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A New Technique to Obtain Initial Basic Feasible Solution for the Transportation Problem

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Abstract— The SS method is a direct method proposed for deriving an initial solution towards transportation problem. This method solves the problem initially. Herewith in this research paper, a transportation matrix is reduced by column reduction to form a transformed matrix by allocating the zero by position in a systematic procedure. Salient features of this method depict lesser calculation time, easy applicability, and avoiding degeneracy to name a few. Depiction with examples provides easy understanding of this method.

Keywords— Transportation problems, supply, Demand, New method, Reduction.

I. INTRODUCTION

With a defined origins and destinations, avoiding a logistical mayhem by optimally allocating/ matching the demand and supply forms the basis of transportation. Here case in being with each origin having certain supply and similarly each destination having its demand. To evolve and quantify the model with minimal cost, not restricting the supply and demand whereas by satisfying all of the demand and the supply would be the fruition of the overall objective towards this model.

Considering the decision variable X_{ij} of transportation model the i^{th} supply at the source to the j^{th} demand at the destination.

The below listed methods are used to deduce the initial feasible solution of a transportation problem:

North West Corner Method

Least Cost Method

Vogel's Approximation Method

As moving towards our objective eventually, an optimal solution is obtained by MODI method or stepping stone method. Amongst the two the former (MODI) method is overly popular, resulting in gargantuan articles being published on this subject.

The Assignment problem is first solved by Hitchcock in 1941. Subsequently, this was further evolved and well-developed by Koopmans (1949) and Dantzig (1951). For the majority of the large scale of the transportation problem, Simplex method would not suit. Furthermore, towards the evolution of better its better applicability in 1954, Charnes and Cooper had developed Stepping Stone method. This was more efficient of their previous counterparts. The quest to develop a more feasible and efficient solution led to Heuristic method developed by Kirca and Stair from the Goyal's version of VAM (Reinfeld and Vogel, 1958).

Herewith in this research paper we have sequenced the sections as follows:

In Section 2 we present the mathematical form of TP. Section 3 deals and discuss the algorithm, Section 4 illustrates some of the numerical examples and finally Section 5 concludes with a brief discussion on the results thus obtained.

II. MATHEMATICAL FORM OF TRANSPORTATION PROBLEM

The LP problem is as follows

$$\text{Minimize } Z = \sum_{i=1}^m \sum_{j=1}^n C_{ij} X_{ij}$$

Subject to the constraints

$$\sum_{j=1}^n X_{ij} \leq S_i \text{ For all } i$$

$$\sum_{i=1}^m X_{ij} \geq d_j \text{ For all } j$$

$$X_{ij} \geq 0$$

A transportation problem is said to be balanced if

$$\sum_{i=1}^m S_i = \sum_{j=1}^n d_j$$

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III.ALGORITHM

Step 1

Construct the matrix of the transportation problem from given problem. In case if the problem is unbalanced we make it balanced.

Step 2

Find the minimum element in each column and construct a table such that minimum element is subtracted from each cost matrix of the corresponding column.

Step 3

Each column is to be discussed

Locate the zero of (i , j)th position and consider the unique position of the matrix in the column. Allocate the minimum of the supply and demand for that distinct position. Delete the corresponding columns or rows where the supply or demand is satisfied.

The remaining table is then discussed. The process is continued to the remaining table till m + n -1 cells are allocated and all the supply and demand is satisfied.

Step 4

If there is contrary to the above condition, that is if there is no distinct row for the corresponding column then look at which column have the same row, the allocation is given to the position where allocation can be a minimum of supply or demand. If the supply or demand is equal, then choose the other zero because it leads to the degeneracy. After allocating delete the corresponding row or column where the supply or demand is satisfied.

Step 5

Repeat steps 2 to step 4 till all the supply and demand is satisfied.

Step 6

Finally, calculate the total minimum cost as a sum of the product of cost and corresponding allocated value of supply or demand.

$$\text{Total cost} = \sum_{i=1}^n \sum_{j=1}^n C_{ij} X_{ij}$$

IV.NUMERICAL EXAMPLES

Example 4.1

Obtain an initial basic feasible solution for the following problem.

Factories		Distribution			
		D ₁	D ₂	D ₃	Supply
	F ₁	6	4	1	50
	F ₂	3	8	7	40
	F ₃	4	4	2	60
	Req.	20	95	35	

Step 1: Column reduction

Factories		Distribution			
		D ₁	D ₂	D ₃	Supply
	F ₁	3	0	0	50
	F ₂	20 0	4	6	40 20
	F ₃	1	0	1	60
	Req.	20 20	95	35	

Locate the position of zero

Distribution Factories

D₁ F₂

D₂ F₁, F₃

D₃ F₁

Delete D₁

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Step 2: Column reduction

		Distribution		
Factories		D ₂	D ₃	Supply
	F ₁	15	35	50
		0	0	15
	F ₂	20	6	40
		4		20
	F ₃	60	1	60
		0		
	Req.	95	35	

Locate the position

Distribution	Factories
D ₂	F ₁ , F ₃
D ₃	F ₁

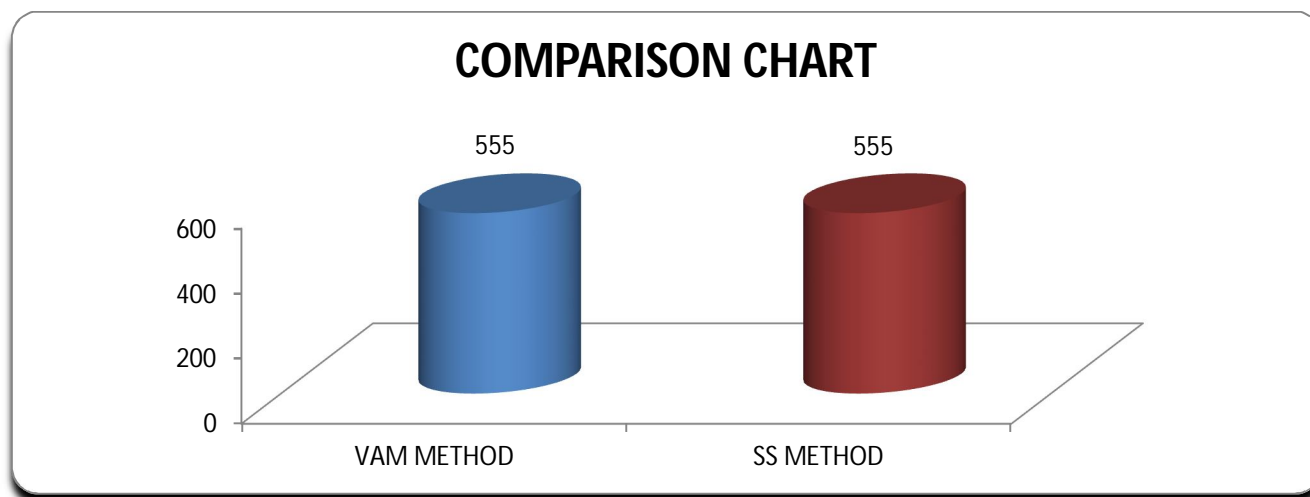
Delete D₃

Step 3:

		Distribution			
Factories		D ₁	D ₂	D ₃	Supply
	F ₁	6	15	35	50
			4	1	
	F ₂	20	20		40
		3	8	7	
	F ₃		60		60
		4	4	2	
	Req.	20	95	35	

$$\text{Minimum cost} = 15 \times 4 + 35 \times 1 + 20 \times 3 + 20 \times 8 + 60 \times 4$$

$$\text{Minimum cost} = 555$$



Example 4.2

Obtain optimal solution for the given transportation problem

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		Destination				
Source		D_1	D_2	D_3	D_4	Supply
	S_1	15	10	17	18	20
	S_2	16	13	12	13	60
	S_3	12	17	20	11	70
	<i>Demand</i>	30	30	40	50	

Solution

Step 1: Column reduction

	D_1	D_2	D_3	D_4	supply
S_1	3	<div style="border: 1px solid black; display: inline-block; padding: 2px;">20</div> 0	5	7	20
S_2	4	3	<div style="border: 1px solid black; display: inline-block; padding: 2px;">40</div> 0	2	60 20
S_3	0	7	8	0	70
<i>Demand</i>	30	30 10	40	50	

Locate the position of zeros

Destination Source

D_1 S_3
 D_2 S_1
 D_3 S_2
 D_4 S_3

Delete S_1 and D_3

Step 2: Column reduction

	D_1	D_2	D_4	supply
S_2	4	<div style="border: 1px solid black; display: inline-block; padding: 2px;">10</div> 0	<div style="border: 1px solid black; display: inline-block; padding: 2px;">10</div> 2	20 10
S_3	<div style="border: 1px solid black; display: inline-block; padding: 2px;">30</div> 0	4	<div style="border: 1px solid black; display: inline-block; padding: 2px;">40</div> 0	70 40
<i>Demand</i>	30	10	50 10	

Destination Source

D_1 S_3
 D_2 S_2
 D_4 S_3

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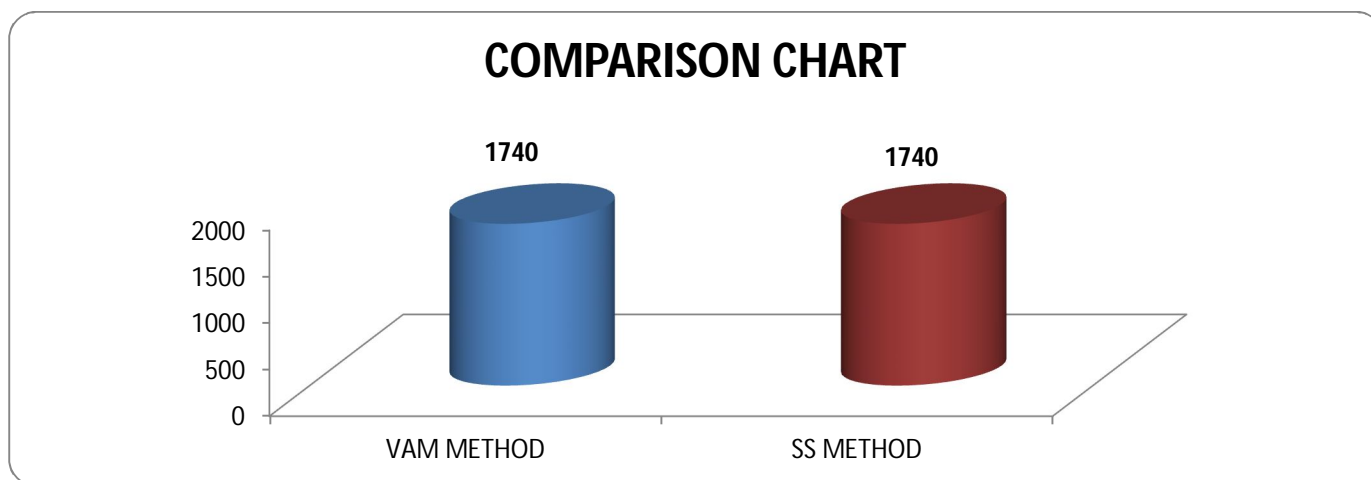
Delete D_2

Step 3:

	D_1	D_2	D_3	D_4	supply
S_1	15	20	17	18	20
		10			
S_2	16	10	40	10	60
		13	12	10	
S_3	30	17	20	40	70
	12			11	
<i>Demand</i>	30	30	40	50	

Minimum cost = $20 \times 10 + 10 \times 13 + 40 \times 12 + 10 \times 10 + 30 \times 12 + 40 \times 11$

Minimum cost = 1740



V. CONCLUSION

We have proposed and shown a direct method in solving the initial solution for the transportation problems through this research paper. Wherein this method can be used and applied to all transportation problems and of its kinds. The SS algorithm delves along a systematic procedure with the uncomplicated comprehensible attribute. This research paper in a conclusive way unravels to pinpoint on the methodical approach on providing initial basic feasible solution directly in fewer steps. The initial solution thus obtained through this method is same as VAM method. The quintessential benefactor attribute of this SS method is its lesser time taken, with astute comprehensibility giving the edge for the decision makers. In a truthful attempt on providing a new method for solving transportation, we propose this which is unique from all known previous methods.

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