Obj function = Minimise $\Sigma\Sigma\, C_{ij} \times X_{ij}$ (subject to supply constraints) # For this chapter only study/revise from copy. Handwritten notes refer notes.

$X_{ij} \geq 0$.

All illustrations.

Video mi dekh lena.

Chapter 11.

The Transportation Problem.

It is a decision making technique. Under it efforts are made to transport certain quantity of goods from certain origin to certain destination with the object of cost minimization.

Transportation problem can be solved by following procedure :-

Phase 1: Initial Solution. (Basic feasible).

It can be determined by following 3 methods :-

1. Least cost corner method
2. North west corner method
3. Vogels Approximation method (VAM) ☑

Phase II: Optimum Solution.

It can be determined by following two methods :-

1. Stepping stone method
2. Modified Distribution method (MOD method) ☑

Initial Solution :-

1. Least cost corner Method. — Under this method, each transportation shall be made at least cost among available cell upto maximum possible extent.

(↓ Read from copy first.)

	D1	D2	D3	D4	D5	D6	Supply
O1	4	6	3	(3) 2	7	(7) 8	10
O2	3	5	4	0	10	(12) 10	12
O3	2	6	9	8	4	13	4
O4	(4) 4	(8) 4	(6) 5	9	3	6	18
O5	9	8	(10) 7	3	(8) 2	(2) 14	20
Demand	8	8	16	3	8	21	64

[Read method first from page 7th of copy.]

- North west corner method :- Under this method each transportation shall be made at first cell and continue as go.

	D_1	D_2	D_3	D_4	D_5	D_6	Supply.
O_1	(8)	(2)					10
O_2		(6)	(6)				12
O_3			(4)				4
O_4			(6)	(3)	(8)	(1)	18
O_5						(20)	20
Demand.	8	8	16	3	8	21.	64

- Vogels Approximation method (VAM) :- Under this method, following procedure shall be used :- (Read from copy first).

Step 1:- Determine penalty for each row & column.
(Penalty is equal to difference between least cost & next least cost of each row & column)

Step 2:- Now select row/column for transportation (the row/column having highest penalty should be selected)

Step 3:- Now, make transportation in the selected row/column at least cost cell.

Step 4:- After each transportation, above procedure shall be repeated.
If same penalty in more than 1 row/column, then selection on basis of least cost in both, if same cost, then select further on basis of quantity (High quantity, select first)

Special Cases in Transportation :-

(i) Unbalanced Transportation problem : When demand & supply is not equal, it is called unbalanced transportation problem
It can be resolved by introduction of dummy row/column.
All elements in Dummy row/column shall be taken "0"

(ii) Prohibited Transportation problem : If goods cannot be transported from a particular origin to a particular destination, then it is called prohibited transportation.
It shall be resolved by introduction of infinitive cost at prohibited cell.

(iii) Preferred Transportation problem : If certain quantity of goods must be transported from a particular origin to a particular destination, then it is called preferred transportation. It shall be resolved by eliminating quantity of preferred transportation from respective row & column

If is question is unbalanced, then dummy introduced either before conversion into opportunity loss matrix ↓ preference dummy introduced before conversion.

Maximisation in Transportation :-

In such case profit matrix shall be converted into opportunity loss matrix. For such conversion, all element of the matrix shall be deducted from highest element of the matrix.

Multiple Optimum Solution :-

If one or more opportunity cost is zero in final, transportation matrix, then problem has more than one optimum solution.

Degeneracy in transportation :-

(a) **At the initial solution :** If no. of occupied cell is less than $(m+n-1)$ then degeneracy occur.
It can be resolved by assigning epsilone (ε)/E.
(very very small quantity, so that no. of occupied cell = $m+n-1$) In least cost unoccupied independent cell.
(Independent cell → A cell in which loops cannot be formed is called independent cell). L → loop, L L format

(b) **during optimum solution :** when two or more occupied cell simultaneously become unoccupied, then degeneracy occur.
It can be resolved by assigning epsilone (ε)/E to recently vacating cell having least cost.

Optimum Solution :-

1. Stepping stone method :- Under this method, following procedure shall be used.

Step 1:- Determine initial solution.

Step 2:- Now ensure that occupied cell must be equal to (m+n-1)

Step 3:- Now, determine opportunity loss for each unoccupied cell with the help of loop.

Note : Loop is a logical arrangement for maintaining balance of demand & supply. It begins from unoccupied cell & then move to occupied cell only by alternative +/- In such a manner so that balance of demand & supply can be maintained.

Step 4:- If all the opportunity cost are positive or zero, then it is an optimum solution, If one or more opportunity loss are (-)ve, then make transportation at the cell having highest (-)ve opportunity cost with the help of loop.

Modified Distribution method (MOD)

Under this method, following procedure may be used :-

Step 1:- Determine initial solution.

Step 2:- Now, ensure that no. of occupied cell must be equal to (m+n-1)

Step 3:- Now, determine value of U_i & V_j with the help of following equation. This equation must be used on occupied cell only

$$Cost = U_i + V_j$$

Step 4:- Now determine opportunity cost for each unoccupied cell with the help of following equation :-

$$\text{opportunity cost} = \text{Cost} - (U_i + V_j)$$
$$\Delta ij$$

Step 5:- If all opportunity cost are positive or zero, then it is an optimum solution. If one or more opportunity cost is -ve, then make transportation at the cell having highest negative opportunity cost with help of loop.

If opportunity cost is -ve, then transportation unit on that cell will be least quantity of (-) cell (can also be "e")

If more than one opportunity cost is negative & same, then calculate no. of units transported in each & make transportation at highest unit transported cell.