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Comparison of Modified ASM and Zero Suffix Method on A Fuzzy Transportation Problem

Joy Sowmiya A¹, Sahaya Sudha A²

PG Student, Department of Mathematics, Nirmala College for Women, Coimbatore, India¹

Assistant Professor, Department of Mathematics, Nirmala College for Women, Coimbatore, India²

ABSTRACT: A fuzzy transportation problem is a transportation problem in which the transportation expenditures, supply and demand quantities are fuzzy quantities. In this paper, the Modified ASM (i.e., Assigning Shortest Minimax) method is compared to the Zero suffix method of transportation problem to reduce the cost of transporting goods to multiple destinations. The Modified ASM algorithm is used as a heuristic approach to solve transportation problems by finding an optimal solution that minimizes total cost while ensuring that no more than a specified maximum number of steps are required for delivery. The results showed that both algorithms performed well when compared with each other under limited conditions. It is concluded that Modified ASM method provides better results than Zero suffix method due to its efficient use of resources and reduction in cost for transporting goods from one location to another.

KEYWORDS: Fuzzy Transportation problem Modified ASM method, Zero suffix method, optimal solution, comparison.

I. INTRODUCTION

The transportation problem is solved using linear programming. Goods must be distributed to meet consumer needs due to the distances between consumers and producers. In the real world, the decision-maker frequently lacks precise knowledge of the coefficients associated with the transportation problem. In this case, the corresponding elements defining the problem can be expressed using a fuzzy set, and the fuzzy transportation problem emerges naturally. Hitchcock [7] pioneered the basic transportation model (1941). [5] Dantzig (1951) solved the transportation problem using linear programming.[2] Bellman and [14] Zadeh proposed the concept of decision-making in a fuzzy environment (1970). [3] Chang (1981) proposed the concept of an alternative's preference function.[13] Yager (1981) investigated a method for ordering fuzzy unit interval subsets. Chen (1985) [4] investigated fuzzy number ranking with maximising and minimising sets. [6] Dinagar and Palanivel (2009) investigated the problem of transportation in a fuzzy environment. [10] Pandian and Natarajan (2010) developed a new algorithm for determining a fuzzy optimal solution to fuzzy transportation problems. Shanmugasundari and Ganesan[11] (2013) investigated a novel approach for solving fuzzy transportation problems. Kaur and Kumar (2012) [8] presented a novel method for resolving fuzzy transportation problems by employing generalised trapezoidal fuzzy numbers (TrFNs). [12] Srinivas and Ganesan (2015) used a revised distribution method to find the best solution to the intuitionistic fuzzy transportation problem. Nagarajan and Solairaju (2010) [9] discovered that under Robust ranking, computing improved fuzzy optimal hungarian assignment problem with fuzzy costs was possible. Ahmed, Khan, Uddin and Ahmed [1] (2016) introduced the allocation table method (ATM) for finding an IBFS.

II. METHODOLOGY

MODIFIED ASM METHOD:

Step-1: Subtract each row and column entries of the table from the respective row minimum and column minimum.

Step-2: Even rows should be swapped with even rows, and odd rows should be swapped with odd rows. This step is carried out until row m , if row m is an even row then row m will be swapped with other even rows, namely rows $2, 4, \dots, m-2$ and odd rows will be swapped for other odd rows, namely rows $1, 3, \dots, m-1$, so that the order of the row swap in the table is $m-1, m, 1, 2, \dots, m-2$. However, if row m is an odd row, then row m will be swapped with another odd row, namely rows $1, 3, \dots, m-2, m$, and even rows will be swapped with other even rows, namely rows $2, 4, \dots, m-1$, so that the order of the row swap in the table is $m, m-1, 1, 2, \dots, m-2$.



Step-3: Exchange even columns for even columns and odd columns for odd columns. This step is repeated until column n is reached; if column n is an even column, it is swapped with another even column, namely column $2, 4, \dots, n-2$, and an odd column is swapped with another odd column, namely column $1, 3, \dots, n-1$, so that the order of the results of swapping columns in the table is $n-1, n-2, \dots, n$. However, suppose column n is an odd column. In that case, column n will be swapped with another odd column, namely columns $1, 3, \dots, n-2, n$, and even columns will be swapped with other even columns, namely columns $2, 4, \dots, n-1$, so that the order of the results of swapping columns in the table is preserved.

Step-4: Select the first 0 by row wise and allocate the goods with $\min(S_i, D_j)$ i.e., cost reduction.

Step-5: Delete the row or column where supply from the source or demand from the destination was met.

Step-6: Repeat the same procedure for all the zeros in the table.

Step-7: After finding all the allocations, allocate the values in the original table.

Step-8: Multiply the allocated values with the cost values of the corresponding cell. And the total of this results in optimal solution.

Zero Suffix Method:

Step-1: Subtracting each row entry from the transportation table's corresponding row minimum and each column entry from the transportation table's corresponding column minimum.

Step-2: There will be atleast one zero in each row and column of the cost matrix, so look for suffix values denoted by S . $S = \text{Add cost from the nearest side zero that is greater than zero/ additional cost}$.

Step-3: If S has only one maximum value, choose that value. If there are two or more items of the same value choose one, and the cost becomes the allocation of the goods taking into account demand and supply.

Step-4: Choose the smallest $\{a_j, b_j\}$ then assign it to be the transportation table. Each row and column in the resulting table must have at least one cost worth zero.

Step-5: Repeat steps 2–4 until the best solution is found.

III. NUMERICAL EXAMPLE

A certain commodity is to be delivered to each of the 3 depots situated at D_1, D_2, D_3 . The requirements of the depots are given in fuzzy numbers respectively, while the capacity of the factories at S_1, S_2, S_3, S_4 , are also given in fuzzy numbers respectively. The cost of transportation is given below in the table

Table 1- Fuzzy transportation table:

SOURCE	D_1	D_2	D_3	SUPPLY
S_1	(3,2,4)	(2,1,3)	(8,7,9)	(260,250,240)
S_2	(1,0,2)	(6,5,7)	(2,3,4)	(350,340,360)
S_3	(7,8,6)	(6,5,4)	(4,3,2)	(400,390,410)
S_4	(5,6,4)	(8,9,10)	(1,3,2)	(200,220,180)
DEMAND	(300,270,330)	(390,410,400)	(500,490,510)	(1200,1100,1300)

Converting the fuzzy values into crisp values by using the ranking,

$$M_0^{Tri}(A) = \frac{1}{4}(2m + \delta + \beta)$$

$$S_1 D_1 = (3, 2, 4)$$

$$= \frac{1}{4}[2(3) + 2 + 4]$$

$$S_1 D_1 = 3,$$

similarly, $S_1 D_2 = 2, S_1 D_3 = 8, S_2 D_1 = 1, S_2 D_2 = 6, S_2 D_3 = 3, S_3 D_1 = 7, S_3 D_2 = 5, S_3 D_3 = 3, S_4 D_1 = 5, S_4 D_2 = 9, S_4 D_3 = 2$



The fuzzy transportation table is converted into a crisp transportation problem is given below

Table-2: CRISP TRANSPORTATION TABLE:

SOURCE	D_1	D_2	D_3	SUPPLY
S_1	3	2	8	250
S_2	1	6	3	350
S_3	7	5	3	400
S_4	5	9	2	200
DEMAND	300	400	500	1200

SOLUTION FOR THE NUMERICAL EXAMPLE:

Modified ASM method:

1. Subtract each row and column entries of the table from the respective row minimum and column minimum.
2. Swap even rows with even rows and odd rows with odd rows.
3. Repeat the same step for columns.
4. Do the cost reduction process with $\min(S_1 D_1)$ and allocate the values.

Table-4: Allocation Table for modified ASM method:

SOURCE	D_1	D_2	D_3	SUPPLY
S_1	3(100)	2(150)	8	250
S_2	1	6(250)	3(100)	350
S_3	7	5	3(400)	400
S_4	5(200)	9	2	200
DEMAND	300	400	500	1200

Substitute the values in the table, we get the optimum solution for ASM method as
 $= 3 \times 100 + 2 \times 150 + 6 \times 250 + 3 \times 100 + 3 \times 400 + 5 \times 200 = 4600$

ZERO SUFFIX METHOD:

1. Subtract each row and column entries of the table from the respective row minimum and column minimum.
2. Since there are zeros in each columns and rows, look for suffix values values denoted by S. S = Add cost from the nearest side zero that is greater than zero/ additional cost.
3. If S has only one maximum value, choose that value. If there are two or more items the same value choose one, and the cost becomes the allocation of the goods taking into account demand and supply.
4. Choose the smallest a_j, b_j assign it to be the transportation table. Each row and column in the resulting table must have at least one cost worth zero.



Table-5: Allocation Table for zero suffix method:

SOURCE	D_1	D_2	D_3	SUPPLY
S_1	3	2(250)	8	250
S_2	1(300)	6	3(50)	350
S_3	7	5(150)	3(250)	400
S_4	5	9	2(200)	200
DEMAND	300	400	500	1200

Substitute the values in the table, we get the optimum solution for zero suffix method as
 $= 2 \times 250 + 300 + 3 \times 50 + 5 \times 150 + 3 \times 250 + 2 \times 200 = 2850$

IV. CONCLUSION

In this study, both the Modified ASM method and the zero suffix method produced effective results. However, with fewer iterations, the zero suffix technique provides the best solution to the fuzzy transportation problem. This process is simple to understand and comprehend, and it saves time by requiring little calculation time. As a result, it will be extremely beneficial to those who are having difficulty in making decisions.

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