IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

COMPARATIVE STUDY OF RUSSEL'S APPROXIMATION METHOD AND HEURISTIC METHOD

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Abstract: Transportation problem (TP) gives out the cost from the source to the destination and Initial Feasible Solution is used to give a better solution. In this paper, apply a Russel's Approximations Method (RAM) and Heuristic Methods (HM) are used for finding the best solution for transportation problem. The major fetching quality of these numerical examples requires an effortless process.

Keywords: **Linear Programming, Transportation problem, Initial basic feasible solution, Optimal solution, Digression percentage, Russel's approximation, Heuristic method**.

I.INTRODUCTION

A Transportation Problem is one of the linear programming problems. The Transportation problem was initiated by F.L.Hitchock [1]. The transportation model isto reduce the total shipping cost while fulfilling both the supply limit and the demandingneeds. The characteristic quality of this method easily goes through with statistical calculations. It makes as clear to acknowledge and to work. TP can be obtained in two steps. The First step is the Initial Basic Feasible Solution and the Second one is Optimal Solution. This research focal point on finding IBFS to get the minimal total cost of the transportation problem[4]. First by comparing RAM and HM methods along with this also adding NWCR and VAM [2] to find which is the better minimum cost. The requires least iterations to reach optimality, by applying the existing methods such as MODI and Stepping Stone method available in the literature. This paper is derived an experimental result statistical formula to compute Fig.3 and Fig.4 in section(6). The principal of the problem is how to pass goods from a group of m sources to n destinations in a way that minimizes the total transportation cost. The transportation problem plays a vital role in the supply chain and logistics. The minimized (maximized) function is called the objectivefunction. It can also apply in many areas. For e.g, Military distribution system, low-cost location, Decision making, resource allocation, service planning, network analysis, asset allocation. Hasibuan N.A solved the transportation problem by RAM and VAM method [3]. Bilquis Chastin Erma's method was solved a heuristic method of finding IBFS to solve the transportation problem.[5][6]. [7][9][8] from this articles randomly choose some numerical examples to evaluate the solution.To see the method is a efficient method to calculate the minimum cost. The paper is structured as follows: Following the introduction in section I, In section II, giving an some definitions, section III has a main formulation of the transportation problem. In section IV has the well known basic algorithms. In section V and VI is RAM algorithmand illustrated by the method. In section VII and IX is HM algorithm and illustrated by the method. In section 9 is discuss about Experimental result. In section X conclusions are drawn.

II SOME DEFINITION

The initial basic feasible solution total supply must be equal to total demand.

Optimal solution: A feasible solution is said to be optimal if it minimizes the total transportation cost.

Non degenerate basic feasible Solution: If a basic feasible solution to a transportation problem contains exactly m + n –1 allocations in independent positions, it is called a Non degenerate basic feasible solution.

Degeneracy: If a basic feasible solution to a transportation problem contains less than m + n –1allocations, it is called a degenerate basic feasible solution. Here m is the numberof rows and n is the number of columns in a transportation problem.

III.MATHEMATICAL FORMULATION

The Transportation problem formulated as,

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

Subject to the constraints,

$$\sum_{i=1}^{n} X_{ij} = A_i, \qquad i=1, 2, ..., n \text{ (Supply constraints)}$$

$$\sum_{j=1}^{m} X_{ij} = B_j \qquad j=1, 2, ..., m \text{ (Demand constraints)}$$

and $X_{ij} \geq 0$ for all i=1, 2, ..., n and j=1, 2, ..., m.

A_i=Quantity of commodity origin i .

B_j =Quantity of commodity origin j.

C_{ij}=From unit cost Origin i to destination j.

X_{ij}=Quantity transportation from origin i to destination j.

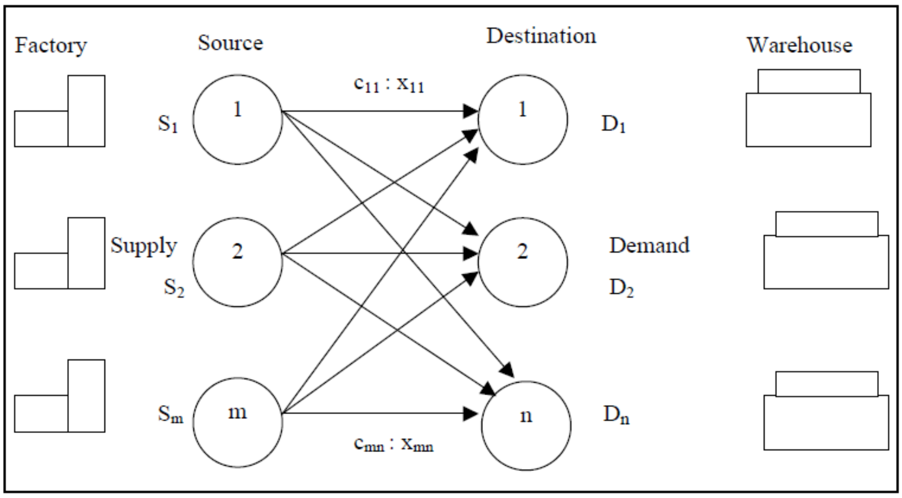

Fig.1: The network Transportation Model

IV. KNOWN ALGORITHMS

The common progress for solving the transportation problems is formed in 3 steps.
These three steps are declared that the feasible solution exists after the operations.

(i) If the main condition of the transportation problem can be made upon only one sourceor destination, set all the cost of transportation to the greatest possible.

(ii) The next one is X_{ij} is set the all cost of the greatest possible in TP.

(iii) Again go to step(i).

V. RUSELL'S APPROXIMATION METHOD

The first method is Russel's Approximation Method which is better than North WestCorner Rule.
The steps for the RAM method:

Step 1: Construct the Transportation Problem Whether TP is balanced or not.

Step 2: For each row, determine its, $\bar{A}_i$ (largest cost in row i)

Step 3: Determine it's $\bar{B}_j$ largest cost in the column j.

Step 4 For each quality calculate Where $\gamma_{ij} = C_{ij} - (\bar{A}_i + \bar{B}_j)$

Step 5: We can choose the high negative value in γ.

Step 6: Again and Again this procedure allocate to end.

VI. NUMERICAL PROBLEM

Destinations → Factory↓	W1	W2	W3	W4	Supply
F1	19	30	50	10	7
F2	70	30	40	60	9
F3	40	8	70	20	18
Demand	5	8	7	14	

Final result for RAM numerical example

Destinations → Factory↓	W1	W2	W3	W4	Supply
F1	19(5)	30(2)	50	10	7
F2	70	30(2)	40(7)	60	9
F3	40	8(4)	70	20(14)	18
Demand	5	8	7	14	

The above table reveals that out of the supply and demand samples 34 responses,F1 factory suppliers the expectation level on the basis offered by low,F2 factory supplies the expectation level on the basis offered by medium. F3 factory is high level expectation.Simillarly,W1 warehouse is low,W2 warehouse is medium, compare to W3 and W4,W4 is high level expectation.

The minimum total transportation cost

$=19\times5+30\times2+30\times2+40\times7+8\times4+20\times14=807.$

VII.HEURISTIC METHOD

The second existing method is Heuristic method.

Step-1: Whether we check the problem is balanced or not.

Step-2: Find the penalty cost, difference between high cost and low cost, row/column.

Step-3: Allocate as much as possible to this variable.

Step-4: Adjust the variable and required quantities.

Step-5: Again do the procedure, until got the best result.

VIII.NUMERICAL EXAMPLES

A factory has 3 supply plants which make 7,9 and 18 bikes. The factory supply tofour buyers whose demands are 5,8,7,14 bikes respectively. The major aim is to establisha schedule of shifting bikes from plants to buyers with the min TC.

The TP cost per piece of bikes is given in table.

Destinations → Factory↓	**W1**	**W2**	**W3**	**W4**	**Supply**
F1	19	30	50	10	7
F2	70	30	40	60	9
F3	40	8	70	20	18
Demand	5	8	7	14	

The final result of HM method

	W1	W2	W3	W4	Supply	Row Penality
F1	19(5)	30	50	10(2)	7	40 | 40 | 40 | − | − |
F2	70	30	40(7)	60(2)	9	40 | 30 | 20 | 20 | 20 | 0 |
F3	40	8(8)	70	20(10)	18	62 | 50 | 50 | 50 | − |
Demand	5	8	7	14		
Column Penality	51 51 – – – –	22 – – – – –	30 30 30 30 0 –	50 50 50 40 0 0		

The minimum total transportation cost =19×5+10×2+40×7+60×2+8×8+20×10=779.

IX.EXPERIMENTAL RESULT:

This section gives a comparison method among the VAM, NWCR, RAM, and HM.The comparison results are shown in the given excel table. From 13 numerical examples,we have to calculate randomly generate the solution.

Table: The experimental results for NWCR, VAM, RAM and HM.

							Digression % for numerical solution			
Author		NWCR	VAM	RAM	HM	Optimal solution	NWCR	VAM	RAM	HM
Abdhallah (2012)		1220	1075	1000	1070	1000	22	7.5	0	7
Mollah Meshahuddin Ahmed(2016)		4400	2900	2850	2850	2850	35.227	1.754	0	0
Mollah Meshahuddin Ahmed(2016)		4160	3320	3320	3620	3320	25.3012	0	0	9.03
Mollah Meshahuddin Ahmed(2016)		540	415	420	415	415	30.12	0	1.2048	0
Sharmin Afroz(2015)		726	542	570	542	542	33.9483	0	5.1661	0
Z.A.M.S Jaman & N.G.S.A.Nawarathni(2018)		1010	990	840	950	840	20.2381	17.8571	0	13.0952
Nelly Astuti Haribuan(2017)		11750	11450	11750	11750	11450	2.6201	0	2.6201	2.6201
Ravikumar(2018)		273	204	200	218	200	36.5	2	0	9
Mohamed H Abdelati(2020)		453	378	378	378	378	19.8413	0	0	0
Shradha Mishra(2017)		12200	12075	12200	12200	12075	1.0352	0	1.0352	1.0352
Adwell Mhlanga(2014)		500	350	350	350	350	42.85	0	0	0
Md.Amirul Islam(2018)		131	131	131	131	131	0	0	0	0
Average		3113.583333	2819.166667	2834.083333	2872.833333	2795.916667	**22.47343333**	**2.425925**	**0.835517**	**3.481708**

In that 13 numerical problems, RAM and HM methods are calculated from the Zmath software. The TORA software use run for successfully NWCR and VAM method calculations. The above experimental table was created in Excel. For all numerical example problem matrix size is m × n. For e.g.,3×3,4×3,etc.

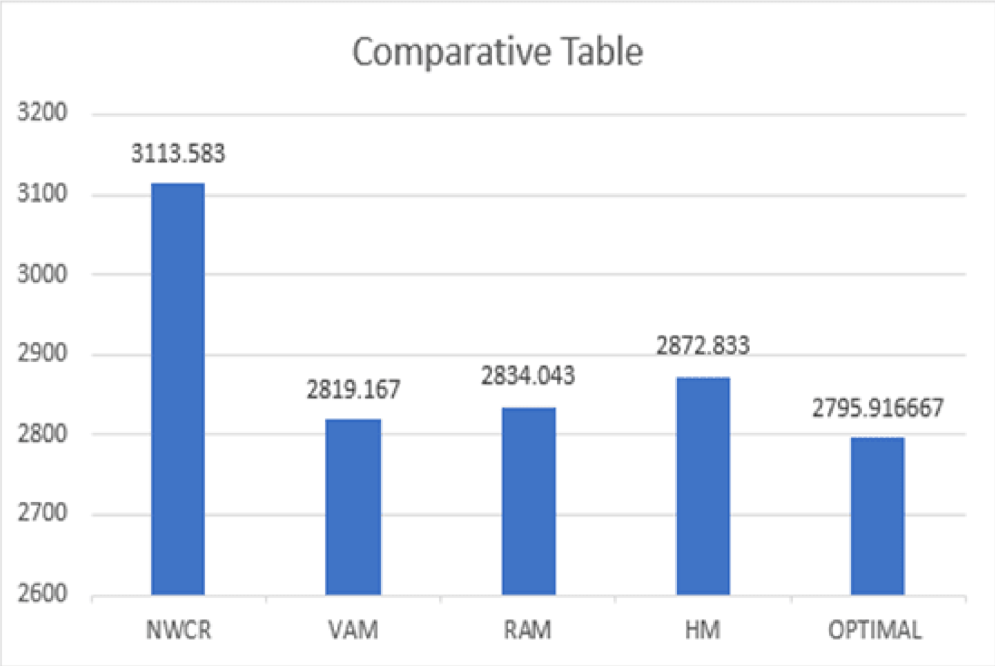

Fig.2: Comparative table

For a given data set, the mean also notify that is each method of a central value ofa set of numbers. Specifically, the sum of the values divided by the number of values. Theabove table indicates that the mean score of expectation of the transportation problem method.

Each and every method calculate the average value. The average value is shown in the above fig.2.The NWCR value is 3113.583, VAM value is 2819.167, RAM value is 2834.043, HMvalue is 2872.

$$DP = \frac{Ics - Op}{Op} \times 100$$

The digression percentage [4] is determined using the above formula.

Notation:

DP	Digression percentage
Ics	Initial cost solution
Op	Optimal solution

Figure: Digression percentage

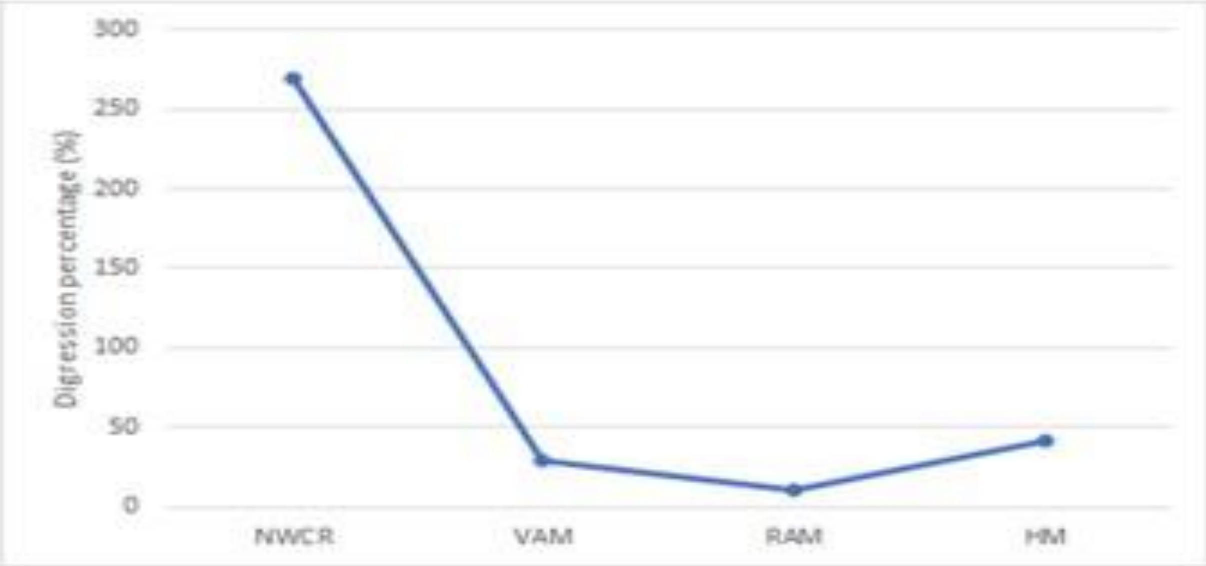

Fig.3: Digression percentage

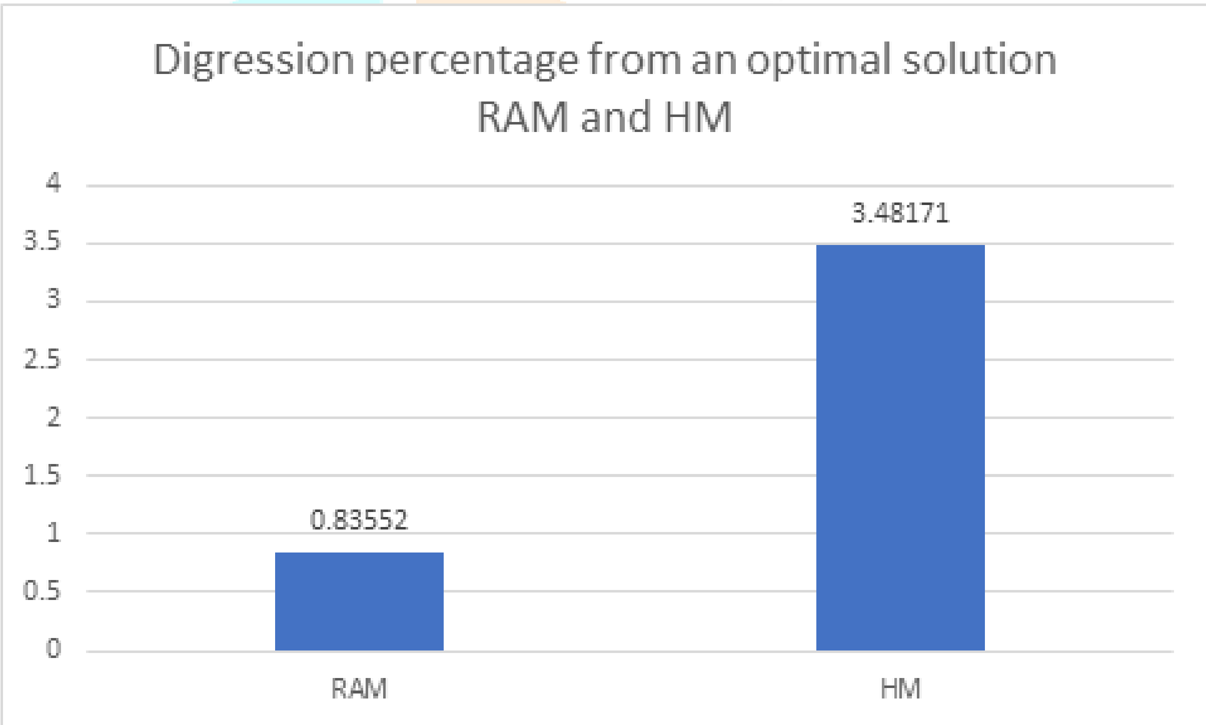

Fig.4: Digression percentage from an optimal solution RAM and HM

The above fig.3 is digression percentage graph, It could be well understand from the above table that the authors responded problem for a NWCR, VAM, HM and RAM are more than the RAM is a lesser optimality than the other method. It can be referred that the RAM expectation on the optimality of services offered by the other factories is high, is indicate that the percentage on the optimality offered by the other factory is low. From the fig.4, digression percentage from an optimal solution RAM and HM meth ods. Comparing RAM and HM methods, the RAM methods gives a minimum cost.

Method	Total no.of Avg numerical example values	Digression percentage
RAM	2834.083	10.0442
HM	2877.833	41.7805

The result is concluded can be refer that the relationship between all those method on the optimality is significant. So the RAM optimality has been providing less changes to give a better solution.

X.CONCLUSION

While comparing both RAM and HM Methods, the RAM method gives a best solution. It is easily applicable compared to the NWCR method. This method also implemented in the Real-life situations. This method provides less time and make easy to understand. So it will be helpful for decision makers who are dealing with this problem. It is also observed that our method is resulting in minimal values, respectively, for cost minimizing TPs.

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