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# A combination of FAHP and fuzzy soft set theory method for solving MCDM problem in sports application

B. Snekaa[1*], C. Dorathy[2] and R. Sophia Porchelvi[3]

**Abstract**
This paper deals with the problem of selecting a player. Here, a combination of FAHP and fuzzy soft theory is applied to solve the problem. This technique gives a clear thought to find out the best among the players.

**Keywords**
FAHP, Comprehensive decision matrix, Fuzzy soft sets, Comparison table, Row-sums, Column-sums.

**AMS Subject Classification**
03E72.

[1,2] *Department of Mathematics, A.D.M College for Women (Autonomous), (Affiliated to Bharathidasan University), Nagapattinam-611001, Tamil Nadu, India.*
**Corresponding author*: [1]bsnekaa@gmail.com;
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## Contents



## 1. Introduction

Many real-life issues in medical fields, engineering, management,and so on,are often involved data that aren't accurate and deterministic in character. This is often because these problems are more subjective and humanistic in nature then; they have to handle differently than those with precise data. A number of developed theories for handling problems with imprecise data are applied mathematics, interval mathematics, rough sets, fuzzy sets, and so on.

L. A. Zadeh introduces fuzzy set in [1]. Saaty explains the AHP approach [11]. Buckley defines fuzzy hierarchical analysis [2]. G.J. Klir et al. elaborate fuzzy sets and fuzzy logic theory with applications [3]. Fuzzy soft set theory was proposed by Molodtsov in [4]. Kahraman analysed MCDM methods and fuzzy sets in [5]. S. K. Pundir et al. explain fuzzy sets with illustrative example [6]. T. J. Neog et al. solved problem of fuzzy soft sets using fuzzy soft matrices in decision making problem [7]. P. K. Das et al. has given an application of fuzzy soft set in MCDM problem [9]. Krishna Gogoi et al. has solved day to day problems using fuzzy soft set theory [10]. Sophia Porchelviet al. proposed an algorithm to solve a MCDM problem using fuzzy Soft Sets in sports field [8]. Sophia Porchelviet al. studied on job preferences given in job change decision of start-up company workers using integrated fuzzy MCDM methodology [12].

The upcoming sections are organized as follows: in section 2, given basic definitions. The combination of fuzzy-AHP and fuzzy soft set theory with application is explained in section 3, section 4 contains conclusion.

## 2. Preliminaries

### 2.1 Row sum

The row-sum, $r_i$ of a product $(p_i)$ is calculated by the formula

$$r_i = \sum_{j=1}^{m} c_{ij}$$

Where, the integer $r_i$ is the total number of parameters in which $p_i$ dominates all the members of P.

### 2.2 Column sum

The column-sum, $C_j$ of a product $(p_j)$ is calculated by the formula

$$C_j = \sum_{i=1}^{m} C_{ij}$$

Where $C_j$ is the total number of parameters in which $p_j$ is dominated by the members of P.

### 2.3 Score

The score, $s_i$ of a product $p_i$ is calculated by the formula

$$s_i = r_i - C_j.$$

## 3. Integration of Fuzzy Analytic Hierarchy Process (FAHP) and Fuzzy Soft Set Theory [12,9]

A combination of FAHP and Fuzzy soft set theory methods is effective to researchers. FAHP method is appropriate for determining criteria weights and Fuzzy soft set approach is used for ranking the alternatives. The integration approach involves the following steps:

- For every criterion construct pair wise comparison matrices.
- Use geometric mean method to define the fuzzy geometric mean and fuzzy weights of each criterion by Buckley [12].
- Then, the procedure of defuzzification is to locate the best non fuzzy performance value using centre of area and obtain criteria weightage.
- Input the performance evaluation of the alternatives by the decision makers as matrices.
- Find the average of all the matrices of decision makers.
- Multiply the weightage of the selection criteria to the corresponding entries of each column to get the comprehensive decision matrix.
- Formulate the comparison table.
- Find the row-sums and column-sums.
- Obtain the score for each alternative and the alternative with maximum weight is recommended as the best alternative.

Now, we solve the solution for the same application in [8].

Three football players are the alternatives and are denoted by $T_1, T_2, T_3$ respectively. Coacher seeks advice from three selection committee members and they are denoted by $F_1, F_2, F_3$. They provided the information about the three players considering the criterion Technique & mind set $(S_1)$, Game intelligence $(S_2)$, Team player $(S_3)$, physique $(S_4)$.

**Table 1.** Linguistic variables for decision criteria and trapezoidal fuzzy numeric expressions

| Linguistic variables | Trapezoidal fuzzy numeric expressions |
|---|---|
| Equal importance | (1,1,1,1) |
| Moderate importance | (1,2,4,5) |
| Strong importance | (3,4,6,7) |
| Very strong importance | (5,6,8,9) |
| Extreme importance | (7,8,9,9) |

A questionnaire on pair wise comparison of criteria was created and distributed to the three selection committee members. Answers in the form of linguistic variables are given numerical expressions and consistent criteria pair wise comparison matrix is created and is shown in table 2.

**Table 2.** Fuzzy Criteria Pair-wise Comparison Matrix

| | $S_1$ | $S_2$ | $S_3$ | $S_4$ |
|---|---|---|---|---|
| $S_1$ | (1,1,1,1) | (6.33,7.33, 8.7,9) | (3.67,4.67, 6.67,7.67) | (2.33,3.33, 5.33,6.33) |
| $S_2$ | (0.11,0.12, 0.14,0.16) | (1,1,1,1) | (1.67,2.67, 4.67,5.67) | (4.33,5.33, 4.67,5.67) |
| $S_3$ | (0.13,0.16, 0.22,0.29) | (0.18,0.22, 0.42,0.78) | (1,1,1,1) | (5,6, 7.87,8.33) |
| $S_4$ | (0.16,0.19, 0.33,0.55) | (0.12,0.14, 0.19,0.24) | (0.12,0.14, 0.18,0.22) | (1,1,1,1) |

Then, calculated the geometric mean $\tilde{r}_i$ for each criterion and is shown in the table 3.

**Table 3.** Geometric Mean for each Criterion

| | Geometric mean, $\tilde{r}_i$ |
|---|---|
| $\tilde{r}_1$ | (2.7124,3.2675,4.19004,4.57204) |
| $\tilde{r}_2$ | (0.9444,1.1432,1.4796,1.65801) |
| $\tilde{r}_3$ | (0.5849,0.6779,0.9175,1.1716) |
| $\tilde{r}_4$ | (0.2191,0.24703,0.3259,0.4128) |

Criteria weights and importance measures of criteria are calculated and is shown in the table 4.

**Table 4.** Weightage of each Criterion and Importance Measures of Criteria

| | Geometric mean, $\tilde{r}_i$ | Weight |
|---|---|---|
| $\widetilde{w}_1$ | (0.34711,0.47264,0.78530,1.02496) | 0.6575 |
| $\widetilde{w}_2$ | (0.12085,0.16536,0.27731,0.37169) | 0.23380 |
| $\widetilde{w}_3$ | (0.07485,0.09806,0.17196,0.26265) | 0.15188 |
| $\widetilde{w}_4$ | (0.02804,0.03573,0.06108,0.09254) | 0.21739 |

With the selection committee members $(F_1, F_2, F_3)$ information we get the performance evaluation matrix as given below.

$$F(S) = \begin{array}{c} \\ S_1 \\ S_2 \\ S_3 \\ S_4 \end{array} \begin{array}{c} \begin{array}{ccc} T_1 & T_2 & T_3 \end{array} \\ \begin{bmatrix} 0.5 & 0.8 & 0.7 \\ 0.57 & 0.8 & 0.67 \\ 0.570 & .730 & .73 \\ 0.670 & .77 & 0.8 \end{bmatrix} \end{array}$$

Hence,

$$F(S)^T = \begin{array}{c} \\ T_1 \\ T_2 \\ T_3 \end{array} \begin{array}{c} \begin{array}{cccc} S_1 & S_2 & S_3 & S_4 \end{array} \\ \begin{bmatrix} 0.5 & 0.570 & .570 & .67 \\ 0.8 & 0.80 & .730 & .77 \\ 0.7 & 0.670 & .73 & 0.8 \end{bmatrix} \end{array}$$

Then, we multiply $F(S)^T[0.6575, 0.23380, 0.15188, 0.21739]$ by the importance measures of weight and get D (comprehensive decision matrix) as follows:

$$D = \begin{array}{c} \\ T_1 \\ T_2 \\ T_3 \end{array} \begin{array}{c} \begin{array}{cccc} S_1 & S_2 & S_3 & S_4 \end{array} \\ \begin{bmatrix} 0.33 & 0.13 & 0.09 & 0.15 \\ 0.53 & 0.18 & 0.11 & 0.17 \\ 0.46 & 0.15 & 0.11 & 0.18 \end{bmatrix} \end{array}$$

The comparison table of the above matrix is given in table 5.

**Table 5.** The Comparison Table

| | $T_1$ | $T_2$ | $T_3$ |
|---|---|---|---|
| $T_1$ | 4 | 0 | 0 |
| $T_2$ | 4 | 4 | 3 |
| $T_3$ | 4 | 2 | 4 |

Then, we calculate the row-sum, column-sum from the above matrix and the score of each player are shown in the below table.

**Table 6.** Score and Rank of Alternatives

| | Row-sum | Column-sum | Score | Rank |
|---|---|---|---|---|
| $T_1$ | 4 | 12 | -8 | 3 |
| $T_2$ | 11 | 6 | 5 | 1 |
| $T_3$ | 10 | 7 | 3 | 2 |

From the score of top players, $T_2$ stands first followed by $T_3$. Clearly, $T_2$ is the good choice for Coacher to his team.

## 4. Conclusion

A combination of FAHP and fuzzy soft set theory is given here in MCDM problem. The final result is derived from the comprehensive decision matrix. Thus, we can see that the integration of FAHP and fuzzy soft set theory is used to solve the decision making problems in a critical situation.

**Conflict of interests:** The author declared no conflict of interests.

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