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An Innovative Method for Minimization of Transportation Cost: An Algorithmic Approach

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Abstract: **Determining efficient solutions for large scale transportation problems is an important task in operations research. In this paper a transportation algorithm is applied to determine the minimum cost. The algorithm determines the initial Basic Feasible Solution of Transportation problems to minimize the cost. Numerical example are provided to illustrate the proposed algorithm. It can be seen that the proposed algorithm gives a better solution to the given transportation problem. At first the Decision Making Indicators (DMI) are calculated from the difference of the greatest unit cost and the nearest-to-the-greatest unit cost. The least entry of the DMI along the highest DMI is taken as the basic cell. Finally, loads have been imposed on the original TT corresponding to the basic cells of the DMI. Herein the cost minimizing least entries (CMLE) table called Cost Minimizing Small Table (CMST) is formed. So CPU time will become small. Also it discussed how to satisfying the supply and demand restrictions, minimize the total transportation cost.**

Keywords: **IBFS, TT, DMI, CMST.**

I. INTRODUCTION

The transportation problem is a special kind of the network optimization problems. It is one of the most useful techniques in many branches in pure and Applied Mathematics**.** Transportation model plays a vital role to ensure the efficient movement and in-time availability of raw materials and finished goods from sources to destinations. Transportation problem is a Linear Programming Problem (LPP) stemmed from a network structure consisting of a finite number of nodes and arcs attached to them. The objective of the TP is to determine the shipping schedule that minimizes the total shipping cost while satisfying the demand and supply limit. This Problem was first presented in 1941 by Hitchcock and it was further developed Koopmans (1949) and Dantzig (1951). The Simplex method is not suitable for the Transportation Problem especially for large Scale transportation problem due to its special Structure of the model in 1954. Charles and Cooper was developed Stepping Stone method for the efficiency reason. Here we use a new transportation algorithm to find the IBFS of time minimization problem with equal constraints. Here it is presented the typical problem of a single product to be shifted from m origins (factories) to n destinations (showroom / sales centers) wherein $a_1, a_2, \ldots, a_m$ and $b_1, b_2, \ldots, b_n$ are the capacities of the origins and destinations respectively. An Initial Basic Feasible Solution(IBFS) for the transportation problem can be obtained by using the north-west corner rule, Row minima, Column minima ,Matrix minima and Vogel's Approximation Method [Reinfeld and Vogel 1958,Goyal"s version of VAM] .Kirca and Stair developed a heuristic method to obtain an efficient initial basic feasible solution. In this paper we present a method which gives better IBFS than given by the methods just mentioned.Our approaches, to find the IBFS through operations on a moderate Transportation Table (TT) called Cost Minimizing Small Table (CMST), are presented herein.

Now we present our developed algorithms in finding the IBFS of Transportation Problem. Proposed algorithm is given next:

Step 1 Divide the entries into the transportation table if necessary.

Step 2 Subtract the smallest entry from each of the elements of every row of the TT and place them on the right-top of corresponding elements.

Step 3 Apply the same operation on each of the columns and place them on the right-bottom of the corresponding elements.

Step 4 Form the CMST whose entries are the average of right-top and right-bottom elements of Steps 2 and 3. If the average is fraction then take pre-integer of them.

Step 5 Step 2,3,4 will continue unless all entries become two digits.

Step 6 Place the row and the column Decision Making Indicators (DMI) just after and below the supply and demand amount respectively within first brackets, which are the differences of the greatest and next-to-greatest element of each row and column of (DMI). If there are two or more greatest elements, difference has to be taken as zero.

Step 7 Identify the highest Decision Making Indicators, if there are two or more highest indicators; choose the highest indicator along which the smallest cost element is present. If there are two or more smallest elements, choose any one of them arbitrarily.

Step 8 Allocate x_{ij} = min (a_i , b_j) on the left top of the smallest entry in the (i, j) th of the CMST.

Step 9 If $a_i < b_j$, leave the ith row and readjust b_j as $b_j^/ = b_j - a_i$.

If $a_i > b_j$, leave the jth column and readjust a_i as $a_i^/ = a_i - b_j$.

If $a_i = b_j$, leave either ith row or j-th column but not both.

Step10 Repeat Steps 5 to 8 until the rim requirement satisfied.

Step 11 Calculate $z = \sum_{i=1}^{m} \sum_{j=1}^{n} c_{ij} x_{ij}$, z being the minimum transportation cost and c_{ij} are the cost elements of the TT corresponding to the basic cells of the CMST.

II. ILLUSTRATION

A company manufactures motor car and it has three factories F_1, F_2 and F_3 whose weekly production capacities are 9, 8 and 10 thousand pieces of cars respectively. The company supplies car to its three showrooms located at S_1, S_2 and S_3 whose weekly demands are 7, 12 and 8 pieces respectively. The transportation costs per piece of car are given in the next TT:

Factories	Showrooms			Supply
	S_1	S_2	S_3	a_i
F_1	4350	4100	4050	9
F_2	4650	4550	4150	8
F_3	4300	4200	4450	10
Demand	7	12	8	27

We want to schedule the shifting of cars from factories to showrooms with a minimum cost. Deviede the entries into the transportation table.

Table.1

Factories	Showrooms			Supply
	S_1	S_2	S_3	a_i
F_1	435	410	405	9
F_2	465	455	415	8
F_3	430	420	445	10
Demand	7	12	8	27

Table.2

Factories	Showrooms			Supply
	S_1	S_2	S_3	a_i
F_1	435_{5}^{30}	410_{0}^{5}	405_{0}^{0}	9
F_2	465_{35}^{50}	455_{45}^{40}	415_{10}^{0}	8
F_3	430_{0}^{10}	420_{10}^{0}	445_{40}^{25}	10
Demand	7	12	8	27

Table.3

Factories	Showrooms			Supply
	S_1	S_2	S_3	a_i
F_1	17	2	0	9
F_2	42	42	5	8
F_3	5	5	32	10
Demand	7	12	8	27

Table.4

Factories	Showroom			Supply	Row Decision making Indicators		
	S_1	S_2	S_3	a_i			
F_1	0	$^{9}2$	0	0	(15)	-	-
F_2	42	42	$^{5}0$	0	(10)	(0)	(37)
F_3	$^{7}5$	$^{3}5$	$^{0}32$	0	(27)	(27)	(27)
Demand	0	0	0	0			
Column Decision making Indicators	(25)	(37)	(27)				
	(37)	(37)	(27)				
	-	(37)	(27)				

The transportation allocation to the original TT is as follows:

Table.5

Factories	Showrooms			Supply
	S_1	S_2	S_3	a_i
F_1	17	$^{9}4100$	4050	9
F_2	4650	4550	$^{8}4150$	8
F_3	$^{7}4300$	$^{3}4200$	$^{0}4450$	10
Demand	7	12	8	27

So, the transportation cost is $z = 4100\times 9 + 4150\times 8 + 4300\times 7 + 4200\times 3 + 4450\times 0$ = 1,12 ,800 units.

Vogel's Approximation Method (VAM):

Factories	Showrooms			Supply	
	S_1	S_2	S_3	a_i	
F_1	4350	4100	4050	9	(50)
F_2	4650	4550	$^{8}4150$	8	(400)
F_3	4300	4200	4450	10	(100)
Demand b_j	7	12	8	27	
	(50)	(100)	(100)		

Factories	Showroom			Supply	Row Decision making Indicators		
	S_1	S_2	S_3	a_i			
F_1	4350	^{9}4100	^{0}4050	0	(50)	(500)	(250)
F_2	4650	4550	^{8}4150	0	(400)	-	-
F_3	^{7}4300	^{3}4200	4450	0	(27)	(27)	(27)
Demand	0	0	0	0			
Column Decision making Indicators	(50)	(100)	(100)				
	(50)	(100)	(400)				
	(50)	(100)	-				

So, the transportation cost is $z = 4100\times 9 + 4050\times 80 + 4150\times 8 + 4300\times 7 + 4200\times 3$ = 1,12, 800 units.

Comparison of VAM and Proposed Method:

The experiments and the analysis of the experimental data are presented in this section.

For the problem instance, a linear programming model was implemented and solved.In order to get a linear programming model for the problem instance, the heuristic solutions were obtained using VAM and proposed method. The performance of the VAM and proposed method in comparison with the optimal solution is presented above.

Performance measure:

Serdar Korukoglu and Serkan Balli,[13] said VAM is very good for small sized transportation problems but it deteriorates when problem size increases. From above, it is seen that the solution by proposed method and VAM is same for small sized transportation problems but if the problem size increases then proposed method is better than VAM. Therefore proposed method yields efficient results by small time and labour than VAM for large sized problems.

III. CONCLUSION

In this study, Vogel's Approximation Method which is one of well-knowntransportation methods for getting initial solution was investigated to obtain moreefficient initial solutions, but it is insufficient for large sized transportation problems.Here we developed a new algorithm for finding an initial basic feasiblesolution of the transportation problem. From example, we found that Vogel'sApproximation Method and Proposed Approximation Method give the same result.But by proposed method we obtains more efficient initial solutions for large scale transportation problems and it reduces total iteration number, CPU times and computational difficulty for the optimal solution.

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