



IIT ROORKEE



NPTEL ONLINE
CERTIFICATION COURSE

SUPPLY CHAIN ANALYTICS

Network Optimization Models

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Network Optimization Models

- Allocating demand to production facilities
- Locating facilities and allocating capacity

Key Costs:

- Fixed facility cost
- Transportation cost
- Production cost
- Inventory cost
- Coordination cost

Which plants to establish? How to configure the network?



Demand Allocation Model

- Which market is served by which plant?
- Which supply sources are used by a plant?

x_{ij} = Quantity shipped from plant site i to customer j

$$\text{Min} \sum_{i=1}^n \sum_{j=1}^m c_{ij} x_{ij}$$

s.t.

$$\sum_{i=1}^n x_{ij} = D_j, j = 1, \dots, m$$

$$\sum_{j=1}^m x_{ij} \leq K_i, i = 1, \dots, n$$

$$x_{ij} \geq 0$$



Plant Location with Multiple Sourcing

- $y_i = 1$ if plant is located at site i , 0 otherwise
- x_{ij} = Quantity shipped from plant site i to customer j

$$\text{Min} \sum_{i=1}^n f_i y_i + \sum_{i=1}^n \sum_{j=1}^m c_{ij} x_{ij}$$

s.t.

$$\sum_{i=1}^n x_{ij} = D_j, j = 1, \dots, m$$

$$\sum_{j=1}^m x_{ij} \leq K_i y_i, i = 1, \dots, n$$

$$\sum_{i=1}^n y_i \leq k; y_i \in \{0,1\}$$



Plant Location with Single Sourcing

- $y_i = 1$ if plant is located at site i , 0 otherwise
- $x_{ij} = 1$ if market j is supplied by factory i , 0 otherwise

$$\text{Min} \sum_{i=1}^n f_i y_i + \sum_{i=1}^n \sum_{j=1}^m D_j c_{ij} x_{ij}$$

s.t.

$$\sum_{i=1}^n x_{ij} = 1, j = 1, \dots, m$$

$$\sum_{j=1}^m D_j x_{ij} \leq K_i y_i, i = 1, \dots, n$$

$$x_{ij}, y_i \in \{0,1\}$$



Cost and Demand Data

	A	B	C	D	E	F	G	H	I	J
1	Inputs- Costs, Capacities, Demands									
2		Demand Destination Production and Transportation cost per 1,000 units					Fixed Cost for low capacity (Rs,000)	Low Capacity	Fixed Cost for High capacity (Rs,000)	High Capacity
3	Supply Source	USA	Brazil	Denmark	UAE	Vietnam				
4	USA	50	70	100	120	100	6,000	10	9,000	20
5	Brazil	70	50	120	150	140	4,500	10	7,000	20
6	Denmark	120	150	80	100	120	7,000	10	10,000	20
7	UAE	90	125	100	75	120	4,000	10	6,000	20
8	Vietnam	150	180	125	100	70	3,500	10	6,000	20
9	Demand	12	6	14	16	7				



Excel Spreadsheet Area for Decision Variables

	A	B	C	D	E	F	G	H	I	J	K
1	Inputs- Costs, Capacities, Demands										
2		Demand Destination Production and Transportation cost per 1,000 units					Fixed Cost for low capacity (Rs,000)	Low Capacity	Fixed Cost for High capacity (Rs,000)	High Capacity	
3	Supply Source	USA	Brazil	Denmark	UAE	Vietnam					
4	USA	50	70	100	120	100	6,000	10	9,000	20	
5	Brazil	70	50	120	150	140	4,500	10	7,000	20	
6	Denmark	120	150	80	100	120	7,000	10	10,000	20	
7	UAE	90	125	100	75	120	4,000	10	6,000	20	
8	Vietnam	150	180	125	100	70	3,500	10	6,000	20	
9	Demand	12	6	14	16	7					
10											
11	Decision Variables										
12		Demand Country- production Allocation					Plants	Plants			
13	Supply Source	USA	Brazil	Denmark	UAE	Vietnam	(1= open)	(1 = open)			
14	USA	0	0	0	0	0	0	0			
15	Brazil	0	0	0	0	0	0	0			
16	Denmark	0	0	0	0	0	0	0			
17	UAE	0	0	0	0	0	0	0			
18	Vietnam	0	0	0	0	0	0	0			
19											

Various Formulae of Model to be Used in Excel Solver

Cell	Cell Formula	Constraint/ Objective Function	Copied to
B28	= B9- SUM (B14: F14)	Constraint (A)	B28: F28
B22	= G14*H4 +H14*J4- SUM(B14:F14)	Constraint (B)	B22:B26
B31	= SUMPRODUCT (B14:F18, B4:F8) + SUMPRODUCT (G14: G18, G4: G8) + SUMPRODUCT (H14: H18, I4: I8)	Objective Function	---



Excel Spreadsheet Area for Decision Variables Including Constraints and Objective Function

	A	B	C	D	E	F	G	H	I	J
1	Inputs- Costs, Capacities, Demands									
2		Demand Destination Production and Transportation cost per 1,000 units					Fixed Cost for low capacity (Rs,000)	Low Capacity	Fixed Cost for High capacity (Rs,000)	High Capacity
3	Supply Source	USA	Brazil	Denmark	UAE	Vietnam				
4	USA	50	70	100	120	100	6,000	10	9,000	20
5	Brazil	70	50	120	150	140	4,500	10	7,000	20
6	Denmark	120	150	80	100	120	7,000	10	10,000	20
7	UAE	90	125	100	75	120	4,000	10	6,000	20
8	Vietnam	150	180	125	100	70	3,500	10	6,000	20
9	Demand	12	6	14	16	7				
10										
11	Decision Variables									
12		Demand Country- production Allocation					Plants	Plants		
13	Supply Source	USA	Brazil	Denmark	UAE	Vietnam	(1= open)	(1 = open)		
14	USA	0	0	0	0	0	0	0		
15	Brazil	0	0	0	0	0	0	0		
16	Denmark	0	0	0	0	0	0	0		
17	UAE	0	0	0	0	0	0	0		
18	Vietnam	0	0	0	0	0	0	0		
19										
20	Constraints									
21	Supply Source	Excess Capacity								
22	USA	0								
23	Brazil	0								
24	Denmark	0								
25	UAE	0								
26	Vietnam	0								
27		USA	Brazil	Denmark	UAE	Vietnam				
28	Unmet Demand	12	6	14	16	7				
29										
30	Objective Function									
31	Cost =									
32										

THANK YOU

