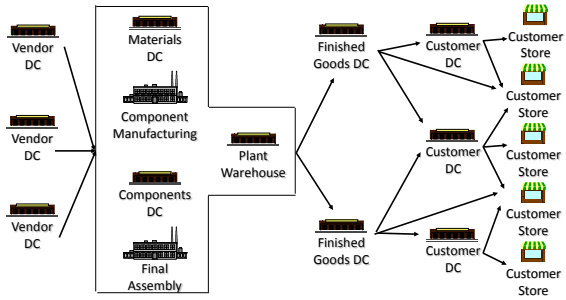
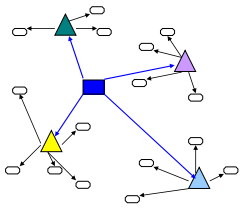
NETWORK CONFIGURATION

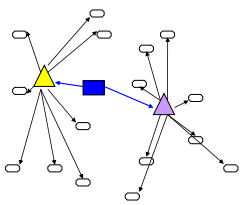
Conventional Network



Network Design

- Network design is a strategic decision. It has a long-term impact on a supply chain's performance.
- It determines very much flexibility / responsiveness and cost effectiveness of a supply chain.
  - Cost focus: Find the lowest-cost location for manufacturing facilities.
  - Responsiveness: Locate facilities closer to the market to react quickly to changing market needs.



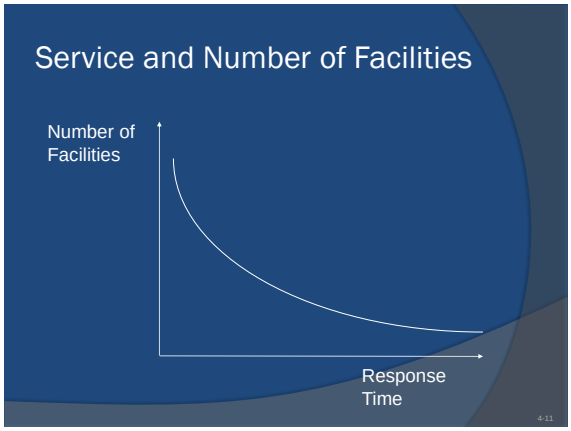


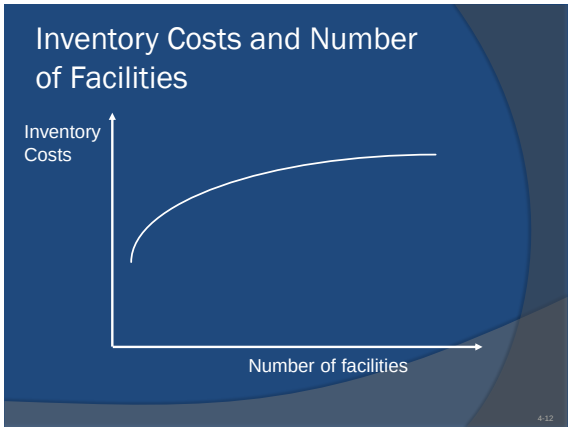

Where inventory needs to be for a 5 day order response time - typical results --> 2 DCs
Customer
DC

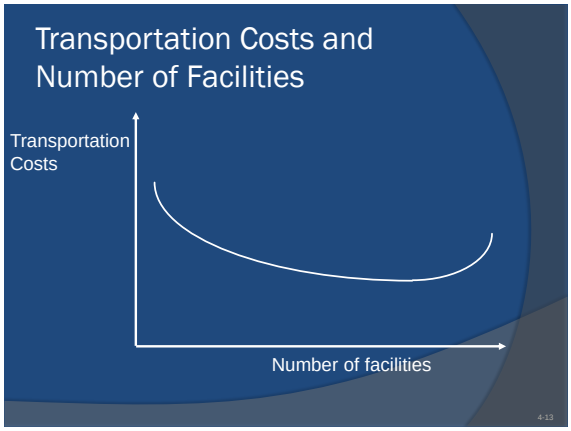

Where inventory needs to be for a 3 day order response time - typical results --> 5 DCs
Customer
DC

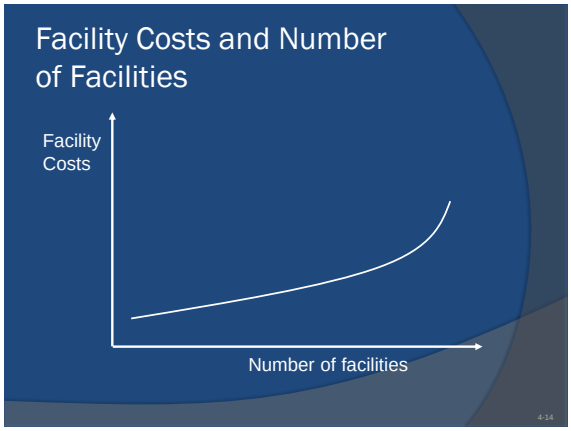

Where inventory needs to be for a next day order response time - typical results --> 13 DCs
Customer
DC

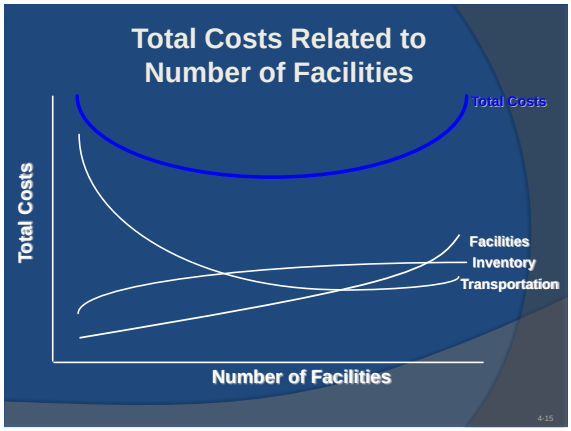

Where inventory needs to be for a same day / next day order response time - typical results --> 26 DCs
Customer
DC

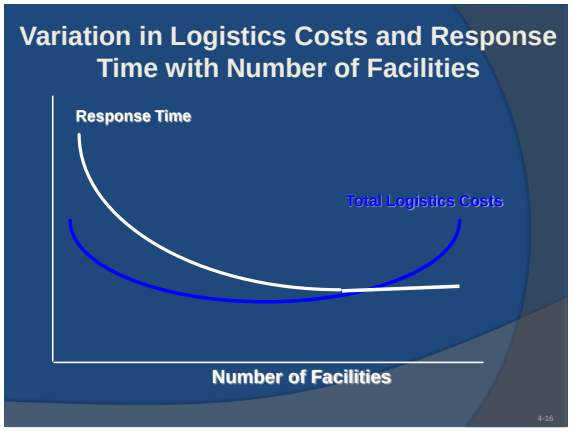

Service and Number of Facilities
Number of Facilities
Response Time
4-11


Inventory Costs and Number of Facilities
Inventory Costs
Number of facilities
4-12









Consolidation Vs Localization

- Consolidation is necessary if products are relatively standard and virtually no local features are needed to be added.
- Localization is suitable for products need high responsiveness and local features are important.
  - HP design different printer for North American, Europe, and Asia.

Factor Influencing Network Design Decisions

- Macroeconomic
- Politic
- Social
- Infrastructure

Macroeconomic Factors to Consider in Designing a Network

- **Tariff and Tax incentives**
  - Guang Zhou offered free tax and other incentives for investors. Many manufacturing and High Tech. companies established factories in Guang Zhou as a result.
  - US responded import and quota barriers by developing supplier in many countries.
- **Exchange Rates and Demand Risks**
  - In 1980s yen was appreciated. Exporting companies received lower profits. Many companies responded by moving operations overseas.

The Role of Distribution in the Supply Chain

- ***Distribution***: the steps taken to move and store a product from the supplier stage to the customer stage in a supply chain
- Distribution directly affects cost and the customer experience and therefore drives profitability
- Choice of distribution network can achieve supply chain objectives from low cost to high responsiveness
- Examples: Wal-Mart, Dell, Proctor & Gamble, Grainger

4-20

Factors Influencing Distribution Network Design

- Distribution network performance evaluated along two dimensions at the highest level:
  - Customer needs that are met
  - Cost of meeting customer needs
- Distribution network design options must therefore be compared according to their impact on customer service and the cost to provide this level of service

4-21

Factors Influencing Distribution Network Design

- Elements of customer service influenced by network structure:
  - Response time
  - Product variety
  - Product availability
  - Customer experience
  - Order visibility
  - Returnability
- Supply chain costs affected by network structure:
  - Inventories
  - Transportation
  - Facilities and handling
  - Information

4-22

Global Bussiness Unit

- Beauty & Grooming
- Health & Well Being
- Household Care

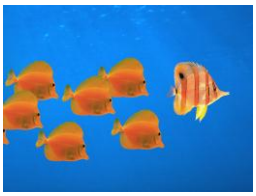
Restrukturisasi P & G:

Menjadi lebih efisien dan responsive

- Secara umum terjadi perampingan dari 11 region menjadi 7 region.
  - North America
  - South America
  - Western Europe
  - Middle East dan Eastern Europe
  - North East Asia
  - Greater China
  - AAI dengan pusat di Singapore
- Thailand menjadi pusat produksi shampoo.
- Philippine akan dijadikan pusat pabrik detergent.
- Indonesia akan menjadi pusat produksi produk kesehatan dan perawatan rambut.
- Marketing berpusat di Singapore.

Keuntungan Restrukturisasi P & G

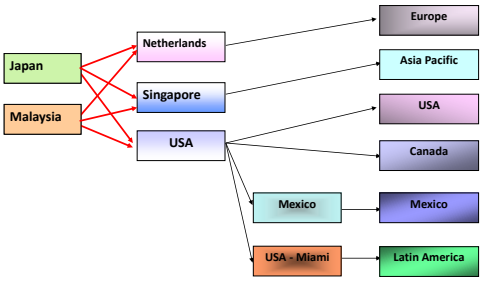
- Penghematan biaya transportasi staff
- Peningkatan economic of relationship dengan supplier (membeli dengan skala yang lebih besar)
- Penghematan biaya promosi



Case

CD-RW @ Hewlett-Packard

Initial Configuration



Competitors Are Mushrooming:

Only 4 in 1997, more than 50 in 2001

Price decreases by 50% annually

Life cycle decreases sharply

Toward Major Changes

Problems with Initial Configuration

- Long
- Costly
- Unresponsive

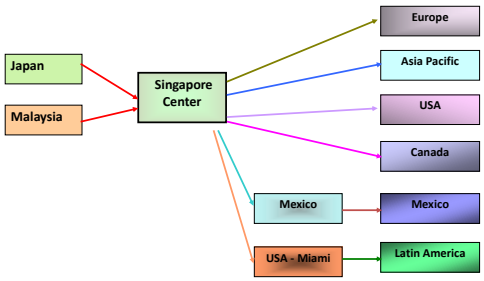
126 days of fulfillment cycle:

- Transit from supplier to DC 30 days
- In DC 91 days
- From DC to stores 5 days

The Project

- A team of 100 people from 14 organizations
- Involving 5 countries and 6 time zones
- Support from top management
- Incentives for keeping the spirit high
- Beer game to attract involvement (including suppliers)

Re-engineered Configuration



Results

- Inventory turnover increases from 3 to 45
- Lead time decreases from 126 days to 8 days.
- Cost savings of US $ 50 million (from overhead, inventory, negotiation with suppliers)

MODELS FOR LOCATION PROBLEMS

- Single Facility Location: *Center of Gravity, Grid, Centroid.*
- Multi Facility Location: *Multiple gravity, Mixed integer programming, Simulation, Heuristics.*
- Capacitated Plant Location Model

Gravity Location Models

- Is used to find the location that minimizes the cost of transporting raw materials from the points of supply and transporting finished goods to the customers.
- Let:
  - X_n, Y_n : coordinate location of either a market or a supply point
  - C_n : cost of shipping one unit for one km from or to location n the facility to be located
  - D_n : Quantity to be shipped from or to location n to the facility
  - d_n : the distance to or from facility n to the facility
- The distance d_n is approximated as follows: (If (x,y) is the coordinate of the location of the facility)

$$d_n = \sqrt{(x - x_n)^2 + (y - y_n)^2}$$

- If there are k supply and market points then total cost of transportation to and from the facility is:

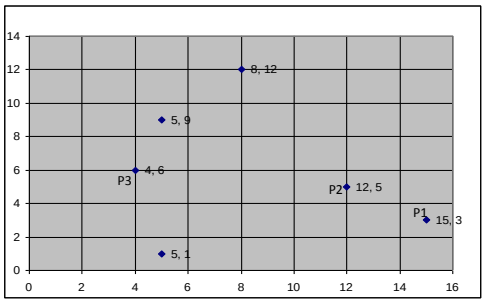
$$TC = \sum_{n=1}^{k} d_n D_n C_n$$

- The location that minimizes the TC can be obtained with the following steps:
  1. For each supply or market position n, calculate d_n as above
  2. Obtain a new location (x',y') where:

$$x' = \frac{\sum_{n=1}^{k} \frac{D_n C_n x_n}{d_n}}{\sum_{n=1}^{k} \frac{D_n C_n}{d_n}} \qquad y' = \frac{\sum_{n=1}^{k} \frac{D_n C_n y_n}{d_n}}{\sum_{n=1}^{k} \frac{D_n C_n}{d_n}}$$

  3. If the new location is almost the same as (x,y) then stop, otherwise set (x,y) = (x',y') and go to step 1.

There are six existing facilities. The new one (a warehouse) will serve all six facilities.



The Relevant Data

Xn	Yn	dn	Dn	Cn
5	1	5.1	100	1.5
4	6	7.2	700	1.8
8	12	14.4	200	2.5
12	5	13.0	150	1.9
5	9	10.3	400	1.7
15	3	15.3	200	2.1

First iteration using (x,y) = (0,0), Result (6.0, 6.4)

Xn	Yn	dn	Dn	Cn	DnCnXn/ dn	DnCnYn/ dn	DnCn/ dn
5	1	5.1	100	1.5	147.1	29.4	29.4
4	6	7.2	700	1.8	698.9	1048.4	174.7
8	12	14.4	200	2.5	277.4	416.0	34.7
12	5	13.0	150	1.9	263.1	109.6	21.9
5	9	10.3	400	1.7	330.2	594.4	66.0
15	3	15.3	200	2.1	411.8	82.4	27.5
Total					2128.5	2280.2	354.2

X'=2128.5/354.2=6.0
Y'=2280.2/354.2=6.4

Second Iteration: Result (5.4, 6.9)

Xn	Yn	dn	Dn	Cn	DnCnXn/ dn	DnCnYn/ dn	DnCn/d n
5	1	5.5	100	1.5	136.6	27.3	27.3
4	6	2.0	700	1.8	2471.1	3706.6	617.8
8	12	5.9	200	2.5	672.7	1009.0	84.1
12	5	6.2	150	1.9	555.1	231.3	46.3
5	9	2.8	400	1.7	1220.5	2197.0	244.1
15	3	9.6	200	2.1	654.8	131.0	43.7
Total					5710.8	7302.1	1063.2

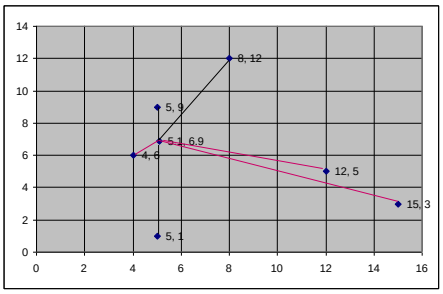
Third Iteration: Result (5.1, 6.9)

Xn	Yn	dn	Dn	Cn	DnCnXn/ dn	DnCnYn/ dn	DnCn/d n
5	1	5.9	100	1.5	126.8	25.4	25.4
4	6	1.7	700	1.8	3028.2	4542.4	757.1
8	12	5.7	200	2.5	698.7	1048.1	87.3
12	5	6.9	150	1.9	498.0	207.5	41.5
5	9	2.1	400	1.7	1590.5	2862.8	318.1
15	3	10.4	200	2.1	608.0	121.6	40.5
Total					6550.2	8807.8	1269.9

Fourth Iteration: Result (5.1, 6.9)

Xn	Yn	dn	Dn	Cn	DnCnXn/ dn	DnCnYn/ dn	DnCn/d n
5	1	5.9	100	1.5	127.0	25.4	25.4
4	6	1.5	700	1.8	3360.0	5040.0	840.0
8	12	5.8	200	2.5	687.5	1031.3	85.9
12	5	7.1	150	1.9	484.4	201.8	40.4
5	9	2.1	400	1.7	1611.8	2901.2	322.4
15	3	10.5	200	2.1	597.3	119.5	39.8
Total					6868.0	9319.1	1353.9

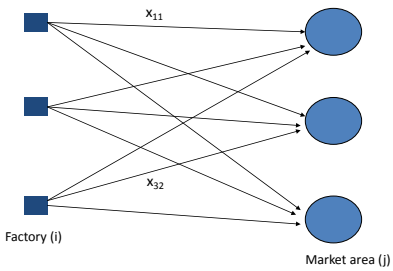
Final Position: Warehouse in (5.1, 6.9)



Capacitated Location Problem

- Suppose there are n factories in different locations to be selected to satisfy demand in m market areas. Each factory location is associated with a fixed cost. The production and delivery costs to from each factory to each demand point is known.
- The problem to solve is: Which factory to open and from which factory each market demand is fulfilled?
- Suppose:
  i = factory location (1, 2,…n)
  j = demand point (1, 2, … m)
  Dj = demand of market area j
  Ki = capacity of factory i
  fi = annualized fixed cost for factory i
  cij = cost of producing and delivering one unit of product from factory i to demand area j
  yi = 1 if factory i is selected, 0 otherwise
  xij = the amount shipped from factory i to market j

Problem Structure



Capacitated Location Problem

$$Minimise \sum_i f_i y_i + \sum_i \sum_j c_{ij} x_{ij}$$

$$\sum_i x_{ij} = D_j$$

$$\sum_j x_{ij} \le K_i y_i$$

$$x_{ij} \ge 0;\ y_i \in (0,1)$$

Problem

	Pasar						
Pabrik	**Fixed**	**JTM**	**JTG**	**JB**	**JKT**	**SS**	**Kapasitas**
Surabaya	250	5	10	15	16	25	**5000**
Pasuruan	165	10	12	17	18	25	**3200**
Gresik	180	6	9	14	12	24	**4000**
Tangerang	200	15	7	4	6	10	**4000**
Permintaan		**2000**	**1800**	**1500**	**3000**	**1700**	

Penyelesaian dengan software LINDO

- MIN 250 Y1 + 165 Y2 + 180 Y3 + 200 Y4 + 5 X11 + 10 X12 + 15 X13 + 16 X14 + 25 X15 + 10 X21 + 12 X22 + 17 X23 + 18 X24 + 25 X25 + 6 X31 + 9 X32 + 14 X33 + 12 X34 + 24 X35 + 15 X41 + 7 X42 + 4 X43 + 6 X44 + 10 X45
- SUBJECT TO

! Capacity of each factory
X11 + X12 + X13 + X14 + X15 - 5000 Y1 <= 0
X21 + X22 + X23 + X24 + X25 - 3200 Y2 <= 0
X31 + X32 + X33 + X34 + X35 - 4000 Y3 <= 0
X41 + X42 + X43 + X44 + X45 - 4000 Y4 <= 0

! Demand of each market areas
X11 + X21 + X31 + X41 = 2000
X12 + X22 + X32 + X42 = 1800
X13 + X23 + X33 + X43 = 1500
X14 + X24 + X34 + X44 = 3000
X15 + X25 + X35 + X45 = 1700
END

- ! Binary number of factory

INT Y1
INT Y2
INT Y3
INT Y4

Solution:
OBJECTIVE FUNCTION VALUE

1) 81030.00

VARIABLE	VALUE	REDUCED COST
Y1	**1.000000**	250.000000
Y2	0.000000	165.000000
Y3	**1.000000**	180.000000
Y4	**1.000000**	-23800.000000
X11	**2000.000000**	0.000000
X12	0.000000	1.000000
X13	0.000000	5.000000
X14	0.000000	4.000000
X15	0.000000	9.000000
X21	0.000000	5.000000
X22	0.000000	3.000000
X23	0.000000	7.000000
X24	0.000000	6.000000
X25	0.000000	9.000000
X31	0.000000	1.000000
X32	**1800.000000**	0.000000
X33	0.000000	4.000000
X34	**2200.000000**	0.000000
X35	0.000000	8.000000
X41	0.000000	16.000000
X42	0.000000	4.000000
X43	**1500.000000**	0.000000
X44	**800.000000**	0.000000
X45	**1700.000000**	0.000000

For total cost = 81030, build factory in Y1 (Surabaya), Y3 (Gresik), and Y4 (Tangerang),

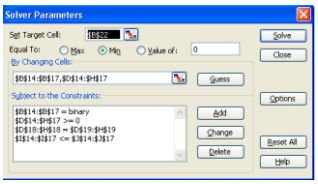
distribute:
X11 (Surabaya—JTM) = 2000
X32 (Gresik—JTG) = 1800
X34 (Gresik—JKT) = 2200
X43 (Tangerang—JB) = 1500
X44 (Tangerang—JKT) = 800
X45 (Tangerang—SS) = 1700

Solution

Variabel	y_i	JTM	JTG	JB	JKT	SS
Surabaya	1	2000	0	0	0	0
Pasuruan	0	0	0	0	0	0
Gresik	1	0	1800	0	2200	0
Tangerang	1	0	0	1500	800	1700

Penyelesaian dengan Solver Excel

	A	B	C	D	E	F	G	H	I	J
12										
13	**Variabel**	**yi**	**Fixed**	**JTM**	**JTG**	**JB**	**JKT**	**SS**	**Total**	**Kapasitas**
14	Surabaya	0	250	0	0	0	0	0	0	5000
15	Pasuruan	0	165	0	0	0	0	0	0	3200
16	Gresik	0	180	0	0	0	0	0	0	4000
17	Tangerang	0	200	0	0	0	0	0	0	4000
18	**total**			0	0	0	0	0		
19	**permintaan**			**2000**	**1800**	**1500**	**3000**	**1700**		
20										
21										
22	total biaya	0								



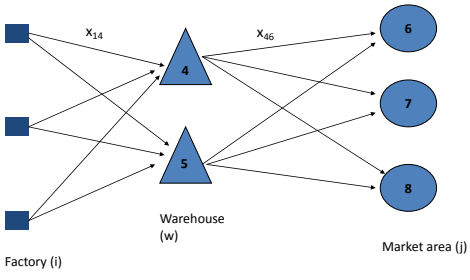
Solusi Akhir

	A	B	C	D	E	F	G	H	I	J
12										
13	**Variabel**	**yi**	**Fixed**	**JTM**	**JTG**	**JB**	**JKT**	**SS**	**Total**	**Kapasitas**
14	Surabaya	1	250	2000	0	0	0	0	2000	5000
15	Pasuruan	0	165	0	0	0	0	0	0	3200
16	Gresik	1	180	0	1800	0	2200	0	4000	4000
17	Tangerang	1	200	0	0	1500	800	1700	4000	4000
18	**total**			2000	1800	1500	3000	1700		
19	**permintaan**			**2000**	**1800**	**1500**	**3000**	**1700**		
20										
21										
22	total biaya	81030								

Dari hasil di atas dapat diketahui hal-hal sebagai berikut :

- Pabrik di Surabaya menyalurkan produk ke pasar JTM sebanyak 2000 unit.
- Pabrik di Gresik menyalurkan produk ke pasar JTG sebanyak 1800 unit dan ke pasar JKT sebanyak 2200 unit.
- Pabrik di Tangerang menyalurkan produk ke pasar JB sebanyak 1500 unit, ke JKT 800 unit, dan ke SS sebanyak 1700 unit.
- Total biaya pengiriman yang dihasilkan adalah sebesar Rp 81.030 per tahun.

Factory and Warehouse Location-Delivery Problem



Factory and Warehouse Location-Delivery Problem

$$Minimise \sum_i f_i y_i + \sum_w f_w y_w + \sum_i \sum_w c_{iw} x_{iw} + \sum_w \sum_j c_{wj} x_{wj}$$

$$\sum_w x_{wj} = D_j$$

$$\sum_w x_{iw} \le K_i y_i$$

$$\sum_i x_{iw} = \sum_j x_{wj}$$

$$\sum_j x_{wj} \le K_w y_w$$

Homework: Use LP software to solve the following problem. You are to decide the most economical factory and warehouse selections.

From I To	W1	W2	W3	Annual. fixed cost	Capacity
F1	320	330	400	2,200,000	4000
F2	400	300	370	1,800,000	4800
F3	200	220	250	2,500,000	5200

F!T	M1	M2	M3	M4	M5	Ann. Fixed cost	Annual Capacity
W1	420	320	320	220	180	200,000	3700
W2	350	180	700	120	110	350,000	4800
W3	230	620	200	340	250	380,000	5000
Annual Demand	**1400**	**1500**	**1250**	**1100**	**1800**		