Analysis and Implementation Fuzzy Multi-Attribute Decision Making SAW Method for Selection of High Achieving Students in Faculty Level

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Abstract

This paper we provide an overview of the analysis and implementation a method of decision-making system for high achieving students selection. The method used is Fuzzy Multi-Attribute Decision Making (FMADM) Simple Additive weighting (SAW). FMADM SAW itself is a method of decision-making that uses a simple weighting system. The use of this method is expected to help and provide the best decision in the selection of high achieving students in the faculty level.

Keywords: *Criteria, FMADM, SAW, weight, high achieving students.*

1. Introduction

Decision-making in the selection of high achieving students requires data processing time given the number of students are owned by a college and not a little to be completely in accordance with the conditions set. The process of selecting high achieving students must be precise, accurate and quality to be able to achieve the expected outcome is to get students achievement appropriate to their criteria or standards set. But the process of selecting and processing data of participants sometimes still use manual techniques that will require a longer time in both data processing and transmission of results.

Along with current technological developments that can be addressed with the establishment of a system that can help the Faculty of Engineering, Udayana University in the decision-making by using a Decision Support System (DSS) in which this system provides the facility to do an analysis so that each process decisions made based on existing criteria. The method used in this research is to use models of Fuzzy Multi-Attribute Decision Making (FMADM), Simple Additive Weighting Method (SAW). The research is expected to provide convenience and efficiency of data processing in the selection of high achieving students in faculty level.

2. Methodology

Overview of Fuzzy SAW method the selection high achieving students in faculty level can be seen in Fig 1.

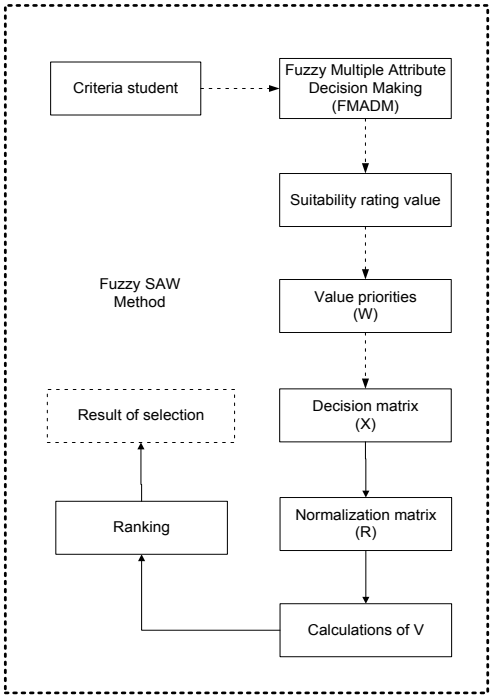


Fig. 1 Overview data flow of the selection of high achieving students using FMADM SAW Method

2.1 Fuzzy Multi-Attribute Decision Making (FMADM)

Fuzzy Multi-Attribute Decision Making is a method used to find the optimal alternative from a number of alternatives to certain criteria. FMADM is the core of determining the value of the weights for each attribute, followed by a ranking process that will select the alternative that has been given. Basically, there are three approaches to find the weights of attributes, namely the approach of subjective, objective approach and the approach to the integration between the subjective and objective. Each approach has advantages and disadvantages. In the subjective approach, the weights are determined based on the subjectivity of decision-makers par, so that some of the factors in ranking the alternatives can be determined independently. While the objective approach, the weights are calculated mathematically that ignoring the subjectivity of the decision makers [4].

There are several methods that can be used to solve the problem FMADM namely [3]:
1. Simple Additive Weighting (SAW)
2. Weighted Product (WP)
3. ELECTRE
4. Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)
5. Analytic Hierarchy Process (AHP)

2.2 Simple Additive Weighting (SAW) Method

Churchman and Ackoff (1945) first utilized the SAW method to with a portfolio selection problem. The SAW method is probably the best known and widely used method for multiple attribute decision making MADM. Because of its simplicity, SAW is the most popular method in MADM problems [2].

SAW method also known as the term is often weighted summation method. The basic concept of SAW method is to find a weighted sum of rating the performance of each alternative on all attributes. SAW method requires a process of normalizing the decision matrix (X) to a scale that can be compared with all the rating of the alternatives.

$$r_{ij} = \begin{cases} \frac{x_{ij}}{Max_i\, x_{ij}} \\ \\ \frac{Min_i x_{ij}}{x_{ij}} \end{cases} \qquad (1)$$

$\frac{x_{ij}}{\text{Max}_i x_{ij}}$ is used if the attribute/criteria is benefit

$\frac{\text{Min}_i x_{ij}}{x_{ij}}$ is used if the attribute/criteria is cost

Where r_{ij} is the normalized performance ratings of alternatives Ai on attributes C_j, i = 1,2, ..., m and j = 1,2, ..., n. Preference value for each alternative (V_i) is given as:

$$V_i = \sum_{j=1}^{n} w_j r_{ij} \qquad (2)$$

A larger V_i value indicates that the alternative A_i more selected.

2.2.1 Step Completion SAW Method

This research uses a model FMADM SAW method. The steps are [3]:
Step 1: Determining the criteria that will be used as a reference in decision-making, namely C_i.
Step 2: Determine the suitability rating of each alternative on each criterion.
Step 3: Making decisions based on criteria matrix (C_i).
Step 4: Normalized matrix equations based tailored to the type attribute (attribute or attributes benefit costs) to obtain normalized matrix R.
Step 5: The final results obtained from the ranking the sum of normalized R matrix multiplication with the weight vector in order to obtain the greatest value is selected as the best alternative (A_i) as a solution.

3. Requirement Analysis for FMADM SAW Method

The criteria taken into consideration in the selection of high achieving students as in Tables 1.

Table 1: Criteria selection of high achieving students

No	Criteria
1	Grade Point Average / GPA
2	TOEFL Score
3	Number of paper that ever made
4	Number of seminars / workshops have been followed – Department level – Faculty level – University level – National level – International level
5	Number of committees have been followed – Department level – Faculty level – University level

6	Number of award-owned – Department level – Faculty level – University level – District level – Province level – National level – International level

High achieving student criteria listed above each have six criteria where there are some criteria that have high levels of valuation. Each level is the criteria that have to be multiplied first by their respective weights in Table 2 for total points of each of these criteria.

Table 2: Level

Level	Weight
Department	1
Faculty	2
University	3
District	4
Province	5
National	6
International	7

Determine the criteria that will be used as a reference in decision-making, namely C_i. Selection of high achieving students in the faculty level using six criteria listed in Table 3. Selection refers to the ability of students in the academic field as seen from the GPA, English language skills (TOEFL), papers, and awards earned. While the non-academic assessment based on active students in campus activities such as committees and seminars / workshops.

Table 3: Criteria of high achieving students (Ci).

Criteria	Name of criteria
C1	Grade Point Average/GPA
C2	TOEFL Score
C3	Number of paper that ever made
C4	Point of seminars/workshops have been followed
C5	Point of committees have been followed
C6	Point of award-owned

Each criterion will be defined as a priority assessment weighting (W) selection high achieving students. The weight consists of five fuzzy numbers such as Very Low (VL), Low (L), Medium (M), High (H) and Very High (VH).

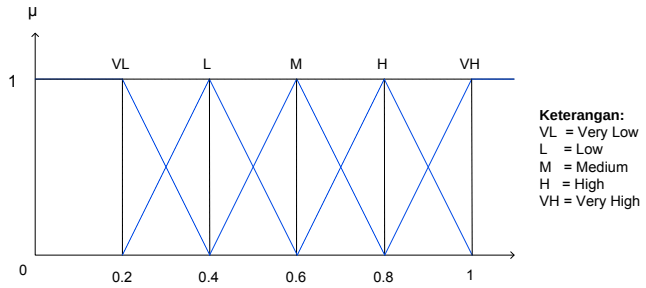


Fig. 2 Overview of fuzzy linguistic variables of the weight for each criterion

The weights of each criterion for the selection of high achieving student are as follows:

Table 4: Priority assessment weighting (W)

Criteria	Fuzzy
C1	Very High
C2	High
C3	Medium
C4	Very Low
C5	Low
C6	High

Criteria C1 and C3 consists of four fuzzy numbers are Very Low (VL), Low (L), Medium (M), and High (H).

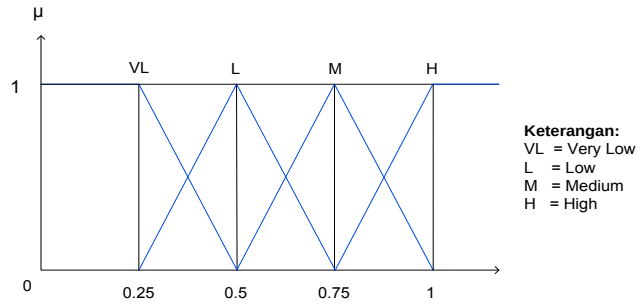


Fig. 3 Overview of fuzzy linguistic variables for criteria GPA (C1) and number of paper (C3)

Table 5: Fuzzy linguistic variables and their correspondent fuzzy number for GPA (C1)

GPA (C1)	Linguistic terms	Linguistic values
GPA < 2,51	Very Low	0.25
GPA 2,51-3,00	Low	0.5
GPA 3,01-3,50	Medium	0.75
GPA > 3,50	High	1

Table 6: Fuzzy linguistic variables and their correspondent fuzzy number for Number of paper (C3)

Number of paper (C3)	Linguistic terms	Linguistic values
Number of paper < 3	Very Low	0,25

Number of paper 3-5	Low	0.5
Number of paper 6-10	Medium	0.75
Number of paper > 10	High	1

Criterion C2 consists of five fuzzy numbers are Very Low (VL), Low (L), Medium (M), High (H) and Very High (VH).

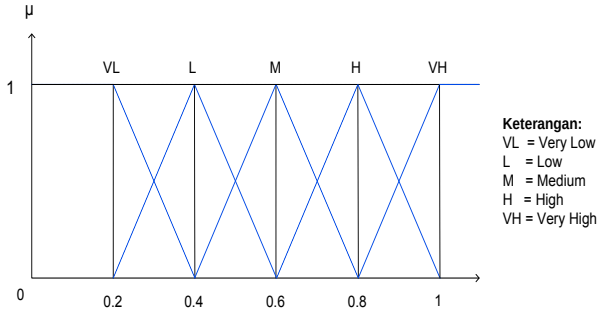


Fig. 4 Overview of fuzzy linguistic variables for criteria TOEFL Score (C2)

Table 7: Fuzzy linguistic variables and their correspondent fuzzy number for TOEFL Score (C2)

TOEFL Score (C2)	Linguistic terms	Linguistic values
TOEFL Score < 311	Very Low	0,2
TOEFL Score 311-420	Low	0.4
TOEFL Score 421-480	Medium	0.6
TOEFL Score 481-520	High	0.8
TOEFL Score > 520	Very High	1

Criterion C4, C5 and C6 consists of three fuzzy numbers are Low (L), Medium (M), and High (H).

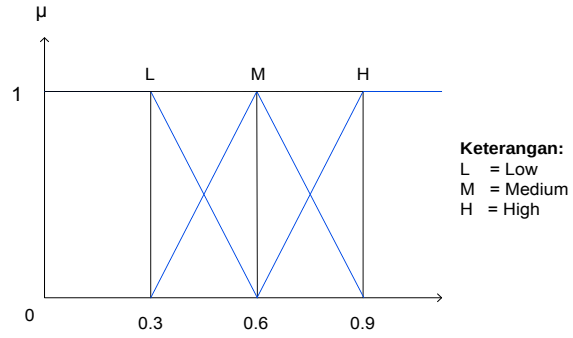


Fig. 5 Overview of fuzzy linguistic variables for criteria point of seminars/workshops (C4), point of committees (C5), and point of award-owned (C6)

Table 8: Fuzzy linguistic variables and their correspondent fuzzy number for Point of seminars/workshops (C4)

Point of seminars/workshops (C4)	Linguistic terms	Linguistic values
Point of seminars/workshops < 31	Low	0.3
Point of seminars/workshops 31-60	Medium	0.6
Point of seminars/workshops > 60	High	0.9

Table 9: Fuzzy linguistic variables and their correspondent fuzzy number for Point of committees (C5)

Point of committees (C5)	Linguistic terms	Linguistic values
Point of committees < 21	Low	0.3
Point of committees 21-40	Medium	0.6
Point of committees > 40	High	0.9

Table 10: Fuzzy linguistic variables and their correspondent fuzzy number for Point of award-owned (C6)

Point of award-owned (C6)	Linguistic terms	Linguistic values
Point of award-owned < 21	Low	0.3
Point of award-owned 21-40	Medium	0.6
Point of award-owned > 40	High	0.9

4. Implementation and Results

Referring to high achieving students data tables described above may be formed suitability rating each alternative on each criterion.

Table 11: Suitability rating

Alternative	Criteria					
	C1	C2	C3	C4	C5	C6
A1	1	0.6	0.5	0.9	0.6	0.9
A2	0.75	0.8	0.75	0.6	0.6	0.3
A3	0.75	0.8	0.5	0.6	0.6	0.3
A4	0.75	0.4	0.5	0.9	0.6	0.3
A5	1	0.4	0.75	0.9	0.6	0.6

Decision matrix (X):

$$X = \begin{bmatrix} 1 & 0.6 & 0.5 & 0.9 & 0.6 & 0.9 \\ 0.75 & 0.8 & 0.75 & 0.6 & 0.6 & 0.3 \\ 0.75 & 0.8 & 0.5 & 0.6 & 0.6 & 0.3 \\ 0.75 & 0.4 & 0.5 & 0.9 & 0.6 & 0.3 \\ 1 & 0.4 & 0.75 & 0.9 & 0.6 & 0.6 \end{bmatrix}$$

Normalized matrix (R):
The example of normalization matrix calculations:

$$r_{11} = \frac{1}{\text{Max}\{1; 0.75; 0.75; 0.75; 1\}} = \frac{1}{1} = 1$$

then the results obtained normalization matrix (R):

$$R = \begin{bmatrix} 1 & 0.75 & 0.67 & 1 & 1 & 1 \\ 0.75 & 1 & 1 & 0.67 & 1 & 0.33 \\ 0.75 & 1 & 0.67 & 0.67 & 1 & 0.33 \\ 0.75 & 0.5 & 0.67 & 1 & 1 & 0.33 \\ 1 & 0.5 & 1 & 1 & 1 & 0.67 \end{bmatrix}$$

Weights:

W =
[Very high; High; Medium; Very low; Low; High]

$$W = [1; \quad 0.8; \quad 0.6; \quad 0.2; \quad 0.4; \quad 0.8]$$

The example of V calculations for the ranking:

$$V1 = (1)(1) + (0.8)(0.75) + (0.6)(0.67) + (0.2)(1) + (0.4)(1) + (0.8)(1)$$

$$= 1 + 0.536 + 0.402 + 0.2 + 0.4 + 0.8$$

$$= 3.338$$

Based on calculations using those calculations, the greatest value is in V1 so that A1 could feasibly be used as the best alternative in selecting of high achieving students. Here are the final results in tabular form.

Table 12: Assessment result

Rank	Alternative	Value
1	A1	3,338
3	A2	2,948
4	A3	2,886
5	A4	2,416
2	A5	3,136

4.1 Implementation in System

In the Fig. 6 is a display system for inputting form high achieving students criteria values where some criteria had levels as described in Table 1.

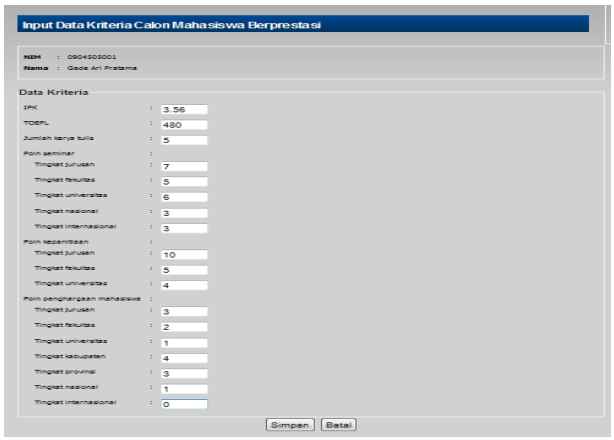


Fig. 6 Overview input criteria form.

The user fills in the form with the value of each criterion and the system will process these values in accordance with the calculation method FMADM SAW. Here's the view from each of the outcome of the calculation on Fig. 7, Fig. 8, and Fig. 9.

Fig. 7 Overview data of suitability rating value.

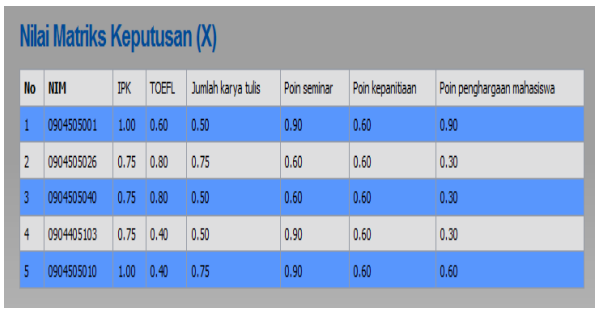
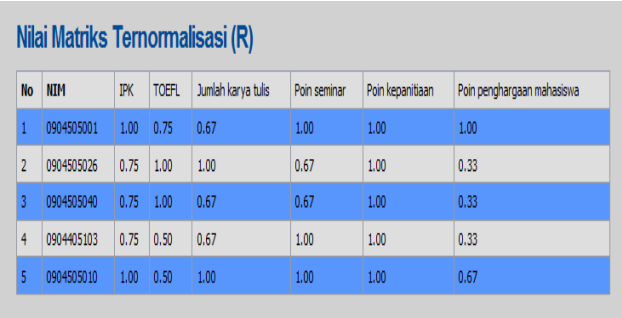


Fig. 8 Overview data of matrix X.



Nilai Matriks Ternormalisasi (R)

No	NIM	IPK	TOEFL	Jumlah karya tulis	Poin seminar	Poin kepanitiaan	Poin penghargaan mahasiswa
1	0904505001	1.00	0.75	0.67	1.00	1.00	1.00
2	0904505026	0.75	1.00	1.00	0.67	1.00	0.33
3	0904505040	0.75	1.00	0.67	0.67	1.00	0.33
4	0904405103	0.75	0.50	0.67	1.00	1.00	0.33
5	0904505010	1.00	0.50	1.00	1.00	1.00	0.67

Fig. 9 Overview data of matrix R.

After processing system to search each value V will then be shown the results of the value of V for each of the attributes that have been sorted by the largest value of V as shown in Fig. 9. Thus it can be determined that students with student ID (NIM) 0904505001 selected as high achieving students.

Hasil Perankingan Pemilihan Mahasiswa Berprestasi

Rank	NIM	Nama	Nilai
1	0904505001	Gede Ari Pratama	3.4
2	0904505010	Ketut Dewiyanti	3.13333333333
3	0904505026	Putu Maharani	2.95
4	0904505040	Surya kencana	2.75
5	0904405103	Made Bayu Saputra	2.41666666667

Fig. 10 Overview of assessment result selection of high achieving students.

5. CONCLUSION

Based on the research that has been done, it can be concluded that the FMADM SAW method can be used in the selection process of high achieving students. The selection results obtained in the form of ranking the final value of the participant. Although using a simple weighting calculations, FMADM SAW method can provide the best decision in the decision process.

Acknowledgments

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