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Empowerment Of Women In Tamil Nadu Based On Fuzzy Normalized Value Based Ranking Method

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Abstract: *Different extensions have been made to multiple criterion decision-making processes in recent years due to the uncertain environment. A decision is a choice made among several feasible actions. Each choice is the result of complex processes that present two or more possibilities with outcomes. Women's empowerment is a controversial issue in India especially in Tamil Nadu. The current study seeks to broaden the use of the newly developed Fuzzy Normalized Value-Based Ranking Method (F-NoVaRM) to study the empowerment of women in the state. In this paper the essential factors for the empowerment of woman are found out by the above -mentioned method. Several decision makers' perspectives are considered while making decisions about the factors. Here, we took Empowerment in Sports (A_1), Empowerment in Politics (A_2), Empowerment in Administrative Service (A_3), Empowerment in Journalism or Media (A_4), Empowerment in Social Work (A_5) and Empowerment in Technology (A_6) as the various alternatives and Family Support (C_1), Financial Support (C_2), Cultural and Religious Barrier (C_3), Child Marriage (C_4), Nutrition (C_5), and Shame and concealment(C_6) as the various criteria. By ranking the alternatives based on F-NoVaRM, choose the factor that will best empower women.*

Keywords: *Empowerment of women, Fuzzy Multi-Criteria Decision -Making Methods, F- NoVaRM , Triangular Fuzzy Number.*

1. INTRODUCTION

Empowerment as a concept was introduced at the international women's conference in 1985 at Nairobi [1]. The conference defined empowerment as a redistribution of social power and control of resource in favour of women [1]. Exposure of women to a world outside their home is a result of education and modernization of culture and society [1]. It is all about authority, or the power embarked on women sharing indistinguishable rights. The term refers to the liberation of women from socio-economic restraints of reliance [2]. Women empowerment is essential to achieve gender equality, when men and women have equal power and opportunities for education, healthcare, economic engagement, and personal growth, India being a progressing country especially in economics, there are calls for the country to pay more attention to social and human development, including women empowerment. Equal rights for men and women are enshrined under articles 14 to 16 in the Indian constitution, which came into effect on 26 January 1950 [1]. Long before many western nations gave women the right to vote, India's independence in 1947 brought about universal suffrage for women. As an attempt to increase female political participation, the Women's Reservation Bill gives 33 per cent reservation for women seats in all levels of Indian politics [1].

In the present time women empowerment is a pressing issue in many states so that everyone is focusing on the same problem. In order to choose for their needs and expectations, women need to have the freedom, faith, and self-worth. In most parts of Tamil Nadu, women are occupied in a very low status due to some of the social factors such as educational facilities, child marriage etc. [1]. Many of the NGO's with a little government support have come up to assist rural women. Multi-Criteria Decision- making Methods (MCDM) are very popular and effective tools that can be used in this scenario. The purpose of this paper is to precisely identify and rank the areas where the empowerment is needed based on certain factors which would influence the process using a newly developed fuzzy MCDM technique known as Fuzzy Normalized Value based Ranking Method (F-NoVaRM).

2. Preliminaries

We briefly review some basic terminology in this part.

Definition 1. (Linguistic Variable) [**Zadeh, 1973**]. Variables whose values are words or sentences in a natural or artificial language.

Table. 1 Linguistic scaling of variables

Linguistic Variables	**Triangular Fuzzy Numbers**
Extremely Insignificant	(1, 1, 3)
Insignificant	(1, 3, 5)
Significant	(3, 5, 7)
Moderately Significant	(5, 7, 9)
Extremely Significant	(7, 9, 9)

Definition 2. (Defuzzification) This technique turns the fuzzy set (fuzzy output) into the crisp set (crisp output). Fuzzy numbers are the end result of fuzzy decisions. As a result, ranking fuzzy numbers may become an issue in MCDM. This issue needs to be defuzzified so that it can be resolved.

3. The pairwise comparison method (ODU G.O, 2019)

This method is used for analysing multiple populations in pairs to determine whether they are significantly different from one another. It can also be used where the decision-maker compares each criterion with others and determines the level of preference for each pair of such criteria. An ordinal scale (1 - 9) is adopted to help in determining the preference value of one criterion over the other. The number of comparisons can be determined by $C_p = \frac{n(n-1)}{2}$. Where C_p = the number of comparisons, and n = the number of criteria. Determining the criteria weights based on the pairwise comparisons method has two main steps. The first step is to develop a matrix by comparing the criteria. Intensity values are used to fill the matrix, such as (1, 3, 5, 7, 9) representing equal importance, moderate importance of one over the other, strong importance, very strong importance, and extreme importance respectively. The diagonal in the matrix is always 1 and the lower left values are inverse values if activity i has one of the above numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i. To fill the lower triangular matrix, we use the reciprocal values of the upper diagonal. This will complete the comparison matrix. The second step is to calculate the criteria weight, which is also known as the priority value or the principal eigenvector. In this step, we sum the values in each column, dividing each element by the column total, and dividing the sum of the normalized scores for each row by the number of criteria.

4. Data Collection

In this study, firstly we fixed the alternatives and then identified the various criteria. Thereafter, a survey was developed to achieve the objectives of this study. For administering the survey, a team of three decision-makers from different age groups and area were selected in an unbiased way. A senior lady professor who has more than 10 years of teaching experience in a co-education institution, Tamil Nadu was the first decision maker. The remaining two decision makers were, a Ph.D scholar (woman) and a PG student(woman) studying in arts and science college in Tamil Nadu . From the responses of decision-makers obtained in the form of crisp values scaling from 1-9, we built an initial fuzzy decision-making matrix by taking the average of responses. Then the ranking of alternatives had been done by the newly introduced fuzzy NoVaRM technique as illustrated below.

5. F-NoVaRM Algorithm

Problem solving by the newly developed MCDM technique F-NoVaRM requires 8 steps which is illustrated as follows**:**

Step 1: Decide the ratings of alternatives.

Here we choose a linguistic scaling of 1-9 to convert linguistic variables into fuzzy numbers as shown in table 1.

Among the various criteria in decision-making, some might be a benefit criterion (a criterion that provides a high potential in the study) and some others might be a cost criterion (a criterion that provides a low potential in the study). In the present study, as per the suggestion obtained from the experts, we assumed C_2 and C_4 as the benefit criteria and C_1, C_3, and C_5 as the cost criteria.

Step 2: Construct an initial fuzzy decision matrix as follows:

C_1 C_2 C_n

$$\tilde{D}= \begin{matrix} A_1 \\ A_2 \\ A_m \end{matrix} \begin{pmatrix} x_{11} & x_{12} \dots & x_{1n} \\ x_{21} & x_{22} \dots & x_{2n} \\ x_{31} & x_{32} \dots & x_{3n} \end{pmatrix} \quad (1)$$

Step 3: Compute criteria weights by Pairwise Comparison Method as described in the section 3.

Step 4: Normalize the initial fuzzy decision matrix as follows: (Neelima B.Kore, 2017)

For Benefit criteria, $C_j^* = \max_i c_{ij}$ (2)

Now, $\bar{r}_{ij} = \left(a_{ij}/C_j^* , b_{ij}/C_j^* , c_{ij}/C_j^* \right)$ (3)

For Cost criteria, $\bar{a}_j = \min_i a_{ij}$ (4)

Now, $\bar{r}_{ij} = \left(\bar{a}_j/c_{ij} , \bar{a}_j/b_{ij} , \bar{a}_j/a_{ij} \right)$ (5)

Step 5: Determine the degree of satisfaction matrix by using the following formula:

$$d_{ij} = \text{Val}\,(a_{ij}, b_{ij}, c_{ij}) = \frac{a_{ij}}{6} + \frac{2}{3} b_{ij} + \frac{c_{ij}}{6} \quad (6)$$

Step 6: Construct a score matrix by multiplying the degree of satisfaction by the corresponding weights of the criteria using the following formula (7),

$$\text{Score}(A_i \to C_j) = d_{ij} w_j \quad (7)$$

$$\begin{matrix} \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{matrix} \begin{matrix} C_1 & C_2 & \dots & C_n \end{matrix} \begin{pmatrix} d_{11}w_1 & d_{12}w_2 \dots & d_{1n}w_n \\ d_{21}w_1 & d_{22}w_2 \dots & d_{2n}w_n \\ \vdots & \vdots & & \vdots \\ d_{m1}w_1 & d_{m2}w_2 \dots & d_{mn}w_n \end{pmatrix} \quad (8)$$

Step 7: Compute the total score $S(A_i)$ for each alternative A_i by using the formula

$$S(A_i) = \sum_{j=1}^{n} d_{ij} w_j \quad (9)$$

Step 8: Based on the total score, rank the alternatives in descending order.

The framework of the methodology is described by means of a flow chart as shown below:

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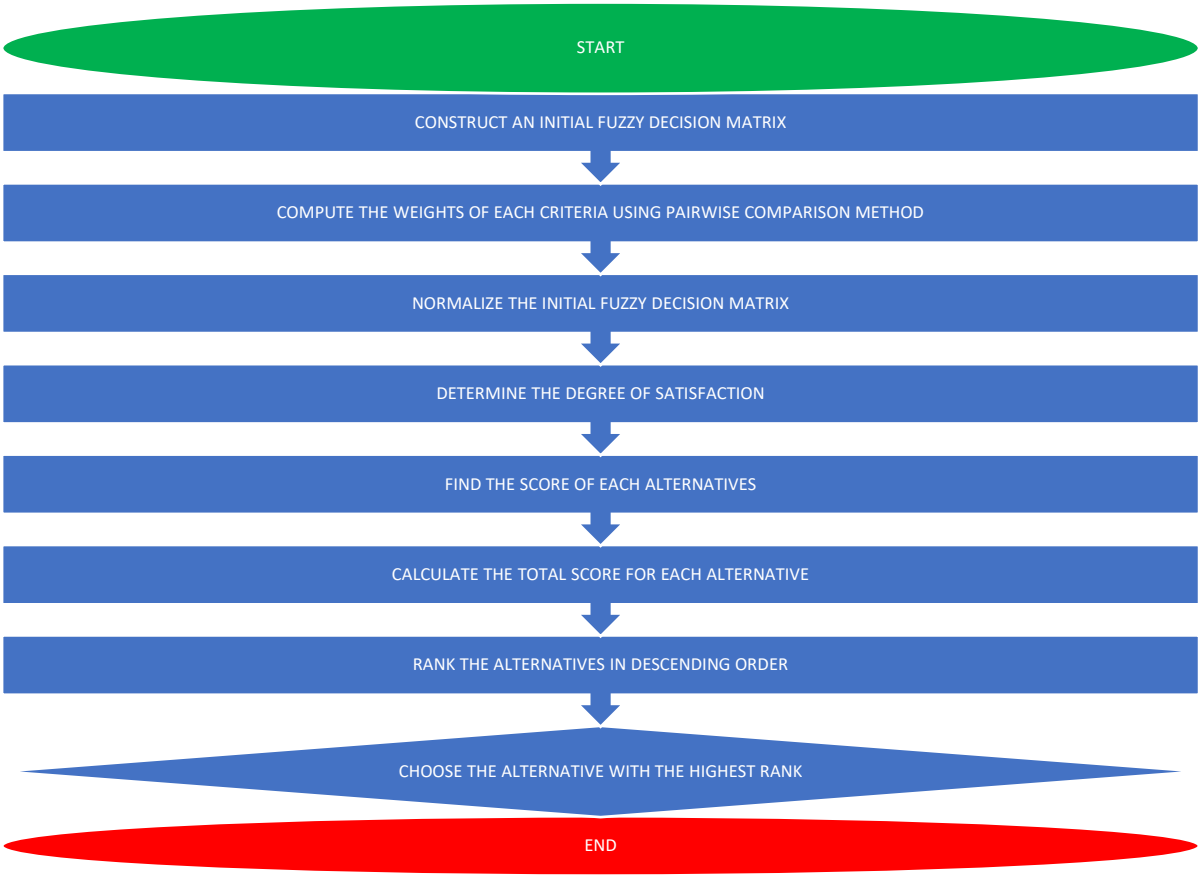

Fig. 1 Framework of methodology

6. F-NoVaRM Empowerment Model

This section describes the empowerment model based on the newly proposed F-NoVaRM decision making method. We have gathered information regarding empowerment of women from various sources. Based on that collected information we choose some of the relevant areas such as sports, politics, administrative service, journalism, social work and technology where the empowerment of women is significant. In this study we have considered these as the several alternatives denoted by A_1, A_2, A_3, A_4, A_5 and A_6 and the various criteria which would affect different types of women empowerment are family support, financial support, cultural and religious barrier, child marriage, nutrition, shame and concealment which are represented by C_1, C_2, C_3, C_4, C_5 and C_6.

Initially, a survey was conducted comprising 15 questions involving women decision makers. The following table illustrates the alternative ratings to the different criteria according to decision makers.

Table 2. Initial Fuzzy Decision matrix

ALTERNATIVES	CRITERIA					
	C_1	C_2	C_3	C_4	C_5	C_6
A_1	(6,8,9)	(4,6,8)	(2,4,6)	(2,4,6)	(7,9,9)	(3,4,5)
A_2	(7,9,9)	(4,6,8)	(2,3,5)	(1,2,4)	(2,3,5)	(5,6,7)
A_3	(6,8,8)	(4,6,8)	(2,3,5)	(3,5,7)	(3,5,7)	(5,7,8)
A_4	(6,8,9)	(2,3,5)	(2,3,5)	(2,4,6)	(3,4,6)	(4,5,6)
A_5	(6,8,9)	(5,7,8)	(1,2,4)	(1,3,5)	(4,6,8)	(5,7,8)
A_6	(5,7,9)	(6,8,9)	(2,4,6)	(2,4,6)	(3,5,7)	(3,5,7)

The criteria weights by pairwise comparison method are $w(C_1) = 0.32$, $w(C_2) = 0.20$, $w(C_3) = 0.16$, $w(C_4) = 0.11$, $w(C_5) = 0.17$, $w(C_6) = 0.05$.

On normalizing the initial fuzzy decision matrix using equations (2)-(5), we get the normalized fuzzy decision matrix as given in table 3.

Criteria/ Alternatives	C_1	C_2	C_3	C_4	C_5	C_6
A_1	(0.67,0.89,1)	(0.4,0.67,0.89)	(0.17,0.25,0.5)	(0.17,0.25,0.5)	(0.78,1,1)	(0.6,0.75,1)
A_2	(0.78,1,1)	(0.4,0.67,0.89)	(0.2,0.3,0.5)	(0.25,0.5,1)	(0.2,0.3,0.56)	(0.43,0.5,0.6)
A_3	(0.67,0.89,0.89)	(0.4,0.67,0.89)	(0.2,0.3,0.5)	(0.1,0.2,0.3)	(0.3,0.56,0.78)	(0.38,0.43,0.6)
A_4	(0.67,0.89,1)	(0.2,0.3,0.56)	(0.2,0.3,0.5)	(0.17,0.25,0.3)	(0.3,0.4,0.67)	(0.5,0.6,0.75)
A_5	(0.67,0.89,1)	(0.56,0.78,0.89)	(0.25,0.5,1)	(0.13,0.17,0.25)	(0.4,0.67,0.89)	(0.38,0.43,0.6)
A_6	(0.67,0.89,1)	(0.67,0.89,1)	(0.17,0.25,0.5)	(0.1,0.2,0.3)	(0.3,0.56,0.78)	(0.43,0.6,1)

Table 3. Normalised Fuzzy Decision Matrix n_{ij}

The degree of satisfaction and score matrix using equations (6) and (7) are as follows:

Table 4. Degree of satisfaction matrix

Criteria/ Alternatives	C_1	C_2	C_3	C_4	C_5	C_6
A_1	0.87	0.66	0.28	0.28	0.96	0.77
A_2	0.96	0.66	0.32	0.54	0.33	0.51
A_3	0.85	0.66	0.32	0.2	0.55	0.45
A_4	0.87	0.33	0.32	0.25	0.43	0.61
A_5	0.87	0.76	0.54	0.18	0.66	0.45
A_6	0.78	0.87	0.28	0.2	0.55	0.64

Table 5. Score matrix

Criteria/ Alternatives	C_1	C_2	C_3	C_4	C_5	C_6
A_1	0.28	0.13	0.04	0.03	0.16	0.04
A_2	0.31	0.13	0.05	0.06	0.06	0.03
A_3	0.27	0.13	0.05	0.02	0.09	0.02
A_4	0.28	0.07	0.05	0.03	0.07	0.03
A_5	0.28	0.15	0.09	0.02	0.11	0.02
A_6	0.25	0.17	0.04	0.02	0.11	0.02

Since we are working on various criteria for decision-making, some might be a benefit criterion (criterion which gives high potential in the study) and some might be a cost criterion, (criterion which gives low potential in the study). Here, we have assumed C_1, C_2 and C_5 as the benefit criteria and the remaining criteria C_3, C_4, C_6 as the cost criteria.

Finally, the total scores obtained are Score $(A_1) = 0.68$, Score $(A_2) = 0.64$, Score $(A_3) = 0.58$, Score $(A_4) = 0.53$, Score $(A_5) = 0.67$, Score $(A_6) = 0.6$.

On arranging the scores in descending order, $\mathbf{A_1 > A_5 > A_2 > A_6 > A_3 > A_4.}$

From the above scores, we conclude that in the perspective of all the three decision makers A_1 has got the highest rank followed by A_5 , A_2, A_6, A_3 and A_4. A_1 is indicating the empowerment in sports. Considering that girls who do sports have greater levels of self-esteem and confidence, and reduced depression levels, enlist the help of parents, boys, and other male role models, break free from the prison of body fear, recover public space, improve girls' mobility, and strengthen their leadership, teamwork, and resilience in the face of adversity develop poise, critical thinking, decision-making skills, and resolution, it is essential to suppose that women should likewise go through these benefits so that the empowerment in sports is significant. Sports is known to improve one's perception of one's body and the problem of body image has grown in recent years particularly with young females. Sports have a significant influence on body image, which improves self-acceptance, independence and self-worth so that the empowerment in sports is vital.

7. CONCLUSION

In this paper, we have extended the application of the newly developed multi-criteria decision-making technique F-NoVaRM to a new field which is women empowerment. The criteria weights are calculated by pairwise comparison method and the defuzzification technique that we apply here is the Pai-wise comparison method. So far fuzzy NoVaRM had been successfully applied in dam rehabilitation, covid - 19 vaccination selection, performance assessment of students and for diagnosing certain diseases. In this study, an attempt has been made to address a socially relevant challenge. In future, researchers can add more alternatives and criteria to strengthen the study conducted. Furthermore, instead of triangular fuzzy numbers higher order fuzzy numbers such as trapezoidal fuzzy number, pentagonal fuzzy number, hesitant fuzzy number etc. can also be adapted which can increase the accuracy of the developed method

REFERENCES

1.Constitution of India,
India.gov.in. https://www.india.gov.in/my-government/constitution-india. Accessed on 11 June 2020.
2.Throwing light on the women empowerment in India and its importance, Hindrise,
Women empowerment in India and its Importance – Hindrise
3.Hannan, A.M & Sepas, A 2018, A hybrid fuzzy BWM-COPRAS method for analyzing key factors of sustainable architecture, Sustainability 2018, vol.10, no.1626, pp.no. 1-26.

4.Rasiulis, R & Leonas, U 2016, Decision model for selection of modernization measures: Public building case, Journal of Civil Engineering and Management, vol.22, no. 1, pp.no. 124–133.
5.Zavadskas, E.K 1994, The new method of multi-criteria complex proportional assessment of projects, Technological and Economic Development of Economy, vol. 1, no. 3, pp. no.131–139.
6.Zavadskas, E.K & A, Kaklauskas 1994, The new method of multi-criteria complex proportional assessment of projects, Technological and Economic Development of Economy, vol. 1, no. 3, pp. 131–139.
7.Zavadskas, E.K & Jurgita, A 2007, Multiple criteria evaluation of rural buildings, Building and Environment, vol.42, pp.no. 436–451.