IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 7, May 2026
Impact Factor: 8.2

Decision Making Problem in Octagonal Fuzzy Number

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Abstract: *In this paper, we begin with the fuzzy decision making problem (FDMP) with Octagonal fuzzy numbers to evaluate the Payoff matrix using Octagonal fuzzy numbers, transform the FDMP into a crisp valued FDMP problem using a ranking method for the payoffs, and then formulate the crisp valued FDMP problem using the savage mini max regret criterion.*

Keywords: Fuzzy decision making problem (FDMP), Octagonal fuzzy number, membership function, Pay off matrix.

I. INTRODUCTION

Fuzzy decision making was first introduced by Bellman and Zadeh [1]. When making judgments, it is essential to identify the options from which a conclusion must be drawn. There are various types of decision-making. Different strategies may be used by people to decide on specific matters. When one person is in charge of making decisions, this is referred to as individual decision making. Multi person decision making, on the other hand, takes place when multiple people collaborate and combine their expertise to make decisions. Enhancing decision-making requires accurate information gathering. Decision making is the process of selecting an appropriate alternative from those needed to execute a specific strategy. Jain [2] was the first to suggest the method for ranking fuzzy numbers in fuzziness-related decision-making scenarios.

The idea of the Octagonal fuzzy number was utilized by V. Raju and Jayagopal [3] in decision making problem. Numerous decisions are made based on data collection. Instead of using actual numbers to convey their ideas, decision makers often employ hexagonal fuzzy numbers. To make a decision, information must be gathered. In both personal and professional life, the ability to make decisions and solve problems is essential. Problem-solving highlights the significance of decision-making. Effective decision-making is crucial for management and leadership.

The modern world offers a number of techniques and approaches to enhance decision-making and its total value. In a decision-making problem that we have covered in this article, imprecise values are represented by Octagonal fuzzy numbers. We have accomplished this by turning it into a clearly valued decision-making problem through the use of a ranking technique. Furthermore, we have extended the fuzzy decision making problem using Octagonal fuzzy numbers with the aid of an example.

II. PRELIMNARIES

In this section, we give the preliminaries that are required for this study.

Definition 2.1. A fuzzy set A is defined by $A = \{(x, \mu_A(x)) : x \in A, \mu_A(x) \in [0,1]\}$. Here x is crisp set A and $\mu_A(x)$ is membership function in the interval$[0,1]$.

Definition 2.2. The fuzzy number A is a fuzzy set whose membership function must satisfy the following conditions.

(i) A fuzzy set A of the universe of discourse X is convex

(ii) A fuzzy set A of the universe of discourse X is a normal fuzzy set if $x_i \in X$ exists

(iii) $\mu_A(x)$ is piecewise continuous

DOI: 10.48175/568

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Definition 2.3 An α-cut of fuzzy set A is classical set defined as ${}^{\alpha}[A] = \{x \in X | \mu_A(x) \geq \alpha\}$

Definition 2.4 A fuzzy set A is a convex fuzzy set iff each of its α-cut ${}^{\alpha}A$ is a convex set.

2.5 Ranking of Hexagonl fuzzy number:

Let I be a normal Hexagonl fuzzy number. The valueM (I), called as measure of I is calculated as

$$M(I) = \frac{e_1 + e_2 + e_3 + e_4 + e_5 + e_6 + e_7 + e_8}{8}$$

Definition 2.6

A fuzzy number A = $(a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8)$ is Octagonal fuzzy number and its membership function is given by

$$\mu_E(x) = \begin{cases} 0, for\ x < a_1 \\ \frac{1}{2}\left(\frac{x - a_1}{a_2 - a_1}\right), for\ a_1 \leq x \leq a_2 \\ 0.5, \quad for \quad a_2 \leq x \leq a_3 \\ \frac{1}{2} + \frac{1}{2}\left(\frac{x - a_2}{a_4 - a_2}\right), for\ a_3 \leq x \leq a_4 \\ 1, for\ a_4 \leq x \leq a_5 \\ \frac{1}{2} + \frac{1}{2}\left(\frac{a_6 - x}{a_6 - a_5}\right), for\ a_5 \leq x \leq a_6 \\ 0.5, \quad for \quad a_6 \leq x \leq a_7 \\ \frac{1}{2}\left(\frac{a_8 - x}{a_8 - a_7}\right), for\ a_7 \leq x \leq a_8 \\ 0, for\ x > a_8 \end{cases}$$

3.1 Mathematical formulation of Fuzzy Decision making problem:

Consider a fuzzy decision making problem in which all the entries of the payoff matrix are Hexadecagonl fuzzy numbers. Let us obtain the problem R has m strategies and problem S has n strategies. Then the payoff matrix m x n is

$$A = \begin{pmatrix} r_{11} & r_{12} & . & r_{1n} \\ r_{21} & r_{22} & . & r_{2n} \\ . & . & . & . \\ r_{m1} & r_{m2} & . & r_{mn} \end{pmatrix}$$

3.2 Procedures for solving Savage Minimax regret criterion:

Step 1: Construct a regret (opportunity loss) table of each alternative for every state of nature from the given pay off matrix

Step 2: Pick out the maximum pay off in each column and subtract all the elements in that column from this maximum value

Step 3: For each decision alternative (row) , pick out the maximum row value and enter this in the last decision column

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Step 4: Choose the decision alternative with the smallest value in the decision column

IV. NUMERICAL EXAMPLE

Let us consider the Matrix

a_{11}	- 2,-1,0,1,2 ,3,4,5	$\mu_{EDC}(a_{11}) = 1.5$
a_{12}	- 1,0,1,2.3. 4.5.6	$\mu_{EDC}(a_{12}) = 2.5$
a_{13}	1,2,3,4,5,6,7,8	$\mu_{EDC}(a_{13}) = 4.5$
a_{21}	- 3,-2,-1,0, 3,7,8,9	$\mu_{EDC}(a_{21}) = 2.625$
a_{22}	- 2,-1,0,1,2 ,3,4,5	$\mu_{EDC}(a_{22}) = 1.5$
a_{23}	0,1,2,4,5,6,7,8	$\mu_{EDC}(a_{23}) = 4.125$
a_{31}	3,4,5,6,7,9,10,11	$\mu_{EDC}(a_{31}) = 6.875$
a_{32}	6,8,9,10,12,13,15,17	$\mu_{EDC}(a_{32}) = 11.25$
a_{33}	- 3,-2,-1,0, 3,7,9,11	$\mu_{EDC}(a_{33}) = 3$

This problem is solved by taking the values *for* $k_1 = \frac{1}{2}$. We obtain the values of Measure of matrix A and is denoted by $\mu_{EDC}(a_{ij})$

Step 1: The given fuzzy decision making problem is reduced to the following payoff profit matrix

Alternatives	Expected level of Sale (in Rupees)		
	I	II	III
Maze	1.5	2.5	4.5
Rice	2.625	1.5	4.125
Ragi	6.875	11.25	3

Step 2: The opportunity loss table for each alternative with the states of nature is depicted below

Alternatives	Expected level of Sale (in Rupees)		
	I	II	III
Maze	5.375	8.75	0
Rice	4.25	9.75	0.375
Ragi	0	0	1.5
Column Maximum	6.875	11.25	4.5

Step 4: The opportunity loss table and the maximum loss in each row is entered and shown in the below table

Alternatives	Expected level of Sale (in Rupees)			Decision Column (Maximum Loss)
	I	II	III	
Maze	5.375	8.75	0	8.75
Rice	4.25	9.75	0.375	9.75
Ragi	0	0	1.5	1.5

Result: Since the minimum of maximum loss is in alternative Ragi = 1.5 rupees, this alternative must be selected.

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V. CONCLUSION

This article describes and discusses the fuzzy decision-making problem and its payout matrix, which consists of Octagonal fuzzy numbers. We have demonstrated the process of selecting alternatives by employing ranking techniques to convert the fuzzy-valued decision-making problem into a crisp-valued decision-making problem. The crisp-valued decision-making problem is addressed using the Savage minimax regret criteria.

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