REPUBLIC POLYTECHNIC

E216 Distribution and Transportation

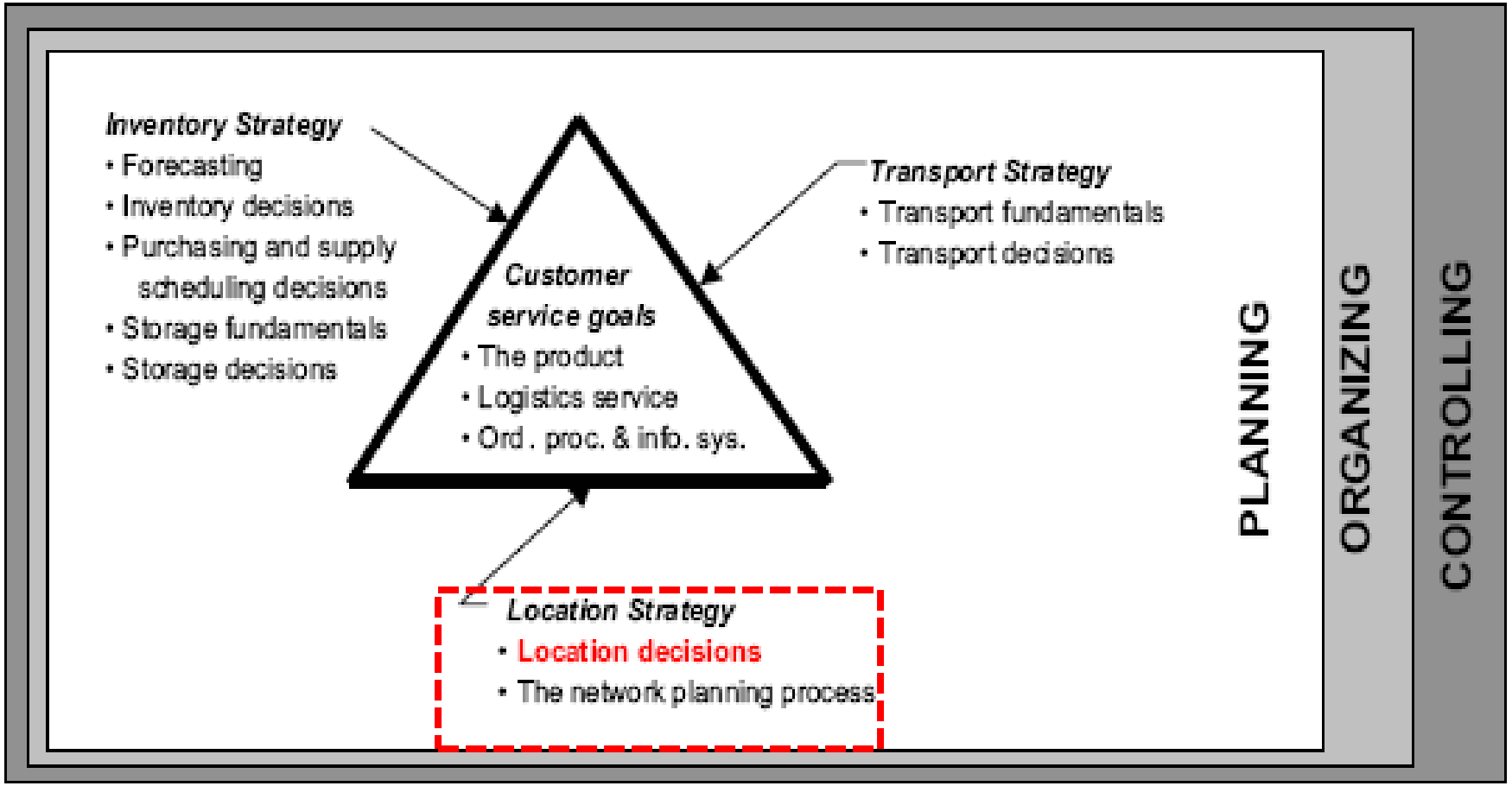
Problem 05

Location Analysis

- Facility Location Decisions
- Factors Affecting Site Selections
- Location Analysis Techniques

SCHOOL OF ENGINEERING

Location Strategy & Decisions



Importance of Location Analysis

- Gives structure to the entire network
- Significantly affects inventory & transportation costs
- Impacts on the customer service level
- Deciding on the various points (or nodes)

Source points
(e.g. Plants, ports, vendors)

Intermediate points
(e.g. Warehouses, Terminals, Service Centers)

Sink points
(e.g. Retail outlets, customers)

Classifications of Facilities

Types of Facilities

Heavy Industry Facilities

- Large, require a lot of space, and are expensive
- e.g. automobile plants, oil refineries, aviation parts

Light Industry Facilities

- Smaller, cleaner plants and usually less costly
- e.g. electronic components, pharmaceutical firms

Retail and Service Facilities

- Smallest and least costly
- e.g. department stores, banks, restaurants, clinics

Factors for Heavy-Industry Facility

- Construction costs
- Land costs
- Raw material and finished goods shipment modes
- Proximity to raw materials
- Utilities
- Means of waste disposal
- Labor availability

Decisions are driven by **Cost Minimization**

Factors for Light-industry facility

- Transportation costs
- Proximity to Markets
- Frequency of delivery required by customer
- Land costs
- Accessibility

Decisions are driven by **Revenue Maximization**

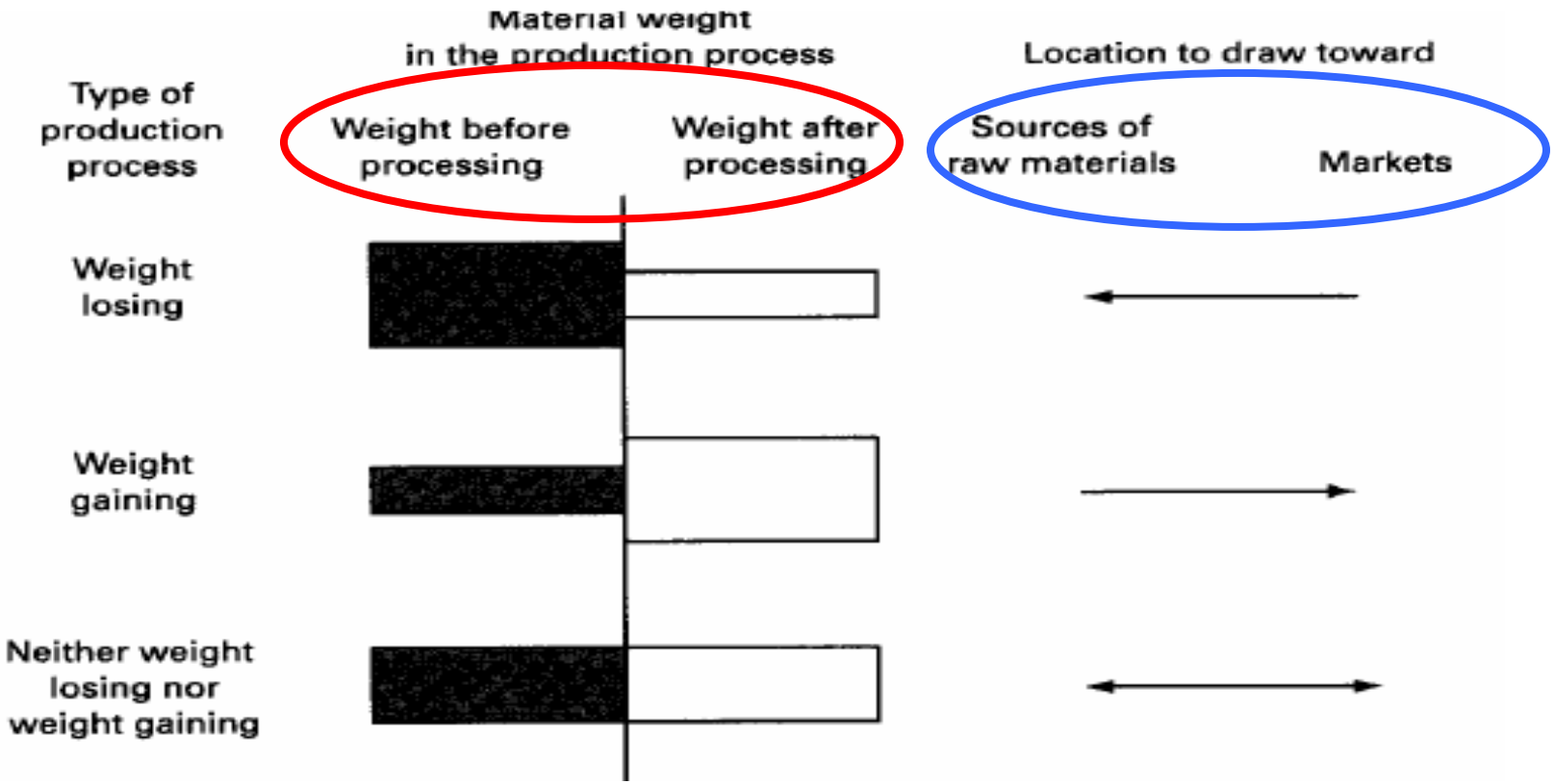
Factors for Retail & Service facility

- Proximity to Customers
- High traffic flow and accessibility
- “Location is Everything”

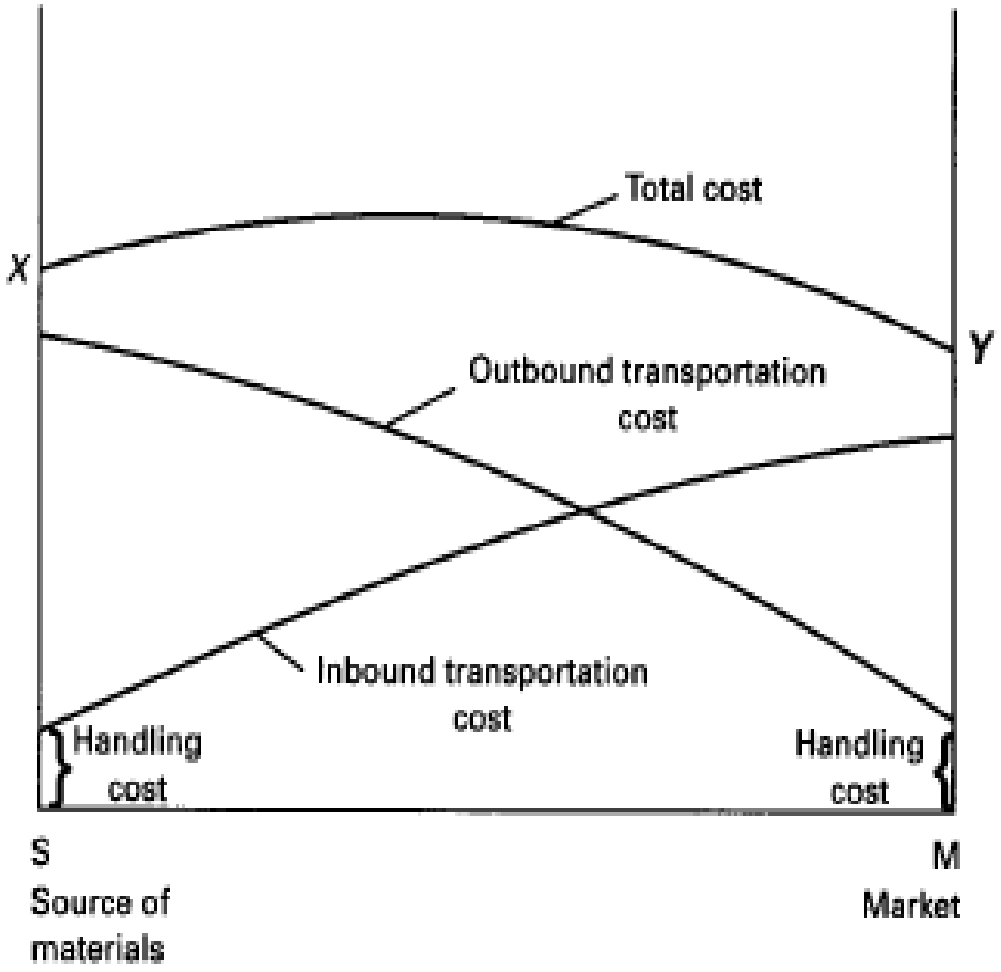
Decisions are driven by **Service Factors**

Weber's Model

- According to Alfred Weber, the optimal site was **one that minimized 'total transportation costs'** – the costs of transferring raw materials to the plant and finished goods to the market

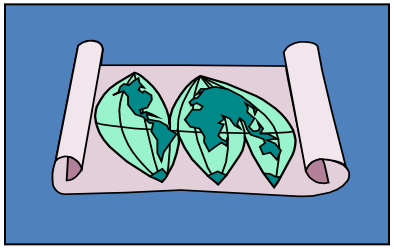


Hoover's Model



- Hoover considered both cost and demand elements
- Stressed cost minimization in determining an optimal location
- Hoover identified that transportation rates & distance were not linearly related

Location Analysis Techniques

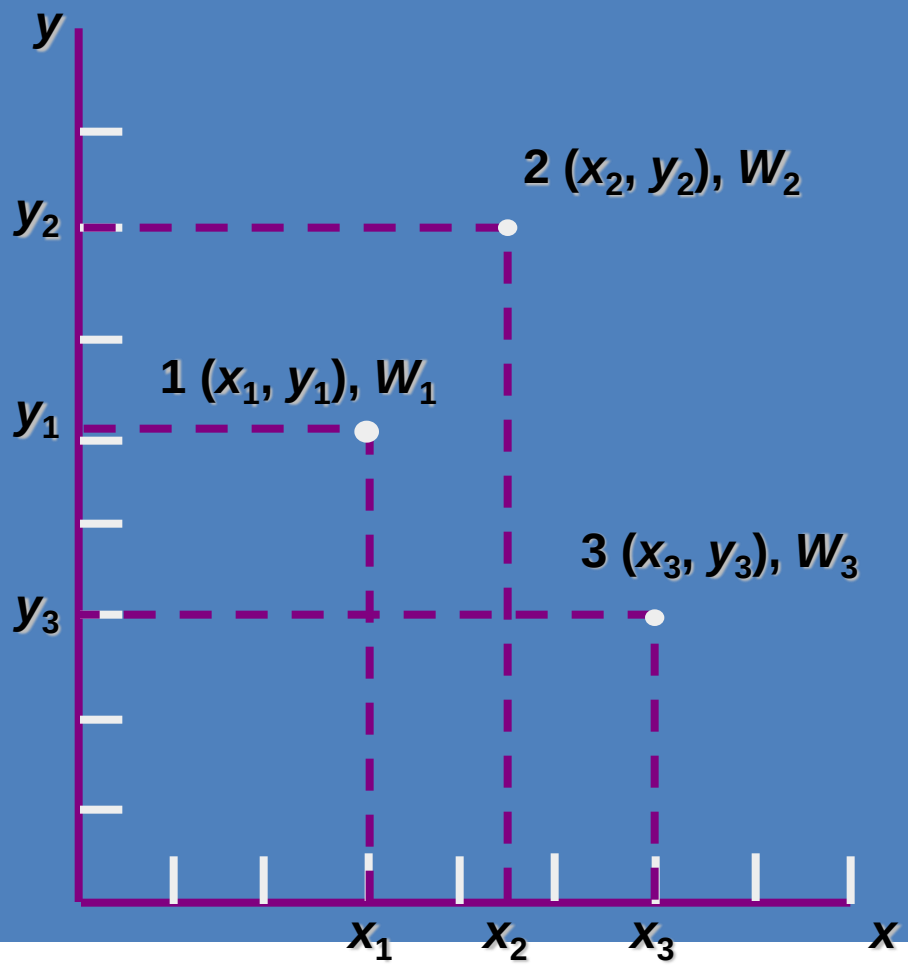


- **Location Analysis Techniques**
  - **Center of Gravity (COG)**
  - **Load-Distance (L-D)**
  - **Location Rating**

Centre-of-Gravity (COG)

- This approach locates a distribution centre at a point that minimizes transportation costs for products moving between a manufacturing plant and the markets
- Steps for computation
  - Locate facility at center of geographic area
  - Based on weight (costs) and distance travelled, establish grid-map of area
  - Identify coordinates and weights shipped for each location

Grid-Map Coordinates



$$x = \frac{\sum_{i=1}^{n} x_i W_i}{\sum_{i=1}^{n} W_i} \qquad y = \frac{\sum_{i=1}^{n} y_i W_i}{\sum_{i=1}^{n} W_i}$$

where,

x, y = coordinates of new facility at center of gravity

x_i, y_i = coordinates of existing facility i

W_i = annual weight (costs) shipped from facility i

Location of Facility

Existing Agents					
Coordinates	Longitude (x)	Latitude (y)	Weight	x * Weight	y * Weight
A-Seattle	-122.3	47.6	60	-7338	2856
B-Atlanta	-84.4	33.7	70	-5908	2359
C-Philadelphia	-75.1	40	80	-6008	3200
D-Shanghai	121.5	31.2	150	18225	4680
E-Berlin	13.4	52.5	170	2278	8925
		Total	530	1249	22020
			Location Coordinates	2.36	41.55

Barcelona is chosen here

COG Method may be a useful method to get a "rough idea" of where to locate the facility

Load-Distance (LD) Method

- A variation of the COG method, where various locations are evaluated using a load-distance value that is a measure of weight & distance
- Steps for computation
  - Compute (Load x Distance) for each site
  - Choose site with lowest (Load x Distance)
  - Distance can be actual or straight-line

Load-Distance Calculations

$$LD = \sum_{i=1}^{n} l_i d_i$$

where,

LD **= load-distance value**

l_i **= load expressed as a weight, number of trips or units being shipped from proposed site and location *i***

d_i **= distance between proposed site and location *i***

$$d_i = \sqrt{(x_i - x)^2 + (y_i - y)^2}$$

where,

(*x*,*y*) = coordinates of proposed site

(x_i , y_i) = coordinates of existing facility

Location of Site

Potential Sites	1-Athens	2-Amsterdam	3-Shanghai
X	23.7	5	121.5
Y	37.9	52.2	31.2

Authorized Agents	A-Seattle	B-Atlanta	C-Philadelphia	D-Shanghai	E-Berlin
X	-122.3	-84.4	-75.1	121.5	13.4
Y	47.6	33.7	40	31.2	52.5
Weight	60	70	80	150	170

	Site 1 to	Site 2 to	Site 3 to
A	146.32	127.38	244.35
B	108.18	91.29	205.92
C	98.82	81.02	196.80
D	98.03	118.38	0.00
E	17.87	8.41	110.18
Load Distance	**41999.6779**	**39701.01845**	**63549.21**

Note: It assumes a straight line distance between each site and the agents

- Since **Amsterdam** has the lowest load-distance value, it can be assumed that this location would also **minimize transportation costs**
- Hence, select **Site 2**

Location Factor Rating

- Factors that are important in the location decision are identified
- Each factor is weighted from **0 to 1.00** to prioritize the factor and reflect its importance; total factor weights = 1.00
- A subjective score is assigned (usually between 0 & 100) to each factor based on its attractiveness compared with other locations, and the weighted scores are summed

Location Factor Rating (Calculation)

		Score (0 - 100)			Weighted Score		
Location Factor	**Weight**	**Site 1**	**Site 2**	**Site 3**	**Site 1**	**Site 2**	**Site 3**
Proximity to raw materials	0.2	65	80	90	13	16	18
Distribution accessibility	0.1	91	100	75	9.1	10	7.5
Land costs	0.1	95	60	72	9.5	6	7.2
Economic stability	0.1	80	75	80	8	7.5	8
Infrastructure	0.05	90	65	95	4.5	3.25	4.75
Construction costs	0.1	92	85	65	9.2	8.5	6.5
Technical expertise	0.05	65	50	90	3.25	2.5	4.5
Available technology	0.2	80	68	75	16	13.6	15
Government regulations	0.1	65	90	80	6.5	9	8
Total	**1**						
				Total	79.05	76.35	**79.45**

- **Shanghai** has the highest factor rating compared to the other locations; however, this evaluation would have to be used with other information, particularly a cost analysis before making a decision

Today's Problem

- It is important that David understands the concept of Location Analysis
  - Identify the type of industry he is in, and the factors that he needs to consider
  - Understand the Global location factors that will affect his decision
  - Use a combinational of methods in his analysis
    - Use Center of Gravity (COG) to roughly determine the location
    - Evaluate potential sites using methods such as Load-Distance (LD) and Factor-Rating

Learning Outcome

- Facility Location Decisions
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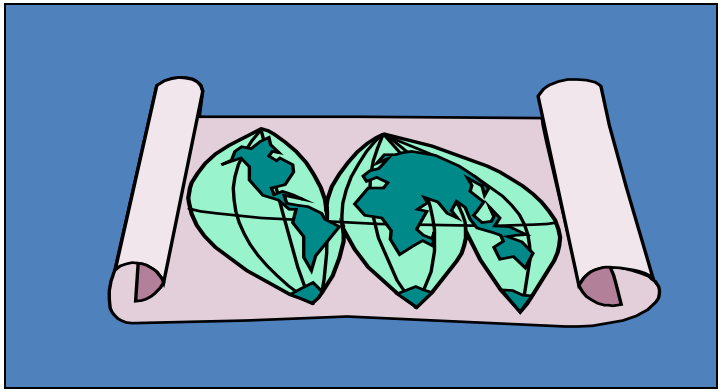
- Location Analysis Techniques



Going Further….

Global Location Factors

What companies must consider when locating in a foreign countries

- Government stability
- Government regulations
- Political and economic systems
- Economic stability and growth
- Exchange rates
- Culture
- Climate
- Export import regulations, duties and tariffs
- Location Incentives
- Raw material availability
- Number and proximity of suppliers
- Transportation and distribution system
- Labor cost and education
- Available technology
- Commercial travel
- Technical expertise
- Cross-border trade regulations
- Group trade agreements