6a.
Location Analysis

STEVENS INSTITUTE of TECHNOLOGY

BIA 674 - Supply Chain Analytics

Outline

- Introduction to Location Analysis
- Weighting Factor Models
- Load Distance Models
- Break-Even Analysis
- Center of Gravity Models
- Facility Location and Capacity Allocation

- In class mini case – Paramount Manufacturing

Importance of location decisions

"Location, Location, Location!"

- Location decisions for residential homes are important because …
  - They affect travel time to work, to school, to recreational centers, and to shopping malls.
  - A home in a good school district is particularly important for most parents with school-age children.
  - A home in a "bad" neighborhood means the residents are exposed to higher risk of crimes and drugs, while a home is a "good" neighborhood is a source of pride and status.

"Location, Location, Location!"

- Location decisions are important to businesses because …
  - They affect the demand from customers
  - They affect the cost of doing business, and the flow of goods and services.
  - They commit the organization to long lasting financial, employment, and distribution patterns. For retail outlets, location affects the demand for their products/services. For labor-intensive operations, labor costs may force an organization to relocate its operations to locations where wages are lower.

Demand-pulled, or …

- Location decisions are either demand-pulled, supply-pushed, or more frequently, both demand-pulled and supply pushed.
- Demand-pulled
  - Market-related factors such as the location of customers, the location of the competition, the need for room for expansion, and the community's attitude towards the organization.

… Supply-pulled

- Supply-pushed location factors
  - Based on the cost of doing business. The cost of doing business may be tangible or intangible.
    - Tangible costs: cost of site and construction, availability and costs of labor, transportation cost (proximity to suppliers and markets), utilities (availability and costs), taxes, and real estate (site acquisition, preparation and construction) costs.
    - Intangible costs: Zoning and legal regulations, community attitudes, proximity to parent company's facilities, expansion potential, labor climate, training and employment services, and the quality of life (schools, recreation and cultural attractions, amount and type of housing available).

Location Decisions

- Location decisions affect processes and departments
  - Marketing
  - Human resources
  - Accounting and finance
  - …..
- Many factors are sensitive to location / High impact on the company's ability to meet its goals
- Facility location is the process of determining a geographical site for a firm's operations.

Dominant factors affecting location

In Manufacturing	In Services
• Proximity to Materials (raw materials & supplies)	• Proximity to customers
• Labor cost and Climate	• Location of competitors
• Proximity to Markets (or to transportation)	• Transportation costs and proximity to markets
• Infrastructure, taxes, real estate costs	• Level and kind of business activity
• Quality of life	• Residential density
• Relation to parent and group companies' facility location	• Traffic flow • Site visibility

The Strategic Importance of Location

- One of the most important decisions a firm makes
- Increasingly global in nature
- Significant impact on fixed and variable costs
- Decisions made relatively infrequently
- Long-term decisions
- Once committed to a location, many resource and cost issues are difficult to change

The Strategic Importance of Location

The objective of location strategy is to maximize the benefit of location to the firm

Options include

1. Expanding existing facilities
2. Maintain existing and add sites
3. Closing existing and relocating

Location and Costs

- Location decisions based on low cost require careful consideration
- Once in place, location-related costs are fixed in place and difficult to reduce
- Determining optimal facility location is a good investment

Factors That Affect Location Decisions

- Globalization adds to complexity:
  - Market economics
  - Communication
  - Rapid, reliable transportation
  - Ease of capital flow
  - Differing labor costs
- Trade quotas, language, culture, government stability and cooperation, monetary system, infrastructure, etc. can sometimes force a multinational corporation to divest its interest in a country.
- Identify key success factors (KSFs)

Location Decisions

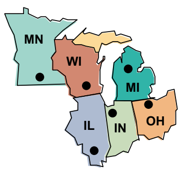
Country Decision

Key Success Factors

1. Political risks, government rules, attitudes, incentives
2. Cultural and economic issues
3. Location of markets
4. Labor talent, attitudes, productivity, costs
5. Availability of supplies, communications, energy
6. Exchange rates and currency risks

Location Decisions

Region/ Community Decision



Key Success Factors

1. Corporate desires
2. Attractiveness of region
3. Labor availability and costs
4. Costs and availability of utilities
5. Environmental regulations
6. Government incentives and fiscal policies
7. Proximity to raw materials and customers
8. Land/construction costs

Location Decisions

Site Decision

Key Success Factors

1. Site size and cost
2. Air, rail, highway, and waterway systems
3. Zoning restrictions
4. Proximity of services/ supplies needed
5. Environmental impact issues

Global Competitiveness Index of Countries

Competitiveness of 142 Selected Countries

COUNTRY	2011-2012 RANKING
Switzerland	1
Singapore	2
Sweden	3
Finland	4
USA	5
Japan	9
UK	10
Canada	12
Israel	22
China	26
Mexico	58
Vietnam	65
Russia	66
Haiti	141
Chad	142

Factors That Affect Location Decisions

- Labor productivity
  - Wage rates are not the only cost
  - Lower productivity may increase total cost

$$\frac{\text{Labor cost per day}}{\text{Productivity (units per day)}} = \text{Cost per unit}$$

South Carolina

$$\frac{\$70}{\text{60 units}} = \$1.17 \text{ per unit}$$

Mexico

$$\frac{\$25}{\text{20 units}} = \$1.25 \text{ per unit}$$

Factors That Affect Location Decisions

- Exchange rates and currency risks
  - Can have a significant impact on costs
  - Rates change over time
- Costs
  - Tangible - easily measured costs such as utilities, labor, materials, taxes
  - Intangible - less easy to quantify and include education, public transportation, community, quality-of-life

Factors That Affect Location Decisions

- Exchange rates and currency risks
  - Can have a significant impact on costs
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  - Tangible - easily me
  utilities, labor, mate
  - Intangible - less eas
  education, public tr
  quality-of-life

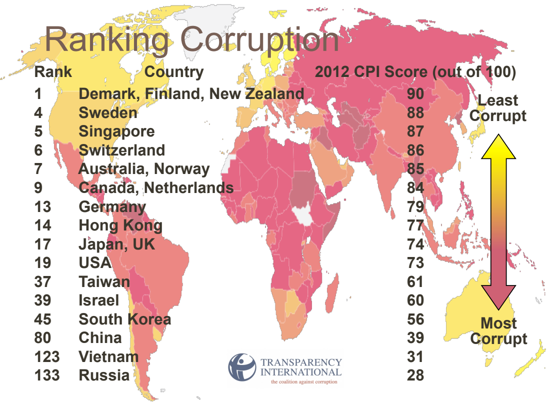
Location decisions based on costs alone can create difficult ethical situations

Factors That Affect Location Decisions

- Political risk, values, and culture
  - National, state, local governments attitudes toward private and intellectual property, zoning, pollution, employment stability may be in flux
  - Worker attitudes towards turnover, unions, absenteeism
  - Globally cultures have different attitudes towards punctuality, legal, and ethical issues

Ranking Corruption

Rank	Country	2012 CPI Score (out of 100)
1	Demark, Finland, New Zealand	90
4	Sweden	88
5	Singapore	87
6	Switzerland	86
7	Australia, Norway	85
9	Canada, Netherlands	84
13	Germany	79
14	Hong Kong	77
17	Japan, UK	74
19	USA	73
37	Taiwan	61
39	Israel	60
45	South Korea	56
80	China	39
123	Vietnam	31
133	Russia	28



Factors That Affect Location Decisions

- Proximity to markets
  - Very important to services
  - JIT systems or high transportation costs may make it important to manufacturers
- Proximity to suppliers
  - Perishable goods, high transportation costs, bulky products

Factors That Affect Location Decisions

- Proximity to competitors (clustering)
  - Often driven by resources such as natural, information, capital, talent
  - Found in both manufacturing and service industries

Weighting Factor Models

Locating a Single Facility

- Expand onsite, build another facility, or relocate to another site?
  - Onsite expansion
  - Building a new plant or moving to a new retail or office space
- Comparing several sites?

Selecting a New Facility

Step 1: Identify the important location factors and categorize them as dominant or secondary

Step 2: Consider alternative regions; then narrow to alternative communities and finally specific sites

Step 3: Collect data on the alternatives

Step 4: Analyze the data collected, beginning with the *quantitative* factors

Step 5: Bring the *qualitative* factors pertaining to each site into the evaluation

Factor-Rating Method

- Popular because a wide variety of factors can be included in the analysis
- Six steps in the method
  1. Develop a list of relevant factors called key success factors
  2. Assign a weight to each factor
  3. Develop a scale for each factor
  4. Score each location for each factor
  5. Multiply score by weights for each factor for each location
  6. Make a recommendation based on the highest point score

Factor-Rating Example

TABLE Weights, Scores, and Solution

KSF	WEIGHT	SCORES (OUT OF 100) FRANCE	DENMARK	WEIGHTED SCORES FRANCE	DENMARK
Labor availability and attitude	.25	70	60	(.25)(70) = 17.5	(.25)(60) = 15.0
People-to-car ratio	.05	50	60	(.05)(50) = 2.5	(.05)(60) = 3.0
Per capita income	.10	85	80	(.10)(85) = 8.5	(.10)(80) = 8.0
Tax structure	.39	75	70	(.39)(75) = 29.3	(.39)(70) = 27.3
Education and health	.21	60	70	(.21)(60) = 12.6	(.21)(70) = 14.7
Totals	1.00			70.4	68.0

Calculating Weighted Scores

EXAMPLE 1

A new medical facility, Health-Watch, is to be located in Erie, Pennsylvania. The following table shows the location factors, weights, and scores (1 = poor, 5 = excellent) for one potential site. The weights in this case add up to 100 percent. A weighted score (WS) will be calculated for each site. What is the WS for this site?

Location Factor	Weight	Score
Total patient miles per month	25	4
Facility utilization	20	3
Average time per emergency trip	20	3
Expressway accessibility	15	4
Land and construction costs	10	1
Employee preferences	10	5

Calculating Weighted Scores

SOLUTION

The *WS* for this particular site is calculated by multiplying each factor's weight by its score and adding the results:

Location Factor	Weight	Score
Total patient miles per month	25	4
Facility utilization	20	3
Average time per emergency trip	20	3
Expressway accessibility	15	4
Land and construction costs	10	1
Employee preferences	10	5

$$WS = (25 \times 4) + (20 \times 3) + (20 \times 3) + (15 \times 4) + (10 \times 1) + (10 \times 5)$$
$$= 100 + 60 + 60 + 60 + 10 + 50$$
$$= 340$$

The total *WS* of 340 can be compared with the total weighted scores for other sites being evaluated.

Calculating Weighted Scores

EXAMPLE 2

Management is considering three potential locations for a new cookie factory. They have assigned scores shown below to the relevant factors on a 0 to 10 basis (10 is best). Using the preference matrix, which location would be preferred?

Location Factor	Weight	The Neighborhood		Sesame Street		Ronald's Playhouse	
Material Supply	0.1	5		9		8	
Quality of Life	0.2	9		8		4	
Mild Climate	0.3	10		6		8	
Labor Skills	0.4	3		4		7	

Calculating Weighted Scores

SOLUTION

Management is considering three potential locations for a new cookie factory. They have assigned scores shown below to the relevant factors on a 0 to 10 basis (10 is best). Using the preference matrix, which location would be preferred?

Location Factor	Weight	The Neighborhood		Sesame Street		Ronald's Playhouse	
Material Supply	0.1	5	0.5	9	0.9	8	0.8
Quality of Life	0.2	9	1.8	8	1.6	4	0.8
Mild Climate	0.3	10	3.0	6	1.8	8	2.4
Labor Skills	0.4	3	1.2	4	1.6	7	2.8
			6.5		5.9		6.8

Load Distance Models

Load-Distance (ld) Method

- Identify and compare candidate locations
  - Like weighted-distance method
  - Select a location that minimizes the sum of the loads multiplied by the distance the load travels
  - Time may be used instead of distance

Load-Distance (ld) Method

- Calculating a load-distance score
  - Varies by industry
  - Use the actual distance to calculate *ld* score
  - Use rectangular or Euclidean distances
  - Different measures for distance
  - Find one acceptable facility location that minimizes the *ld* score
- Formula for the *ld* score

$$ld = \sum_i l_i d_i$$

Load-Distance (ld) Method

What is the distance between (20, 10) and (80, 60)?

SOLUTION

Euclidean distance:

$$d_{AB} = \sqrt{(x_A - x_B)^2 + (y_A - y_B)^2} = \sqrt{(20 - 80)^2 + (10 - 60)^2} = 78.1$$

Rectilinear distance:

$$d_{AB} = |x_A - x_B| + |y_A - y_B| = |20 - 80| + |10 - 60| = 110$$

Load-Distance (ld) Method

EXAMPLE 3

Management is investigating which location would be best to position its new plant relative to two suppliers (located in Cleveland and Toledo) and three market areas (represented by Cincinnati, Dayton, and Lima). Management has limited the search for this plant to those five locations. The following information has been collected. Which is best, assuming rectilinear distance?

Location	*(x, y)* coordinates	Trips/year
Cincinnati	(11, 6)	15
Dayton	(6, 10)	20
Cleveland	(14, 12)	30
Toledo	(9, 12)	25
Lima	(13, 8)	40

Calculating the distances

Rectilinear distance:

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

		(11, 6)	(6, 10)	(14, 12)	(9, 12)	(13, 8)
		CIN	DAY	CLE	TOL	LIM
(11, 6)	CIN	0	9	9	8	4
(6, 10)	DAY	9	0	10	5	9
(14, 12)	CLE	9	10	0	5	5
(9, 12)	TOL	8	5	5	0	8
(13, 8)	LIM	4	9	5	8	0

Load-Distance (ld) Method

SOLUTION

Calculations:
(using rectilinear distances)

Location	(x, y) coordinates	Trips/year
Cincinnati	(11, 6)	15
Dayton	(6, 10)	20
Cleveland	(14, 12)	30
Toledo	(9, 12)	25
Lima	(13, 8)	40

Cincinnati = 15(0) + 20(9) + 30(9) + 25(8) + 40(4) = 810
Dayton = 15(9) + 20(0) + 30(10) + 25(5) + 40(9) = 920
Cleveland = 15(9) + 20(10) + 30(0) + 25(5) + 40(5) = 660
Toledo = 15(8) + 20(5) + 30(0) + 25(0) + 40(8) = 690
Lima = 15(4) + 20(9) + 30(5) + 25(8) + 40(0) = 590

Center of Gravity Models

Center-of-Gravity Method

- Finds location of distribution center that minimizes distribution costs
- Considers
  - Location of markets
  - Volume of goods shipped to those markets
  - Shipping cost (or distance)

Center-of-Gravity Method

- Place existing locations on a coordinate grid
  - Grid origin and scale is arbitrary
  - Maintain relative distances
- Calculate *x* and *y* coordinates for 'center of gravity'
  - Assumes cost is directly proportional to distance and volume shipped

Center of Gravity Method

- A good starting point (shortest distance location)
  - Find x coordinate, x^*, by multiplying each point's x coordinate by its load (l_i), summing these products $\Sigma l_i x_i$, and dividing by Σl_i
  - The center of gravity's y coordinate y^* found the same way
  - Generally not the optimal location

$$x^* = \frac{\sum_i l_i x_i}{\sum_i l_i} \qquad y^* = \frac{\sum_i l_i y_i}{\sum_i l_i}$$

Finding the Center of Gravity

EXAMPLE 4

A supplier to the electric utility industry produces power generators; the transportation costs are high. One market area includes the lower part of the Great Lakes region and the upper portion of the southeastern region. More than 600,000 tons are to be shipped to eight major customer locations as shown below:

Customer Location	Tons Shipped (l_i)	(x, y) Coordinates
Three Rivers, MI	5,000	(7, 13)
Fort Wayne, IN	92,000	(8, 12)
Columbus, OH	70,000	(11, 10)
Ashland, KY	35,000	(11, 7)
Kingsport, TN	9,000	(12, 4)
Akron, OH	227,000	(13, 11)
Wheeling, WV	16,000	(14, 10)
Roanoke, VA	153,000	(15, 5)

Finding the Center of Gravity

What is the center of gravity for the electric utilities supplier? Using rectilinear distance, what is the resulting load–distance score for this location?

Customer Location	Tons Shipped	x, y Coordinates
Three Rivers, MI	5,000	(7, 13)
Fort Wayne, IN	92,000	(8, 12)
Columbus, OH	70,000	(11, 10)
Ashland, KY	35,000	(11, 7)
Kingsport, TN	9,000	(12, 4)
Akron, OH	227,000	(13, 11)
Wheeling, WV	16,000	(14, 10)
Roanoke, VA	153,000	(15, 5)

SOLUTION

The center of gravity is calculated as shown below:

$$\sum_i l_i = 5 + 92 + 70 + 35 + 9 + 227 + 16 + 153 = 607$$

$$\sum_i l_i x_i = 5(7) + 92(8) + 70(11) + 35(11) + 9(12) + 227(13) + 16(14) + 153(15) = 7{,}504$$

$$x^* = \frac{\sum_i l_i x_i}{\sum_i l_i} = \frac{7{,}504}{607} = 12.4$$

Finding the Center of Gravity

What is the center of gravity for the electric utilities supplier? Using rectilinear distance, what is the resulting load–distance score for this location?

Customer Location	Tons Shipped	x, y Coordinates
Three Rivers, MI	5,000	(7, 13)
Fort Wayne, IN	92,000	(8, 12)
Columbus, OH	70,000	(11, 10)
Ashland, KY	35,000	(11, 7)
Kingsport, TN	9,000	(12, 4)
Akron, OH	227,000	(13, 11)
Wheeling, WV	16,000	(14, 10)
Roanoke, VA	153,000	(15, 5)

$$\sum_i l_i y_i = 5(13) + 92(12) + 70(10) + 35(7) + 9(4) + 227(11) + 16(10) + 153(5) = 5{,}572$$

$$y^* = \frac{\sum_i l_i y_i}{\sum_i l_i} = \frac{5{,}572}{607} = 9.2$$

Finding the Center of Gravity

What is the center of gravity for the electric utilities supplier? Using rectilinear distance, what is the resulting load–distance score for this location?

Customer Location	Tons Shipped	x, y Coordinates
Three Rivers, MI	5,000	(7, 13)
Fort Wayne, IN	92,000	(8, 12)
Columbus, OH	70,000	(11, 10)
Ashland, KY	35,000	(11, 7)
Kingsport, TN	9,000	(12, 4)
Akron, OH	227,000	(13, 11)
Wheeling, WV	16,000	(14, 10)
Roanoke, VA	153,000	(15, 5)

The resulting load-distance score is

$$ld = \sum_i l_i d_i = 5(5.4 + 3.8) + 92(4.4 + 2.8) + 70(1.4 + 0.8) + 35(1.4 + 2.2) + 90(0.4 + 5.2) + 227(0.6 + 1.8) + 16(1.6 + 0.8) + 153(2.6 + 4.2) = 2{,}662.4$$

where

$$d_i = |x_i - x^*| + |y_i - y^*|$$

Finding the Center of Gravity

EXAMPLE 5

A firm wishes to find a central location for its service. Business forecasts indicate travel from the central location to New York City on 20 occasions per year. Similarly, there will be 15 trips to Boston, and 30 trips to New Orleans. The x, y-coordinates are (11.0, 8.5) for New York, (12.0, 9.5) for Boston, and (4.0, 1.5) for New Orleans. What is the center of gravity of the three demand points?

SOLUTION

$$x^* = \frac{\sum_i l_i x_i}{\sum_i l_i} = \frac{[(20 \times 11) + (15 \times 12) + (30 \times 4)]}{(20 + 15 + 30)} = 8.0$$

$$y^* = \frac{\sum_i l_i y_i}{\sum_i l_i} = \frac{[(20 \times 8.5) + (15 \times 9.5) + (30 \times 1.5)]}{(20 + 15 + 30)} = 5.5$$

Break-even Analysis

Locational Cost-Volume Analysis

- An economic comparison of location alternatives
  - Cost – Volume analysis / Break Even Analysis
- Five steps:
  1. Determine fixed and variable costs for each location
  2. Plot the total line cost for each location
  3. Identify the approximate ranges for which each location has lowest cost
  4. Solve algebraically for break-even points over the relevant ranges
  5. Select location with lowest total cost for the expected production volume

Locational Cost-Volume Analysis Example

Three locations:

Selling price = $120
Expected volume = 2,000 units

City	Fixed Cost	Variable Cost	Total Cost
Athens	$30,000	$75	$180,000
Brussels	$60,000	$45	$150,000
Lisbon	$110,000	$25	$160,000

Total Cost = Fixed Cost + (Variable Cost x Volume)

Locational Cost-Volume Analysis Example

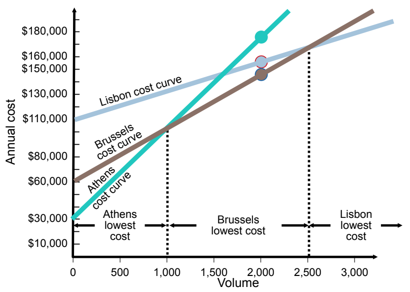
Crossover point – Athens/Brussels

$$
\begin{aligned}
30{,}000 + 75(x) &= 60{,}000 + 45(x) \\
30(x) &= 30{,}000 \\
(x) &= 1{,}000
\end{aligned}
$$

Crossover point – Brussels/Lisbon

$$
\begin{aligned}
60{,}000 + 45(x) &= 110{,}000 + 25(x) \\
20(x) &= 50{,}000 \\
(x) &= 2{,}500
\end{aligned}
$$

Locational Cost-Volume Analysis Example



Break-Even Analysis for Location

EXAMPLE 7

An operations manager narrowed the search for a new facility location to four communities. The annual fixed costs (land, property taxes, insurance, equipment, and buildings) and the variable costs (labor, materials, transportation, and variable overhead) are as follows:

Community	Fixed Costs per Year	Variable Costs per Unit
A	$150,000	$62
B	$300,000	$38
C	$500,000	$24
D	$600,000	$30

Break-Even Analysis for Location

Step 1: Plot the total cost curves for all the communities on a single graph. Identify on the graph the approximate range over which each community provides the lowest cost.

Step 2: Using break-even analysis, calculate the break-even quantities over the relevant ranges. If the expected demand is 15,000 units per year, what is the best location?

Break-Even Analysis for Location

SOLUTION

To plot a community's total cost line, let us first compute the total cost for two output levels: Q = 0 and Q = 20,000 units per year. For the Q = 0 level, the total cost is simply the fixed costs. For the Q = 20,000 level, the total cost (fixed plus variable costs) is as follows:

Community	Fixed Costs	Variable Costs (Cost per Unit)(No. of Units)	Total Cost (Fixed + Variable)
A	$150,000		
B	$300,000		
C	$500,000		
D	$600,000		

Break-Even Analysis for Location

SOLUTION

To plot a community's total cost line, let us first compute the total cost for two output levels: $Q = 0$ and $Q = 20{,}000$ units per year. For the $Q = 0$ level, the total cost is simply the fixed costs. For the $Q = 20{,}000$ level, the total cost (fixed plus variable costs) is as follows:

Community	Fixed Costs	Variable Costs (Cost per Unit)(No. of Units)	Total Cost (Fixed + Variable)
A	$150,000	$62(20,000) = $1,240,000	$1,390,000
B	$300,000	$38(20,000) = $760,000	$1,060,000
C	$500,000	$24(20,000) = $480,000	$980,000
D	$600,000	$30(20,000) = $600,000	$1,200,000

Break-Even Analysis for Location

Figure shows the graph of the total cost lines.

The line for community A goes from (0, 150) to (20, 1,390). The graph indicates that community A is best for low volumes, B for intermediate volumes, and C for high volumes. We should no longer consider community D, because both its fixed and its variable costs are higher than community C's.

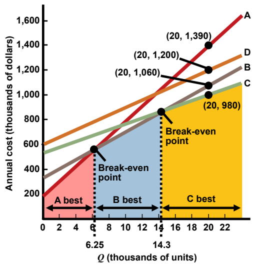


Figure – Break-Even Analysis of Four Candidate Locations

Break-Even Analysis for Location

Step 2: The break-even quantity between A and B lies at the end of the first range, where A is best, and the beginning of the second range, where B is best. We find it by setting both communities' total cost equations equal to each other and solving:

(A)	(B)
$150,000 + 62Q$ =	$300,000 + 38Q$
Q = 6,250 units	

The break-even quantity between B and C lies at the end of the range over which B is best and the beginning of the final range where C is best. It is

(B)	(C)
$300,000 + 38Q$ =	$500,000 + 24Q$
Q = 14,286 units	

Break-Even Ana

No other break-even quantities are needed. The break-even point between A and C lies above the shaded area, which does not mark either the start or the end of one of the three relevant ranges.

Step 2: The break-even quantity
first range, where A is b
range, where B is best. Y
total cost equations equ

(A)	(B)
$150,000 + 62Q$ =	$300,000 + 38Q$
Q = 6,250 units	

The break-even quantity between B and C lies at the end of the range over which B is best and the beginning of the final range where C is best. It is

(B)	(C)
$300,000 + 38Q$ =	$500,000 + 24Q$
Q = 14,286 units	

Break-Even Analysis for Location

EXAMPLE 8

By chance, the Atlantic City Community Chest has to close temporarily for general repairs. They are considering four temporary office locations:

Property Address	Move-in Costs	Monthly Rent
Boardwalk	$400	$50
Marvin Gardens	$280	$24
St. Charles Place	$350	$10
Baltic Avenue	$60	$60

Use the graph on the next slide to determine for what length of lease each location would be favored? Hint: In this problem, lease length is analogous to volume.

Break-Even Analysis for Location

SOLUTION

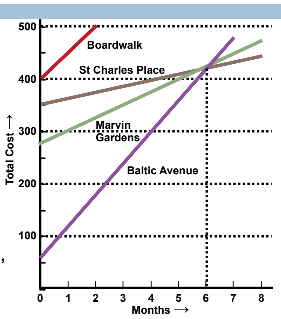
$F_s + c_s Q = F_B + c_B Q$

$$Q = \frac{F_B - F_s}{c_s - c_B}$$

$$= \frac{\$60 - \$360}{\$10 - \$60}$$

$$= \frac{-300}{-50} = 6 \text{ months}$$

The short answer: Baltic Avenue if 6 months or less, St. Charles Place if longer



Locating a single facility – In class mini case

In class mini case

Paramount Manufacturing

Find the best location choosing from three, A, B and C, using Euclidian and rectilinear distances respectively. Compute the center of gravity and analyse whether location there is even better.

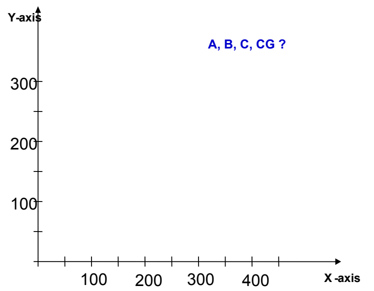
In A and B are located two of the company's suppliers. In C is located the market for the concerned product.

The following information has been collected for the three locations:

Loc.	Coordinates	Tons/Year	Rate ($/ton-mile)
A	(100,200)	4.000	3,00
B	(400,100)	3.000	1,00
C	(100,100)	4.000	3,00

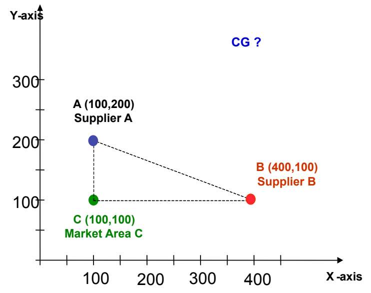
Locating a Single Facility

Paramount Manufacturing



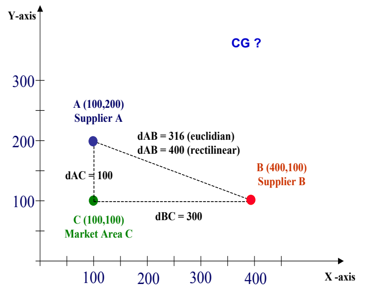
Locating a Single Facility

Paramount Manufacturing



Locating a Single Facility

Paramount Manufacturing



Locating a Single Facility

Paramount Manufacturing