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# A Simple Approach To Fuzzy Multiple Attribute Decision Making (FMADM) Problem Using Profit Function

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***Abstract - In this paper a method is framed to solve fuzzy multiple attribute decision making problem. It is based on scoring and profit. Different profit functions namely linear, quadratic and cubic are developed in order to calculate the profit. An illustrative example is also discussed.***

***Keywords- Fuzzy multi attribute decision making beneficial attribute – Ideal best alternatives – Profit functions.***

## 1. INTRODUCTION

Fuzzy Multiple Attribute Decision Making (FMADM) is an abstract technique because of the presence of the models subjectivity. FMADM include two cycles, rating and the positioning of options. Assuming the rating results are fresh, the positioning strategy turns out to be straight-forward, henceforth the accentuation of this paper is on getting fresh evaluating for options.

As indicated by Bellman and Zadeh [1], "A large part of the dynamic in reality happens in a climate wherein the objectives, the limitations and the outcomes of potential activities are not known accurately". As per Mac-Crimmon [8] the most well-known can be separated into two classes, weighting strategies and successive end techniques.

For a true choice issue, the exhibitions of traits may be portrayed by various units of estimation containing quantitative, subjective or fuzzy data. To lessen the intricacy in the preparing of fuzzy information, the semantic terms or fuzzy number contained in the information ought to be changed into fresh numbers through the defuzzification cycle. Be that as it may, deciding the best and effective strategy for changing fuzzy appraisals into mathematical evaluations is as yet a significant issue, principally worried about the affectability to the varieties and the capacity to segregate among marginally extraordinary fuzzy information. The most generally utilized defuzzification strategies comprise of the weighted focus approach, the zone place technique, the complete fundamental estimation of fuzzy number, the left and right alloted scores and the strategy integrated by Chen and Hwang [2].

Fuzzy to-Fuzzy methodologies, the Fuzzy-to-Crisp methodology proposes strategies to change fluffy information over to fresh qualities to utilize them in a traditional MADM model Fuzzy-to-Fuzzy proposes calculations to create FMADM procedures equipped for utilizing fuzzy information.

FMADM is utilized to make the choice of various choices in restricted amounts are managed by Ashraf et al., (2016); Bahiraei et al., (2015); Wang and Ji, (2014); Gong et al., (2013); Mohyeddin and Gharaee, (2014). In the event that the information or data gave both by the jury and information standards of competitors are inadequate or contain vulnerability, at that point to address the issue of vulnerability we use the FMADM by Kusumadewi et al., (2006 )[5].

A scientific categorization of techniques for old style MADM issues and fuzzy positioning strategies can be found in the examination by Chen and Hwang (1992) [2]. The main role of dynamic frameworks can uphold and improve dynamic interaction to be performed by the leaders, albeit in one hand, it is hard to quantify the results of the choice identified with the quality and certainty choices. To meet these targets, the exploration identified with improving the nature of dynamic and certainty being created and brought about the dynamic techniques which were likewise evolved alongside the longing for quality and the correct certainty to choice results got.

Some new methodologies dependent on the above scoring and trading off techniques can be found in the examinations by Yang et.al (2013) [14] are famous concordance techniques.

In this paper, a basic strategy for FMADM issues has been presented dependent on benefit capacities. This strategy utilizes the way of thinking of both scoring and creating techniques. The paper is coordinated, the proposed benefit work approach is portrayed and the absolute benefit for picking an option is inferred. Additionally, use the proposed benefit work way to deal with dynamic issues taken from writing and examination of the outcomes with other mainstream techniques. In the preliminary we finish up comments and rundown.

*Profit Function Approach (PFA)*

In the proposed technique, at first, the best option must be acquired from the accessible other options. The ideal best elective comprises of all higher qualities for useful qualities. The benefit for picking every option needs to ascertain regarding the ideal best other option. The option with most noteworthy conceivable complete benefit is picked as the best other option. The benefit can be determined dependent on quadratic capacity, yet they can be determined utilizing direct and cubic benefit works moreover

The choice framework of a MADM issue with n choices and p credits is appeared in the table.

| Alternatives | Attributes | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | .... | $p$ |
| 1 | $y_{11}$ | $y_{12}$ | $y_{13}$ | $y_{14}$ | .... | $y_{1p}$ |
| 2 | $y_{21}$ | $y_{22}$ | $y_{23}$ | $y_{24}$ | .... | $y_{2p}$ |
| . | . | . | . | . | .... | . |
| . | | | | | | |
| $n$ | $y_{n1}$ | $y_{n2}$ | $y_{n3}$ | $y_{n4}$ | .... | $y_{np}$ |

Let $y_{ij}$ represent the value of $j^{th}$ attribute in the $i^{th}$ alternative.

The Ideal Best Alternative (IBA) selected from data matrix of table can be represented mathematically as,

$$IBA \quad = \left\{ \min_{i} (y_{ij} / j \in U, \max_{i} \left\{ y_{ij} / j \in V \right\} \right.$$
$$i = 1, 2, ..., n$$

Where $U$ and $V$ are represents the set of beneficial and non-beneficial attributes respectively. The credits of any picked elective must be contrasted and qualities of IBA and the benefit for not being the awesome each property must be determined. The amount of the benefits brought about by all credits of an elective gives the all out benefit for picking a specific other option.

*Minimum and Maximum profits for attributes*

To compute the complete benefit of any other option, at first the benefit brought about by each property of that specific option must be determined. To figure the benefit brought about by each property, the attributes of the picked elective are to be contrasted and those of ideal best other option.

For an advantageous trait, the greatest benefit is taken to be one when the property measures the base worth concerning all options viable. The benefit is taken to be least when a useful characteristic is at greatest worth. On a zero-one scale, the benefit is viewed as equivalent to zero when the property estimation is at most extreme concerning all choices viable.

Utilizing a similar rationale for a non advantageous trait, the greatest benefit is taken as one when the credits esteem is at most extreme and the base benefit is taken as zero when the characteristic have the base worth.

Let $y^{j}_{\min}$ address the base estimation of the $j^{th}$ attribute among all other options,

ie., $y^{j}_{\min} = \min\left(y_{ij}\right) \forall i = 1, 2, ..., n$

Let $y^{j}_{\max}$ address the greatest estimation of the trait among all other options.

ie., $y^{j}_{\max} = \max\left(y_{ij}\right) \forall i = 1, 2, ..., n$

The most extreme and least benefits $P^{j}$ for a useful characteristic can be communicated numerically as,

$$P^{j} = \begin{cases} 0 & if \;\; y_{ij} = y^{j}_{\min} \\ 1 & if \;\; y_{ij} = y^{j}_{\max} \end{cases} \; j \in U \qquad (1)$$

Likewise, the greatest and least benefits $P^{j}$ for a non-useful attribute can be communicated numerically as,

$$P^{j} = \begin{cases} 0 & if \;\; y_{ij} = y^{j}_{\min} \\ 1 & if \;\; y_{ij} = y^{j}_{\max} \end{cases} \; j \in V \qquad (2)$$

From condition (2) and (3), it very well may be noticed the base benefit is viewed as equivalent to zero when the gainful property is at most extreme and the non-advantageous credits at least qualities. Be that as it may, every one of the credits is not similarly weighted in MADM issues. Consequently, the base benefits can't be viewed as equivalent to 0 for all ascribes.

Fusing the loads of various ascribes, the base benefit for each credits is gotten by increasing the base benefit (equivalent to nothing) by individual load of the characteristic.

Thinking about the individual loads, everything being equal, the base and most extreme benefits of valuable ascribes would now be able to be communicated as

$$P^j = \begin{cases} 1 & if \ \ y_{ij} = y^j_{\min} \\ w^j_U & if \ \ y_{ij} = y^j_{\max} \end{cases} \ j \in U$$

Also, the base and greatest benefits for a non-benefit attributes would now be able to be communicated as

$$P^j = \begin{cases} 1 & if \ \ y_{ij} = y^j_{\max} \\ w^j_V & if \ \ y_{ij} = y^j_{\min} \end{cases} \ j \in V$$

Where $w^j_U$ and $w^j_V$ address the loads of non-valuable and useful ascribes individually.

*Profit calculation for a non-beneficial / beneficial attribute*

In this part, the benefit conditions for non-advantageous/useful ascribes are inferred for direct, quadratic and cubic capacities. In the event of direct capacity, the benefit is thought to be relative to the deviation of the property from the best estimation of the attributes.

Additionally, in quadratic benefit work the benefit is thought to be corresponding to the square of the deviation of the property from the best estimation of the trait. Benefit is thought to be corresponding to the shape of the deviations in the event of cubic benefit capacities.

Expecting a straight benefit work ie, the benefit is corresponding to the deviation, the benefit work for the $j^{th}$ trait of any option can be composed as

$$p\left(y_{ij}\right) = K^j_V\left(y_{ij} - y^j_{max}\right) \qquad (3)$$

Where $K^j_V$ is the constant of proportionality for a non-beneficial attributes

At $y_{ij} = y^j_{max}$

$$P\left(y_{ij}\right) = 1 \qquad (4)$$

At $y_{ij} = y^j_{min}$

$$P\left(y_{ij}\right) = W^j_V \qquad (5)$$

Consolidating (3) and (5)

$$W^j_V = K^j_V\left(y^j_{\min} - y^j_{\max}\right) \qquad (6)$$

The steady of proportionality can be acquired from (6) as

$$K^j_V = \frac{W^j_V}{\left(y^j_{\min} - y^j_{\max}\right)} \qquad (7)$$

Utilizing the estimation of steady of proportionality from (7), the direct benefit work for a non-valuable characteristic can be composed as,

$$P\left(y_{ij}\right) = \frac{W^j_V\left(y_{ij} - y^j_{\max}\right)}{\left(y^j_{\min} - y^j_{\max}\right)} \qquad (8)$$

Utilizing quadratic benefit work, the benefit for a non-gainful trait can be determined as

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$$P\left(y_{ij}\right)=K_V^j\left(y_{ij}-y_{\max}^j\right)^2 \qquad (9)$$

From (4) and (5)

$$K_V^j=\frac{W_V^j}{\left(y_{\min}^j-y_{\max}^j\right)^2} \qquad (10)$$

Utilizing (9) and (10), the quadratic benefit work for a non-useful quality can be gotten as

$$P\left(y_{ij}\right)=W_V^j\left[\frac{\left(y_{ij}-y_{\max}^j\right)}{\left(y_{\min}^j-y_{\max}^j\right)}\right]^2 \qquad (11)$$

Essentially, the cubic benefit capacities for a non-gainful property can be gotten as,

$$P\left(y_{ij}\right)=W_V^j\left[\frac{\left(y_{ij}-y_{\max}^j\right)}{\left(y_{\min}^j-y_{\max}^j\right)}\right]^3 \qquad (12)$$

Presently, the straight benefit work for a gainful quality can be gotten as

$$P\left(y_{ij}\right)=W_U^j\frac{\left(y_{\min}^j-y_{ij}\right)}{\left(y_{\min}^j-y_{\max}^j\right)} \qquad (13)$$

The quadratic benefit work for an advantageous quality can be gotten as

$$P\left(y_{ij}\right)=W_U^j\left[\frac{\left(y_{\min}^j-y_{ij}\right)}{\left(y_{\min}^j-y_{\max}^j\right)}\right]^2 \qquad (14)$$

The cubic benefit work for helpful trait can be gotten as

$$P\left(y_{ij}\right)=W_U^j\left[\frac{\left(y_{\min}^j-y_{ij}\right)}{\left(y_{\min}^j-y_{\max}^j\right)}\right]^3 \qquad (15)$$

*Total profit calculation for an alternative*

Expecting that any option in the choice network has blend of advantageous and non-valuable credits, the complete benefit for picking any elective i, can be composed as

$$P_i=P_U+P_V$$

Where $P_U$ is the profit brought about by the useful credits and $P_V$ is the profit brought about by the non-useful ascribes.

For a straight benefit work, the benefit brought about by the, non-gainful ascribes of an elective i is given by

$$P_V=\sum_{j\in V}\frac{W_V^j\left(y_{ij}-y_{\max}^j\right)}{\left(y_{\min}^j-y_{\max}^j\right)} \qquad (16)$$

The benefit brought about by the valuable quality is given by

$$P_U=\sum_{j\in U}\frac{W_U^j\left(y_{\min}^j-y_{ij}\right)}{\left(y_{\min}^j-y_{\max}^j\right)} \qquad (17)$$

The complete benefit brought about by the elective i, utilizing direct benefit work is given by

$$P_V = \sum_{j\in V} \frac{W_V^j \left( y_{ij} - y_{\max}^j \right)}{\left( y_{\min}^j - y_{\max}^j \right)} + \sum_{j\in U} \frac{W_U^j \left( y_{\min}^j - y_{ij} \right)}{\left( y_{\min}^j - y_{\max}^j \right)}$$

(18)

The complete benefit brought about by the elective i utilizing quadratic benefit work is given by

$$P_i = \sum_{j\in V} \frac{W_V^j \left( y_{ij} - y_{\max}^j \right)^2}{\left( y_{\min}^j - y_{\max}^j \right)^2} + \sum_{j\in U} \frac{W_U^j \left( y_{\min}^j - y_{ij} \right)^2}{\left( y_{\min}^j - y_{\max}^j \right)^2} \quad (19)$$

The absolute benefit brought about by the elective i utilizing cubic benefit work is given by

$$P_i = \sum_{j\in V} \frac{W_V^j \left( y_{ij} - y_{\max}^j \right)^3}{\left( y_{\min}^j - y_{\max}^j \right)^3} + \sum_{j\in U} \frac{W_U^j \left( y_{\min}^j - y_{ij} \right)^3}{\left( y_{\min}^j - y_{\max}^j \right)^3} \quad (20)$$

In everyday structure, the complete benefit brought about by the elective i can be composed as

$$P_i = \sum_{j\in V} \frac{W_V^j \left( y_{ij} - y_{\max}^j \right)^n}{\left( y_{\min}^j - y_{\max}^j \right)^n} + \sum_{j\in U} \frac{W_U^j \left( y_{\min}^j - y_{ij} \right)^n}{\left( y_{\min}^j - y_{\max}^j \right)^n} \quad (21)$$

Where n is the record of benefit work. For n=1, 2 and 3 the benefit work is direct, quadratic and cubic individually. The benefit work approach with benefit work list n is assigned as PFA–n.

*Proposed profit function approach with example*

The benefit work approach with various benefit records has been proposed. Various ascribes may have distinctive files, yet for straightforwardness of clarification the proposed benefit work approach has been utilized to tackle MADM issue with the accompanying presumptions.

1. The file of benefit work for each quality can be accepted securely with earlier information about the attributes.
2. The benefit work list is something very similar for all credits of various other options.

The means of proposed Profit Function Approach (PFA) of dynamic

**Step 1** Collect the information relating to all accessible choices in the information containing subjective data. Convert the subjective information in to quantitative information utilizing a proper procedure.

**Step 2** The credits are to be named non-advantageous or gainful ascribes dependent on the idea of the attributes. In the event that a most extreme worth is wanted for the trait viable, it is taken as a helpful characteristic. On the off chance that a base worth is wanted for a quality, it is taken as non-valuable property.

**Step 3** Obtain the heaviness of each characteristic utilizing one of the current strategies, in view of the adequacy and prominence.

**Step 4** Assign a most extreme benefit for each trait equivalent to the weight the relating characteristic.

**Step 5** Decide upon the proper benefit work proposed are straight or quadratic or cubic capacities.

**Step 6** Calculate the benefit of picking an elective utilizing (18) or (19) or (20). Orchestrate the option in rising request of their benefit esteems. This provides the request for inclination for every other option.

In the following area outlines a portion of the MADM issues utilizing the proposed benefit work approach. At first, the issues are settled utilizing the proposed benefits work approach. The arrangements acquired are then contrasted and those got from a portion of the MADM strategies

*Numerical Example*

A firm expects to choose one individual as a CEO from four contenders. Five credits should be assessed. They are

[1] Previous Experience
[2] Presence of Brain
[3] Educational Qualification
[4] Decision Making Ability
[5] Leadership Capacity

The weights are = $\left(w_1, w_{2,}...., w_5\right)^T$

= $\left(0.12, 0.28, 0.18, 0.22, 0.20\right)^T$

The individual ascribes of every individual are to be analyzed to go to a right choice.

The choice framework $\tilde{R} = \left(r_{ij}\right)_{m\times n}$ is given as follows.

$$E_1$$

$$\tilde{R} = \begin{pmatrix} [0.15, 0.21, 0.32, 0.42] \\ [0.21, 0.33, 0.45, 0.49] \\ [0.13, 0.19, 0.31, 0.39] \\ [0.18, 0.25, 0.32, 0.43] \end{pmatrix}$$

$$E_2$$

$$\begin{matrix} [0.11, 0.19, 0.23, 0.31] \\ [0.13, 0.15, 0.25, 0.34] \\ [0.21, 0.23, 0.29, 0.42] \\ [0.22, 0.25, 0.39, 0.43] \end{matrix}$$

$$E_3$$

$$\begin{matrix} [0.17, 0.27, 0.37, 0.43] \\ [0.21, 0.33, 0.42, 0.51] \\ [0.15, 0.20, 0.35, 0.49] \\ [0.16, 0.23, 0.36, 0.39] \end{matrix}$$

$E_4$

$[0.25, 0.35, 0.45, 0.55]$

$[0.21, 0.32, 0.43, 0.56]$

$[0.13, 0.15, 0.25, 0.29]$

$[0.15, 0.23, 0.41, 0.44]$

$E_5$

$[0.15, 0.23, 0.34, 0.47]$

$[0.18, 0.25, 0.36, 0.43]$

$[0.19, 0.23, 0.35, 0.43]$

$[0.24, 0.34, 0.45, 0.61]$

A person with Previous Experience $(E_1)$, Educational Qualification $(E_3)$ and Leadership Capacity $(E_5)$ are beneficial attributes. The remains two attributes, namely Presence of Brain $(E_2)$ and Decision Making Ability $(E_4)$ are non-beneficial attributes.

*Procedure to obtain Linear, Quadratic and Cubic Profit Function*

**Stage 1** By given data in the past decision matrix. There are five attributes. Convert the given subjective information into quantitative information.

**Stage 2** Using positioning capacity

R= $\frac{a_1 + a_2 + a_3 + a_4}{4}$ to change over the given fluffy Trapezoidal number into a fresh one, we get,

| | $E_1$ | $E_2$ | $E_3$ | $E_4$ | $E_5$ |
|---|---|---|---|---|---|
| $A_1$ | 0.2750 | 0.2100 | 0.3100 | 0.4000 | 0.2975 |
| $A_2$ | 0.3700 | 0.2175 | 0.3675 | 0.3800 | 0.3050 |
| $A_3$ | 0.2550 | 0.2875 | 0.2975 | 0.2050 | 0.3000 |
| $A_4$ | 0.2950 | 0.3225 | 0.2850 | 0.3075 | 0.4100 |

**Stage 3** By taken outline, there are five credits, the loads of each ascribes can consider.

**Stage 4** The base benefit happens when the quality takes on a most extreme incentive for the gainful trait.

**Stage 5** Solve the issue dependent on direct, quadratic, cubic benefit capacities.

Consider straight benefit work

From the fresh worth table

$y^1_{\max} = 0.3700$ $y^1_{\min} = 0.2550$

$y^2_{\max} = 0.3225$ $y^2_{\min} = 0.2100$

$y^3_{\max} = 0.3675$ $y^3_{\min} = 0.2850$

$y^4_{\max} = 0.4000$ $y^4_{\min} = 0.2050$

$y^5_{\max} = 0.4100$ $y^5_{\min} = 0.2975$

The benefits for choosing various options are determined utilizing (18), the separate benefits are get underneath

$P_1$=0.7446, $P_2$=0.3561,

$P_3$= 0.7450, $P_4$=0.6172

The outcome we get from straight benefit work (linear profit function)

$$A_3 > A_1 > A_4 > A_2$$

Using quadratic profit function, the profits obtained for all alternatives, we get

$P_1$ = 0.6582, $P_2$ = 0.3197,

$P_3$ = 0.6720, $P_4$ = 0.5088

The solution is

$$A_3 > A_1 > A_4 > A_2$$

Additionally utilizing cubic benefit works, the benefits for picking various options are given beneath.

P1 = 0.5860, P2 = 0.2927, P3 = 0.2927, P4 = 0.4345

The arrangement from cubic benefit work is

$$A_3 > A_1 > A_4 > A_2$$

Contrast with all the benefit capacities considering here the other options $(A_3)$ as best other option

## 2. CONCLUSION

In this paper, a method is coined to fuzzy multiple attribute decision making problem using profit function. The fuzzy attributes with fuzzy trapezoidal number is converted to crisp one by using ranking function. Diverse benefit capacities, for example, linear, quadratic and cubic capacities have been proposed to figure the benefit. A numerical example is inspected to exhibit the execution interaction of the strategy.

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