


Facilities Planning

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Product Design

- ❑ The process of defining features and characteristics of the product. It refers to the arrangement of elements or parts that collectively form a product.
- ❑ Product design defines a product's characteristics such as:
 - Appearance
 - Material it is made of
 - Its dimensions and tolerances
 - Its performance standards.
- ❑ An organization can get competitive edge through designs that bring new ideas to the market quickly, do a better job of satisfying customer needs or are easier to manufacture use and repair the existing products.

Product Design

- ❑ A company's product designs must also support the company's business strategy.
 - ❑ Product design is a major factor in a company's ability to keep and build its customer base. In any business venture, product design is the first step immediately after accepting the concept of a product.
 - ❑ A company's product design must match the needs and preferences of the customer group targeted by the company's business strategy. Otherwise the company will lose its customer base and erode its market position.
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Product Selection

Product selection is a decision process, in which the design team selects one or few product concept for further development.

Service Design

Service design is the activity of planning and organizing a business's resources (people, props, and processes) in order to directly improve the employee's experience, and indirectly, the customer's experience.

Imagine a restaurant where there are a range employees: hosts, servers, busboys, and chefs. Service design focuses on how the restaurant operates and delivers the food it promises—from sourcing and receiving ingredients, to on-boarding new chefs, to server-chef communication regarding a diner's allergies. Each moving part plays a role in the food that arrives on the diner's plate, even though it is not directly part of their experience.

“When you have two coffee shops right next to each other, and each sells the exact same coffee at the exact same price, service design is what makes you walk into one and not the other.”


Service design is a process where designers create sustainable solutions and optimal experiences for both customers in unique contexts and any service providers involved. Designers break services into sections and adapt fine-tuned solutions to suit all users' needs

Service Design

[What is service design? \(mycustomer.com\)](#)

<https://youtu.be/BeEUemtdoJQ>


Approach for Successful Technology Selection

- Validate the need
 - Compile requirements
 - Determine focal needs
 - Create a technology shortlist
 - Create a service provider shortlist
 - Conduct information exchanges
 - Conduct request for proposal process
 - Hold a proof of concept
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Facility Location

Facility location may be defined as a place where the facility will be set up for producing goods or services.

The need for location selection may arise under any of the following conditions:


- When a business is newly started.
 - When the existing business unit has outgrown its original facilities and expansion is not possible; hence a new location has to be found.
 - When the volume of business or the extent of market necessitates the establishment of branches.
 - When the lease expires and the landlord does not renew the lease.
 - Other social or economic reasons.
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Need for Facility Location Planning

- ❑ Facility location planning is also required for providing a cost benefit to the organization.
 - ❑ The location planning should help in reducing the transportation cost for the organization. This ultimately helps in decreasing the cost of production and generating cost advantage for the organization.
 - ❑ It is also needed to identify proximity to the sources of raw materials and transportation facilities.
 - ❑ A facility should ideally be located at a place where raw materials are available. This is necessary for maintaining continuity in the production process.
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Factors Affecting Facility Location Decisions

While selecting a facility location, an organization should consider various factors that may have significant impact on its performance. These factors are explained below:


- Availability of power
 - Transportation
 - Suitability of climate
 - Government policy
 - Competition between states
 - Availability of labor
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Procedures and Techniques for Selecting Facility Location


An organization follows certain steps to make a correct location choice. These steps are:

- Decide on the criteria for evaluating location alternatives
 - Identify important factors
 - Develop location alternatives
 - Evaluate the alternatives
 - Make a decision and select the location
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Centre of Gravity Method

- ❑ It is also called Grid or Centroid Method.
 - ❑ It takes into account the existing locations of plants and markets, the volume of goods moved and transportation distance or cost.
 - ❑ Centre of Gravity is defined to be the location that minimizes the weighted distance between the warehouse and its supply and distribution points.
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Centre of Gravity Method

- ❑ It finds location of single distribution centre serving several destinations.
 - ❑ This method assumes that the distribution cost is a function of the volumes shipped and the rectilinear distances.
 - ❑ The distance in each of the X and Y coordinates are averaged, using the volume as weights.
 - ❑ The resultant coordinates then constitutes the centre of gravity for that grid.
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Steps

- ❑ Place the location on a coordinate system
- ❑ Find the relative grid position of all the existing locations.
- ❑ Find the load at each location.
- ❑ The centre of Gravity is determined by the formula.

Plant Location Methodology: Center of Gravity Method Formulae

$$C_x = \frac{\sum d_{ix} V_i}{\sum V_i} \quad C_y = \frac{\sum d_{iy} V_i}{\sum V_i}$$

C_x = X coordinate of center of gravity

C_y = Y coordinate of center of gravity

d_{ix} = X coordinate of the ith location

d_{iy} = Y coordinate of the ith location

V_i = Volume of goods moved to or from ith location

Numerical

$$A - (10, 2) - 6$$

$$B - (10, 10) - 10$$

$$C - (8, 6) - 8$$

$$D - (12, 5) - 4$$

Location	X	V	XV
A	10	6	60
B	10	10	100
C	8	8	64
D	12	4	48
		28	272

Location	Y	V	YV
A	2	6	12
B	10	10	100
C	6	8	48
D	5	4	20
		28	180

Problem 1

The table below shows eight market locations to which a manufacturer of wooden windows expects to ship its products. The shipment volumes, X and Y coordinates of the locations are given. Using the centre of gravity method, find the X_C and Y_C and suggest a possible warehouse location.

Market Area	Volume (V)	X (km)	Y (km)
A	8	2.5	10
B	20	3	5
C	12	6.5	8
D	10	11	10
E	30	11	8
F	20	10	4
G	40	13	3.5
H	30	12	2

Problem 2

The new health care facility is targeted to serve seven census tracks in a city. The table below shows the coordinates for the centre of each along with projected population, measured in thousands. If we use population as the loads and use rectilinear distance, where do you think we should locate our new facility.

S. No	Region	Population (V)	X (km)	Y (km)
1	A	2	2.5	4.5
2	B	5	2.5	2.5
3	C	10	5.5	4.5
4	D	7	5	2
5	E	10	8	5
6	F	20	7	2
7	G	14	9	2.5


Simple Median Method

It is used for single facility location problems with rectilinear distance.

Rectilinear Distance: Only horizontal or vertical movement

$$d_{AB} = (x_A - x_B) + (y_A - y_B)$$

Steps in Simple Median Method

- ❑ Find the relative grid position of all the existing and perspective locations, in terms of x and y coordinates.
 - ❑ Find the load at each location. This can be the number of people served or the amount of goods to be transported.
 - ❑ Arrange the x and y coordinates in the ascending order with their respective loads in 2 different tables.
 - ❑ Find the cumulative value of the load and identify the median value for both x and y coordinates.
 - ❑ The value of median obtained is taken as the optimum or most suitable location.
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Numerical

A – (10, 10) 100

B – (2,5) 150

C – (5, 4) 250

D – (15,12) 200

Location	X	Load	Cumulative Load
B	2	150	150
C	5	250	400
A	10	100	500
D	15	200	700


Location	Y	Load	Cumulative Load
C	4	250	250
B	5	150	400
A	10	100	500
D	12	200	700

Problem 1

There are 5 existing plants which have material movement relationship with a new plant. The locations of existing plants and the number of tonnes of material transported per year for the new plant are mentioned in table below. Determine the optimum location for the new plant such that the distance moved is minimum along with total cost as cost for moving is 2\$ per location.

Existing Plants	Weight (V)	X (km)	Y (km)
1	450	400	200
2	1200	800	500
3	300	1100	800
4	800	200	900
5	1500	1300	300

Dimensional Analysis

- A method of making an integrated comparison of alternative sites on the basis of both tangible and intangible cost.
 - When required to optimize different objectives which are interrelated but cannot be represented in the same dimensions.
 - The location decision can be taken by making use of Dimensional Analysis.
 - Also, called as Bridgeman's Dimensional Analysis as it was developed by Bridgeman in 1963.
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Dimensional Analysis

- Let M and N be two sites and their various cost components be $C_{1M}, C_{2M}, \dots, C_{nM}$ and $C_{1N}, C_{2N}, \dots, C_{nN}$ respectively.
- The weight of each component be W_1, W_2, \dots, W_n respectively.

Dimensional Analysis Value (DAV) is given by

$$\left(\frac{C_{1M}}{C_{1N}}\right)^{w_1} \times \left(\frac{C_{2M}}{C_{2N}}\right)^{w_2} \times \dots \times \left(\frac{C_{nM}}{C_{nN}}\right)^{w_n}$$

Dimensional Analysis

- ❑ If the calculated value is > 1 , site N is superior and vice versa.
 - ❑ If one takes profit into consideration instead of cost, then the condition would reverse.
1. Data for two locations are given below; use Dimensional Analysis to determine which of the two is a better location.

Site – Cost	Labour	Power	Educational Facilities	Healthcare Facilities
M	200,000	4,000,000	2	2
N	100,000	2,500,000	6	4
Weightage	1	1	2	2

Question 1

Select the most appropriate site using Bridgeman's Dimensional Analysis:

Factors	Site 1	Site 2	Weights
Building Cost and Equipment Cost	2,500,000	1,500,000	4
Taxes (per year)	25,000	100,000	4
Power Cost (per year)	100,000	150,000	4
Community Attitude	2	4	1
Product Quality	4	6	5
Flexibility to adopt to situations	5	30	2

Question 2

An equipment supplier has collected the following data on possible plant locations. If you were responsible for making the decision on the basis of the information given, which site would you select and why? Use Dimensional Analysis.

Factors	Site P	Site Q	Site R
Rent and Utilities	20,000	24,000	30,000
Taxes	4,000	3,000	2,000
Labour	190,000	160,000	180,000
Materials	260,000	264,000	254,000
Community Service	2	4	3
Community Attitude	3	3	2

Question 2

$\frac{P}{Q} = 0.649 < 1$  select P \rightarrow P is better than Q.

$\frac{R}{Q} = 2.2173 > 1$ \therefore select R \rightarrow R is better than Q.


$\frac{P}{R} = 1.4406 > 1$ \therefore select R \rightarrow R is better than P.

Hence R is the best site.
followed by P
last choice is Q.

Factor Rating Method

- ❑ Also called as “Linear Scoring Rule”
- ❑ Most widely used location technique
- ❑ Useful for service and industrial locations
- ❑ Rates location using factors:
 - Intangible (qualitative factors)
 - Ex. Education quality, labour skills
 - Tangible (quantitative factors)
 - Ex. Short run and long run costs

Steps

- ❑ Identify the important location factors.
 - ❑ Rate each factor according to its relative importance, such as higher rating indicates its prominence.
 - ❑ This can be done by assigning a weight to each factor to indicate its relative importance (weights may total 1.00).
 - ❑ Assign each location according to the merit of the location for each factor using a common scale (ex. 0 to 100 points).
 - ❑ Calculate the rating for each location by multiplying factors assigned to each location with basic factors considered.
 - ❑ Find the sum of product calculated for each factor and select best location having highest total score.
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Problem

Factors	Weights	A	B	C	W * A	W * B	W * C
Land cost	0.25	50	70	90			
Proximity to the market	0.10	55	75	85			
Cost of labour	0.30	95	60	50			
Edu. Facility	0.20	60	65	80			
Environment of living	0.15	75	70	60			

Question 1

Lets assume that a new medical facility is to be located in a city. The location factors, factors rating and scores (1 = poor, 5 = excellent) for two potential sites are shown in the following table. Which is the best location based on factor rating method?

	Location Factor	Rating	Location 1	Location 2
1	Facility location	8	3	5
2	Total patient per month	5	4	3
3	Average time per emergency trip	6	4	5
4	Land and construction costs	3	1	2
5	Employee's preferences	5	5	3

Question 2

A glass company is evaluating four locations A, B, C, and D for a new plant and has weighted the relevant factors as shown in table below. Scores have been assigned with higher values indicative of preferred conditions. Using these scores, develop a qualitative factor comparison for the four locations.

Relevant Factors	Assigned Weight	A	B	C	D
Production cost	0.33	50	40	35	30
Raw material supply	0.25	70	80	75	80
Labour Availability	0.20	55	70	60	45
Cost of living	0.05	80	70	40	50
Environment	0.02	60	60	60	90
Market	0.15	80	90	85	50


Factors and weights for three locations

Weight	Factor	Score		
		Minneapolis	Winnipeg	Springfield
0.25	Proximity to customer	95	90	65
0.15	Land and construction prices	60	60	90
0.15	Wage rates	70	45	60
0.10	Property taxes	70	90	70
0.10	Business taxes	80	90	85
0.10	Commercial travel	80	65	75
0.08	Insurance costs	70	95	60
0.07	Office services	90	90	80


Weighted Factor Method

LOCATION FACTOR	SCORES (0 TO 100)			
	WEIGHT	<i>Site 1</i>	<i>Site 2</i>	<i>Site 3</i>
Labor pool and climate	.30	80	65	90
Proximity to suppliers	.20	100	91	75
Wage rates	.15	60	95	72
Community environment	.15	75	80	80
Proximity to customers	.10	65	90	95
Shipping modes	.05	85	92	65
Air service	.05	50	65	90

Brown and Gibson Model

- The Brown and Gibson model is one of the many techniques for multi-attribute decision making.
 - This method was developed in 1972 by P. Brown and D. Gibson.
 - This is one of the few models which integrates both objective and subjective factors in decision making.
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The Brown and Gibson Model is a mathematical decision making tool that anyone can use, where the decision to be taken involves both Quantitative (Objective) as well as Qualitative (Subjective) factors.



The Brown and Gibson Model can be mathematically represented as:

$$M=C*[D*O+(1-D)*S]$$

Where,

M = Measure for an alternative “I”

C = Critical factor measure which could be between 0 or 1 for an alternative.

O = Objective factor measure which could be between 0 and 1 however the sum of all objective factor measures for different alternatives should add back to 1.

S = Subjective factor measure which could be between 0 and 1 however the sum of all subjective factor measures for different alternative should add back to 1.

D = Objective factor decision weight and this should be between and 0 and 1.

Brown and Gibson Model

So Can Mathematical Models solve daily-life problems?

