept in ready position for further use. All decision about spares are based on the financial cost of inventory on such spares and the costs that may arise due to their non-availability.

#### ❖ PURPOSE OF HOLDING INVENTORY

- Although holding inventories involves blocking of a firm's funds and the cost of storage and handling, every business enterprise has to maintain a certain level of inventories to facilitate uninterrupted production and smooth running of business.
- There are three main purpose or motives of holding inventories.





- I. **The Transaction Motive** which facilitates continuous production and timely execution of sales orders.
- II. **The Precaution Motive** which necessitates the holding of inventories for meeting the unpredictable changes in demand and supplies of materials.
- III. **The Speculative Motive** which induces to keep inventories for taking advantage of price fluctuations, saving in re-ordering cost and quantity discount, etc.

#### ❖ RISK AND COSTS OF HOLDING INVENTORIES

❖ The various costs and risks involved in holding inventories are as below:

1. **Capital Costs:** Maintaining of inventories results in blocking of the firm's financial resources. The funds may be arranged from own resources or from outsiders. In the former case, there is an opportunity cost of investment while in the latter case, the firm has to pay interest to the outsiders.
2. **Storage and Handling costs:** The storage costs include the rental of the godown, insurance charges, etc.
3. **Risk of Price Decline:** This may be due to increased market supplies, competition or general depression in the market.
4. **Risk of Obsolescence:** The inventories may become obsolete due to improved technology, changes in requirements, change in customer's tastes, etc.
5. **Risk Deterioration in Quality:** The quality of the materials may also deteriorate while the inventories are kept in store.



## ❖ INVENTORY MANAGEMENT

- It is necessary for every management to give proper attention to inventory management. A proper planning of purchasing, handling, storing and accounting should form a part of inventory management. An efficient system of inventory management will determine (a) what to purchase (b) how much to purchase (c) from where to purchase (d) where to store, etc.
- There are conflicting interests of different departmental heads over the issue of inventory. The finance manager, production manager. The purpose of inventory management is to keep the stocks in such a way that neither there is over-stocking nor under-stocking. The investments in inventory should be kept in reasonable limits.

## ❖ OBJECTIVES OF INVENTORY MANAGEMENT

- The main objectives of inventory management are operational and financial.
  - The operational objective mean that the materials and spares should be available in sufficient quantity so that work is not disrupted for want of inventory.
  - The financial objective means that investments in inventories should not remain idle and minimum working capital should be locked in it.
1. To ensure continuous supply of materials, spares and finished goods so that production should not suffer at any time and the customers demand should also be met.
  2. To avoid both over-stocking and under-stocking of inventory.
  3. To maintain investments in inventories at the optimum level as required by the operational and sales activities.



4. To keep material cost under control so that they contribute in reducing cost of production and overall costs.
5. To eliminate duplication in ordering or replenishing stocks. This is possible with the help of centralizing purchases.
6. To minimize losses through deterioration, pilferage, wastages and damages.
7. To ensure perpetual inventory control so that materials shown in stock ledgers should be actually laying in the stores.
8. To ensure right quality goods at reasonable prices.
9. To facilitate furnishing of date for short-term and long-term planning and control of inventory.

#### ❖ TOOLS AND TECHNIQUES OF INVENTORY MANAGEMENT

- The following are the important tools and technique of inventory management and control.
  1. Determination of stock levels.
  2. Determination of safety stocks.
  3. Selecting a proper system of ordering for inventory.
  4. Determination of economic order quantity.
  5. A.B.C. Analysis.
  6. V.E.D. Analysis. V-vital, E-stands for essential and D-stands for desirable items.
  7. Inventory turnover ratios.
  8. Aging schedule of inventories
  9. Classification and codification of inventories
  10. Preparation of inventory reports.



## ❖ ECONOMIC ORDERING QUANTITY (EOQ)

- 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 managing inventory is made up solely of two parts i.e., ordering costs and carrying costs.

**A. Ordering costs:** These are the costs which are associated with the purchasing or ordering of materials. These costs include:

- I. Costs of staff posted for ordering of goods.
  - II. A purchase order is processed and then placed with suppliers. The labor spent on this process is included in ordering costs.
  - III. Expenses incurred on transportation of goods purchased.
  - IV. Inspection costs of incoming materials.
  - V. Cost of stationery, typing, postage, telephone charges, etc.
- These costs are also known as **buying costs** and will arise only when some purchases are made. When materials are manufactured in the concern then these costs will be known as set-up costs. These costs will include costs of setting up machinery for manufacturing materials, time taken up in setting, cost of tools, etc.
  - The ordering costs are totaled up for the year and then divided by the number of orders placed each year.



**B. Carrying costs:** These are the costs of holding the inventories. These costs will not be incurred if inventories are not carried. These costs include:

- I. The Costs of capital invested in inventories.
- II. An interest will be paid on the amount of capital locked-up in inventories.
- III. Cost of storage which could have been used for other purpose.
- IV. The loss of materials due to deterioration and obsolescence. The materials may deteriorate with passage of time. The loss of obsolescence arises when the materials in stock are not usable because of change in process or product.
- V. Insurance cost.
- VI. Cost of spoilage in handling of materials.

- The longer the materials kept in stocks, the costlier it becomes by 20 percent every year.
- **The ordering and carrying costs have a reverse relationship.**
- The ordering cost goes up with the increase in number of orders placed on with the increase in number of units, purchased and stored.
- The ordering and carrying costs of materials being high, an effort should be made to minimize these costs.
- The quantity to be ordered should be large so that economy may be made in transport costs and discounts may also be earned.
- On the other hand, storing facilities, capital to be locked up, insurance costs should also be taken into account.



## ❖ RETAILER'S MODEL FOR INVENTORY MANAGEMENT (EOQ MODEL)

- **Assumptions of EOQ:** While calculating EOQ the following assumptions are made.
  1. The annual demand of the item is constant and known.
  2. The annual demand of the item is uniformly distributed. If the annual demand 3650 per day then the rate of consumption is 10 unit.
  3. The lead time is zero.
  4. When above-mentioned conditions are satisfied, economic order quantity can be calculated with the help of the following formula:

$$EOQ = \frac{\sqrt{2Ao}}{c}$$

Where A = Annual consumption in rupees.

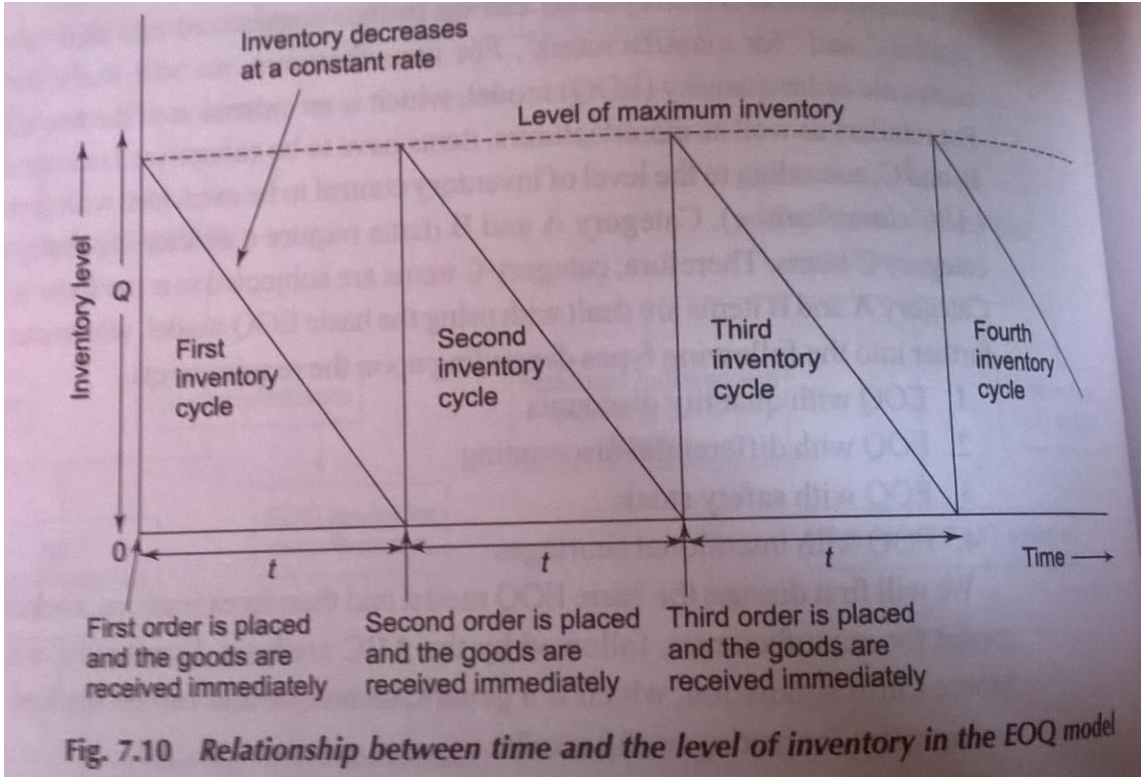
o = Cost of placing an order.

c = Inventory carrying costs of one unit.

Based on three underline assumption the EOQ model helps to identify the ordering quantity which is economically feasible for the organization.

Let **A** be the annual demand, **Q** be Economic Ordering Quantity, **o** the ordering cost in Rs. Per order and **c** is carrying cost per unit per year.

The relationship between time and inventory level can be find with the help of following graph:





The level of inventory keeps on changing continuously with the passage of time. Therefore, we have to find out average inventory during one year.

Assume that the level of inventory is constant throughout the year at 100 units and the CC is Rs.3 per unit per year.

In this situation the total annual CC is RS.3 per unit \* 100 units = Rs. 300.

**In the EOQ model if we find out average inventory during the year the annual CC can be calculated exactly shown as above:**

**The average inventory can be found out as follows:**

$$\text{Average Inventory} = \frac{\text{maximum inventory} + \text{minimum inventory}}{2}$$

In the figure minimum inventory is 0. therefore,

$$\text{Average Inventory} = \frac{\text{maximum inventory} + 0}{2}$$

Here, the maximum inventory is 'Q' items, then

$$\text{Average inventory} = Q/2$$

$$\text{Annual CC} = \text{average inventory} \times \text{CC per unit per year}$$

$$= Q/2 \times c$$

$$\text{Annual OC} = \text{no. of orders per year} \times \text{OC per order}$$

$$= \frac{A (\text{units/year})}{Q (\text{units/order})} \times o (\text{Rs/order})$$

$$\text{Total inventory cost} = \text{annual OC} + \text{annual CC}$$

$$= \frac{Ao}{Q} + \frac{Qc}{2}$$





We have to minimize the total inventory cost  $T$  by applying differential calculus. To imply that, total inventory cost is minimize when two related cost are equal. That is why,

$$= \frac{A_o}{Q} + \frac{Qc}{2}$$

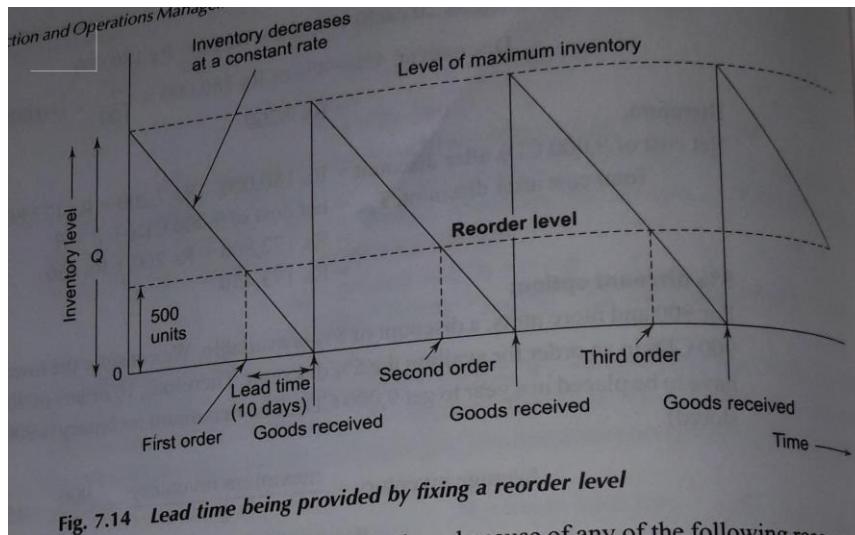
#### ❖ **EOQ and Quality Discount:**

- Customer is offered some discount for bulk purchase or if the size of a single order is large. Thus, the price per unit of an item may decrease for buying larger quantities.
- The quantity discount affect inventory cost in three ways:
  - I. As the price per unit is reduced, the total price for the lot is reduced.
  - II. The lot size is increased, the number of offers is reduced and as a result the total ordering cost is reduced.
  - III. The average inventory holding increase and as a result the storage cost will increase.
- Thus, to decide whether to avail the quantity discount or not, first of all EOQ is determined and then its total cost without quantity discount and with quantity discount is determined. In case, the total cost is less due to quantity discount the offer is accepted, otherwise it is rejected. The following example illustrates the point:

❖ **Safety stock:** The assumption in the EOQ models are far from being real. In practical situation, the demand of items may fluctuate at any point of time. In addition, supplier always need some led time to supply the goods.

For ex. If the lead time of an item is 10 days, the order can be placed 10 days before the inventory become zero. Let the uniform consumption rate of an inventory be 50 units per day.

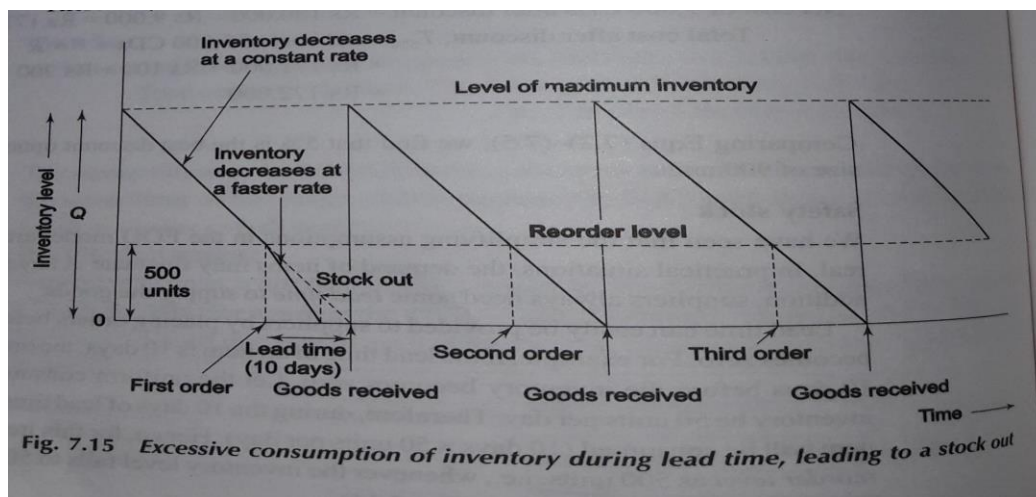
Therefore, during the 10 days of lead time 500 units of the item will be consumed. Hence, we can fix reorder level at 500 units of an item.



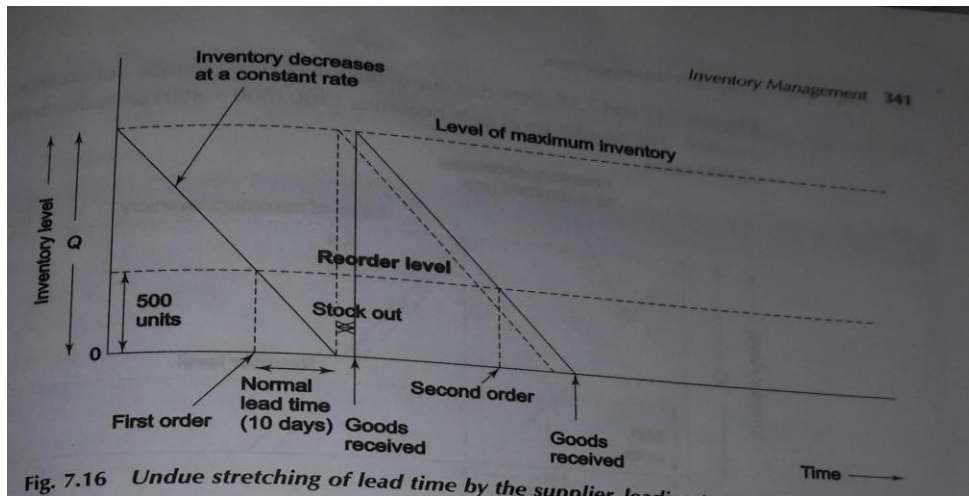
A stock out may still occur sometime because of any of the following situation:

1. Excessive consumption of inventory during lead time.
2. Undue stretching of lead time by supplier.

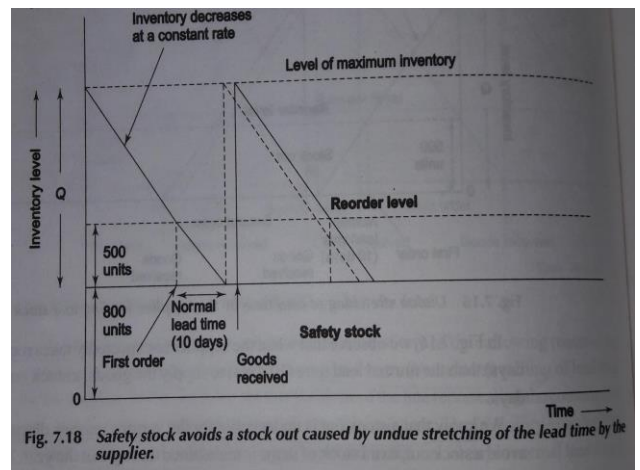
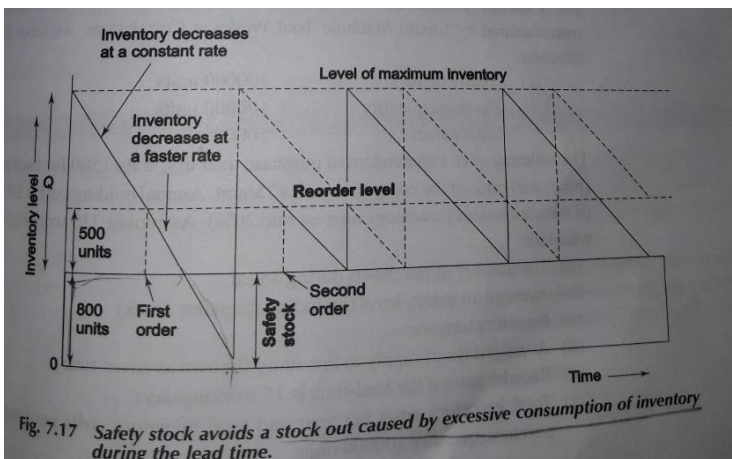
In the following figure we can see that the slop of line representing the consumption rate increases due to rise in demand during the lead time. The inventory gets utilized in 7 days while it's lead time is of 10 days. Therefore, there is stock out for 3 days.



In the following figure we observe that when the supplier unexpectedly takes more than the normal lead time to supply the goods, a stock out happens for 3 days.



To avoid stock out, extra stock of items is maintained throughout the year. That is called **safety stock**.





## ❖ INVENTORY TURNOVER RATIO

- Inventory turnover ratios are calculated to indicate whether inventories have been used efficiently or not.
- The purpose is to ensure the blocking of only required minimum funds in inventory. The inventory turnover ratio also known as stock velocity is normally calculated as sales/average inventory or cost of goods sold/average inventory cost.
- Inventory conversion period may also be calculated to find the average time taken for clearing the stocks. This measures how many times average inventory is "turned" or sold during a period.

$$\begin{aligned} \text{Inventory Turnover Ratio} &= \frac{\text{Cost of Goods Sold}}{\text{Average Inventory at Cost}} \\ &= \frac{\text{Net Sales}}{\text{Average Inventory}} \end{aligned}$$

## ❖ PRODUCTION CONTROL

- Production control is essentially the control of quantity in manufacturing.
- Production control is defined as the task of coordinating manufacturing activities in accordance with manufacturing plans so that pre conceived schedules can be attained with minimum economy and efficiency.



## ❖ Methods of Production Control

1. Routing
2. Scheduling
3. Dispatching
4. Expediting

## ❖ Benefit of Production Control

- Better Service to customer
- Less overtime works
- Need of smaller inventories of work in progress
- More effective processing
- Less loss of time



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Sr.No.	Question	Answer
1.	What do you know by facility?	A facility is an establishment of an organization through which the organization operates such
2.	What is the manufacturing facility of a company?	A factory or a plant
3.	What is warehouse?	A warehouse is the storage facility of a manufacturing or distribution company.
4.	The facility location design is very important for big business houses as well as new entrepreneurs. True/False?	True
5.	Do Wrong location of the facility may lead to a failure of the complete project?	Yes
6.	What decides the fate of the business?	Site selection is an important activity which decides the fate of the business
7.	A good location may reduce cost of production and distribution. True/False?	true
8.	What does Locating a business involves?	Locating a business involves a large, relatively permanent investment.



9.	If the site selection is not proper installation will go waste. True /False?	True
10.	While selecting a Site is It necessary to consider technical, commercial and financial aspects thenselect a site that may provide maximum advantages?	Yes
11.	What is Location?	Location refers to the geographical position of an object, person or place.
12.	What is Location Planning?	Location Planning refers to all the activities involved in determining & selecting the most suitable location and utilizing its benefits in an efficient manner.
13.	What is the first Step to Be Followed in Proper Facility Location Planning?	Generate the list of alternative location options for the facility
14.	What is the second Step to Be Followed in Proper Facility Location Planning?	Find out factors relevant to facility being planned
15.	What are the strategies for the organizations to have more than	(i)Separate Facilities for Different Products/Services (ii)Separate Facilities to Serve Different Geographical Areas





	one facility for pursuing their operations?	(iii) Separate Facilities for Different Processes
16.	Companies which are into diversified product/service ranges prefer to have separate facilities. True/False?	True
17.	Do Many organizations have their different facilities for their manufacturing process?	Yes
18.	What reduces the cost of transportation?	Proximity to Customers (Markets).
19.	Raw material gets available at cheaper rate because of negligible transportation costs. True /False?	True
20.	Who have the advantage of good transportation Facilities?	Regions near metro cities have the advantage of good transportation facilities, as they have good rail, air, water, and road transportation networks.
21.	What is a basic requirement of most industries?	Uninterrupted power supply is a basic requirement of most industries
22.	Some factories have to set up their own captive power plants if located in areas power problems.	True





	True/False?	
23.	Many state governments promote industrial activities in their regions by creating what?	Industry Development Zones
24.	No sales tax regions' and, therefore we find that most of the companies have their offices/ warehouses located there True/False?	True
25.	Many state governments have strict environmental policies in place, which have to be followed by the industries operating there True /False?	True
26.	The presence of small ancillary units manufacturing small components/sub-assemblies is important for any new factory. True /False?	True
27.	What is the basic necessity for the construction of new plant?	Land
28.	Regions such as UP, Bihar, and Orissa may be lucrative for big companies because of what?	Cheap Land
29.	When Less Construction Costs can occur?	Construction costs of a plant may be low a particular place



		due to cheap labor available there, construction material may also be cheaper.
30.	Globalization has made consumers expect the best products at the lowest prices irrespective of where they are produced. True /False?	True
31.	Why Companies are under competitive pressure to engage in global production and service operations?	Due to the rapid growth of global Markets.
32.	Recent changes in world politics and economy have made facility location decisions even more significant and challenging. True /False?	True
33.	The government in some countries imposes trade barriers on the import of the products of foreign companies. True /False?	True
34.	Why The imported products thus become expensive?	Due to import duties imposed and at times unavailable due to restrictions imposed in the form of quotas.
35.	Foreign companies can overcome trade barriers by producing the	True



	goods in that country locally. True/False?	
36.	If a company's competitors are starting or already have operations facilities in a country, it is natural for the company to start operations in that country. True/False?	True
37.	Harsh regulatory measures imposed by the government of a country can be avoided by starting operations facilities in another country True /False?	True
38.	What do International location provide to organizations?	International location provides organizations with access to a host of additional resources such as natural resources, skilled human resources, technologies etc.
39.	Why The overall cost of operations may be lower at certain foreign locations?	Due to low cost of labor, material, transportation, financing, etc.
40.	In order to promote FDI, the central and state governments in certain countries provide industrial infrastructure, insurance, tax exemptions/ reductions, interest-free/subsidized loans etc. True /False?	True



41.	What is Exploitation of Firm-Specific Advantage?	Internationally famous brands and technologies of an organization can easily get established in a new country when it starts a new base of operations
42.	Initiating operations at the competitor's home country may at times force the competitor to concentrate more on the home turf and wind up or downsize its international operations True /False?	True
43.	What is factor ratings?	These factors are rated from 1 to 5 to indicate the importance attached to them. The rating of 5 is given to the most important factor and rating of 1 is given to the least important one. These are called factor ratings.
44.	What is location rating?	according to the benefits a particular location option offers. Location ratings vary from <b>1 to 10</b> is given to the most beneficial factor at that particular location. Similarly, a rating of <b>1</b> is given to the least beneficial factor at that location
45.	Which are Variable cost?	Variable cost is cost of labor, raw material cost etc.



46.	As volume of production increases, variable costs also increase. True /False?	True
47.	What is contribution margin?	The difference between revenue per unit and variable cost per unit, $R-v$ , is known as contribution margin.
48.	When SIMPLE MEDIAN MODEL is useful?	This model is used for the final selection of the best location option.
49.	Transportation cost is a major consideration in facility location planning, SIMPLE MEDIAN MODEL helps to locate a new facility such that the total transportation cost is the minimum. True/False?	True
50.	What do the term median refers to?	The term median refers to statistical median of the load to be transported between the existing facility and the new facility.
51.	What do you know by TRANSPORTATION MODEL?	Under this model varying demands are considered and is correlated with capacity so as to reduce the transportation cost. The cost of transportation involved in transporting raw material and the finished goods.



52.	Evaluation of location is based on the cost of material to the market and samereceiving the same from the warehousing. True /False?	True
53.	Departments are located based on which circumstances?	Departments may be located based on some considerations such as less walking distance, logical sequence of the procedure, or any special requirements of the product
54.	What are the types of basic layouts?	There are four product, process, fixed-position, and cellular layout.
55.	What are the synonymous of Product Layout?	Product Layout is also referred as 'Single Line Layout', 'Line Processing Layout', 'Flow Line Layout', or 'Layout for Serialized Manufacture'.
56.	What is Product Layout?	This type of layout provides arrangement of equipment in order to representtheir sequential role in process of manufacturing.
57.	FLOW SHOP/ASSEMBLY LINE WORK FLOW is suitable when a product is having standard features is to be produced in largevolume. True /False?	True



58.	Specialized machines and equipment are arranged one after another in the order of sequence required in FLOW SHOP/ASSEMBLY LINE WORK FLOW process. True /False?	True
59.	The basic structure of products to be manufactured the raw form are placed on the conveyer at equal distance from each other. True /False?	True
60.	Do Monotonous repetitive tasks lead to frustration for workers?	Yes
61.	When U-shaped assembly line is useful?	U-shaped assembly line is useful particularly when there is a single worker in the line taking care of all the work stations
62.	The U shape of the line reduces the walking distance of the worker by almost half. True /False?	True
63.	The U-shaped line reduces material handling as the entry and exit points of the material on the line are nearby. True /False?	True
64.	What is process layout?	General purpose machines are arranged in no particular sequence, as the processing requirements and sequence are



		different for the various types of products to be manufactured.
65.	What are the synonymous of process layout?	machine shop or job shop
66.	Give example of a process layout?	Process layout can be seen at any Maruti Service Station. Here, separate departments with general-purpose machines are assigned for dent corrections, painting, wheel alignment, oil replacement, engine correction, electrical check-up, interiors, washing, cleaning, etc.
67.	Process layout is particularly suitable when different products are produced in lots or batches . True /False?	True
68.	What is Intermittent Manufacturing?	Process layout is particularly suitable when different products are produced in lots or batches. This is called <b>Intermittent Manufacturing</b> .
69.	What is FIXED POSITION LAYOUT?	In this layout, the product is very bulky, heavy, large, or has a fixed position. Thus, machines, equipment, raw materials, workers, etc. have to be taken to the site of the product.
70.	Product layout is desirable by most organizations, but the low volume	True





	and the variety of their products does not warrant it. True /False?	
71.	Product layout and process layout represent the two extremes of layout techniques. True /False?	True
72.	An intermittent manufacturing of a high variety of products with the advantages of a product layout. True /False?	True
73.	In a cellular layout of the same factory, groups of items with similar processing requirements are identified, and separate manufacturing cells are formed for each group, which contain the required machines in the desired sequence. True/False?	True
74.	What is Aggregate Production Planning?	Aggregate Production Planning is planning the number of units of the product to be produced on a weekly or monthly basis for the coming 6-18 months.
75.	What is the meaning of Aggregate?	Aggregate means complete or total
76.	Aggregate Production Planning is based up on the demand	True



	forecasts provided by the marketing department. True/False?	
77.	Why Aggregate planning is needed?	Aggregate planning is needed to <b>minimize the various types of costs</b> related tounplanned production
78.	Where do Unplanned production leads ?	Unplanned production leads to high costs such as hiring and laying-off costs ofworkers, overtime costs, inventory costs,also to shortages of the product.
79.	A shortage or stock out is most harmful to the company, as it results in loss ofgoodwill on the part of the customers. True /False?	True
80.	The basic production planning strategies are based on what?	The basic production planning strategies are based up on three variables. Work forcesize, utilization of workers and inventory size.
81.	The inventory size is varied keeping the workforce size and utilization of work forceconstant. True/False?	True



82.	During months of low demand, the excess units produced over demand are accumulated inventory. True/False?	True
83.	During the months of high demand, the units required over the units produced are taken from the inventory. True/False?	True
84.	The workforce size is varied according what?	According to demand, keeping the utilization of workers and inventory size constant
85.	In Chase Plan During months of low demand, the workforce size is decreased and the extra workers are laid-off. True /False?	True
86.	In Chase Plan The hiring and laying-off cost are substantial in this plan. True /False?	True
87.	If the inventory is almost negligible do inventory cost is also negligible?	Yes
88.	What is Varying Utilization Plan?	The utilization of workers is varied keeping the workforce size and inventory size constant.
89.	Overtime is usually expensive compared to the regular wages given to the workers and also leads to less efficiency on the part of workers and	True



	more accidents due to lack of concentration. True /False?	
90.	What is The aggregate plan?	The aggregate plan gives information about production requirements in general terms, as it includes different models of the product in the number of units to be produced.
91.	Different models of the product may, in general, require common parts and components, but some parts may be specific to the models. True /False?	True
92.	The aggregate plan is an intermediate planning stage and in the next stage the aggregate plan is to be disaggregated (broken down into parts) to include information about the different models of the product to be produced. True /False?	True
93.	What is the result of the disaggregation of an aggregate plan?	Master Schedule
94.	What do The master schedule shows?	The master schedule shows the quantity and timing of specific end items for a time horizon often spanning six to eight weeks.
95.	The time periods in a master schedule called time buckets may	True



	not be equal throughout the time horizon considered. True /False?	
96.	The master schedule is more and more tentative for the distant future than in the near future. True /False?	True
97.	There is no upper limit on the duration of the time horizon for a master schedule, but there is a lower limit. True /False?	True
98.	The duration of the time horizon what has to cover?	The duration of the time horizon has to cover at least the cumulative lead time of production of end items.
99.	If the production of an end item requires three days of procurement of raw materials, four days for manufacturing components, two days for putting together sub-assemblies, and one day for the final assembly, the cumulative lead time will be 10 days. True /False?	True
100.	The master schedule must cover a time horizon of how many days?	10 days.
101.	The aggregate plan is disaggregated in phases or parts into the master schedule.	True



	True/False?	
102.	The initial master schedule is what kind of nature?	Tentative in nature
103.	Reality capacity of the production system may not be able to support its practical implementation. True/False?	True
104.	What is MRP?	Material Requirement Planning
105.	What do The master schedule provides?	Details about the quantities and delivery timings of a product, but not the production plan.
106.	It is necessary for sales personnel to know how many units of the product atmaximum they can commit to customers in a given time period. True /False?	True
107.	The MPS cannot be changed near the actual production time. True /False?	True
108.	If changes are made in which stage, the whole exercise of a production planning willbecome useless?	TIME FENCES
109.	Production managers set various time fences to regulate changes in the MPS. True /False?	True
110.	Between two and three months, product models may be substituted,	True



	provided therequired components are available. True /False?	
111.	How sub-assemblies are made by?	By joining various components together.
112.	material requirement planning (MRP) is used for what?	Material requirement planning (MRP) is used for planning of futurerequirement of dependent demand
113.	What is MRP?	MRP constitute a set of techniques that use bill of material, inventory data, and master production schedule to calculate the requirement of material.”
114.	What is inventory status or inventory data?	Number of items already in inventory is called inventory status or inventory data.
115.	What is Master production schedule?	Number of finished goods to be produced in near future using these items is calledMaster production schedule.
116.	What is Bill of material?	Number of units of items required for manufacturing a single unit of finished goods is called bill of material.
117.	Which document tells us about an item’s product structure, showing thesequence in which components/subassemblies are	Bills of material



	assembled and their required numbers.	
118.	Bills of material contains detail about the workstations at which the item is assembled. True /False?	True
119.	Aggregate production plan tells us about number of units that is to be produced in coming 6-18 weeks. True /False?	True
120.	MPS is extension of APP. It tells number of units of different models to be manufactured on weekly or monthly basis. True /False?	True
121.	What is Inventory Status?	It gives status of the inventory of an item at present, or in a given interval of time in the coming future
122.	What is Planned Orders Report?	It gives information planned orders to be released on some future date during a given interval of time.
123.	Planned Orders report is also helpful in preparing for fund required for payment to supplier in future according to dates and order size. True /False?	True
124.	What is Order Release Report?	It gives information about order to be released on present date.





125.	Order Release Report helps purchase manager to release purchase order to the supplier and also keep track of the purchase order that have to be sent on a particular day. True /False?	True
126.	What do you know by Open order?	Open order are those orders which have been placed in past and the suppliersof the item is preparing for these supplies to be made to the company.
127.	During the lead time the MPS of the company may fluctuate. True/False?	True
128.	According to that suppliers are told to either cancel the orders placed earlier by the company or postponed for some time. True /False?	True
129.	The order changes report gives to whom for all such changes with information about all such changes to be made in the open order with the supplies?	The purchase manager
130.	What provides a cushion for future price fluctuations?	Inventory
131.	What is The purpose of inventory management?	To ensure availability of materials in sufficient quantity as and when



		required and also to minimize investment in inventories.
132.	What is The dictionary meaning of inventory?	“stock of goods, or a list of goods”
133.	What is The meaning of inventory in accounting language?	Stock of finished goods only.
134.	The quantity of raw materials required will be determined by what?	The rate of consumption and the time required for replenishing the supplies
135.	The factors like the availability of raw materials and government regulations also affect the stock of raw materials. True /False?	True
136.	What is work-in-progress?	The work-in-progress is that stage of stocks which are in between raw materials and finished goods
137.	The greater the time taken in manufacturing; the more will be the amount of work in progress. True /False?	True
138.	What are Consumables?	These materials do not directly enter production but they act as catalyst.
139.	There can be instances where these materials may account for much value than the raw materials. True /False?	True



140.	What form a substantial part of cost?	The fuel oil
141.	What do you know by Finished Goods?	These are the goods which are ready for the consumers
142.	The stock of finished goods provides a buffer between what?	Production and market
143.	What is The purpose of maintaining inventory?	To ensure proper supply of goods to consumers
144.	In some concerns the production is undertaken on order basis, in these concerns there will not be a need for finished goods. True/False?	True
145.	What provides a cushion for future price fluctuations?	Inventory
146.	By what The quantity of raw materials required can be determined?	By the rate of consumption and the time required for replenishing the supplies
147.	What are the factors affect the stock of raw materials.	The factors like the availability of raw materials and government regulations.
148.	What do you know by Finished Goods?	These are the goods which are ready for the consumers.
149.	What is The purpose of maintaining inventory?	To ensure proper supply of goods to consumers.
150.	In some concerns the production is undertaken on order basis, in these	True



	concerns there will not be a need for finished goods. True/False?	
151.	When The need for finished goods inventory will be more?	When production is undertaken in general without waiting for specific orders.
152.	The need for finished goods inventory will be more when production is undertaken in general without waiting for specific orders. True /False?	True
153.	Do Spares also form a part of inventory?	Yes
154.	What industries require more spares than the other concerns?	Some industries like transport will require more spares than the other concerns.
155.	All decision about spares are based on what?	The financial cost of inventory on such spares and the costs that may arise due to their non-availability.
156.	Holding inventories involves what?	blocking of a firm's funds and the cost of storage and handling
157.	Every business enterprise has to maintain a certain level of inventories to facilitate uninterrupted production and smooth running of business. True/False?	True



158.	What is The Transaction Motive?	Facilitates continuous production and timely execution of sales orders
159.	What do you know by The Precaution Motive?	Which necessitates the holding of inventories for meeting the unpredictable changes in demand and supplies of materials.
160.	What is The Speculative Motive?	Which induces to keep inventories for taking advantage of price fluctuations, saving in re-ordering cost and quantity discount, etc.
161.	Do costs and risks involved in holding inventories?	Yes
162.	Maintaining of inventories results in blocking of the firm's financial resources. True /False?	True
163.	From where The funds may be arranged?	From own resources or from outsides
164.	What do The storage costs include?	The rental of the godown, insurance charges, etc.
165.	Why Risk of Price Decline occur?	This may be due to increased market supplies, competition or general depression in the market.
166.	Why The inventories can become obsolete?	The inventories may become obsolete due to improved technology, changes in



		requirements, change in customer's tastes, etc.
167.	The quality of the materials may also deteriorate while the inventories are kept in store. True /False?	True
168.	Is It necessary for every management to give proper attention to inventory management?	Yes
169.	What forms a part of inventory management?	A proper planning of purchasing, handling, storing and accounting should form a part of inventory management.
	An efficient system of inventory management will determine what?	(a) what to purchase; (b) how much to purchase; (c) from where to purchase; (d) where to store, etc.
170.	There are conflicting interests of different departmental heads over the issue of inventory. True /False?	True
171.	What is the purpose of inventory management?	To keep the stocks in such a way that neither there is over-stocking nor under-stocking.
172.	The investments in inventory should be kept in reasonable limits. True /False?	True



173.	What are the main objectives of inventory management?	Operational and financial.
174.	What do you mean by The operational objective?	The operational objective mean that the materials and spares should be available in sufficient quantity so that work is not disrupted for want of inventory.
175.	What is the meaning of The financial objective?	The financial objective means that investments in inventories should not remain idle and minimum working capital should be locked in it.
176.	To ensure continuous supply of materials, spares and finished goods so that production should not suffer at any time and the customers demand should also be met. True /False?	True
177.	To maintain investments in inventories at the optimum level as required by the operational and sales activities. True/False?	True
178.	Is this necessary To keep material cost under control so that they	Yes



	contribute in reducing cost of production and overall costs?	
179.	How To eliminate duplication in ordering or replenishing stocks?	This is possible with the help of centralizing purchases
180.	How To minimize losses?	Through deterioration, pilferage, wastages and damages.
181.	Why To ensure perpetual inventory control?	To ensure perpetual inventory control so that materials shown in stock ledgers should be actually laying in the stores.
182.	What is Economic order quantity?	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.
183.	Economic order quantity is the point at which inventory carrying costs are equal to order costs. True /False?	True
184.	In determining economic order quantity, it is assumed that cost of managing inventory is made up solely of two parts. True /False?	True
185.	it is assumed that cost of managing inventory is made up solely of two parts. What are the names?	ordering costs and carrying costs





186.	What are Ordering costs?	These are the costs which are associated with the purchasing or ordering of materials
187.	Costs of staff posted for what?	Ordering of goods
188.	A purchase order is processed and then placed to whom?	The suppliers.
189.	Expenses incurred on transportation of goods purchased. True /False?	True
190.	What do you know by set-up costs?	When materials are manufactured in the concern then these costs will be known as set-up costs.
191.	What do Set-up costs include?	Costs of setting up machinery for manufacturing materials, time taken up in setting, cost of tools, etc.
192.	The ordering costs are totaled up for the year and then divided by the number of orders placed each year. True /False?	True
193.	Which costs are holding the inventories?	Carrying costs
194.	Carrying costs will not be incurred if inventories are not carried. True/False?	True
195.	When The loss of obsolescence arises ?	When the materials in stock are not usable because of change in process or product.



196.	The longer the materials kept in stocks, the costlier it becomes by 20 percent every year. True/False?	True
197.	The ordering and carrying costs have a reverse relationship. True/False?	True
198.	How The ordering cost goesup?	With the increase in number of orders placed on with the increase in number of units, purchased and stored.
199.	The ordering and carrying costs of materials being high, an effort should be made to minimize these costs. True/False?	True
200.	The quantity to be ordered should be large so that economy may be made in transport costs and discounts may also be earned. True/False?	True
201.	The annual demand of the item is constant and known, How the following assumptions can be made?	While calculating EOQ
202.	If the annual demand 3650 per day then the rate of consumption?	10 unit.



203.	In what EOQ model helps?	To identify the ordering quantity which is economically feasible for the organization.
204.	The level of inventory keeps on changing continuously with the passage of time. True /False?	True
205.	When a Customer is offered some discount?	Customer is offered some discount for bulk purchase or if the size of a single order is large
206.	Do the price per unit of an item may decrease for buying larger quantities?	Yes
207.	The quantity discount affect inventory cost in how many ways?	Three ways
208.	As the price per unit is reduced, the total price for the lot is reduced. True/False?	True
209.	The lot size is increased, the number of orders is reduced and as a result the total ordering cost is reduced. True/False?	True
210.	The average inventory holding increase and as a result the storage cost will increase. True/False?	True
211.	The assumption in the EOQ models are far from being real. In practical situation, the demand of items may fluctuate at any point of time. True/False?	True



212.	Do supplier always need some lead time to supply the goods?	Yes
213.	How A stock out may still occur sometime?	1. Excessive consumption of inventory during lead time. 2. Undue stretching of lead time by supplier.
214.	How Inventory turnover ratios are calculated?	To indicate whether inventories have been used efficiently or not
215.	How Stock Velocity normally calculated?	Sales/Average inventory or cost of goods sold/average inventory cost.
216.	The inventory turnover ratio also known as stock velocity. True/False?	True
217.	Why Inventory conversion period also be calculated?	To find the average time taken for clearing the stocks
218.	What is Production control?	Production control is defined as the task of coordinating manufacturing activities in accordance with manufacturing plans so that pre conceived schedules can be attained with minimum economy and efficiency
219.	Production control is essentially what?	The control of quantity in manufacturing.
220.	What are the Methods of Production Control?	1. Routing 2. Scheduling 3. Dispatching 4. Expediting



221.	Do Production Control can give Better Service to customer and Less overtime works?	Yes
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## ❖ Forecasting for Inventories and Production Control

### ❖ IMPORTANCE

- Initial analysis
- Forecasting method
- Extending the management information used
- Forecasting software
- Motivation, training and expertise

### ❖ LIMITATIONS

- Poor quality data
- Overtly long lead time
- Techniques used
- Choosing a suitable technique
- Link with marketing
- Limited information in the information system