Facility Location

Module 7
July 17, 2014

Examples

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Outline

- **Location Decisions**
  - Strategic importance
  - Sequence
  - Methods of evaluating location alternatives
    - Complete Enumeration
    - The Factor-Rating Method
    - Center-of-Gravity Method
    - Transportation Method
- **Service Location Decisions**
- **Globalization**

FACILITY LOCATION

The term “facility” is used to cover:

- Plants
- Warehouses
- Hotels
- Medical Clinics
- Fire Stations
- Distribution Centers
- Post Offices
- Libraries
- Schools

LOCATION Questions

1. Why is PPD located in Wilmington?
2. Where should UNCW locate 'branch' facilities?
3. Why did the German auto firms locate S. Carolina?
4. Why is Walt Disney World in Orlando and Paris?
5. Are location decisions important in the service sector?

Nature of Location Decisions

- Strategic Importance of location decisions
  - Long term commitment/costs
  - Impact on investments, revenues, and operations
  - Supply chains

Nature of Location Decisions

- Objectives of location decisions
  - Profit potential
  - No single location may be better than others
  - Identify several locations from which to choose

Nature of Location Decisions

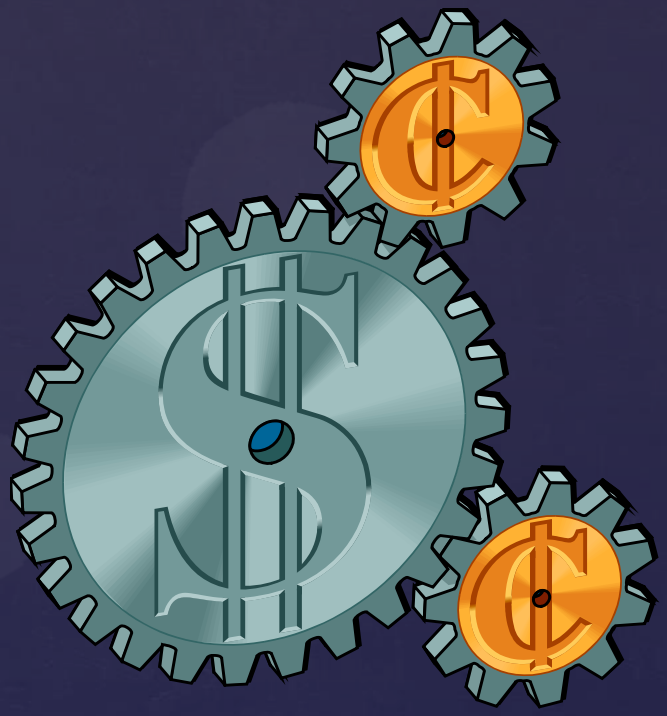
- Location Options
  - Expand existing facilities
  - Add new facilities
  - Move

Making Location Decisions

- Decide on the criteria
- Identify the important factors
- Develop location alternatives
- Evaluate the alternatives
  - Identify general region
  - Identify a small number of community alternatives
  - Identify site alternatives
- Evaluate and make selection

Facility Location Decisions

- *Cost* focus
  - Revenue varies little between locations
- Location is a major cost factor
  - Affects shipping & production costs (e.g., labor)
  - Costs vary greatly between locations



The Facility Planner generally must answer the following questions:

- How many facilities should be established? This includes the options of:
  - Opening new ones,
  - Closing existing ones,
  - Expanding existing ones
- Where should they be located?
- What should be their sizes (capacities)? (including configuration of products/services)
- How should the facility configurations change over time?

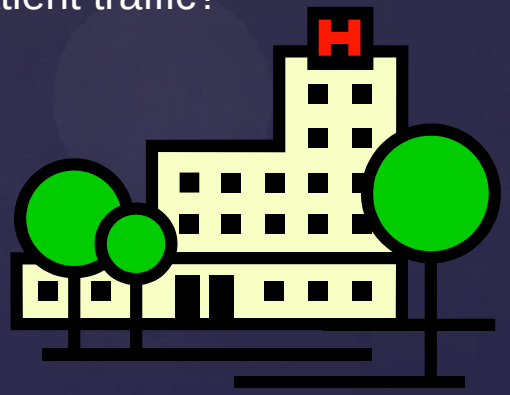
5. What should their service territories be?

Factors to consider…

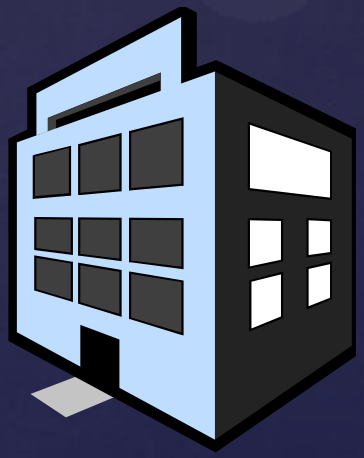
An amusement park?

Length of summer season?
Sufficient population?
Quantity of labor?
Labor costs?
Local laws?

Distances to surrounding community?
Patient traffic?



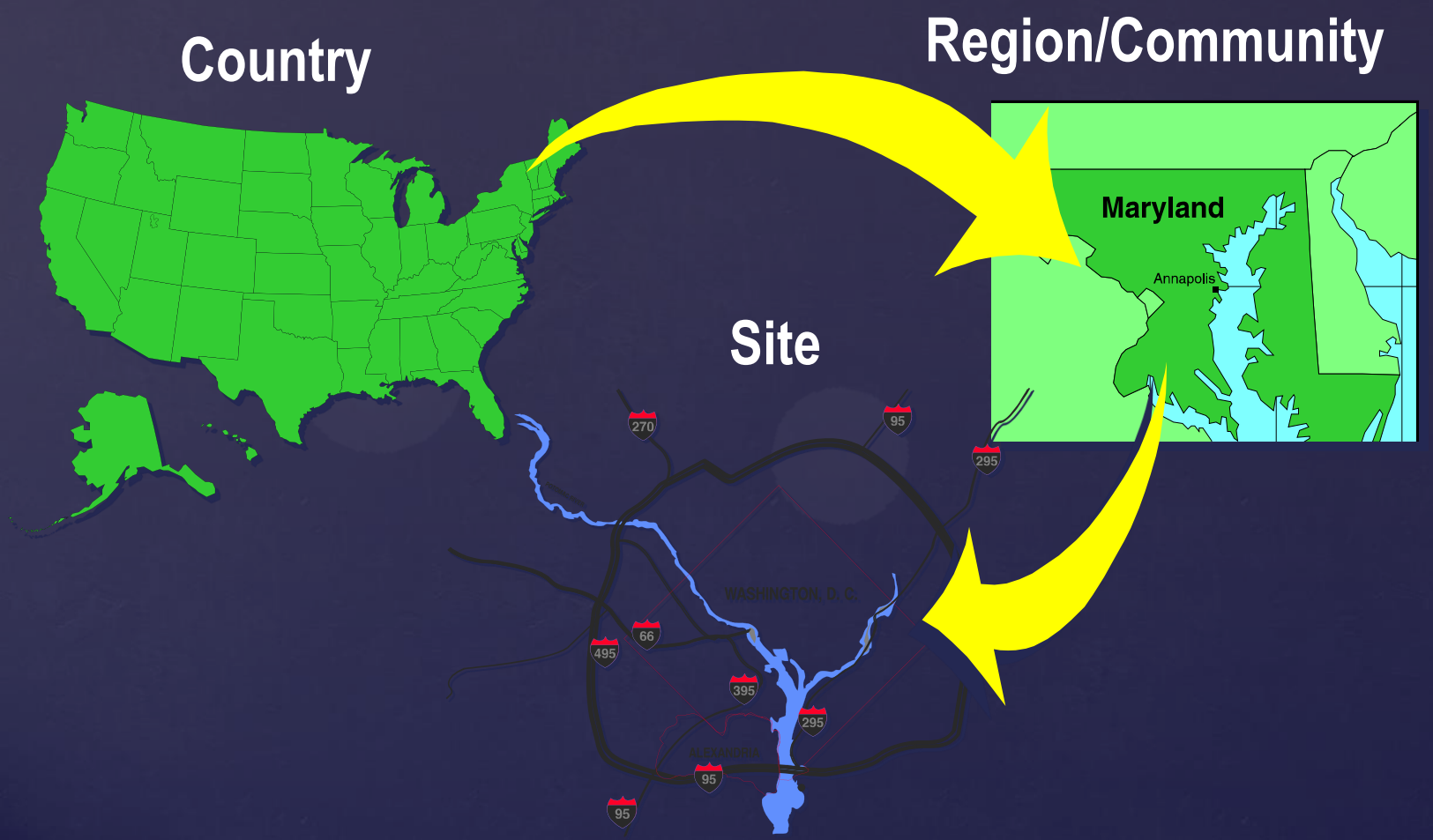
A new pharmacy?



Distances from online customers?
Transportation costs?
Unions?
Taxes?

Amazon's new distribution center?

Location Decision Sequence



Factors Affecting Country Decisions

- Economic and political stability
- Infrastructure
- Location of markets
- Labor costs
- Trade barriers
- …

Ranking of Business Environment

Economist.com rankings

Business environment, June 2007

Forecast 2007-11, total score out of 10

Best

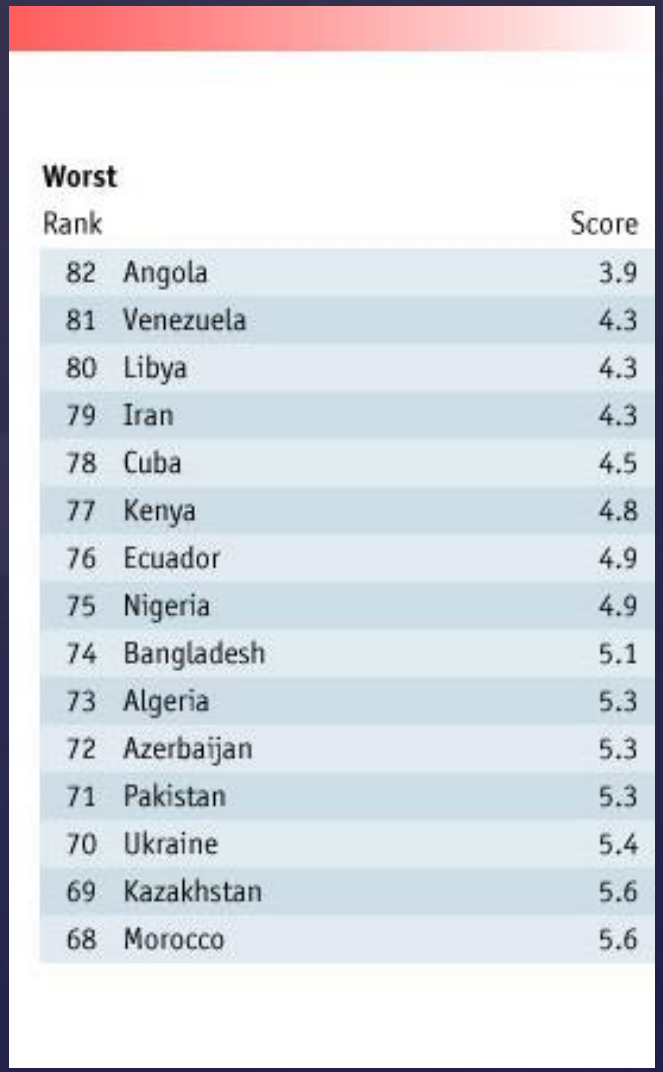
Rank		Score*
1	Denmark	8.8
2	Finland	8.8
3	Singapore	8.7
4	Switzerland	8.7
5	Canada	8.7
6	Hong Kong	8.7
7	United States	8.7
8	Netherlands	8.6
9	Australia	8.6
10	Britain	8.6
11	Sweden	8.6
12	Ireland	8.6
13	Germany	8.5
14	New Zealand	8.3
15	Belgium	8.3

Worst

Rank		Score
82	Angola	3.9
81	Venezuela	4.3
80	Libya	4.3
79	Iran	4.3
78	Cuba	4.5
77	Kenya	4.8
76	Ecuador	4.9
75	Nigeria	4.9
74	Bangladesh	5.1
73	Algeria	5.3
72	Azerbaijan	5.3
71	Pakistan	5.3
70	Ukraine	5.4
69	Kazakhstan	5.6
68	Morocco	5.6

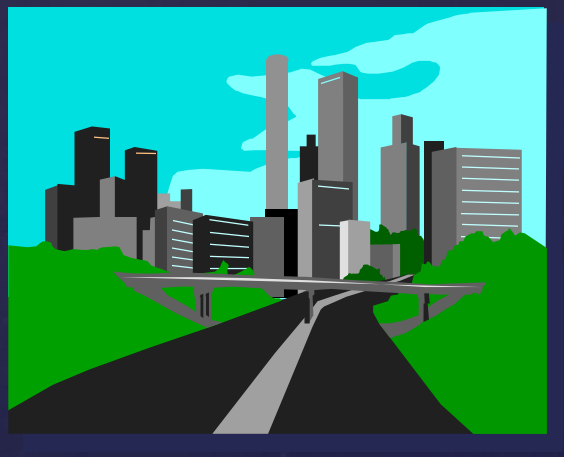
*10=most attractive and 1=least attractive.

Source: Economist Intelligence Unit



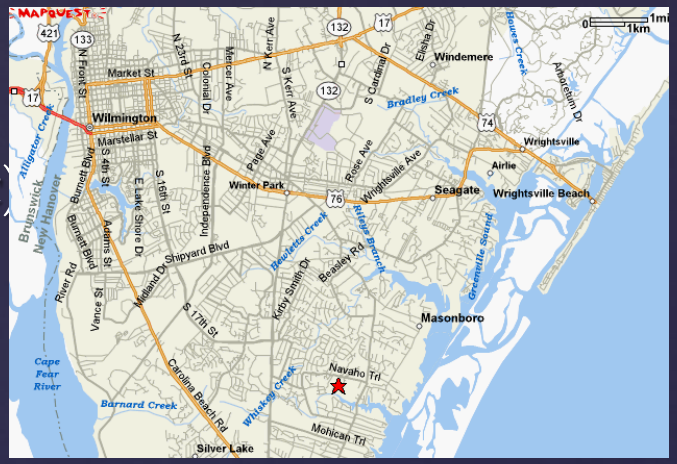
Factors Affecting Region/Community Decisions

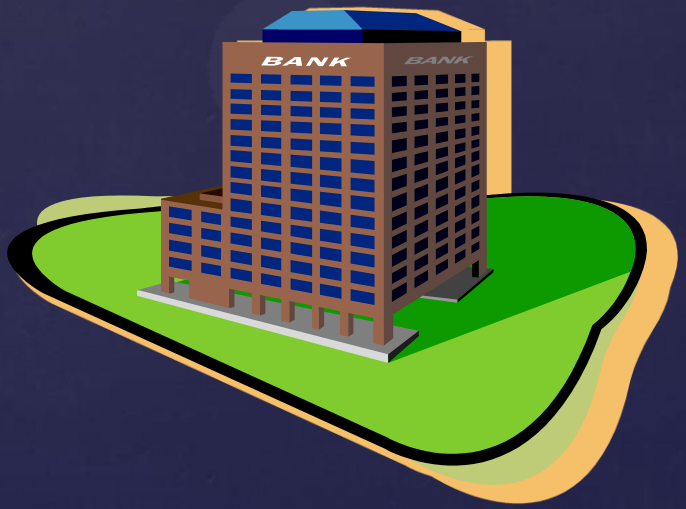
- Proximity to customers & suppliers
- Transportation availability
- Population
- Climate
- Attractiveness of region
- Local laws/taxes
- Land/construction $$$
- Corporate desires
- Services
- ….



Factors Affecting Site Decision

- Access to customers (air, rail, highways, etc)
- Site size and cost
- Zoning restrictions
- Proximity of services
- Transportation in/out
- Environmental impact
- Legal
- Taxes





Hard Rock Cafe

Location Evaluation Methods

1. Complete enumeration
2. Factor-rating method
3. Center of gravity method
4. Transportation method
5. Linear Programming
6. Mixed Integer Programming
7. Dynamic Programming
8. Goal Programming
9. ….

1. Complete Enumeration

- Given 3 potential locations: A, B, C
  - ✓A
  - ✓B
  - ✓C
  - ✓AB
  - ✓AC
  - ✓BC
  - ✓ABC

2^n-1 possible configurations = 2^3-1 = 7

Open the set of locations that satisfy demands and capacity constraints at the lowest cost

2. Factor-Rating Method

- Most widely used location technique
- Rates locations using factors
  - Intangible (qualitative) factors
    - education quality, labor skills, etc.
  - Tangible (quantitative) factors
    - Production costs, cost of living, etc.
- Decision based on weighted average

Steps in Factor Rating Method

1. List relevant factors
2. Assign importance weight to each factor
   - e.g., 1 to 10, with 10 being the most important
3. Score each location along the factor dimensions
   - e.g., 0 to 10, with 10 being the best
4. Multiply weights by scores and sum for each location
5. Choose the location with the most points

Factor Rating Example - 3 locations: A, B, C

1. List relevant factors
2. Assign weights to each factor (let's use weights 0-1)
3. Score each location on each factor

Factor	weight	A	B	C
[redacted]	[redacted]	10	9	7
[redacted]	[redacted]			
[redacted]	[redacted]			
[redacted]	[redacted]			

Factor Rating Example - 3 locations: A, B, C

1. List relevant factors
2. Assign weights to each factor (let's use weights 0-1)
3. Score each location on each factor
4. Multiply the weight and score and sum for each location

Factor	weight	A	B	C
Cost	0.3	10	9	7
Proximity to trans.	0.2	7	3	10
Taxes	0.1	7	5	10
Labor	0.4	6	8	5

(0.3)(10)+(0.2)(7)+(0.1)(7)+(0.4)(6) = 7.5

Factor Rating Example - 3 locations: A, B, C

1. List relevant factors
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Factor	weight	A	B	C
Cost	0.3	10	9	7
Proximity to trans.	0.2	7	3	10
Taxes	0.1	7	5	10
Labor	0.4	6	8	5
		7.5	7	7.1

5. Choose the location with the most points. **A is best**

3. Center of Gravity Method

- Locates a *single* facility to serve many destinations (customers)

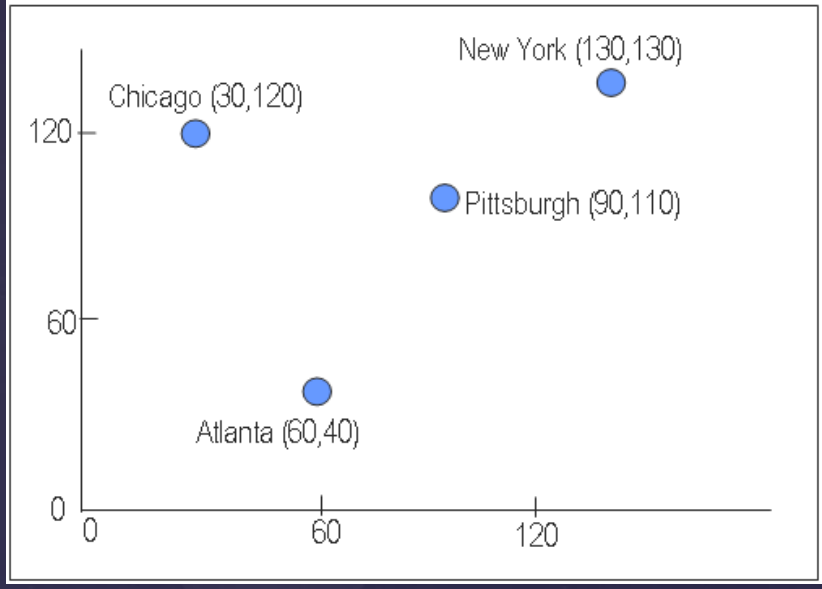
- Attempts to minimize the cost of distributing products to surrounding markets

Center of Gravity Method Steps

- Given each existing destination's
  - X and Y coordinates
  - expected volume of goods to be shipped there

- Center of gravity location
- = weighted average of X & Y coordinates

Center of Gravity Example



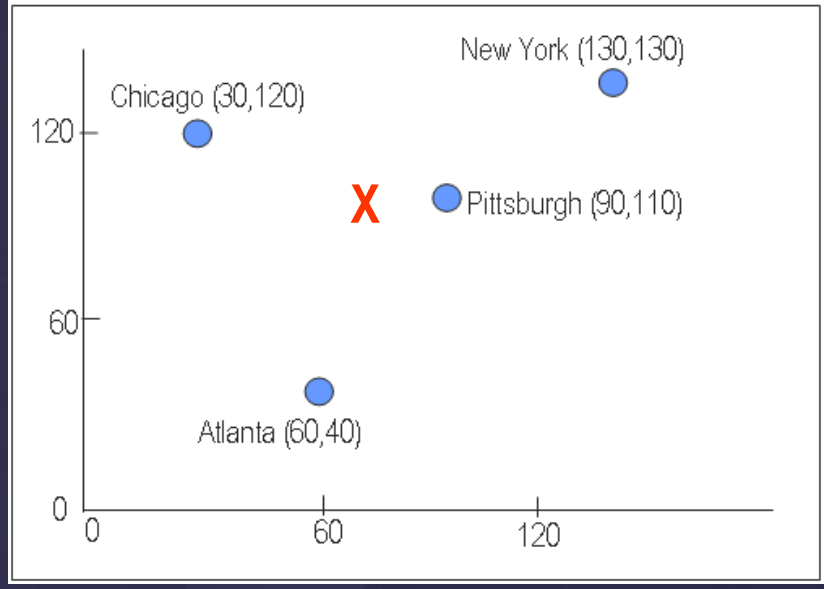
Suppose Buy.com serves 4 cities with the following volumes & coordinates

Location	Volume V_i	X-coord x_i	Y-coord y_i
Chicago	200	30	120
Pittsburgh	100		
New York	100		
Atlanta	200		

Where should the company position a new warehouse to minimize the cost of distributing to these 4 markets?

Center of Gravity Example

Suppose Buy.com serves 4 cities with the following volumes & coordinates



Location	Volume V_i	X-coord x_i	Y-coord y_i	$V_i * x_i$		$V_i * y_i$	
Chicago	200	30	120	200*30	= 6000	200*120	= 24000
Pittsburgh	100	90	110	100*90	= 9000	100*110	= 11000
New York	100	130	130	100*130	= 13000	100*130	= 13000
Atlanta	200	60	40	200*60	= 12000	200*40	= 8000

$\Sigma V_i =$ 600 $\quad \Sigma V_i * x_i =$ 40000 $\quad \Sigma V_i * y_i =$ 56000

$$X_c = \frac{\sum_i V_i x_i}{\sum_i V_i} = \frac{40000}{600} = 66.67$$

$$Y_c = \frac{\sum_i V_i y_i}{\sum_i V_i} = \frac{56000}{600} = 93.33$$

4. Transportation Method

- Finds amount to be shipped from *several* sources to several destinations
- Used primarily for industrial locations
- Type of linear programming model
  - Objective: Minimize total production & shipping costs
  - Constraints
    - Production capacity at source (factory)
    - Demand requirement at destination

With the trend towards globalization, supply chains are becoming more complex and longer in terms of

lead-time,
distances,
handling of goods,
containerization,
information systems,
tariffs and duties,
and the impact on cost and profit.

Transportation Method

Therefore, it is essential to improve the **logistics** (distribution/transportation) involved with the delivery of raw material and finished goods or the appropriate equivalents in the service sector.

Methods for Coming Up with Solutions to A Transportation Problem

Consider a manufacturing company that must determine the best pattern of shipments from several supply sources (e.g., plants) to several demand destinations (e.g., warehouses) so as to minimize total transportation cost.

Methods for Coming Up with Solutions to A Transportation Problem

There is a cost to ship per unit as shown in the next table.
The table also shows that each plant has a limited supply of products and each warehouse has a specific demand for the products
(Note: total supply = total demand).

What is the best way to distribute the products in order to minimize costs?

Warehouse (cost to ship)

FACILITY	W	X	Y	Z	Supply
A	$ 25	$ 65	$36	$60	18
B	$55	$ 30	$ 45	$38	14
C	$40	$50	$ 26	$65	14
Demand	10	12	15	9	46

There are several ways for coming up with a **feasible solution** (the solution that meets the demand and is within the capacity) to a transportation problem.

In this class, we will present one method, namely the Northwest Corner method.

Most of the time, the initial solutions obtained from such methods are not the best (the technical word for it is **optimal)**.

However, these methods are useful in coming up with a **starting solution quickly and effectively**. Improvement techniques are available that allow for improvement of any feasible solution and eventually could lead to the optimal solution.

The Northwest Corner Method:

1. **Begin in the upper left (or northwest) corner of the transportation tableau and assign as many units as possible (in the sense of satisfying the corresponding customer but without violating the warehouse capacity).**

The Northwest Corner Method:

2. **Update the demand of the corresponding customer (respectively, the capacity of the warehouse) by subtracting the amount assigned from the initial demand (respectively capacity).**

3. If the demand is fully satisfied, then cross out the corresponding column. On the other hand, if the Supply is fully exhausted, then cross out the corresponding row.

4. Continue applying this procedure to the most northwest cell in the tableau that does not lie in a crossed-out row or column.

5. **There will come a point where there is only one cell that can be assigned a value. Assign a shipment to this cell in the amount of its row or column demand. Stop at this stage. An initial feasible solution has been obtained.**

Let us apply the Northwest Corner to come up with a feasible assignment to the following problem:

Warehouse

Plant	W	X	Y	Z	Supply
A	$ 25 **10**	$ 65 **8**	$36	$60	~~18~~ ~~8~~ **8** **0**
B	$55	$ 30 **4**	$ 45 **10**	$38	~~14~~ ~~10~~ **10** **0**
C	$40	$50	$ 26 **5**	$65 **9**	~~14~~ ~~9~~ **9** **0**
Demand	~~10~~ **0**	~~12~~ ~~4~~ **4** **0**	~~15~~ ~~5~~ **5** **0**	~~9~~ **0**	46

Is the solution feasible?
(Why or why not?)

What is the cost of this solution?

$25 x 10 = 250
$65 x 8 = 520
$30 x 4 = 120
$45 x 10 = 450
$26 x 5 = 130
$65 x 9 = 585

Total Cost = $2,055

Service and Retail Locations

- Manufacturers – cost focused
- Service and retail – **revenue** focused
  - Traffic volume and convenience most important
  - Demographics
    - Age
    - Income
    - Education
  - Location, location, location
  - Good transportation
  - Customer safety

Comparison of Service and Manufacturing Considerations

Manufacturing	Service/Retail
Cost Focus	**Revenue focus**
Transportation modes/costs	Demographics: age, income, etc
Energy availability, costs	Population/drawing area
Labor cost/availability/skills	Competition
Building/leasing costs	Traffic volume/patterns
	Customer access/parking

Service Location Decisions

- ✓ *Revenue* focus
  - ✓ Costs vary little between market areas
- ✓ Location is a major revenue factor
  - ✓ Affects amount of customer contact
  - ✓ Affects volume of business

Global Locations

- Reasons for globalization
- Benefits
- Disadvantages
- Risks
- Global operations issues

Globalization

- Facilitating Factors
  - Trade agreements
  - Technology
- Benefits
  - Markets
  - Cost savings
  - Legal and regulatory
  - Financial

Globalization

- Disadvantages
  - Transportation costs
  - Security
  - Unskilled labor
  - Import restrictions
  - Criticisms
- Risks
  - Political
  - Terrorism
  - Legal
  - Cultural

Foreign Government	a. Policies on foreign ownership of production facilities Local Content Import restrictions Currency restrictions Environmental regulations Local product standards Liability laws b. Stability issues
Cultural Differences	Living circumstances for foreign workers / dependents Religious holidays/traditions
Customer Preferences	Possible buy locally sentiment
Labor	Level of training and education of workers Work ethic Possible regulations limiting number of foreign employees Language differences
Resources	Availability and quality of raw materials, energy, transportation infrastructure

Final Thought

The ideal location for many companies in the future will be a floating factory ship that will go from port to port, from country to country – wherever cost per unit is lowest.

Summary

- Location Decisions
  - Strategic Factors
  - Objectives of Decision
  - Cost focus (product driven firms)
- Location Evaluation Methods
- Service vs. Manufacturing location decisions
- Globalization Impact
- What is logistics?