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# PRODUCT DESIGN PLANNING PLANT LOCATION



# CAPACITY PLANNING

Capacity is defined as the ability to achieve, store or produce. For an organization, capacity would be the ability of a given system to produce output within the specific time period. In operations, management capacity is referred as an amount of the input resources available to produce relative output over period of time. Product design, capacity and process selection have a direct relationship. Product design determines the value provided to the customer; the value determines the market size; the market size determines the volumes and therefore the capacity; and capacity leads to the process. Capacity planning should be solely based on the principle of maximizing the value delivered to the customer. This reflects in minimizing costs of producing products and services, providing them in a timely manner, and ensuring that the products provide the highest level of quality. Capacity planning has become a strategic tool in the operations function. It guides our choices on capacity, locations, and layout for the long-term. It also helps in managing supply and demand, and these choices in turn, affect the ways a firm uses its resources and facilities in the short-term.



Normal Capacity describes the maximum producible output when plants and equipment are operated for an average period of time to produce a normal mix of output. Due to defining capacity in this manner, it is not unusual for a facility to operate at more than 100 percent capacity. Capacity is mathematically expressed as:

Capacity = (Maximum production rate/Hour) x (Number of hours worked/Period);

where Production Rate = Number of units produced/Amount of time

The firm's capacity to produce, whether measured as output or input, depends on the number or type of equipment it has – the intensity with which this equipment is used – the production

efficiency, the nature, and extent of the supply chain; the product mix to be produced, the demand.



## **Capacity Planning Classification**

Capacity planning based on the timeline is classified into three main categories longrange, medium range and short-range.

- Long-Term Capacity: Long range capacity of an organization is dependent on various other capacities like design capacity, production capacity, sustainable capacity, and effective capacity. The design capacity is the maximum output possible as indicated by the equipment manufacturer under ideal working conditions.
- Production capacity is the maximum output possible from equipment under normal working conditions or day.
- Sustainable capacity is the maximum production level achievable in realistic work conditions and considering normal machine breakdown, maintenance, etc.
- Effective capacity is the optimum production level under pre-defined job and work schedules, normal machine breakdown, maintenance, etc.
- Medium-Term Capacity: The strategic capacity planning undertaken by an organization for 2 to 3 years of a time frame is referred to as medium-term capacity planning.
- Short-Term Capacity: The strategic planning undertaken by an organization for a daily weekly or quarterly time frame is referred to as short term capacity planning.



### **Capacity Planning Resource Utilization Components With Arrows**



**Resource Utilization** 

# **CAPACITY PLANNING RESOURCE PLANNING**



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Assessing the capacity of a specific resource to complete tasks within one project

Planning the capacity of a workplace or department to deliver on several projects



# **Capacity Strategy Planning**

	Jan	Feb	Mar	Apr	May	Jun
Demand	4500	5500	7000	10000	8000	6000
Beginning Inventory	250	2130	2140	1230	-2680	-4300
Net Requirements	4250	3370	4860	8770	10680	10300
Beginning # of Workers	6	6	6	6	6	6
<b>Required Workers</b>	4	4	5	9	10	11
Workforce Adjustment	0	0	0	0	0	0
<b>Production Quantity</b>	6380	5510	6090	6090	6380	5800
Ending Inventory	2130	2140	1230	-2680	-4300	-4500

**Plant location or the facilities location problem** is an important strategic level decision making for an organisation. One of the key features of a conversion process (manufacturing system) is the efficiency with which the products (services) are transferred to the customers. This fact will include the determination of where to place the plant or facility.

# The need for selecting a suitable location arises because of three situations

- When starting a new organisation, i.e., location choice for the first time.
- In case of existing organisation.
- In case of Global Location.

# I. In Case of Location Choice for the First Time or New Organisations

Cost economies are always important while selecting a location for the first time, but should keep in mind the cost of long-term business/organisational objectives. The following are the factors to be considered while selecting the location for the new organisations:

1. Identification of region: The organisational objectives along with the various long-term considerations about marketing, technology, internal organisational strengths and weaknesses, region specific resources and business environment, legal-governmental environment, social environment and geographical environment suggest a suitable region for locating the operations facility.

2. Choice of a site within a region: Once the suitable region is identified, the next step is choosing the best site from an available set. Choice of a site is less dependent on the organisation's long-term strategies. Evaluation of alternative sites for their tangible and intangible costs will resolve facilities-location problem. The problem of location of a site within the region can be approached with the following cost-oriented non-interactive model, i.e., dimensional analysis.

3. Dimensional analysis: If all the costs were tangible and quantifiable, the comparison and selection of a site is easy. The location with the least cost is selected. In most of the cases intangible costs which are expressed in relative terms than in absolute terms. Their relative merits and demerits of sites can also be compared easily. Since both tangible and intangible costs need to be considered for a selection of a site, dimensional analysis is used.



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II. In Case of Location Choice for Existing Organisation In this case a manufacturing plant has to fit into a multiplant operations strategy. That is, additional plant location in the same premesis and elsewere under following circumstances:

- **1. Plant manufacturing distinct products.**
- 2. Manufacturing plant supplying to specific market area. 3.Plant divided on the basis of the process or stages in manufacturing.
- 4. Plants emphasizing flexibility



In Case of Global Location Because of globalisation, multinational corporations are setting up their organizations in India and Indian companies are extending their operations in other countries. In case of global locations there is scope for virtual proximity and virtual factory.

VIRTUAL PROXIMITY With the advance in telecommunications technology, a firm can be in virtual proximity to its customers. For a software services firm much of its logistics is through the information/ communication pathway. Many firms use the communications highway for conducting a large portion of their business transactions. Logistics is certainly an important factor in deciding on a location—whether in the home country or abroad. Markets have to be reached. Customers have to be contacted. Hence, a market presence in the country of the customers is quite necessary.

VIRTUAL FACTORY Many firms based in USA and UK in the service sector and in the manufacturing sector often out sources part of their business processes to foreign locations such as India. Thus, instead of one's own operations, a firm could use its business associates' operations facilities. The Indian BPO firm is a foreign-based company's 'virtual service factory'. So a location could be one's own or one's business associates. The location decision need not always necessarily pertain to own operations.

## FACTORS INFLUENCING PLANT LOCATION/FACILITY LOCATION

Facility location is the process of determining a geographic site for a firm's operations. Managers of both service and manufacturing organizations must weigh many factors when assessing the desirability of a particular site, including proximity to customers and suppliers, labour costs, and transportation costs. Location conditions are complex and each comprises a different Characteristic of a tangible (i.e. Freight rates, production costs) and non-tangible (i.e. reliability, Frequency security, quality) nature. Location conditions are hard to measure. Tangible cost based factors such as wages and products costs can be quantified precisely into what makes locations better to compare. On the other hand non-tangible features, which refer to such characteristics as reliability, availability and security, can only be measured along an ordinal or even nominal scale. Other non-tangible features like the percentage of employees that are unionized can be measured as well. To sum this up non-tangible features are very important for business location decisions



It is appropriate to divide the factors, which influence the plant location or facility location on the basis of the nature of the organization as

1. General locational factors, which include controllable and uncontrollable factors for all types of organizations.

2. Specific locational factors are specifically required manufacturing and service organizations. Location factors can be further divided into two categories: Dominant factors are those derived from competitive priorities (cost, quality, time, and flexibility) and have a particularly strong impact on sales or costs. Secondary factors also are important, but management may downplay or even ignore some of them if other factors are more important.

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**General locational factors** 

### **CONTROLLABLE FACTORS**

- **1. Proximity to markets**
- 2. Supply of materials
- 3. Transportation facilities
- 4. Infrastructure availability
- 5. Labour and wages
- 6. External economies
- 7. Capital

### **UNCONTROLLABLE FACTORS**

- 8. Government policy
- 9. Climate conditions
- **10. Supporting industries and services**
- **11. Community and labour attitudes**
- **12. Community Infrastructure**





### **ALFRED WEBER'S THEORY OF THE LOCATION OF INDUSTRIES**

Alfred Weber (1868–1958), with the publication of Theory of the Location of Industries in 1909, put forth the first developed general theory of industrial location. His model took into account several spatial factors for finding the optimal location and minimal cost for manufacturing plants. The point for locating an industry that minimizes costs of transportation and labour requires analysis of three factors:

1. The point of optimal transportation based on the costs of distance to the 'material index'—the ratio of weight to intermediate products (raw materials) to finished products.

2. The labour distortion, in which more favourable sources of lower cost of labour may justify greater transport distances.

3. Agglomeration and degglomerating.



Agglomeration or concentration of firms in a locale occurs when there is sufficient demand for support services for the company and labor force, including new investments in schools and hospitals. Also supporting companies, such as facilities that build and service machines and financial services, prefer closer contact with their customers.

Degglommeration occurs when companies and services leave because of over-concentration of industries or of the wrong types of industries, or shortages of labor, capital, affordable land, etc. Weber also examined factors leading to the diversification of an industry in the horizontal relations between processes within the plant.



### Specific Locational Factors **Manufacturing Organisation**

1. Favorable labour climate: A favorable labour climate may be the most important factor in location decisions for labour-intensive firms in industries such as textiles, furniture, and consumer electronics. Labour climate includes wage rates, training requirements, attitudes toward work, worker productivity, and union strength. Many executives consider weak unions or al low probability of union organizing efforts as a distinct advantage.

2. Proximity to markets: After determining where the demand for goods and services is greatest, management must select a location for the facility that will supply that demand. Locating near markets is particularly important when the final goods are bulky or heavy and outbound transportation rates are high. For example, manufacturers of products such as plastic pipe and heavy metals all emphasize proximity to their markets.

3. Quality of life: Good schools, recreational facilities, cultural events, and an attractive lifestyle contribute to quality of life. This factor is relatively unimportant on its own, but it can make the difference in location decisions.

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4. Proximity to suppliers and resources: In many companies, plants supply parts to other facilities or rely on other facilities for management and staff support. These require frequent coordination and communication, which can become more difficult as distance increases.

5. Utilities, taxes, and real estate costs: Other important factors that may emerge include utility costs (telephone, energy, and water), local and state taxes, financing incentives offered by local or state governments, relocation costs, and land costs.

### **SECONDARY FACTORS**

There are some other factors needed to be considered, including room for expansion, construction costs, accessibility to multiple modes of transportation, the cost of shuffling people and materials between plants, competition from other firms for the workforce, community attitudes, and many others. For global operations, firms are emphasizing local employee skills and education and the local infrastructure.



# Specific Locational Factors for Service Organisation

### **PROXIMITY TO CUSTOMERS**

Location is a key factor in determining how conveniently customers can carry on business with a firm. For example, few people would like to go to remotely located dry cleaner or supermarket if another is more convenient. Thus the influence of location on revenues tends to be the dominant factor.

### **TRANSPORTATION COSTS AND PROXIMITY TO MARKETS**

For warehousing and distribution operations, transportation costs and proximity to markets are extremely important. With a warehouse nearby, many firms can hold inventory closer to the customer, thus reducing delivery time and promoting sales.

### **LOCATION OF COMPETITORS**

One complication in estimating the sales potential at different location is the impact of competitors. Management must not only consider the current location of competitors but also try to anticipate their reaction to the firm's new location. Avoiding areas where competitors are already well established often pays. However, in some industries, such as new-car sales showrooms and fastfood chains, locating near competitors is actually advantageous. The strategy is to create a critical mass, whereby several competing firms clustered in one location attract more customers than the total number who would shop at the same stores at scattered locations. Recognizing this effect, some firms use a follow –the leader strategy when selecting new sites.

### **SECONDARY FACTORS**

Retailers also must consider the level of retail activity, residential density, traffic flow, and sit visibility. Retail activity in the area is important, as shoppers often decide on impulse to go shopping or to eat in a restaurant. Traffic flows and visibility are important because businesses' customers arrive in cars. Visibility involves distance from the street and size of nearby buildings and signs. High residential density ensures nighttime and weekend business when the population in the area fits the firm's competitive priorities and target market segment.

Various models are available which help to identify the ideal location. Some of the popular models are:

**1. Factor rating method** 2. Weighted factor rating method **3. Load-distance method** 4. Centre of gravity method **5. Break-even analysis** 



### **Factor Rating Method**

The process of selecting a new facility location involves a series of following steps: **1. Identify the important location factors.** 

2. Rate each factor according to its relative importance, i.e., higher the ratings is indicative

of prominent factor.

3. Assign each location according to the merits of the location for each factor.

4. Calculate the rating for each location by multiplying factor assigned to each location with

basic factors considered.

5. Find the sum of product calculated for each factor and select best location having highest

total score.

### **Weighted Factor Rating Method**

In this method to merge quantitative and qualitative factors, factors are assigned weights based on relative importance and weightage score for each site using a preference matrix is calculated. The site with the highest weighted score is selected as the best choice



		Fastan	Location rating		
Sl.No	Location Factor	Factor Rating	Location 1	Locatio	
1	<b>X1</b>	3	3	2	
2	<b>X2</b>	4	5	4	
3	Х3	6	3	1	
4	<b>X4</b>	4	1	1	



## PLANT LAYOUT

Plant layout refers to the physical arrangement of production facilities. It is the configuration of departments, work centers, and equipment in the conversion process. It is a floor plan of the physical facilities used in production.

According to Moore "Plant layout is a plan of an optimum arrangement of facilities including personnel, operating equipment, storage space, material handling equipment and all other supporting services along with the design of best structure to contain all these facilities".



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### **Objectives of Plant Layout**

The primary goal of the plant layout is to maximise the profit by arrangement of all the plant facilities to the best advantage of total manufacturing of the product. The objectives of plant layout are:

- Streamline the flow of materials through the plant.
- Facilitate the manufacturing process.
- Maintain high turnover of in-process inventory.
- Minimise materials handling and cost.
- Effective utilisation of men, equipment and space.
- Make effective utilisation of cubic space.
- Flexibility of manufacturing operations and arrangements.
- Provide for employee convenience, safety and comfort.
- Minimize investment in equipment.
- Minimize overall production time.
- Maintain flexibility of arrangement and operation.
- Facilitate the organizational structure.



## **Principles of Plant Layout**

1. Principle of integration: A good layout is one that integrates men, materials, machines and supporting services and others in order to get the optimum utilisation of resources and maximum effectiveness.

2. Principle of minimum distance: This principle is concerned with the minimum travel (or movement) of man and materials. The facilities should be arranged such that, the total distance travelled by the men and materials should be minimum and as far as possible straight line movement should be preferred.

3. Principle of cubic space utilisation: The good layout is one that utilise both horizontal and vertical space. It is not only enough if only the floor space is utilised optimally but the third dimension, i.e., the height is also to be utilised effectively.

4. Principle of flow: A good layout is one that makes the materials to move in forward direction towards the completion stage, i.e., there should not be any backtracking.
5. Principle of maximum flexibility: The good layout is one that can be altered without much cost and time, i.e., future requirements should be taken into account while designing the present layout.

6. Principle of safety, security and satisfaction: A good layout is one that gives due consideration to workers safety and satisfaction and safeguards the plant and machinery against fire, theft, etc.

7. Principle of minimum handling: A good layout is one that reduces the material handling

• to the minimum.

