# Right Maximum Minimum Budget Ultimate Procedure for Protected and Crazy Rectangular Network

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**Abstract:** In this Research, proposed algorithm namely Right Maximum Minimum Allotment method is applied to find the optimal feasible solution to reduce the cost from the basic feasible solution for transportation problems. The proposed algorithm is a unique way to reach the feasible (or) may be optimal (for some extant) solution without disturbance of degeneracy condition

**Keywords:** Assignment problem, Degeneracy, Maximum, Minimum, Optimum cost, Pay off Matrix (POM), Pivot Element, Right, Transportation problem

## 1. Introduction

The transportation problem is a special type of linear programming problem where the objective consists in **minimizing transportation cost** of a given commodity from a number of **sources** or **origins** (e.g. factory, manufacturing facility) to a number of **destinations** (e.g. warehouse, store)[1][2]. Each source has a limited supply (i.e. maximum number of products that can be sent from it) while each destination has a demand to be satisfied (i.e. minimum number of products that need to be shipped to it)[3][4]. The cost of shipping from a source to a destination is directly proportional to the number of units shipped [5][6].

Transportation problems have been widely studied in Medical Science and Operations Research. It is one of the fundamental problems of network flow problem which is usually use to minimize the transportation cost for Bio medical Engineering with number of sources and number of destination (Hospitals) while satisfying the supply limit and demand requirement for the medicines[7].

Transportation models play an important role in medicine distribution management along with cost minimizing and improving service in effective manner [8]. Some early approaches have devised solution procedure for the transportation problem with precise supply and demand parameters with respect to the medicine supply management in quick delivery with minimum cost[9][10].

## 2. Algorithm

### Right Maximum Minimum Allotment (RMxMiA)

***STEP 1:*** Construct the TT for the given pay off matrix (POM).

***STEP 2:*** Find the Maximum cost from the given POM and find the minimum cost from the right side of the maximum cost as a Pivot element occurred in the column.

***STEP 3:*** Allot the demand from the corresponding supply for the Pivot element which follows Step 2.

***STEP 4:*** Repeat the procedure until the degeneracy conditions prevails.

***Note:*** If the given pay off is not balanced then balance the POM by introducing Zero column and Zero row along with the equated demand and supply cost in the very last iteration.

**Example 1 :** Consider the following Balanced POM to achieve minimum cost.

| | $D_1$ | $D_2$ | $D_3$ | $D_4$ | Supply |
|---|---|---|---|---|---|
| $S_1$ | 6 | 1 | 9 | 3 | 70 |
| $S_2$ | 11 | 5 | 2 | 8 | 55 |
| $S_3$ | 10 | 12 | 4 | 7 | 90 |
| Demand | 85 | 35 | 50 | 45 | 215 |

**Table .1**

By Applying the above said Procedure, We get

Step 1: Here the Maximum cost is 12 in (3, 2) is a Pivot Element in the table 1.1; it is highlighted with Violet Colour. Select the minimum cost 1 in the Pivot element column and allot the maximum possible demand 35 units. Blue colour marked row is not considered for the next iteration.

| | $D_1$ | $D_2$ | $D_3$ | $D_4$ | Supply |
|---|---|---|---|---|---|
| $S_1$ | 6 | 1 [35] | 9 | 3 | 35 |
| $S_2$ | 11 | 5 | 2 | 8 | 55 |
| $S_3$ | 10 | 12 | 4 | 7 | 90 |
| Demand | 85 | 0 | 50 | 45 | 180 |

**Table .1.1**

Step 2: Here the Maximum cost is 11 in (2, 1) is a Pivot Element in the table 1.2; it is highlighted with Violet Colour. Select the minimum cost 2 from the right side of the Maximum Pivot element and allot the maximum possible demand 50 units. Blue colour marked column is not considered for the next iteration.

| | $D_1$ | $D_3$ | $D_4$ | Supply |
|---|---|---|---|---|
| $S_1$ | 6 | 9 | 3 | 35 |
| $S_2$ | 11 | 2 [50] | 8 | 5 |
| $S_3$ | 10 | 4 | 7 | 90 |
| Demand | 85 | 0 | 45 | 130 |

**Table .1.2**

Step 3: Here the Maximum cost is 11 in (2, 1) is a Pivot Element in the table 1.3; it is highlighted with Violet Colour. Select the minimum cost 3 from the right side of the Maximum Pivot element and allot the maximum possible demand 35 units. Blue colour marked row is not considered for the next iteration.

| | $D_1$ | $D_4$ | Supply |
|---|---|---|---|
| $S_1$ | 6 | 3 [35] | 0 |
| $S_2$ | 11 | 8 | 5 |
| $S_3$ | 10 | 7 | 90 |
| Demand | 85 | 10 | 95 |

**Table .1.3**

Step 4: Here the Maximum cost is 11 in (2, 1) is a Pivot Element in the table 1.4; it is highlighted with Violet Colour. Select the minimum cost 8 from the right side of the Maximum Pivot element and allot the maximum possible demand 5 units. Blue colour marked row is not considered for the next iteration.

| | $D_1$ | $D_4$ | Supply |
|---|---|---|---|
| $S_2$ | 11 | 8 [5] | 0 |
| $S_3$ | 10 | 7 | 90 |
| Demand | 85 | 5 | 90 |

**Table .1.4**

Step 5: Here the Maximum cost is 10 in (3, 1) is a Pivot Element in the table 1.5; it is highlighted with Violet Colour. Supply the maximum possible supply 85 units in (3, 1) and 5 units in (3, 4) which leads to the solution satisfying all the conditions.

| | $D_1$ | $D_4$ | Supply |
|---|---|---|---|
| $S_3$ | 10<br>85 | 7<br>5 | 90<br>0 |
| Demand | 0 | 0 | 90 |

**Table .1.5**

The resulting Optimum feasible solution is given below.

| | $D_1$ | $D_2$ | $D_3$ | $D_4$ | Supply |
|---|---|---|---|---|---|
| $S_1$ | 6 | 1<br>35 | 9 | 3<br>35 | 70 |
| $S_2$ | 11 | 5 | 2<br>50 | 8<br>5 | 55 |
| $S_3$ | 10<br>85 | 12 | 4 | 7<br>5 | 90 |
| Demand | 85 | 35 | 50 | 45 | 215 |

**RESULT:**

| Supply | 3 | 1 | 2 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| Demand | 1 | 2 | 3 | 4 | 4 | 4 |
| Cost | 850 | 35 | 100 | 105 | 40 | 35 |
| Optimum Cost | | | | | | 1165 |

Example 2 : Consider the following Balanced POM to achieve minimum cost.

| | $D_1$ | $D_2$ | $D_3$ | $D_4$ | $D_5$ | Supply |
|---|---|---|---|---|---|---|
| $S_1$ | 100 | 150 | 200 | 140 | 35 | 400 |
| $S_2$ | 50 | 70 | 60 | 65 | 80 | 200 |
| $S_3$ | 40 | 90 | 100 | 150 | 130 | 150 |
| Demand | 100 | 200 | 150 | 160 | 140 | 750 |

**Table .2**

By Applying the above said Procedure, We get the resulting Optimum feasible solution for Example 2.

| | $D_1$ | $D_2$ | $D_3$ | $D_4$ | $D_5$ | Supply |
|---|---|---|---|---|---|---|
| $S_1$ | 100<br>100 | 150<br>50 | 200 | 140<br>110 | 35<br>140 | 400 |
| $S_2$ | 50 | 70 | 60<br>150 | 65<br>50 | 80 | 200 |
| $S_3$ | 40 | 90<br>150 | 100 | 150 | 130 | 150 |
| Demand | 100 | 200 | 150 | 160 | 140 | 750 |

**RESULT:**

| Supply | 1 | 1 | 3 | 2 | 1 | 2 | 1 |
|---|---|---|---|---|---|---|---|
| Demand | 1 | 2 | 2 | 3 | 4 | 4 | 5 |
| Cost | 10,000 | 7,500 | 13, 500 | 9,000 | 15, 400 | 3, 250 | 4, 900 |
| Optimum Cost | | | | | | | 63, 550 |

**Example 3:** Consider the following Balanced POM to achieve minimum cost.

| | $D_1$ | $D_2$ | $D_3$ | $D_4$ | $D_5$ | Supply |
|---|---|---|---|---|---|---|
| $S_1$ | 3 | 4 | 6 | 8 | 9 | 20 |
| $S_2$ | 2 | 10 | 1 | 5 | 8 | 30 |
| $S_3$ | 7 | 11 | 20 | 40 | 3 | 15 |
| $S_4$ | 2 | 1 | 9 | 14 | 16 | 13 |
| Demand | 40 | 6 | 8 | 18 | 6 | 78 |

**Table .3**

By Applying the above said Procedure, We get the resulting Optimum feasible solution for Example 3

| | $D_1$ | $D_2$ | $D_3$ | $D_4$ | $D_5$ | Supply |
|---|---|---|---|---|---|---|
| $S_1$ | 3 [20] | 4 | 6 | 8 | 9 | 20 |
| $S_2$ | 2 [4] | 10 | 1 [8] | 5 [18] | 8 | 30 |
| $S_3$ | 7 [9] | 11 | 20 | 40 | 3 [6] | 15 |
| $S_4$ | 2 [7] | 1 [6] | 9 | 14 | 16 | 13 |
| Demand | 40 | 6 | 8 | 18 | 6 | 78 |

**RESULT:**

| Supply | 1 | 2 | 3 | 4 | 4 | 2 | 2 | 3 |
|---|---|---|---|---|---|---|---|---|
| Demand | 1 | 1 | 1 | 1 | 2 | 3 | 4 | 5 |
| Cost | 60 | 8 | 63 | 14 | 6 | 8 | 90 | 18 |
| Optimum Cost | | | | | | | | 267 |

**3. Comparison with Existed Method:**

**3.1 Comparision With Leastcost Method (LCM):**

| EXAMPLE | LCM | RMiMxA | ACCURACY IN % |
|---|---|---|---|
| 1 | 1165 | 1165 | 100.00 |
| 2 | 63550 | 63550 | 100.00 |
| 3 | 555 | 267 | 207.86 |
| AVERAGE ACCURACY | | | 135.95 |

**3.2 Comparision With North West Corner Method (NWC):**

| EXAMPLE | NWC | RMiMxA | ACCURACY IN % |
|---|---|---|---|
| 1 | 1,265 | 1,165 | 108.58 |
| 2 | 92,450 | 63,550 | 145.47 |
| 3 | 267 | 267 | 100.00 |
| AVERAGE ACCURACY | | | 118.01 |

**3.3 Comparision With Vogel's Approximation Method (VAM):**

| EXAMPLE | VAM | RMiMxA | ACCURACY IN % |
|---|---|---|---|
| 1 | 1220 | 1165 | 104.72 |
| 2 | 66300 | 63550 | 104.33 |
| 3 | 267 | 267 | 100.00 |
| AVERAGE ACCURACY | | | 103.01 |

**4. Result and Conclusion:**

| Average Accuracy | |
|---|---|
| With NWC | 118.01 |
| With LCM | 135.95 |
| With VAM | 103.01 |
| Overall Accuracy | 118.99 |

The Proposed Procedure gives the optimal feasible solutions118.99 % accuracy in the optimal feasible solution than the existed optimization method so called Vogel's Approximation. **18.99 %** better than existed method.

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**References**

1. Amaravathy, V. Seerengasamy, S. Vimala, Comparative study on MDMA Method with OFSTF Method in Transportation Problem, International Journal of Computer & Organization Trends(IJCOT) – Volume 38 Number 1 - December 2016, ISSN 2249-2593.

2. Amaravathy, K. Thiagarajan , S. Vimala, Cost Analysis – Non linear Programming Optimization Approach , International Journal of pure and applied mathematics Volume 118 No.10 2018, 235-245 ISSN:1311-8080(printed version), ISSN:1314-3395(on –line version)
3. Amaravathy, K. Thiagarajan, S. Vimala, MDMA Method –An Optimal Solution for Transportation Problem, Middle – East Journal of Scientific Research 24(12):3706-63710,2016 ISSN 1990-9233
4. Amaravathy, K. Thiagarajan , S. Vimala, Optimal Solution of OFSTF, MDMA Methods with Existing Methods Comparison, International Journal of pure and applied mathematics Volume 119 No.10 2018, 989-1000 ISSN:1311-8080(printed version), ISSN:1314-3395(on –line version)
5. Gass, SI (1990). On solving the transportation problem. Journal of Operational Research Society, 41(4), 291-297.
6. Goyal, SK (1984). Improving VAM for unbalanced transportation problems. Journal of Operational Research Society, 35(12), 1113-1114.
7. K. Thiagarajan, A. Amaravathy, S. Vimala, K. Saranya (2016). OFSTF with Non linear to Linear Equation Method – An Optimal Solution for Transportation Problem, Australian Journal of Basic and Applied Sciences, ISSN – 1991-8178 Anna University-Annexure II, SI No. 2095.
8. Reinfeld, NV and WR Vogel (1958). Mathematical Programming. Englewood Gliffs, New Jersey: Prentice-Hall.
9. Shih, W (1987). Modified Stepping-Stone method as a teaching aid for capacitated transportation problems. Decision Sciences, 18, 662-676.
10. S. Vimala, K. Thiagarajan, A. Amaravathy, OFSTF Method –An Optimal Solution for Transportation Problem, Indian Journal of Science and Technology, Vol 9(48), DOI:17485/ijst/2016/v9i48/97801, December 2016. ISSN (Print) : 0974-6846 ,ISSN (Online) : 0974-5645.