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Identification of Student Area of Interest using Fuzzy Multi-Attribute Decision Making (FMADM) and Simple Additive Weighting (SAW) Methods (Case Study: Information System Major, Universitas Pembangunan Nasional "Veteran" Yogyakarta)

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Abstract

Identifying the area of interest is a must for every student in each study program before choosing the elective courses. Ideally, a student chooses their area of interest by considering the scores of all courses that they have been completed. Nevertheless, they do not thoughtfully choose their interest since they may follow what their friends' are. Decide to choose the wrong area of interest may result in difficulty while completing their education. This research aims to help students' academic supervisors guide their students by implementing a decision support system to help students and academic supervisors determine their area of interest. Decision support systems in this research are built through two stages: observation, decision-support modeling. Observations were made to determine the criteria and attributes used. The decision support model was made using the Fuzzy Multi-Attribute Decision Making (FMADM) method, followed by ranking the result to obtain the best possible recommendation using the Simple Additive Weighting (SAW) method. With FMADM and SAW, the decision support system has been successfully carried out and resulted in the recommendations ranking to support the assortment of area of interest for Information System students in UPN "Veteran" Yogyakarta.

Keywords: Decision Support System, Fuzzy Multi-Attribute Decision Making (FMADM), Simple Additive Weighting (SAW)

I. INTRODUCTION

Choosing the area of interest or study concentration that corresponds to students' interests and capabilities in a College degree is essential. The area of interest or study concentration relates to many parties, such as deciding what elective courses should be taken or determining the theses final assignment research area. Due to some condition, the student's decision should be made and approved by the academic supervisor, who play a role in providing academic advice to help students in any course-related problems. Through the help of an academic supervisor, it is expected that students can have the right area of interest or study concentration to graduate in a timely way and lessen the difficulties when they work on their thesis. As guided in the Accreditation Program Study Book V (Guidebook Assessment of Accreditation Instruments) (BAN-PT, 2009) in the 3rd standard, which writes down about students and graduation, one of the elements of an assessment is the average of the study period until the student's graduation (in years). It proves that a student's study period is essential in the assessment of accreditation.

In today's technological development era, our daily lives have been made easier by some computerized processes. Therefore, the area of interest or study concentration determination is also probable to be computerized. The idea is to make students or academic supervisors automatically decide the best option through the decision support system that evaluates the given criteria. As has happened, students may face difficulties in defining their area of interest or study concentration due to their department's lack of experience and information (MZ, 2016). Meanwhile, the decision support system offers some benefits in several ways, such as providing the best recommendations by evaluating the given criteria and giving the result in the form of an option suitable with the student's profile (Prasetyo, Kusrini, & Arief, 2019).

The decision support system is one way to provide an alternative decision that is interactive, flexible, and easily adaptable to the problem domain (Surya, 2015). The development of a decision support system for deciding area of study or concentration has been carried out using several methods, such as SMART and ANN for high school students (Adhi, Suryani, & Setiawan, 2012), Weighted Product for high school corner (Fartindyyah & Subiyanto, 2013; Prabowo & Noranita, 2013), FMADM and SAW for lecture interest (MZ, 2016; Oktotino, 2019; Tinaliah & Elizabeth, 2019), and Weighted Product for course interest selection (Alifa & Utami, 2017). Meanwhile, the use of Fuzzy Multi-Attribute Decision Making (FMADM) and Simple Additive Weighting (SAW) provides pretty good results (MZ, 2016; Oktotino, 2019; Tinaliah & Elizabeth, 2019). Nonetheless, previous research still does not consider the achievement index or students' grades as a criterion in their decision support system approach.

This research offers some development of previous studies using the student's grade of chosen courses as an attribute in the decision-making process to automatically identify the best recommendation of concentration for the Information System major students in Universitas Pembangunan Nasional "Veteran" Yogyakarta.

II. LITERATURE REVIEW

II.1. DECISION SUPPORT SYSTEM

The decision support system is an interactive, flexible, and adaptable computer-based information system specifically developed to support the completion of the unstructured issues to improve the decision-making process (Surya, 2004). A Decision-making system is an interactive information system that provides information, modeling, and data manipulation. The system is used to assist decision-making in a semi-structured and unstructured situation, in which no one knows for sure how decisions should be made (Surya & Yubarda, 2014).

II.2. Fuzzy Multi-Attribute Decision Making (FMADM)

The FMADM method is the development of more from MADM. MADM refers to creating decisions based on selecting multiple selections, using multiple attributes, and inter-conflicting attributes. In retrieval decisions where a problem cannot be presented appropriately into the crips value, or in other words, into boolean values, the application of Fuzzy logic can be one troubleshooting [4]. Application of fuzzy logic in MADM, the next referred to as FMADM. Disadvantages of MADM method data that is imprecise and within the estimated range of values can be covered.

II.3. Simple Additive Weighting SAW

SAW methods are often also known as weighted summing method. SAW's basic concept is looking for a weighted summation of each alternate's rating performance on all attributes. Method SAW process of normalizing the decision matrix (X) to a scale comparable to all rating existing alternatives [2][5].

III. RESEARCH METHODOLOGY

III.1. Data Collection

Data collection was conducted in the Information System study program of Universitas Pembangunan Nasional "Veteran" Yogyakarta. The data is collected from 200 students who have passed four semesters of courses. The data used consists of student grade data and lists of courses that characterize each area of interest in the Information System study program in Universitas Pembangunan Nasional "Veteran" Yogyakarta.

III.2. Fuzzy Multi-Attribute Decision Making (FMADM)

FMADM uses multi-attribute decision-making methods, which are combined with fuzzy membership functions. Parameters used for multi-attribute decision making consists of the importance level and the suitability level. The aggregation results between these two parameters are then used to calculate the α value. By choosing to implement FMADM, there are several steps to note, such as representing problems, evaluating fuzzy sets, and selecting the optimal alternatives (Yusro & Wardoyo, 2013).

III.2.1. Problem Representation

There are two stages performed to represent the problem, which are:

1. Identify the objectives and alternative decisions
   This research aims to select the best and second-best area of interest or concentration alternatives. Since there will be two alternative decisions, then alternatives will be written as:
   $$A = \{A_i | i = 1,2, \dots, n\}$$
2. Identify the set of criteria
   The set of criteria contains all criteria used to determine the assortment of several alternative decisions to be nominated. We will have several names of courses as criteria here so that the criteria can be written as
   $$C = \{C_j \big| j = 1,2,3, \dots, k\}$$

III.2.2. Fuzzy Sets Evaluation

The three stages required in evaluating the fuzzy set are:

1. Choose a set of ratings for the criteria weights and each alternate match's degree to the criteria.
   The weight of the criteria and the degree of the match are represented by x, while the rating of each weight of that criterion is denoted by $T(x)$. Each element of $T(x)$ relates to a membership

function that must be specified because $T(x)$ is a set. By the triangular membership function, the membership function can be described as shown in Figure 1.

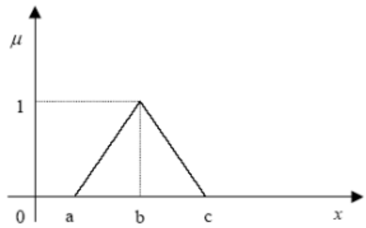

Figure 1. The triangular fuzzy membership function

2. Evaluate the weight of criteria and degree of criteria match
   Weight of criteria and degree of criteria match with alternative decisions represented in the triangular fuzzy membership function.

3. Aggregation of the weight of criteria and degree of criteria match
   To aggregate the weight of each alternate match's criteria and degrees with the criteria, we can use several aggregation methods such as mean, max, min, median, and mixed operator.

III.2.3. Selecting Optimal Alternatives

Since the aggregation results are represented by using a triangular fuzzy number, in the next step, to determine the optimum alternatives by Simple Additive Weighting (SAW) method, it is necessary to use a method that able to process the fuzzy number, such as integral total value calculation. While G is a triangular fuzzy number, $G = (a, b, c)$, then the total integral value can be written as:

$$I^{\alpha}(G) = \left(\frac{1}{2}\right)(\alpha c + b + a - a\alpha)$$

Where α represents a degree of optimism in decision-making (0<α<1), last, perform the summation of a total integral value matrix, the greater the value indicates the best alternative or decision.

IV. FINDING AND DISCUSSION

To evaluate our proposed decision support system approach, which combines FMADM and SAW methods, we review the Information System study program Universitas Pembangunan Nasional "Veteran" Yogyakarta's student area of interest or concentration. To get the recommendations, these following steps are fulfilled: identifying the problem, evaluating the fuzzy set of alternative options, and finding the optimal selection of alternatives.

We will find out about which area of interest or concentration which suitable for each student of Information System major in Universitas Pembangunan Nasional "Veteran" Yogyakarta. The steps for resolving the case are as follows:

IV.1. Step 1. Problem Representation

a. Our decision support system is expected to help students and academic supervisors choose the area of interest or concentration that best suits students' capabilities. Students can pick one of these three types of concentrations: Business Information Management (BIM), Business Intelligence and Analytics (BIA), and IS/ESIS Integration and Development (ISID). Therefore, these three will be a set of alternatives that will be ranked.
b. We choose 21 criteria of attributes, which are 21 courses which relate to the given types of concentrations. The list of courses are: *Pengantar TIK* (C1), *Algoritma dan Pemrograman 1* (C2), *Kalkulus* (C3), *Manajemen Basis Data* (C4), *Pengantar Sistem Informasi* (C5), *Algoritma dan Pemrograman 2* (C6), *Dasar-Dasar Manajemen* (C7), *Pemrograman Web* (C8), *Struktur Data* (C9), *Matematika Diskrit* (C10), *Statistika Bisnis* (C11), *Sistem Operasi* (C12), *Pemrograman Berorientasi Objek* (C13), *Teori dan Perilaku Organisasi* (C14), *Jaringan Komputer* (C15), *Interaksi Manusia dan Komputer* (C16), *Arsitektur dan Organisasi Komputer* (C17), *E-Commerce* (C18), *Pemrograman Mobile* (C19), *Informatika Sosial* (C20), and *Pemodelan Proses Bisnis* (C21).

IV.2. Step 2. Fuzzy Sets Evaluation

a. Linguistic variables that represent the weight of each criterion given as $W = \{VL, L, M, H, VH\}$, in which: VL = Very Low, L= Low, M = Medium, H = High, VH = Very High. The triangular fuzzy membership function is given below.

VL = (0, 0, 0.25)
L = (0, 0.25, 0.5)
M = (0.25, 0.5, 0.75)
H = (0.5, 0.75, 1)
VH = (0.75, 1, 1)

In conclusion, the weight of the match criteria of each alternate decision showed in Table 1.

Table 1. Weight of Courses Criterion for Each Type of Decision Alternatives

Area of Interest	Weight																				
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21
BIM	H	VL	VL	M	VH	L	VH	M	L	M	H	L	VL	VH	H	M	H	VH	L	H	VH
BIA	L	VH	VH	H	L	VH	L	H	H	VH	VH	M	H	L	M	VL	VL	VL	M	M	H
ISID	M	T	H	VH	VL	VH	VL	VH	H	M	L	M	VH	VL	H	H	M	L	VH	L	L

b. Alternate match's degree represents grades of each given criteria that earned by students during four semesters. A linguistic variable of grades given as $G = \{E, D, C, B, A\}$, which corresponds to the triangular membership function given below. There will be no C+ or B+ membership function; therefore, when a student's grade is C+ or B+, it will be converted into C and B, respectively.

E = (0, 0, 0.25)
D = (0, 0.25, 0.5)
C = (0.25, 0.5, 0.75)
B = (0.5, 0.75, 1)
A = (0.75, 1, 1)

For example, let us pick one of the students' sets of grades consists of all those 21 chosen criteria courses (Table 2). First, we need to identify whether B+ or C+ grades exist. If so, replace it with B or C grades, as exemplified in Table 3.

Table 2. "Student A" Real Grades

Student	Grades																				
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21
Student A	A	B	A	A	B+	B	A	B+	A	B	A	B	B+	B	A	B	A	A	A	A	A

Table 3. "Student A" Converted Grades

Student	Grades																				
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21
Student A	A	B	A	A	B	B	A	B	A	B	A	B	B	B	A	B	A	A	A	A	A

c. Then, substitute the fuzzy triangular membership function to each linguistic variable and calculate the fuzzy match value of each decision alternatives, with calculation details given and exemplified as the following sample.

$$Y_a, Q_a, Z_a = \frac{\left(W_{c_1[i]} \times W_{c_1[i]}\right) + \left(W_{c_{2[i]}} \times G_{c_{2[i]}}\right) + \left(W_{c_{3[i]}} \times G_{c_{3[i]}}\right) \ldots (W_{c_n[i]} \times G_{c_n[i]})}{n}$$

<u>BIM alternative</u>

$$Y_{BIM} = \frac{(0.5 \times 0.75) + (0 \times 0.5) + (0 \times 0.75) + \ldots (0.75 \times 0{,}75)}{21}$$

$$Q_{BIM} = \frac{(0.75 \times 0.75) + (0 \times 0.5) + (0 \times 0.75) + \ldots (1 \times 0{,}75)}{21}$$

$$Z_{BIM} = \frac{(1 \times 0.75) + (0.25 \times 0.5) + (0.25 \times 0.75) + \ldots (1 \times 0{,}75)}{21}$$

<u>BIA alternative</u>

$$Y_{BIA} = \frac{(0 \times 0.75) + (0.75 \times 0.5) + (0.75 \times 0.75) + \ldots (0.5 \times 0{,}75)}{21}$$

$$Q_{BIA} = \frac{(0.25 \times 0.75) + (1 \times 0.5) + (1 \times 0.75) + \ldots (0.75 \times 0{,}75)}{21}$$

$$Z_{BIA} = \frac{(0.5 \times 0.75) + (1 \times 0.5) + (1 \times 0.75) + \ldots (1 \times 0,75)}{21}$$

ISID alternative

$$Y_{ISID} = \frac{(0.25 \times 0.75) + (0.5 \times 0.5) + (0.5 \times 0.75) + \ldots (0 \times 0,75)}{21}$$

$$Q_{ISID} = \frac{(0.5 \times 0.75) + (0.75 \times 0.5) + (0.75 \times 0.75) + \ldots (0.25 \times 0,75)}{21}$$

$$Z_{ISID} = \frac{(0.75 \times 0.75) + (1 \times 0.5) + (1 \times 0.75) + \ldots (0.5 \times 0,75)}{21}$$

As a result, we will get a fuzzy match value matrix written as follows. The first row obtained from BIM's Y_{BIM}, Q_{BIM}, Z_{BIM}calculations, The second row came from BIA's Y_{BIA}, Q_{BIA}, $Z_{BIA}$and The third row from ISID's Y_{ISID}, Q_{ISID}, Z_{ISID}.

$$\begin{bmatrix} Y_{BIM} & Q_{BIM} & Z_{BIM} \\ Y_{BIA} & Q_{BIA} & Z_{BIA} \\ Y_{ISID} & Q_{ISID} & Z_{ISID} \end{bmatrix} = \begin{bmatrix} 0.232 & 0.217 & 0.214 \\ 0.512 & 0.485 & 0.494 \\ 0.750 & 0.738 & 0.726 \end{bmatrix}$$

IV.3. Step 3. Selecting Optimal Alternatives

a. The fuzzy match matrix obtained in the previous calculation is then multiplied by the weight value of the optimism degree given in three different ∝ weights: ∝ = 0, ∝= 0.5, and ∝= 1 to obtain the total integral value of each alternative area of interest or concentration. Calculation details and exemplified on BIM alternative given as follows

$$I_1^0 = \left(\frac{1}{2}\right)\left((\propto)(Z_i) + (Q_i) + (1{-}\propto)(Y_i)\right)$$

For ∝ = 0

$$I_1^0 = \left(\frac{1}{2}\right)\left((0)(0.214) + (0.217) + (1-0)(0.232)\right) = 0.3720$$

For ∝ = 0.5

$$I_1^0 = \left(\frac{1}{2}\right)\left((0.5)(0.214) + (0.217) + (1-0.5)(0.232)\right) = 0.5015$$

For ∝ = 1

$$I_1^0 = \left(\frac{1}{2}\right)\left((1)(0.214) + (0.217) + (1-1)(0.232)\right) = 0$$

b. By performing the calculation on Step 3a above on each area of interest (calculation), the total integral value of all alternatives presented in Table 4.

Table 4. The total integral value calculation result

Area of Interest	$\propto = 0$	$\propto = 0.5$	$\propto = 1$
BIM	0.3720	0.5015	0.6310
BIA	0.3512	0.4814	0.6116
ISID	0.3542	0.4821	0.6101

To rank and find the best alternative options, we sum up the total integral value weighting results. The result is shown in Table 5. Through the summation, the best area of interest alternative for "Student A" is BIM, and the second one is ISID. Therefore, the student academic advisor may suggest these two alternatives to "Student A."

Table 5. Total integral value summation

Area of Interest	BIM	BIA	ISID
SUM	1.5045	1.4442	1.4464

V. CONCLUSION AND FURTHER RESEARCH

Research and implementation on a decision support system to find the best area of interest or concentration for the 5th-semester student with Fuzzy MADM and SAW gives the following results

1. FMADM and SAW method can be applied in selecting the best area of interest or concentration because the selection process considers several criteria, and each criterion performs different weights.
2. The total integral value is performed to deal with fuzzy data and represent a weighting calculation in the SAW method. The total integral value is then summed up to achieve the additive weighting process in SAW.
3. The selection of the best area of interest or concentration can be made more accurately by using FMADM SAW methods, which considers students' grades in determining the best suitable area of interest or concentration.

This research could be improved by obtaining dynamic weighting in courses linguistic variables to support the dynamic curriculum change. Also, the weighting decision itself can be improved by calculating the percent of relevance with the area of interest or concentration.

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