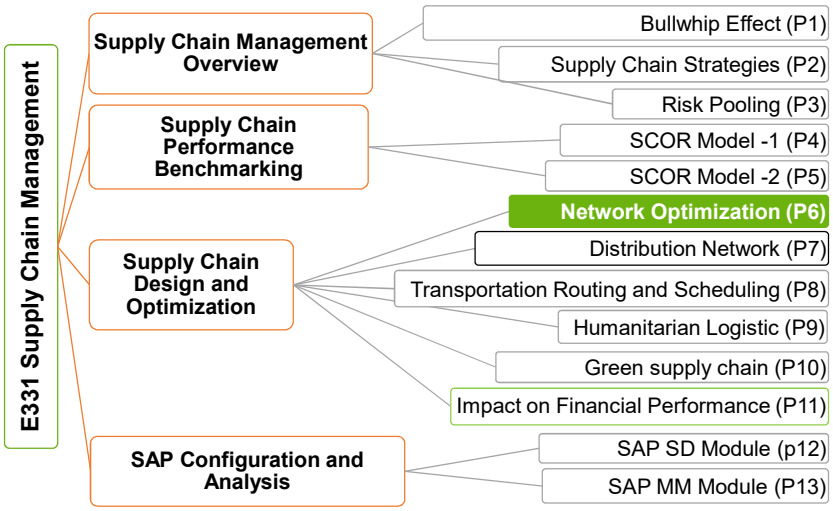
Lesson 06

Make a Wise Decision!

E331 – Supply Chain Management

E331 Module Overview



Supply Chain Network Design Decisions

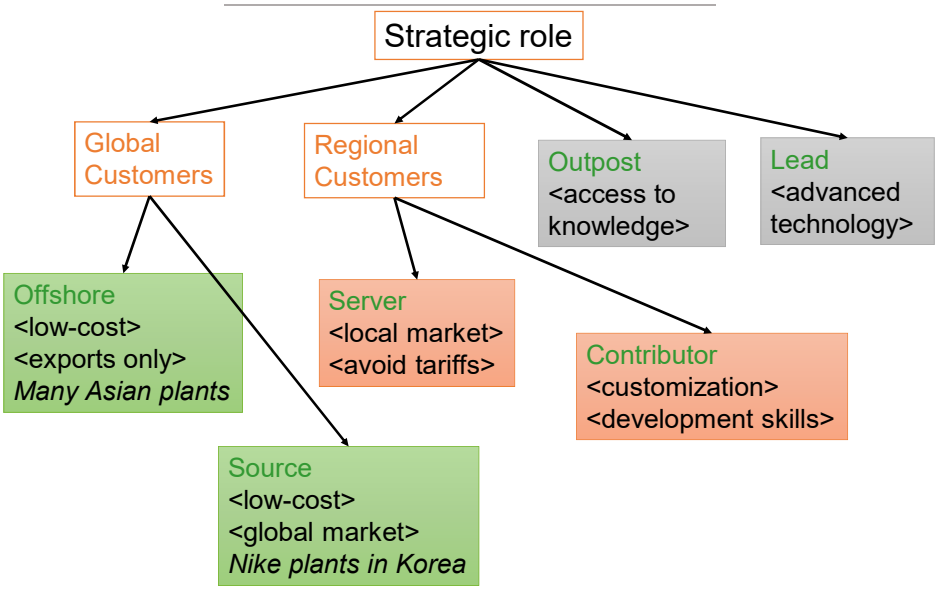
Network design decisions have a long-term impact on supply chain performance:

- **Facility role:** Should we build it as a plant, distribution center, warehouse or retail store?
- **Facility location:** Where should the facilities be located?
- **Capacity allocation:** How much capacity should be allocated to each facility? Should we build a small or big plant?
- **Market and supply allocation:** Which plants should serve which markets?

Strategic Factors

- Cost oriented
- Customer responsiveness
- Classification of facilities:
  - **Offshore Facility:** Low-cost facility for export production
  - **Source Facility:** Low cost facility for global production – facilities with low costs , well-developed infrastructure and available skilled workforce. resulting from the evolution of good offshore facilities
  - **Server Facility :** Regional production facility, to supply the market where it is located with the consideration of tax incentive, tariff barriers and high logistic cost to supply the region from elsewhere
  - **Contributor Facility:** Regional production facility with development skills (mainly focusing on customization for the local market)
  - **Outpost Facility:** Regional production facility built to gain local skills
  - **Lead Facility:** Facility that leads in development and process technologies

Strategic Factors



Strategic Factors

- If the manufacturing plant is set up in Thailand, the plant could be an Source facility or Server facility
  - Source Facility: Low cost facility for global production – facilities with relative low costs , well-developed infrastructure and available skilled workforce
  - Server facility: to supply the market where it is located with the consideration of tax incentive , tariff barriers, and high logistics cost to supply the region from elsewhere
- If the manufacturing plant is set up in Singapore, the plant could be a Contributor facility
  - Contributor Facility: Regional production facility with development skills (mainly focusing on customization/process improvement for the local market)
- For today's problem, strategic role of the new factories will be source facility

Technological Factors

- Characteristics of available production technologies have a significant impact on the network design
  - If production technology provides significant economies of scale, then having a few high capacity locations is the most effective strategy
    Example: Wafer Fabrication Plant
  - If lower fixed costs is preferred, many local facilities are recommended
    Example: Bottling Plant
- Flexibility of the production technology impacts the degree of consolidation in the network
  - Flexible production → can produce various products → *Few but large facilities*
  - Inflexible production → can only produce certain products → *Many local facilities*

Macroeconomic Factors (Risks)

- Political, exchange rate and demand risk
- *Exchange rate risks*: This risk arises from the fact that companies might incur their costs in one currency and collect their revenues in other currencies.
- *Potential protection to exchange rate risk:* Build some flexible over-capacity to the regional facilities so that production is shifted to the lower-cost regions.
- *Demand risk:* Comes from extensive demand fluctuation due to regional economic crises (e.g. Asian markets between 2008-2012) Plant flexibility is also a potential protection to demand risk.
- *Political risks:* need for Well-defined rules of commerce, independent and clear legal systems , political stability

Macroeconomic Factors (Tax Incentives)

- Tax and tariffs incentive are very important factors in location selection
  - ✓ ***Tariffs*** are any duties that must be paid when products and/or equipment are moved across international, state or city boundaries. High tariffs necessitate localized production.
  - ✓ ***Free trade zones*:** Areas where duties and tariffs are relaxed as long as production is used primarily for export. It allows companies to take better advantage of low labor costs.
- The corporate tax rate of Singapore is 17%, just 0.5% higher than that of Hong Kong – Singapore's closest competitor in Asian region.
- Singapore is a favorable location for MNCs to set up offshore facilities due to its political, infrastructure and technological factors. The Economic Development Board (EDB) offers various tax rebate schemes to attract FDI (Foreign Direct Investment) and new technology into Singapore.
  - ✓ ***Pioneer Incentive:*** EDB may grant pioneer tax incentive to an approved industry which is not being carried on in Singapore on a scale adequate to the economic needs of Singapore, and for which there are favorable prospects for development.
  - ✓ ***Development & Expansion Incentive:*** A tax relief period of up to 10 years for the manufacturing or increased manufacturing of any product from any industry that would be of economic benefit to Singapore

Factors Influencing Network Design

Country level factors

- Government stability
- Government regulations
- Economic stability and growth
- Exchange rates
- Culture
- Climate
- Export and import regulations
- Duties and tariffs

Logistics related factors

- Raw material availability
- Number and proximity of suppliers
- Transportation and distribution systems
- Labor force cost and education
- Available technologies
- Technical expertise

Infrastructure Factors

- Availability of skilled labor
- Availability of transportation facilities
  - *Ports*
  - *Airports*
  - *Rail*
  - *Highways*
- Availability of necessary utilities
  - *Power*
  - *Water*
  - *Sewage*
  - *Telecommunications / IT*

Network Optimization Model:
The Capacitated Plant Location Model

- Locating facilities and allocating capacity
  - 2 options: either a low or high capacity plant
- Two decisions to make:
  - Locate the plants and decide the plant capacity
  - Allocate the demand to supply regions
- Data required to build the model (What info do we need to have?)
  - Number of supply regions
  - Number of demand regions
  - Fixed facility costs of opening a facility
  - Transportation costs from a supply region to a demand region
  - Production costs in a supply region
  - Annual demand from each demand region
  - Annual production capacity of a facility

Define Decision Variables

Two types of Decision Variables:

- x_{ij} = Quantity shipped from supply region "I" to demand region "j"
- y_i = 1 if plant is located at site "I", 0 otherwise (binary variable)

x_{ij} y_i

Decision Variables

Supply Region	*Demand Region - Production Allocation*					Low Capacity Plant (1=open)	High Capacity Plant (1=open)
	Japan	Korea	China	ASEAN	Australia		
Singapore	0	0	0	0	60	1	0
Vietnam	0	0	0	0	0	0	0
Thailand	0	0	0	0	0	0	0
North China	60	50	0	0	0	0	1
South China	0	0	160	0	0	1	1
Philippines	0	0	0	100	0	0	1

Define Constraints

Two Main Constraints:

- Excess capacity for each supply region >=0
- Unmet demand for each demand region = 0

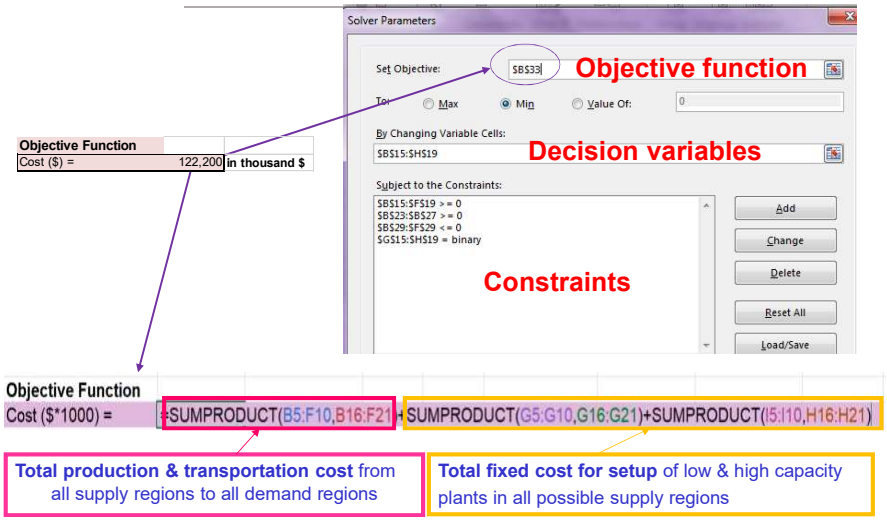
Excess capacity for each supply region >=0

Constraints

Supply Region	*Excess Capacity*				
Singapore	0				
Vietnam	0				
Thailand	0				
North China	10				
South China	20				
Philippines	20				
	Japan	Korea	China	ASEAN	Australia
Unmet Demand	0	0	0	0	0

Unmet demand for each demand country/region <=0

Define Objective Function



Solutions for Today's Problem

Decision Variables

Supply Region	Demand Region - Production Allocation					Low Capacity Plant (1=open)	High Capacity Plant (1=open)
	Japan	Korea	China	ASEAN	Australia		
Singapore	0	0	0	0	60	1	0
Vietnam	0	0	0	0	0	0	0
Thailand	0	0	0	0	0	0	0
North China	60	50	0	0	0	0	1
South China	0	0	160	0	0	1	1
Philippines	0	0	0	100	0	0	1

- Total cost = $122,200,000
- 1 small in Singapore
- 1 big in North China
- 1 big and 1 small in South China
- 1 small in Philippines
- Excess capacity in North China, South China and Philippines
- All demand are met

Supply Region	Excess Capacity
Singapore	0
Vietnam	0
Thailand	0
North China	10
South China	20
Philippines	20

	Japan	Korea	China	ASEAN	Australia
Unmet Demand	0	0	0	0	0

Alternative Scenario

- If the company wants to set up at most one plant in each supply region:

Decision Variables

Supply Region	Demand Region - Production Allocation					Low Capacity Plant (1=open)	High Capacity Plant (1=open)
	Japan	Korea	China	ASEAN	Australia		
Singapore	0	0	0	0	60	1	0
Vietnam	0	0	0	0	0	0	0
Thailand	0	0	0	60	0	1	0
North China	30	50	40	0	0	0	1
South China	0	0	120	0	0	0	1
Philippines	30	0	0	40	0	0	1

- One new constraint: total number of plants in each supply region <= 1
- Total cost = $127,500,000 (higher)
- 1 small plant in Singapore
- 1 small plant in Thailand
- 1 big plant in North China
- 1 big plant in South China
- 1 big plant in Philippines
- Philippines has excess capacity of 50 thousand drums/year

Supply Region	Excess Capacity
Singapore	0
Vietnam	0
Thailand	0
North China	0
South China	0
Philippines	50

Recommendations

- It is a complicated decision on determining the suitability of the plant locations, the company needs to consider the followings besides the cost factor :
  - Strategic factor, focus on cost or customer responsiveness
  - Technology factor, such as available production technologies
  - Macroeconomic factor, such as independent and clear legal systems, political stability, low tax rate.
  - Infrastructure factor, such as the availability of skilled labour, transportation facilities and necessary utilities, etc.

Supply Chain Optimization

- Optimization is similar to network design
  - Use the word “design” when new facilities are added
  - Use the word “optimization” when existing network is evaluated and relocated
- Network design/optimization decisions
  - Number & locations of facilities (plants, warehouses, etc.)
  - Capacities (size) of facilities and product mix at plants
  - Allocation of plants to warehouses
  - Allocation of warehouses to stores
  - Customers clustering and aggregation
  - Product grouping
- Software (desired in complex SC design & optimization)
  - ILOG
  - Supply Chain Guru
  - SAP SCM Supply Network Planning, etc.

Learning Outcome

- Describe the factors influencing supply chain network design decisions
- Apply The Capacitated Plant Location Model to determine the location and capacity allocation for each facility using Integer Programming
- Identify the potential locations in each region for which a company has decided to site a manufacturing plant
- Determine how markets will be allocated to facilities