NEW RANKING FUNCTION 
ON OCTAGONAL FUZZY 
NUMBER FOR SOLVING 
FUZZY TRANSPORTATION 
PROBLEM

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Abstract

The aim of this paper, a new ranking function to introduce on octagonal fuzzy numbers. We introduce a new model to solve octagonal fuzzy number with fuzzy transportation problem. By defining a ranking to the octagonal fuzzy numbers, to convert the fuzzy valued transportation problem (cost, supply and demand appearing as octagonal fuzzy numbers) to a crisp valued transportation problem, which then can be solved initial feasible solution using the DK method.

AMS Subject Classification:

Key Words and Phrases: Octagonal Fuzzy numbers, Fuzzy Transportation Problem, Fuzzy Ranking, Membership Function.
1 Introduction

The transportation problem is a special linear programming problem which arises in many practical applications. A fuzzy transportation problem is a transportation problem in which the transportation costs, supply and demand quantities are fuzzy quantities. Michael has proposed an algorithm for solving transportation problem with fuzzy constraints and has investigated the relationship between the algebraic structure of the optimum solution of the deterministic problem and its fuzzy equivalent. Nagoor Gani and Abdul Razack [5] obtained a fuzzy solution for a two stage cost minimizing fuzzy transportation problem in which supplies and demands are trapezoidal fuzzy numbers. There are several approaches by different authors to solve such a problem viz.

In this paper, a new ranking function introduced an octagonal fuzzy numbers. Using this ranking the fuzzy transportation problem is converted to a crisp valued problem, which can be solved using DK method for initial feasible solution.

2 Octogonal Fuzzy Numbers

Definition 1 (Mathematical formulation of a fuzzy Transportation problem). The general form of Transportation problem

Minimize (Total cost) \( Z = \sum_{i=1}^{m} \sum_{j=1}^{n} c_{ij}x_{ij} \)

Subject to the constraints \( \sum_{j=1}^{n} x_{ij} = a_i, \ i = 1, 2, 3, \ldots, m \)

\( \sum_{i=1}^{m} x_{ij} = b_j, \ j = 1, 2, 3, \ldots, n \)

\( x_{ij} \geq 0 \) for all \( i \) and \( j \).

Definition 2. A fuzzy numbers \( \tilde{A} \) is said to be a generalized octagonal fuzzy number denoted by \( \tilde{A} = (a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8) \) where

\( a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8; k, w \) are real numbers such that \( a_1 \leq a_2 \leq a_3 \leq a_4 \leq a_5 \leq a_6 \leq a_7 \leq a_8 \) and \( 0 < k < w \) and its
membership function given by

\[
\mu_{\tilde{A}_0}(x) = \begin{cases} 
0 & x < a_1 \\
\frac{k(x - a_1)}{a_2 - a_1} & a_1 \leq x \leq a_2 \\
k & a_2 \leq x \leq a_3 \\
\frac{k + k(x - a_3)}{a_4 - a_3} & a_3 \leq x \leq a_4 \\
1 & a_4 \leq x \leq a_5 \\
1 - k\frac{x - a_5}{a_6 - a_5} & a_5 \leq x \leq a_6 \\
k & a_6 \leq x \leq a_7 \\
\frac{k(x - a_8)}{a_7 - a_8} & a_7 \leq x \leq a_8 \\
0 & x > a_8
\end{cases}
\]

Figure 1: Octagonal Fuzzy Number

**Definition 3.** An effective approach for ordering the elements of \( F(R) \) is also to define a ranking function \( \mathcal{R} : F(R) \rightarrow R \) which maps each fuzzy number into the real line, where a natural order exists. We define orders on \( F(R) \) by:

\( \tilde{a} \geq \tilde{b} \) if and only if \( \mathcal{R}(\tilde{a}) \geq \mathcal{R}(\tilde{b}) \)

\( \tilde{a} > \tilde{b} \) if and only if \( \mathcal{R}(\tilde{a}) > \mathcal{R}(\tilde{b}) \)

\( \tilde{a} = \tilde{b} \) if and only if \( \mathcal{R}(\tilde{a}) = \mathcal{R}(\tilde{b}) \)

**Definition 4 (New Ranking Technique).** The octagonal fuzzy number into two plane figures. These two plane figures are ABGH and CDEF. Let the CE line on the BG. The
balancing point for a generalized octagonal fuzzy number \( \tilde{A} = (a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8) \) is

\[
\Re(\tilde{A}) = \frac{1}{6}(a_1 + a_8 + k(a_2 + a_3 + a_6 + a_7) + (a_4 + a_5))
\]

3 Numerical Example

A company has four warehouses \( L_1, L_2, L_3 \) and \( L_4 \). It is required to deliver a product from these warehouses to three customers \( G_1, G_2 \) and \( G_3 \). The warehouses have the following amounts in stock:

<table>
<thead>
<tr>
<th>Warehouse</th>
<th>( L_1 )</th>
<th>( L_2 )</th>
<th>( L_3 )</th>
<th>( L_4 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Units</td>
<td>(2,4,5,6,7,9,10,13)</td>
<td>(0,1,2,4,5,8,9,11)</td>
<td>(-3,1,2,3,4,5,6,7)</td>
<td>(-4,0,1,2,3,4,5,6)</td>
</tr>
</tbody>
</table>

and the customers’ requirements are

<table>
<thead>
<tr>
<th>Customers</th>
<th>( G_1 )</th>
<th>( G_2 )</th>
<th>( G_3 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Units</td>
<td>(1,2,3,5,7,9,10,11)</td>
<td>(2,3,6,8,9,11,12,13)</td>
<td>(5,7,8,9,11,12,13,15)</td>
</tr>
</tbody>
</table>

The table shows the costs of transporting one unit from warehouse to the customer.

<table>
<thead>
<tr>
<th>( G_1 )</th>
<th>( G_1 )</th>
<th>( G_1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( L_1 )</td>
<td>(4,0,1,2,3,4,5,6)</td>
<td>(2,3,6,8,9,11,12,13)</td>
</tr>
<tr>
<td>( L_2 )</td>
<td>(-3,1,2,3,4,5,6,7)</td>
<td>(-4,3,2,1,0,1,2,6)</td>
</tr>
<tr>
<td>( L_3 )</td>
<td>(5,6,8,10,11,14,16,18)</td>
<td>(1,2,3,5,7,9,10,11)</td>
</tr>
<tr>
<td>( L_4 )</td>
<td>(2,4,5,6,7,9,10,13)</td>
<td>(2,3,6,8,9,11,12,13)</td>
</tr>
</tbody>
</table>

Determine the IBFS to the following Transportation problem.

**Solution:**

The above octagonal fuzzy number converted to crisp number using the proposed ranking function.

<table>
<thead>
<tr>
<th>Warehouse</th>
<th>( L_1 )</th>
<th>( L_2 )</th>
<th>( L_3 )</th>
<th>( L_4 )</th>
<th>Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>( G_1 )</td>
<td>2</td>
<td>3</td>
<td>11</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>( G_1 )</td>
<td>1</td>
<td>0</td>
<td>6</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>( G_1 )</td>
<td>5</td>
<td>8</td>
<td>15</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Demand</td>
<td>7</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>
Since $\Sigma a_j = \Sigma b_j$ the problem is a balanced TP. The steps of DK method are as follows;
(i) For each row (column) with strictly positive supply (demand). Determine the cardinality of even (odd) set, which is maximum including zero if it is there.
(ii) Identify the minimum variable in that set, allocate as much as possible to the variable with the least unit cost in the selected row or column. Adjust the supply and demand, and cross out the satisfied row or column. If a row and a column are satisfied simultaneously, only one of the two is crossed out, and the remaining row or column is assigned zero supply (demand).
(iii) Repeat the procedure until the entire available supply at various sources and demand at various destinations is satisfied.

The total transportation cost of the Initial Basic Feasible solution calculated as an below
Total cost = $4 \times 3 + 2 \times 11 + 1 \times 0 + 7 \times 5 + 1 \times 15 + 2 \times 9 = 102$.

4 Conclusion

In today’s highly competitive market, various organizations want to deliver products to the customers in a cost effective way, so that the
transportation model provides a powerful framework to determine the best ways to deliver goods to the customers.

In this article, a new ranking function proposed, finally it can be claimed that the method may provide initial basic feasible solution by ensuring minimum transportation cost. This will help to achieve the goal to those who want to maximize their profit by minimizing the transportation cost.

**References**


