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SOLUTION OF TRANSPORTATION PROBLEMS USING SUMMATION METHOD

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ABSTRACT

Transportation problem (TP) is considered a dynamic important aspect that has been studied in a wide range of operations including research domains. As such, it has been used in simulation of several real life problems. Thus, optimizing TP of variables has been remarkably significant to various disciplines. This paper suggests a new approach to improve the Initial Basic Feasible Solution (IBFS) of all types TPs using row summation and column summation. This approach improves the Vogel's Approximation Method (VAM) in order to get improved (sometimes) IBFS of an unbalanced TP in comparison to usual VAM.

Key words: *Transportation Problem, Row Summation, Column Summation, Vogel's Approximation Method.*

INTRODUCTION

TP is a type of Linear Programming Problem (LPP) that may be solved by using simplex technique called transportation method. It includes major application in solving problems involving several product sources and several destinations of products, this type of problem is frequently called the TP. The two common objectives of such problems are either

(1) Minimize the cost of shipping m units to n destinations (or)
(2) Maximize the profit of shipping m units to n destinations.

The aim of this study is to determine the minimum transportation cost in an easy and efficient manner.

TP can also be formulated as LPP that can be solved using either dual simplex or Big M method. Sometimes this can also be solved using interior approach method. However it is difficult to get the solution using all this method. There are many methods for solving TP. Vogel's method gives approximate solution while MODI and Stepping Stone (SS) method are considered as a standard technique for obtaining to optimal solution. Since decade these two methods are being used for solving TP. Goyal (1984) improving VAM for the Unbalanced TP, Ramakrishnan (1988) discussed some improvement to Goyal's Modified VAM for Unbalanced TP. Moreover Sultan (1988), Sultan and Goyal (1988) studied initial Goyal (1984) basic feasible solution and resolution of degeneracy in TP.

There are various types of transportation models and the simplest of them was first presented by Hitchcock (1941). It was further developed by Koopmans (1949) and Dantzig (1951). Several extensions of transportation model and methods have been subsequently developed. TP is based on supply and demand of commodities transported from several sources to the different destinations. The sources from which we need to transport refer the supply while the destination where commodities arrive referred the demand. It has been seen that on many occasion, the decision problem can also be formatting as TP. In general we try to minimize total transportation cost for the commodities transporting from source to destination.

Adlakha and Kowalski (2009) suggested a systematic analysis for allocating loads to obtain an alternate optimal solution. However, the study on alternate optimal solutions is clearly limited in the literature of transportation with the exception of Sudhakar *et.al.*, (2012) who suggested a new approach for finding an optimal solution for TPs. Girmay and Sharma (2013) suggested a heuristic approach in order to balance the unbalanced TP and improve the VAM. Few researchers have tried to give their alternate method for overcoming major obstacles over MODI and SS method.

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Goyal (1984) suggested that to assume the largest unit cost of transportation to and from a dummy row or column, present in the given cost matrix rather than assuming to be zero as usual in VAM. He claimed that by this modification, the allocation of units to dummy row or column is automatically given least priority and in addition to this the row or column penalty costs are considered for each interaction. He justified his suggestion by comparing the solution of a numerical problem with VAM and Shimshak (1981). While Shimshak (1981) suggested ignoring the penalty cost involved with the dummy row or column. So that to give least priority to the allocation of units in dummy row or column. With this suggestion Shimshak (1981) obtained initial solution by VAM. Sridhar and Allah Pitchai (2018a) discussed Unbalanced Transportation Problems Using Vogels Approximation Method Sridhar and .Allah Pitchai, (2018b) discussed Unbalanced Transportation Problems Using Least cost Method without using dummy row and dummy column.

1.2 TYPES OF TP
There are two types of TP namely Balanced TP and Unbalanced TP.

1.2.1 BALANCED TP
A TP is said to be balanced TP if total number of supply is same as total number of demand.

1.2.2 UNBALANCED TP
A TP is unbalanced if the sum of all available quantities is not equal to the sum of requirements or vice-versa. In regular approach, to balance the unbalanced TP either a dummy row or dummy column is introduced. If total availability is more than the total requirement then a dummy column (destination) is introduced with the requirement to overcome the difference between total availability and total requirement. Cost for dummy row or column is set equal to zero. Such problem is usually solved by VAM to find an initial solution. This paper suggests an algorithm which gives improved initial solution than VAM.

2. SUGGESTION

This paper suggests a method to balance an unbalanced TP. In this present method dummy row or dummy column is not needed in order to balance the unbalanced TP. To find the basic initial solution, increase the demand or supply to balance the unbalanced TP. That is, if the sum of supply is X (say) and the sum of demand is Y (say), then

(i) Suppose total supply is greater than total demand then increase the demand X-Y=C to the column which has the minimum cost cell.
(ii) Suppose total demand is greater than total supply then increase the demand X-Y=D to the row which has the minimum cost cell.

3. EXISTING METHOD FOR FINDING AN INITIAL BASIC FEASIBLE SOLUTION [IBFS]

A set of non-negative allocations which satisfies the row and column restrictions is known as IBFS. This is an initial solution of the problem and is also known as a starting solution of TP. The IBFS may or may not be optimal. By improving upon the IBFS we obtain an optimal solution.

3.1 SUMMATION METHOD
It is observed that this method produces better IBFS for all TP. The solution procedure of this method is described step by step in below.

1. If the given TP is Unbalanced then convert the given TP into a balanced TP using dummy row and dummy column with zero transportation cost.
2. Obtain the sum of each row and each column store the results in an array namely Row-Sum (RS) and Column-Sum (CS).
3. Identify the row or column with the highest sum. Allocate as much as possible quantity to the variable with the lowest unit cost in the selected row or column. Adjust the supply and demand and cross out the row or column that is already satisfied. If both the row and column are satisfied simultaneously, cross out both of them. If tie occurs in the summation give the priority to the variable which has the maximum possible allocation quantity.
4. Calculate the fresh sum costs for the remaining sub-matrix as in Step- 2 and follows the procedure of Steps 3. Continue the process until all rows and columns are satisfied.
5. Finally calculate the total transportation cost which is the sum of the product of cost and corresponding allocated value.

4. NUMERICAL EXAMPLES

Example 4.1: Consider the following transportation

	D1	D2	D3	D4	Supply
O1	9	8	5	7	12
O2	4	6	8	7	14
03	5	8	9	5	16
demand	8	18	13	3	

INITIAL SOLUTION BY VAM

	D1	D2	D3	D4	Supply
O1	9	8	5(12)	7	12
O2	4	6(14)	8	7	14
03	5(8)	8(4)	9(1)	5(3)	16
demand	8	18	13	3	

Initial transportation cost is equal to

$$12\times 5+14\times 6+5\times 8+8\times 4+1\times 9+3\times 5=240$$

Initial solution by present method

	D1	D2	D3	D4	Supply
O1	9	8	5(12)	7	12
O2	4	6(13)	8(1)	7	14
03	5(8)	8(5)	9	5(3)	16
demand	8	18	13	3	

Initial transportation cost is equal to

$$12\times 5+13\times 6+1\times 8+8\times 5+8\times 5+3\times 5=241$$

Example 4.2: Consider the following transportation

	D1	D2	D3	Supply
O1	4	8	8	76
O2	16	24	16	82
03	8	16	21	77
demand	72	102	41	

Here, total supply =235, total demand =215

That is, $\text{Total supply} \neq \text{Total demand}$

Therefore, the given TP is unbalanced.

INITIAL SOLUTION BY VAM

To find initial solution for the given problem introduce the dummy column with zero cost and requirement is equal to 20.

	D1	D2	D3	D4	Capacity
O1	4	8**(35)**	8**(41)**	0	76
O2	16	24**(62)**	16	0**(20)**	82
03	8**(72)**	16**(5)**	21	0	77
Requirement	72	102	41	20	

Initial transportation cost is equal to

$$8\times 35+8\times 41+24\times 62+0\times 20+8\times 72+16\times 5=2752$$

INITIAL SOLUTION BY PRESENT ALGORITHM

Here total supply =235, total demand =215, so create a dummy column with availability 20

	D1	D2	D3	D4	Capacity
O1	4	8(35)	8(41)	0	76
O2	16(62)	24	16	0(20)	82
03	8(10)	16(67)	21	0	77
Requirement	92	102	41	20	

Initial transportation cost is equal to

$$8\times 35+8\times \mathbf{41}+16\times \mathbf{6}2+16\times 67+8\times 10=2752$$

Example 4.3: Consider the following transportation

	D1	D2	D3	D4	D5	Capacity
O1	5	8	6	6	3	800
O2	4	7	7	6	5	500
O3	8	4	6	6	4	900
O4	0	0	0	0	0	300
Requirement	400	400	500	400	800	

Here $\sum a_i = 2200$ and $\sum b_i = 2500$

That is, $\text{Total supply} \neq \text{Total demand}$

Therefore, the given TP is unbalanced.

INITIAL SOLUTION BY VAM

To find initial solution for the given problem introduce the dummy row with zero cost and capacity is equal to 300.

	D1	D2	D3	D4	D5	Capacity
O1	5	8	6**(200)**	6**(300)**	3**(300)**	800
O2	4**(400)**	7	7	6**(100)**	5	500
O3	8	4**(400)**	6	6	4**(500)**	900
O4	0	0	0**(300)**	0	0	300
Requirement	400	400	500	400	800	

Using VAM initial solution is equal to

$$6\times 200+6\times 300+3\times 300+4\times 400+6\times 100+4\times 400+4\times 500+0\times 300=9700$$

INITIAL SOLUTION BY PRESENT ALGORITHM

	D1	D2	D3	D4	D5	Capacity
O1	5	8	6	6(100)	3(700)	800
O2	4(400)	7	7	6	5(100)	500
O3	8	4(400)	6(500)	6	4	900
O4	0	0	0	0(300)	0	300
Requirement	400	400	500	400	800	

Initial solution is equal to

$$6\times 1\mathbf{00}+3\times 7\mathbf{00}+4\times \mathbf{400}+5\times \mathbf{100}+4\times \mathbf{400}+6\times \mathbf{500}\ =9400$$

5. CONCLUSION

The present method provides better feasible solution than others which are very close to optimal solution and sometimes it is equal to optimal solution. All the times this method provides least feasible solution but most of the times it gives better approach.

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