ORIGINAL RESEARCH PAPER | Management | Volume : 6 | Issue : 11 | November 2016 | ISSN - 2249-555X | IF : 3.919 | IC Value : 74.50

A COMPARATIVE STUDY OF ASM, BCM, AND MODI METHOD

KEYWORDS ASM, BCM, MODI, Transportation Problem

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ABSTRACT *The main objective of Transportation Problem (TP) is to minimize the cost or the time of transportation. Several methods are available to obtain the initial solution to a Transportation Problem. Three different methods such as ASM, BCM, and MODI for finding solution to one common TP has been discussed in this paper with the help of an illustration. The solution thus obtained from these methods are compared and checked for optimality.*

INTRODUCTION

Linear Programming (LP) is a mathematical technique , which is used for allocating limited resources to a number of demands in an optimal manner. In industry, managers often wants to make the best use of scarce resources such as capital, time, and human resources so that organization remains competitive and cost effective. LP's commonly used by the managers when they are faced with a situation where a set of alternatives is available and a decision has to be taken to select the best alternative. It is very helpful in decision making and assists management in taking rational decisions in complex situations.

The history of LP can be traced back to World War II. In 1947, George B. Dantzig of the U.S. Air Force created LP model for taking care of military logistics issues. Since then the LP has gained applications in every field. For example planning, administration, aviation, computers, agribusiness, transportation, logistics, oil refining and so on. One important application of LP is in the area of physical distribution of goods and services from several source centers to several demand centers. Since transportation cost is the single most important element in the supply chain that significantly increases the cost of the goods and services if company operates from many distant sources and delivers to places located far and wide. In order to stay competitive, it is essential for companies to incur least cost from moving goods and services from source to destination.

To take care of the issue of transportation and logistics, many methods and techniques have been developed over the years to save computation time and to provide the closest to optimal or perfect optimal solution to the optimization problems such as Assignment Problem (AP) and Transportation Problem (TP). Many such methods, despite their pros and cons, provide the starting solution but commonly fail to provide optimal solution directly. In this paper, two methods namely ASM and BCM which claim to provide optimal solution directly has been studied along with MODI method to check and verify this claim. Hlayel Abdallah Ahmad (2012), in one of his study proposed the Best Candidates Method (BCM) for solving optimization problems such as Assignment Problem (AP) and Transportation Problem (TP).This method, according to him, minimizes the computation time by providing the lowest cost-quantity combinations to help reach optimal solution directly. The existing methods such as Northwest Corner rule (NWCR), Minimum Cost (MC), and Vogel's Approximation Method (VAM) do not always provide the optimal solution. To reach the optimal solution from the starting solution provided by these methods, MODI method is used which requires lengthy iterations and difficult computations. However, BCM saves computation time and is said to provide optimal solution directly without using MODI method.

Abdul Quddoos, Shakeel Javaid, and M.M. Khalid (2012) developed a new method for finding an optimal solution for Transportation Problem (TP).They named this new method as ASM (initials of their first name).The ASM method, as reported by them, provides an optimal solution directly and requires fewer iteration. In addition, this method is also claimed to provide easier and simpler heuristics approach than the methods proposed by Pandian et al. (2010) and Sudhakar et al. (2012) for finding an optimal solution directly.

In light of the above two methods developed by Quddoos et al. (2012) and HlayelAbdallah Ahmad (2012), an illustration is used to check and verify the claims of these methods with MODI method. Each method's working is explained step by step so that reader can design and solve his own problems.

3.1 ASM Method:-

Step 1: Develop the Transportation Table from given Transportation Problem.

Step 2: Subtracteach row entries of the Transportation Table from the respective row minimum element. Similarly, subtract each column entries from respective column minimum element.

Step 3: The reduced cost matrix will have at least one zero in each row and in each column. Proceed with zero occurring in the row of cost matrix. Assume this zero occurs in (i,j)thcell, count the remaining zeros in the ith row and jth column. Select the next row which have a zero cell entry and proceed in the same manner until all zeros are covered.

Step 4: Find a zero cell which have the minimum zero count in the ith row and jth column and assign the maximum amount satisfying the supply and demand sides. If tie occurs for minimum zero count then choose that zero cell for which total sum of all the elements of respective row and column is maximum.

Step 5: Eliminate the rows or columns for which demand or supply is already exhausted before carrying out further

Volume : 6 | Issue : 11 | November 2016 | ISSN - 2249-555X | IF : 3.919 | IC Value : 74.50

calculation.

Step 6: Check if the reduced cost matrix has at least one zero in each row and in each column. If not, start step 2 again, otherwise move to next step.

Step 7: If the demand and the supply still remain unfulfilled, start step3 to step 6 again until all the demand and all the supply are exhausted.

3.1.1 Numerical illustration to the ASM Method

Consider the following TP with four sources and four destinations.

	D_1	D_2	D_3	D_4	Supply
O_1	5	1	3	3	34
O_2	3	3	5	4	15
O_3	6	4	4	3	12
O_4	4	1	4	2	19
Demand	21	25	17	17	80

3.1.2 Solution using ASM Method

	D_1	D_2	D_3	D_4	Supply
O_1	5	1 $\boxed{25}$	3 $\boxed{9}$	3	34
O_2	3 $\boxed{15}$	3	5	4	15
O_3	6	4	4 $\boxed{8}$	3 $\boxed{4}$	12
O_4	4 $\boxed{6}$	1	4	2 $\boxed{13}$	19
Demand	21	25	17	17	80

On solving, we get
Optimum solution: =Rs 191

3.2 Best Candidates Method (BCM)

BCM reduces the computation time by providing the lowest cost and quantity combination structure to reach the optimal solution in a few iterations. This method includes three steps which are as follows:

Step 1: Construct the cost matrix of the given TP and check whether matrix is balanced or unbalanced. If it is unbalanced i.e. total demand is not equal to total supply then introduce dummy row or column and assign that quantity to either demand or supply side which equals total demand and total supply. Put zero cost in the individual cells of the dummy row or dummy column.

Step 2: If the objective of TP is to minimize the total cost then look for the best combinations of cost and quantity satisfying the demand and supply constraint from the cost matrix which minimize the total cost of TP. Similarly, if the objective is to maximize the profit of TP then look for the best combinations of cost and quantity that maximize the total profit.

Step 3: Once identified, start assigning quantity satisfying the demand and supply constraint to the cell of smallest cost first and move to the cell of next smallest cost and so on.

Strikethrough the row/column for which demand/supply has exhausted. Continue choosing the cell of smallest cost from the reduced matrix to assign quantity until all the demand and supply are exhausted.

Proposed Method using BCM by Abdallah A. Hlayel Mohammad A. Alia(2012)

Step1: We must check the matrix balance, If the total supply is equal to the total demand, then the matrix is balanced and also apply Step 2. If the total supply is not equal to the total demand, then we add a dummy row or column as needed to make supply is equal to the demand. So the transportation costs in this row or column will be assigned to zero.

Step2: Applying BCM to determine the best combination that is to produce the lowest total weight of the costs, where is one candidate for each row and column.

Step3: Identify the row with the smallest cost candidate from the chosen combination. Then allocate the demand and the supply as much as possible to the variable with the least unit cost in the selected row or column. Also, we should adjust the supply and demand by crossing out the row/column to be then assigned to zero. If the row or column is not assigned to zero, then we check the selected row if it has an element with lowest cost comparing to the determined element in the chosen combination, then we elect it.

Step4: Elect the next least cost from the chosen combination and repeat Step 3 until all columns and rows is exhausted.

3.2.1 Numerical illustration to the BCM Method:-

	D_1	D_2	D_3	D_4	Supply
O_1	5	1	3	3	34
O_2	3	3	5	4	15
O_3	6	4	4	3	12
O_4	4	1	4	2	19
Demand	21	25	17	17	80

3.2.2 Solution using BCM Method

	D_1	D_2	D_3	D_4	Supply
O_1	5	1 $\boxed{25}$	3 $\boxed{9}$	3	34
O_2	3 $\boxed{15}$	3	5	4	15
O_3	6 $\boxed{4}$	4	4 $\boxed{8}$	3	12
O_4	4 $\boxed{2}$	1	4	2 $\boxed{17}$	19
Demand	21	25	17	17	80

Optimal Solution= Rs 195

3.3 MODI (Modified Distribution) Method

For minimization transportation problem the transportation algorithm of MODI (Modified Distribution) method gives an Iterative procedure. The procedure determines an optimum solution in a finite number of steps which are as follows :

Step 1: For an underlying fundamental plausible arrangement with m+n-1 involved cells, figure $u_g$and $v_h$for lines and segments.

To start with, any one of $u_i^{'s}$ or $v_j^{'s}$ is, assign the value zero. It is superior to assign zero to a exacting u_i or v_j there are greatest number of allotments in succession or segments separately, as this will lessen the essentially math work. Then complete the calculation of $u_i^{'s}$ and $v_j^{'s}$ for other rows and columns by using the relation

$c_{ij} = u_i + v_j$, for all occupied cells (i, j)

Step 2 : For unoccupied cells , calculate the opportunity cost (the difference that indicates the per unit cost reduction that can be achieved by an allocation in the

Volume : 6 | Issue : 11 | November 2016 | ISSN - 2249-555X | IF : 3.919 | IC Value : 74.50

unoccupied cell).

Do this by using the relationship

$d_{ij} = c_{ij} - (u_i + v_j)$ for all I and j

Step 3: Examine sign of each

If $d_{ij} > 0$ then the present fundamental achievable arrangement is ideal.

If $d_{ij} = 0$ then the present fundamental attainable arrangement will stay unaffected however an option arrangement exists.

If one or more $d_{ij} < 0$ then an Improved arrangement can be gotten by entering abandoned cell$^{(i,j)}$in the premise. An abandoned cell having the biggest negative estimation of d_{ij} is decided for going into the arrangement blend (new transportation plan).

Step 4: Build a shut - way (or circle) for the vacant cell with biggest negative open door cost. Begin the shut way with the chose vacant cell and imprint an or more sign (+) in this cell. Draw a path along the lines (or areas) to a head cell, check the corner with a short sign (-) and continue down the portion (or section) to an included cell. At that point check the corner with in addition to sign (+) and short sign (-) on the other hand. Close the way back to the chosen abandoned cell.

Step 5 : Select the littlest amount amongst the cells set apart with less sign on the edges of shut circle. Apportion this quality to the chose vacant cell and add it to other involved cells set apart with in addition to signs. Presently subtract this from the possessed cells set apart with short signs.

Step 6 : Get another Improved arrangement by distributing units to the abandoned cell as indicated by step 5:- and compute the new aggregate transportation cost.

Step 7 : Further test the amended answer for optimality. The methodology ends when all $d_{ij} \geq 0$ for unoccupied cells.

3.3.1 Numerical illustration to the MODI Method:-

	D_1	D_2	D_3	D_4	*Supply*
O_1	*5*	*1*	*3*	*3*	*34*
O_2	*3*	*3*	*5*	*4*	*15*
O_3	*6*	*4*	*4*	*3*	*12*
O_4	*4*	*1*	*4*	*2*	*19*
Demand	*21*	*25*	*17*	*17*	*80*

3.3.2 Initial Solution using VAM

	D_1	D_2	D_3	D_4	Supply
O_1	5	1 $\boxed{25}$	3 $\boxed{9}$	3	34
O_2	3 $\boxed{15}$	3	5	4	15
O_3	6 $\boxed{4}$	4	4 $\boxed{8}$	3	12
O_4	4 $\boxed{2}$	1	4	2 $\boxed{17}$	19
Demand	21	25	17	17	80

Basic Solution = Rs 195

Solution using MODI Method:

	D_1	D_2	D_3	D_4	Supply
O_1	5	1 $\boxed{25}$	3 $\boxed{9}$	3	34
O_2	3 $\boxed{15}$	3	5	4	15
O_3	6	4	4 $\boxed{8}$	3 $\boxed{4}$	12
O_4	4 $\boxed{6}$	1	4	2 $\boxed{13}$	19
Demand	21	25	17	17	80

Optimal Solution= Rs 191

Conclusion

Abdul Quddoos, Shakeel javaid ,M.M Khalid in their research work entitled "A new method for finding an optimal solution for Transportation Problem" in 2012 found that ASM method gives the same solution as the MODI method and AbdallahA.Hlayel Mohammad A. Alia in 2012 also claimed that BCM method gives the best result as MODI but when the three methods were generalized , it was concluded that MODI and ASM gives the best results while when compared with BCM it was observed that BCM gives the Initial basic feasible solution equivalent to VAM but it does not give the best solution as MODI and ASM. The result is concluded by performing the illustration on 4-5 numerical problems

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