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Heptagonal Fuzzy Numbers by Max-Min Method

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ABSTRACT
In this paper, we propose another methodology for the arrangement of fuzzy transportation problem under a fuzzy environment in which transportation costs are taken as fuzzy Heptagonal numbers. The fuzzy numbers and fuzzy values are predominantly used in various fields. Here, we are converting fuzzy Heptagonal numbers into crisp value by using range technique and then solved by the MAX-MIN method for the transportation problem.

KEYWORD: *Fuzzy Heptagonal Number, Range Technique, MAX-MIN Method*

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I. INTRODUCTION

In our daily life situations, various decision-making problems such as fixing the cost of goods, profit for sellers, making decisions for real-life multi-objective functions, etc. are seeking a solution by the transportation problem. In real-life problems, Zadeh (9) and (10) had introduced the uncertainty theory, which is very useful for copying a large number of data.

A new method of solving a fuzzy transportation problem basedon the assumption that the decision -maker is uncertain about transportation cost was introduced by AmarpeetKaur (1). In 1941, Hitchcock (2) initiated the fundamental transportation problem; S. Sathya Geetha, K. Selvakumari (4) Proposed A New Method for Solving Fuzzy Transportation Problem Using Pentagonal Fuzzy numbers In 1976 Jain (3) had introduced a new method of ranking fuzzy numbers. Still, the researchers recently focus on a lot of different methods that make a betterment of Transportation Problem.

In this paper, we propose MAX-MIN method with Range technique, where the objective is to maximize the profit by converting the maximization problem into a minimization problem for a balanced transportation problem. This paper is written as follows, Introduction to the concepts were given in section 1.Some basic concepts in section 2, An algorithm is proposed in section 3, A numerical example is illustrated in section 4,finally conclusion in section 5

II. FUZZY SET[FS]:

Let X be a nonempty set. A fuzzy set $\bar{A}$ of Xis defined as$\bar{A}$={$< x, \mu_{\bar{A}}(x) > / x \in X$}. Where $\mu_{\bar{A}}(x)$ is called membership function, which maps each element of X to a value between 0 and 1.

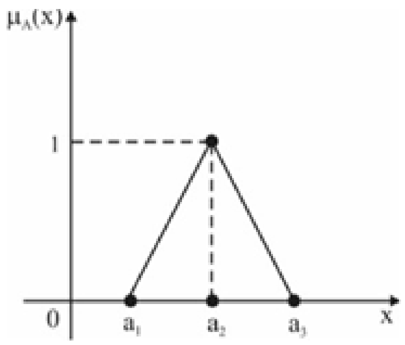
2.2. FUZZY NUMBER[FN]:

$A$is a fuzzy set on the real line R, must satisfy the following conditions.

1. $\mu A(x0)$ is piecewise continuous
2. There exist at least one x0∈ ℜ with $\mu_A(x_0)$=1
3. A must be regular &convex

3.3. TRIANGULAR FUZZY NUMBER [TFN]:

A Triangular fuzzy number $\bar{A}$ is denoted by 3 – tuples (a_1, a_2, a_3), wherea_1, a_2 and $a_3$are real numbers and $a_1 \le a_2 \le a_3$ with membership function defined as



$$\mu_{\bar{A}}(x) = \begin{cases} \dfrac{x - a_1}{a_2 - a_1} \; for \; a_1 \le x \le a_2 \\ \dfrac{a_3 - x}{a_3 - a_2} \; for \; a_2 \le x \le a_3 \\ 0 \; otherwise \end{cases}$$

3.4. TRAPEZOIDAL FUZZY NUMBER [TRFN]:

A trapezoidal Fuzzy number is denoted by 4 tuples $\bar{A} = (a_1, a_2, a_3, a_4)$,Where a_1, a_2, a_3 and $a_4$arereal numbers and $a_1 \le a_2 \le a_3 \le a_4$ with membership function defined as

$$\mu_{\bar{A}}(x) = \begin{cases} \frac{x - a_1}{a_2 - a_1} \; for \; a_1 \leq x \leq a_2 \\ 1 \; for \; a_2 \leq x \leq a_3 \\ \frac{a_4 - x}{a_4 - a_3} \; for \; a_3 \leq x \leq a_4 \\ 0 \; otherwise \end{cases}$$

3.5. PENTAGON FUZZY NUMBER [PFN]:

A Pentagon Fuzzy Number $\bar{A}_P = (a_1, a_2, a_3, a_4, a_5)$ Where a_1, a_2, a_3, a_4 and a_5 are real numbers

and $a_1 \leq a_2 \leq a_3 \leq a_4 \leq a_5$ with membership function is given below

$$\mu_{\bar{A}}(x) = \begin{cases} 0 \; for \; x < a_1 \\ \frac{x - a_1}{a_2 - a_1} \; for \; a_1 \leq x \leq a_2 \\ \frac{x - a_2}{a_3 - a_2} \; for \; a_2 \leq x \leq a_3 \\ 1 \; for \; x = a_3 \\ \frac{a_4 - x}{a_4 - a_3} \; for \; a_3 \leq x \leq a_4 \\ \frac{a_5 - x}{a_5 - a_4} \; for \; a_4 \leq x \leq a_5 \\ 0 \; for \; x > a_5 \end{cases}$$

3.6. HEXAGONAL FUZZY NUMBER [HFN]:

A Hexagon Fuzzy Number $\bar{A}_H$ is specified by 6 tuples, $\bar{A}_H = (a_1, a_2, a_3, a_4, a_5, a_6)$. Where a_1, a_2, a_3, a_4, a_5 and a_6 are real numbers and $a_1 \leq a_2 \leq a_3 \leq a_4 \leq a_5 \leq a_6$ with membership function is given below,

$$\mu_{\bar{A}}(x) = \begin{cases} \frac{1}{2}\left(\frac{x - a_1}{a_2 - a_1}\right) \; for \; a_1 \leq x \leq a_2 \\ \frac{1}{2} + \frac{1}{2}\left(\frac{x - a_2}{a_3 - a_2}\right) \; for \; a_2 \leq x \leq a_3 \\ 1 \; for \; a_3 \leq x \leq a_4 \\ 1 - \frac{1}{2}\left(\frac{x - a_4}{a_5 - a_4}\right) \; for \; a_4 \leq x \leq a_5 \\ \frac{1}{2}\left(\frac{a_6 - x}{a_6 - a_5}\right) \; for \; a_5 \leq x \leq a_6 \\ 0 \; for \; otherwise \end{cases}$$

3.7. HEPTAGONAL FUZZY NUMBER:

A Heptagonal Fuzzy Number $\bar{A}_H$ is specified by 7 tuples, $\bar{A}_H = (a_1, a_2, a_3, a_4, a_5, a_6, a_7)$. Where $a_1, a_2, a_3, a_4, a_5, a_6$ and a_7 are real numbers and $a_1 \leq a_2 \leq a_3 \leq a_4 \leq a_5 \leq a_6 \leq a_7$ with membership function is given below,

$$\mu_{\bar{A}}(x) = \begin{cases} 0 \; for \; x < a_1 \\ \frac{1}{2}\left(\frac{x - a_1}{a_2 - a_1}\right) \; for \; a_1 \leq x \leq a_2 \\ \frac{1}{2} \; for \; a_2 \leq x \leq a_3 \\ \frac{1}{2} + \frac{1}{2}\left(\frac{x - a_3}{a_4 - a_3}\right) \; for \; a_3 \leq x \leq a_4 \\ \frac{1}{2} + \frac{1}{2}\left(\frac{a_5 - x}{a_5 - a_4}\right) \; for \; a_4 \leq x \leq a_5 \\ \frac{1}{2} \; for \; a_5 \leq x \leq a_6 \\ \frac{1}{2}\left(\frac{a_7 - x}{a_7 - a_6}\right) \; for \; a_6 \leq x \leq a_7 \\ 0 \; for \; x \geq a_7 \end{cases}$$

Range Technique:

The range is defined as the difference between the maximum value and minimum value.

Range = Maximum amount – Minimum amount.

III. MAX-MIN ALGORITHM

Step (1)

Construct the transportation table we examine whether total demand equals total supply then go to step 2

Step (2)

By using range technique, we convert the fuzzy cost can be converted into crisp values to the given transportation problem

Step (3)

For the row-wise difference between maximum and minimum of each row, and it is divided by the number of columns of the cost matrix.

Step (4)

For the column-wise difference between maximum and minimum of each column, and it is divided by the number of rows of the cost matrix.

Step (5)

We find the maximum of the resultant values and find the corresponding minimum cost value and do the allocation of that particular cell of the given matrix. Suppose we have more than one maximum consequent value. We can select anyone.

Step (6)

Repeated procedures 1 to 5 until all the allocations are completed.

IV. NUMERICAL EXAMPLE

Consider the Balanced fuzzy transportation problem Product is produced by three warehouses Warehouse1, Warehouse2,Warehouse3.Production capacity of the Three Warehouse are 12,10 and 32 units, respectively. The product is supplied to Four stores Store1, Store2, Store3, and Store 4 the requirements of Demands, which are 10,13,16 and 15 respectively. Here Unit costs of fuzzy transportation are represented as fuzzy heptagonal numbers are given below. Find the fuzzy transportation plan such that the total production and transportation cost is minimum.

Source \ Destination	Store 1	Store 2	Store 3	Store 4	Capacity
Warehouse 1	(1,2,3,4,5,6,8)	(1,4,5,6,7,8,9)	(1,3,5,7,8,9,10)	(2,3,4,5,6,7,8)	12
Warehouse 2	(3,4,6,8,9,10,12)	(1,2,3,5,7,9,11)	(0,2,3,4,5,7,8)	(2,6,7,9,10,11,13)	10
Warehouse 3	(2,7,9,10,12,14,15)	(4,7,9,10,12,14,16)	(6,8,10,12,14,16,20)	(4,5,7,9,10,11,13)	32
Demand	10	13	16	15	54

By using Range technique, we have to convert fuzzy Heptagonal numbers into a crisp value.

TABLE: 1

Destination / Source	Store 1	Store 2	Store 3	Store 4	Capacity
Warehouse 1	7	8	9	6	12
Warehouse 2	9	10	8	11	10
Warehouse 3	13	12	14	9	32
Demand	10	13	16	15	54

Destination / Source	Store 1	Store 2	Store 3	Store 4	Capacity	$\frac{Max - min}{4}$
Warehouse 1	[10] 7	8	9	6	12 [2]	$\frac{3}{4} = 0.75$
Warehouse 2	9	10	8	11	10	$\frac{3}{4} = 0.75$
Warehouse 3	13	12	14	9	32	$\frac{5}{4} = 1.25$
Demand	10	13	16	15		
$\frac{Max - min}{3}$	$\frac{6}{3} = 2$	$\frac{4}{3} = 1.33$	$\frac{6}{3} = 2$	$\frac{5}{3} = 1.66$		

TABLE: 2

Destination / Source	Store 1	Store 2	Store 3	Store 4	Capacity	$\frac{Max - min}{3}$
Warehouse 1	[10] 7	8	9	6	12[2]	1
Warehouse 2	9	10	8 [10]	11	10	1
Warehouse 3	13	12	14	9	32	$\frac{5}{3} = 1.66$
Demand	10	13	16[6]	15		
$\frac{Max - min}{3}$	$\frac{6}{3} = 2$	$\frac{4}{3} = 1.33$	$\frac{6}{3} = 2$	$\frac{5}{3} = 1.66$		

Reduced Table of MAX-MIN Method

Destination / Source	Store 1	Store 2	Store 3	Store 4	Capacity
Warehouse 1	[10] 7	8	9	[2] 6	12
Warehouse 2	9	10	8 [10]	11	10
Warehouse 3	13	12 [13]	14 [6]	9 [13]	32
Demand	10	13	16	15	

The transportation cost=(10*7)+(2*6)+(8*10)+(12*13)+(14*6)+(9*13)=519

COMPARISON WITH EXISTING METHOD

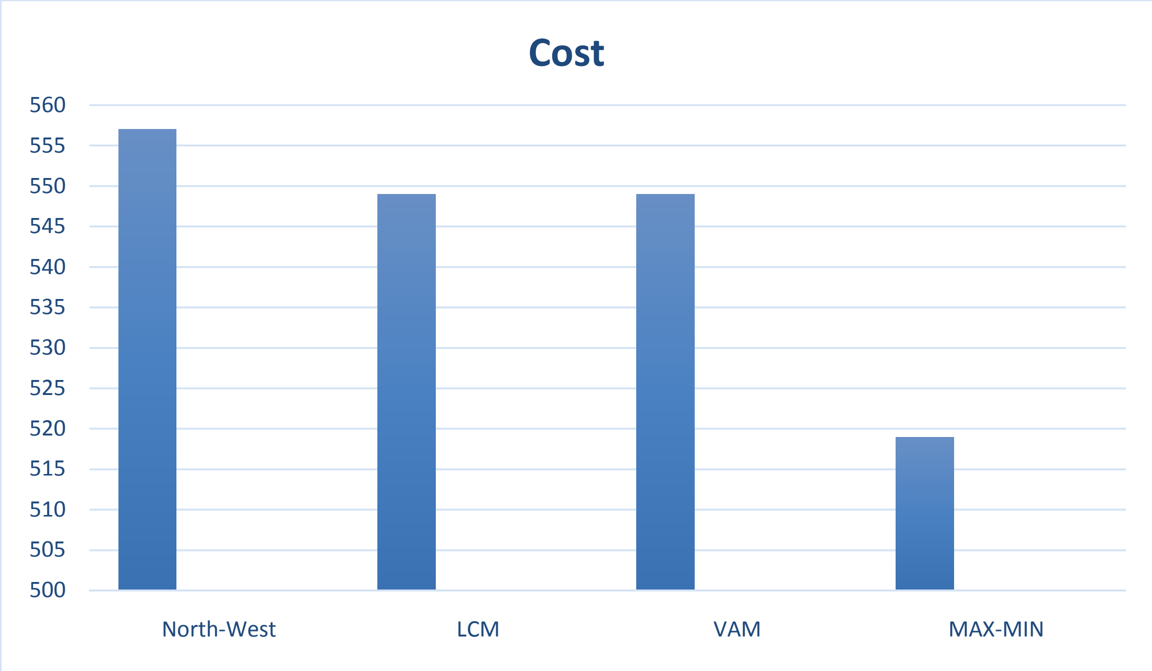
The comparison of the proposed method with the existing process is tabulated below, in which it is clearly shown that the proposed method provides the optimal results.

Applying **North West Corner method**, Table corresponding to initial basic feasible solution is = 557

Applying **LCM** method, Table corresponding to initial basic feasible solution is = 549

Applying **VAM** method, Table corresponding to initial basic feasible solution is = 549

Applying **MAX-MIN** method, Table corresponding to Optimal solution is = 519



V. CONCLUSION:

In this paper, fuzzy transportation problem has been transformed into crisp transportation problem by using range technique, we used North -West corner method, Least cost method, Vogel's Approximation method to solve fuzzy transportation problem to get the optimal solution. From these three methods Least cost method, Vogel's Approximation method gives minimum transportation cost compared to North-West corner method.

MAX-MIN method provides a better optimal solution with less time for transportation problem .This method easy to understand and to apply for finding a fuzzy optimal solution to fuzzy transportation problems occurring in real life situations. So it will be helpful for decision makers who are dealing with the problem the example of Fuzzy Transportation Problem of Heptagonal numbers. It is concluded that Heptagonal Fuzzy Transportation method proves to be minimum cost of Transportation by using MAX-MIN Method.

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