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An Analysis of Transportation Problems and its Initial Basic Feasible Solution (IBFS)

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ABSTRACT

The transportation problem is a type of linear programming problem in which commodities are transported from a set of sources to a set of destinations based on the supply and demand of the source and destination, respectively, in order to minimize the total transportation cost.An Initial Basic Feasible Solution (IBFS) is necessary to obtain the optimal solutionof transportation problems. The optimality gives us the optimal route that prompts or least aggregate cost whichever is required to solve transportation problem.The main purpose of this paper is to find the best method for finding an initial basic feasible solution through the North-West Corner Method (NWCM), Least Cost Method (LCM), and Vogel's Approximation Method (VAM). In this research paper, the researcher has explained how to find an initial basic viable solution for minimize the transportation problem through three methods: the North-West Corner Method (NWCM), the Least Cost Method (LCM), and Vogel's Approximation Method (VAM). The research concludes that Vogel's Approximation Method is best method for finding the Initial Basic Feasible Solution (IBFS).

Key-word: Transportation problem, Supply and Demand,North -west Corner Method (NWCM), Least Cost Method (LCM), Vogel's Approximation Method (VAM).

INTRODUCTION

The transportation problem is one of the most common areas of Operations Research, which has wide range of applications in inventory control, communication network, production planning, scheduling, personal allocation, etc. In order to reduce costs and improve service, transportation problem aspects are important in logistics and supply chain management. In the today's highly competitive market, businesses discover better methods to generate and deliver products and services for better customer services. For transporters it becomes difficult to figure out how and when to supply products to consumers in the amount they required in a cost-effective manner. Transportation models provide a powerful tool for dealing with this issues. They guarantee the efficient supply of raw materials and finished commodities, as well as make them timely available. The aim of the transportation problem is to find a shipment plan that reduces total shipping cost while sustaining supply and demand constraints.A company's primary goal is to make money. The cost of transportation or caring has a strong influence on company's financial activities, and their cost which is inversely related to profit. Companieswill choose the routes which allow businesses to obtain and transport their necessary products at the lowest possible cost withmaximize profit. The transportation problem is based on the supply and demand of goods carried from various sources to various destinations, and it is one of the most significant and early applications of linear programming. Because of its common adoption in determining optimal transportation routes, transportation problems are assigned as best solution for solving transportation problems. Transportation is an important activity of any economy. Transportation is an important component for the success of industrial businesses, especially in a large country like India. A company's product or commodities must be properly distributed to its distributors, dealers, sub-dealers, and other partners.

Transportation problem can be expressed mathematical as

$$\text{Minimize } Z = \sum_{i=1}^{m}\sum_{j=1}^{n} C_{ij}\, x_{ij} \ (\text{Total Transpiration Cost})$$

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Subject to $\sum_{j=1}^{n} x_{ij} = a_i\,, \quad i = 1, 2, 3, \ldots\ldots.m$ (Supply from sources)

$\sum_{i=1}^{m} x_{ij} = b_j, \quad j = 1,2,3, \ldots\ldots n$ (Demand from destinations)

$$x_{ij} \geq 0\,, \quad \text{for all i and j}$$

$$\text{Supply}\left(\sum_{i=1}^{m} a_i\right) = \text{Demand}\left(\sum_{i=1}^{m} a_i\right)$$

Where Z : Total Transportation cost to be minimized.

C_{ij} : Unit Transportation cost of commodity from each source i to destination j.

x_{ij} : Number of units of commodity sent from source i to destination j.

a_i: Level of supply at each source i.

b_j : Level of demand at each destination j.

Tabular representation of Transportation problem

Source	Destination					Total Supply
	D_1	D_2	D_3	----	D_n	
S_1	X_{11} C_{11}	X_{12} C_{12}	X_{13} C_{13}	----	X_{1n} C_{1n}	a_1
S_2	X_{21} C_{21}	X_{22} C_{22}	X_{23} C_{23}	----	X_{2n} C_{2n}	a_2
S_3	X_{31} C_{31}	X_{32} C_{32}	X_{33} C_{33}	----	X_{3n} C_{3n}	a_3
⋮	⋮	⋮	⋮	⋮	⋮	⋮
S_m	X_{m1} C_{m1}	X_{m2} C_{m2}	X_{m3} C_{m3}	----	X_{mn} C_{mn}	a_m
Total Demand	b_1	b_2	b_3	----	b_n	$\left(\sum_{i=1}^{m} a_i\right) = \left(\sum_{j=1}^{n} b_j\right)$

The objective of the study is to compare the three methods to find an Initial basic feasible solution for the transportation problems.

LITERATURE REVIEW

Sharma, S., &Nazki, H. (2020) aims to find an optimal solution of transportation problem by using North West Corner Method, Least Cost Method, Vogel's Approximation Method, Stepping Stone Method, ASM Method and ATM Method and also compared these methods with each other. In this paper the researcher were applied six methods for finding the initial basic feasible solution. The researcher has found that ASM method provides comparatively better result than the results obtained by other methods, because ASM method provides an optimal solution directly, in less iteration. Also ASM method consumes less time and is very easy even for a layman to understand and apply.

Kaur, L., Rakshit, M., & Singh, S. (2019) the goal of the research is to find better optimal solution of transportation problem.The objective of this research is to determine the initial basic feasible solution by using VAM, MDM and KCM methods with the help of ARPD (Average relative percentage deviation) technique. The Researcher has found that KCM method is better and effective initial basic feasible solution and developed technique is very easy to apply and consume less time to compute.

V.T, L., & M., U. (2018) the main purpose of this research paper to determine the Minimum Transportation Cost by Comparing the Initial Basic Feasible Solution of a Transportation Problem by North West Corner Rule(NWCR), Least Cost Method (LCM), Vogel's Approximation Method (VAM), Modified Vogel's Approximation Method (MVAM) and ASM Method. The Researcher has found that Vogel's Approximation Method (VAM) ,Modified Vogel's Approximation Method (MVAM) and ASM Method to got same initial basic feasible solution for balanced transportation problem with minimum transportation cost better than the remaining two methods i.eNorth West Corner Rule(NWCR) and , Least Cost Method (LCM).

Raigar, S., &Modi, G. (2017) aim of the researchers is to find the optimum solution of a transportation problem and is to minimize the cost by proposed method, North West Corner Rule(NWCR), Least Cost Method (LCM), Vogel's Approximation Method (VAM) and Modified Distribution Method (MODI). The researcher has found that the proposed method is an attractive method which is very simple, easy to understand and gives result exactly or even lesser to VAM method. The researcher also has compared that the Vogel's Approximation Method (VAM), Modified Distribution Method (MODI) and the proposed Method got same solution.

MATERIALS AND METHODS

North-West Corner Method (NWCM):
The North-West Corner Method for calculating the initial feasible solution of the transportation problem. This method is called North-West Corner because the basic variables are chosen from the extreme left corner.
In this method, the researcher has followed the following steps

Selection of the North West Corner Method square as the starting point.

Comparing the supply and demand figures in the row and column, and assign units to the supply or demand figure that is lower.

The researcher has followed norms "If the demand in the column is satisfied then move to Right Square in the next column. If the supply in the row is satisfied then move down to the square in the next row. If both demand and supply are satisfied then move to the diagonal square forward by the next column and next row".

Repeated the steps 2 and 3 until all supply and demand requirements have been satisfied.

Least Cost Method (LCM):
The Least Cost Method for calculating the initial feasible solution of the transportation problem is an another method considered by the research for solving transportation problem. The allocation process starts with the cell having the lowest cost. With the aim of getting the lowest transportation cost, the lower-cost cells are chosen over the higher-cost cells.
In this method, the researcher has followed the following steps

Evaluated the transportation cost and selected the square with lowest cost. In case of tie one can make an arbitrary selection.

Depending upon the supply and demand condition allocation of the maximum possible units to this squares having the lowest cost.

Deleted the row or column or both satisfied by the allocation.

Repeated the step 1 to step 3 for the reduce transformation table until all the supply and demand condition are satisfied.

Vogel's Approximation Method (VAM):
The Vogel's Approximation Method (VAM) is an iterative procedure for calculated the initial feasible solution to a transportation problem.

In this method, the researcher has followed the following steps

1. Calculated the difference between two minimum elements for each row and each column.
2. Selected row or column with largest difference.
3. Allocated maximum number of units to the square with the minimum cost in the selected row or column.
4. Crossed out the row or column completed by assignment.
5. Re-determined the row and column difference for each row and for each column except the filled and crossed out square.
6. Repeated steps 2 to 5 until all assignments are completed.

RESULTS AND DISCUSSION

Researcher has solved hypothetical example for proving the objective of the research.

Numerical Example: For all three methods

A Company has three plants –X, Y and Z for which capacities are 7, 10 and 18 units. It has four warehouses P, Q, R and S for which demand are 5, 8, 7 and 15 units. The unit transportation cost (in thousand rupees) is as follows.

Plants	Warehouses			
	P	Q	R	S
X	38	60	100	24
Y	140	60	80	120
Z	80	20	120	40

Find Initial Basic Feasible Solution

North-West Corner Method (NWCM):

Plants	Warehouses				Supply
	P	Q	R	S	
X	5 $\boxed{38}$	2 $\boxed{60}$	$\boxed{100}$	$\boxed{24}$	7
Y	$\boxed{140}$	6 $\boxed{60}$	4 $\boxed{80}$	$\boxed{120}$	10
Z	$\boxed{80}$	$\boxed{20}$	3 $\boxed{120}$	15 $\boxed{40}$	18
Demand	5	8	7	15	35 35

$$\therefore\ X_{11} = 5,\ C_{11} = 38,\qquad X_{12} = 2,\ C_{12} = 60$$
$$X_{22} = 6,\ C_{22} = 60,\qquad X_{23} = 4,\ C_{23} = 80$$
$$X_{33} = 3,\ C_{33} = 120,\qquad X_{34} = 15,\ C_{34} = 40$$

Total Minimum Cost =$(X_{11} \text{ x } C_{11}) + (X_{12} \text{ x } C_{12}) + (X_{22} \text{ x } C_{22}) + (X_{23} \text{ x } C_{23}) + (X_{33} \text{ x } C_{33}) + (X_{34} \text{ x } C_{34})$
= (5 x 38) +(2 x 60) + (6 x 60) + (4 x 80) + (3 x 120) + (15 x 40)
= 190 + 120 + 360 + 320 + 360 + 600
= 1950 (In thousand rupees)

= 1950 x 1000
= 1950000 Rs.
∴ Initial basic Feasible Solution (IBFS) = 1950000 Rs

Least Cost Method (LCM):

Plants	Warehouses				Supply
	P	Q	R	S	
X	38	60	100	7 24	7
Y	3 140	60	7 80	120	10
Z	2 80	8 20	120	8 40	18
Demand	5	8	7	15	35 35

$$\therefore \quad X_{14} = 7,\ C_{14} = 24$$
$$X_{21} = 3,\ C_{21} = 140\,, \qquad X_{23} = 7,\ C_{23} = 80$$
$$X_{31} = 2,\ C_{31} = 80, \qquad X_{32} = 8,\ C_{32} = 20, \qquad X_{34} = 8,\ C_{34} = 40$$

Total Minimum Cost = $(X_{14} \text{ x } C_{14}) + (X_{21} \text{ x } C_{21}) + (X_{23} \text{ x } C_{23}) + (X_{31} \text{ x } C_{31}) + (X_{32} \text{ x } C_{32}) + (X_{34} \text{ x } C_{34})$
= (7 x 24) + (3 x 140) + (7 x 80) + (2 x 80) + (8 x 20) + (8 x 40)
= 168 + 420 + 560 + 160 + 160 + 320
= 1788 (In thousand rupees)
= 1788 x 1000
= 1788000 Rs.
∴ Initial basic Feasible Solution (IBFS) = 1788000 Rs.

Vogel's Approximation Method (VAM):

Plants	Warehouses				Supply	Row Penalties			
	P	Q	R	S					
X	5 38	60	100	2 24	7	14	36	76	76
Y	140	60	7 80	3 120	10	20	20	40	40
Z	80	8 20	120	10 40	18	20	20	80 ←	-
Demand	5	8	7	15	35 35				
Column Penalties	42↑	40	20	16					
	-	40↑	20	16					
	-	-	20	16					
	-	-	20	96↑					

$\therefore \quad X_{11} = 5,\ C_{11} = 38, \qquad X_{14} = 2,\ C_{14} = 24$
$X_{23} = 7,\ C_{23} = 80, \qquad X_{24} = 3,\ C_{24} = 120$
$X_{32} = 8,\ C_{32} = 20, \qquad X_{34} = 10,\ C_{34} = 40$

Total Minimum Cost = $(X_{11} \text{ x } C_{11}) + (X_{14} \text{ x } C_{14}) + (X_{23} \text{ x } C_{23}) + (X_{24} \text{ x } C_{24}) + (X_{32} \text{ x } C_{32}) + (X_{34} \text{ x } C_{34})$
= (5 x 38) + (2 x 24) + (7 x 80) + (3 x 120) + (8 x 20) + (10 x 40)
= 190 + 48 + 560 + 360 + 160 + 400
= 1718 (In thousand rupees)
= 1718 x 1000
= 1718000 Rs.
∴ Initial basic Feasible Solution (IBFS) = 1718000 Rs.

CONCLUSION

In this research paper, the researcher has analyzed and compared the three methods for finding the initial basic feasible solution (IBFS) for transportation problem. The result obtained from the analysis of three methods by using above numerical examples is that, the North-West Corner Method (NWCM) gives higher optimal solution cost as compare to Least Cost Method (LCM) and Vogel's Approximation Method (VAM). The Least Cost Method (LCM) gives higher optimal solution cost as compare to Vogel's Approximation Method (VAM) and lowest optimal solution cost as compare to the North-West Corner Method (NWCM). The Vogel's Approximation Method (VAM) is Lowest Optimal cost as compared to North-West Corner Method (NWCM) and Least Cost Method (LCM) to finding initial basic feasible solution (IBFS) for transportation problem.

Overall of three methods the researcher has found that the Vogel's Approximation Method (VAM)is the best and lowest optimal solution cost to finding initial basic feasible solution (IBFS) for transportation problem.

REFERENCES

[1]. Sharma, S., &Nazki, H. (2020). Comparison Of Various Methods For Solving Real Life Problems Related Transportation Scheduling. *Advances in Mathematics: Scientific Journal*, *9*(8), 5389-5400. doi:10.37418/amsj.9.8.10.
[2]. Bhadane, A. P., &Manjarekar, S. D. (2020). APB's method for the IBFS of a Transportation Problem and comparison with Vogel's Approximation Method. *Quest Journals Journal of Research in Applied Mathematics*, *6*(3), 28-32.
[3]. Rajeswara Reddy, M. (2020). Study Of A Transportation Problem Of An Essential Item From Various Origins To Different Destinations By Using Eqm. *Journal of Engineering Sciences*, *11*(3), 974-980.
[4]. Kaur, L., Rakshit, M., & Singh, S. (2019). An Alternate Approach For Finding The Initial Basic Feasible Solution Of Transportation Problem. *International Journal of Scientific & Technology Research*, *8*(9), 442-447.
[5]. V.T, L., & M., U. (2018). To Determine the Minimum Transportation Cost by Comparing the Initial Basic Feasible Solution of a Transportation Problem by Various Methods. *International Journal of Innovative Science and Research Technology*, *3*(9), 186-188.
[6]. Raigar, S., &Modi, G. (2017). An Effective Methodology for Solving Transportation Problem. *International Journal of Scientific and Innovative Mathematical Research*, *5*(10), 23-27. doi:10.20431/2347-3142.0510004.
[7]. Mishra, S. (2017). Solving Transportation Problem by Various Methods and Their Comparison. *International Journal of Mathematics Trends and Technology*, *44*(4), 270-275. doi:10.14445/22315373/ijmtt-v44p538.
[8]. Soomro, A. S., Tularam, G. A., &Bhayo, G. M. (2014). A comparative study of initial basic feasible solution methods for transportation problems. *Mathematical Theory and Modeling*, *4*(1), 11-18. Retrieved 2014.
[9]. Anderson, T. M. (1935). *The transportation problem*. Augusta, Ga.?: Publisher not identified.
[10]. Truscott, D. C. (1969). *A transportation problem*. Berkeley: University of California.