International Journal of Engineering Science Invention (IJESI)
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org ||Volume 7 Issue 10 Ver I || Oct 2018 || PP 05-07

A New Approach For Optimal Solution Of Transportation Problem

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Abstract: *The classical Transportation problem is one of the many well -structured problems in operational research that has been extensively studied in the literature. The transportation problem is one of the subclasses of the linear programming problems. Since finding the initial feasible solution is crucial for all kinds of transportation problem, this is still one of the important research topic in literature. To improve the initial basic feasible solution and to get the solution which is nearer to the optimum solution so many new algorithms are proposed. The ancient methods to find the initial basic feasible solution are North west corner rule , Least cost entry method , Volge's approximation method[4]. The Vogel's approximation method is the most important method nearer to the optimum solution. Later on many versions of Vogel's approximation method are proposed. Among them Balakrishnan's version of VAM[1], Shore's application of VAM[2], H.S. Kasana et al[3]. etc,. In the proposed method the initial basic feasible solution is obtained very easily.By using the proposed method the degeneracy can be solved very easily than MODI's method. This method is not the iterative method. It is easy to apply and computationally takes less time.*

Date of Submission: 28-09-2018 Date of acceptance: 08-10-2018

I. Introduction

The classical Transportation problem is one of the many well -structured problems in operational research that has been extensively studied in the literature. The transportation problem is one of the subclasses of the linear programming problems. The important features of the problem were, these were the earliest class of linear programs discovered to have totally uni-modular matrices and integral extreme points resulting in considerable simplification of the simplex method.Study of the transportation problems laid the foundation for further theoretical and algorithmic development of the minimal cost network flow problems. The most important are the many applications in distribution scheduling, etc.

There are different types of transportation problems. The classical transportation problem was first presented by Hitchcock (1941), along with a constructive solution and later independently, by Koopmans (1947). Because of his spearhead research and the work done earlier by Hitchcock, the classical case is often referred as the Hitchcock –Koopmans transportation problem.

Mathematical Formation of Transportation problem:

Let a_i = Quantity of product available at source i

b_j = quantity of product required at destination j

c_{ij} = Cost of transporting one unit of product from source i to destination j

x_{ij} =Quantity of product transported from source i to destination j

Then the transportation model would be in the form as follows:

Minimize $Z = \sum_{j=1}^{n} \sum_{i=1}^{m} c_{ij} x_{ij}$

Subject to $\sum_{j=1}^{n} x_{ij} = a_i \quad i = 1 \text{ to } m$

$$\sum_{i=1}^{m} x_{ij} = b_j \quad j = 1 \text{ to } n$$

$$\forall i, j \; x_{ij} \geq 0$$

Formation of Transportation Table:

S_i/D_j	D_1	D_2	……….	D_n	Availability
S_1	$c_{11}(x_{11})$	$c_{12}(x_{12})$	………	$c_{1n}(x_{1n})$	a_1
S_2	$c_{21}(x_{21})$	$c_{22}(x_{22})$	……….	$c_{2n}(x_{2n})$	a_2
………	……….	……….	……...	……….	………
S_m	$c_{m1}(x_{m1})$	$c_{m2}(x_{m2})$	……	$c_{mn}(x_{mn})$	a_m

Demand	b_1	b_2	……..	b_n	$\sum_{i=1}^{m} a_i = \sum_{j=1}^{n} b_j$

The Transportation problem can be solved in two steps . In the first step the initial basic feasible solution is obtained. In the second step the initial solution obtained in the first step is improved. There are so many methods in literature to find the initial basic feasible solution, Since finding the initial feasible solution is crucial for all kinds of transportation problem, this is still one of the important research topic in literature. To improve the initial basic feasible solution and to get the solution which is nearer to the optimum solution so many new algorithms are proposed. The ancient methods to find the initial basic feasible solution are North west corner rule , Least cost entry method , Volge's approximation method[4]. North –west corner rule starts at the starting point of the transportation table and continuous allocation will be done till all supplies are exhausted and all demands are satisfied. This method does not consider the cost criteria. Least cost method is the efficient method to find the initial basic feasible solution in which the allocation is made depending on the least cost. The Vogel's approximation method is the most important method nearer to the optimum solution. Later on many versions of Vogel's approximation method are proposed. Among them Balakrishnan's version of VAM[1], Shore's application of VAM[2], H.S. Kasana et al[3]. Extremum difference method etc,. In the proposed method the initial basic feasible solution is obtained very easily.

The advantages of the Proposed method:
1. This method is easy to understand and to apply for the transportation method.
2. This method depends only on primal problem, it is not required to calculate the dual variables.
3. The optimal solution is also easily obtained without considering the cost differences.

Algorithm
1. Convert the problem into transportation table.
2. Check whether it is balanced or not.
3. Select the minimum and next to minimum in each row. If this minimum is repeated select it again. If next to minimum is repeated select the cell which has maximum allocation possibility.Observe whether atleast one cell in each column is selected or not. If not select in the same manner.
4. First allocate to the unique selected cell in the corresponding row or column and then allocate the remaining cells starting with the minmum cost .
5. Idetify the basic cell which has the highest cost. Construct a loop starting at the corresponding cell and ending with that cell in such a manner that atleast one basic cell will leave and the loop must pass through the minimum cost cells than the highest cost.
6. Repeat the step 5 until an optimum feasible solution is obtained.

Numerical Illustration:

Table 1

Source\Destination	D_1	D_2	D_3	D_4	D_5	Supply
S_1	6	4	4	7	5	100
S_2	5	6	7	4	8	125
S_3	3	4	6	3	4	175
Demand	60	80	85	105	70	

Solution:
1. The transportation problem is balanced.

Table 2

Source\Destination	D_1	D_2	D_3	D_4	D_5	Supply
S_1	6	4(15)	4(85)	7	5	100
S_2	5	6(65)	7	4	8(60)	125
S_3	3(60)	4	6	3(105)	4(10)	175
Demand	60	80	85	105	70	

Among the basic cells the highest cost cell is (2,5) having the cost 8. Construct the loop starting with (2,5), and the cells having less cost than 8. The loop is constructed with the cells (2,5),(2,4),(3,4),(3,5) and (2,5). $\theta = \min(60,105) = 60$. subtract θ alternatively from the costs in the loop starting with (2,5).

Table 3

Source\Destination	D_1	D_2	D_3	D_4	D_5	Supply
S_1	6	4(15)	4(85)	7	5	100
S_2	5	6(65)	7	4(60)	8	125

S_3	3(60)	4	6	3(45)	4(70)	175
Demand	60	80	85	105	70	

Construct one more loop starting at the cell (2,2) having the highest cost 6 and ending at (2,2) with the cells (2,4),(3,4) and (3,2). $\theta = \min(65,45) = 45$.
subtract θ alternatively from the costs in the loop starting with (2,2). The modified transportation table is

Table 4

Source\Destination	D_1	D_2	D_3	D_4	D_5	Supply
S_1	6	4(15)	4(85)	7	5	100
S_2	5	6(20)	7	4(105)	8	125
S_3	3(60)	4(45)	6	3	4(70)	175
Demand	60	80	85	105	70	

Construct one more loop starting at the cell (2,2) having the highest cost 6 and ending at (2,2) with the cells (2,1),(3,1) and (3,2). $\theta = \min(20,60) = 20$.
subtract θ alternatively from the costs in the loop starting with (2,2). The modified transportation table is

Table 5

Source\Destination	D_1	D_2	D_3	D_4	D_5	Supply
S_1	6	4(15)	4(85)	7	5	100
S_2	5(20)	6	7	4(105)	8	125
S_3	3(40)	4(65)	6	3	4(70)	175
Demand	60	80	85	105	70	

Here in the above table loop cannot be constructed with the highest cost and all the cells having lowest cost than the selected cost. The optimum allocation is done.

The optimum cost is $4 \times 15 + 4 \times 85 + 5 \times 20 + 4 \times 105 + 3 \times 40 + 4 \times 65 + 4 \times 70 = 1580$.

II. Conclusion

By using the proposed method the degeneracy can be solved very easily than MODI's method. This method is not the iterative method. It is easy to apply and computationally takes less time .

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M.Madhavi" A New Approach For Optimal Solution Of Transportation Problem"International Journal of Engineering Science Invention (IJESI), vol. 07, no. 10, 2018, pp 05-07