Fuzzy Multiple Attribute Decision Making Approach for Determining The Best Vocational High School

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Abstract. Vocational High School has its charm for prospective students. Graduates have ready-to-work capability based on the skills needed in the workplace. Decision-Making System using Fuzzy Multiple Attribute Decision Making with Weighted Product method as the best SMK determinant method is an interactive computer-based system that can help decision-makers to find the best alternative based on predetermined criteria. In this case, the proposed alternative is to determine the best Vocational High School based on the criteria by finding the weight value for each attribute. The criteria needed in decision making are Facility, Accreditation, Quality, Student (Non-Academic Achievement), Cost, Human Resources Teacher.

Keywords: vocational high school, decision support system, weighted product

1. Introduction

Law Number 20 the Year 2003 regarding National Education System (UU SISDIKNAS) formulated the functions and objectives of national education that should be used in developing educational efforts in Indonesia. Article 3 of the National Education System Law states that the function of the national education is to develop and form the character and civilization of dignified nation to educate the nation. School culture plays a role in developing the potential of learners to become human beings who are faithful and devoted to God Almighty, have a noble character, healthy, knowledgeable, capable, creative, independent, and become responsible citizens [1]. Vocational High School is a period of student transition to adulthood; this means the time to the real world of work or career. Vocational students are in middle teenagers aged 15-18 years. The students are socially recognized as a way (directly or indirectly) to meet the needs, develop feelings in society, and obtain something desired and achieve goals life [2].

Some studies are conducted in this issue, such as the determination of scholarship recipients of PPA (Scholarship for Academic Education Improvement) and BBP-PPA (Education Cost Help for Academic Education Improvement). The motivation of this research is to provide assurance of guarantee and fund transfer based on the right object, the amount and time according to the principle owned by the general directorate for learning and study of research and technology ministry reflected
on its policy: "general guidance of scholarship and tuition fee of academic achievement improvement" (PPA) 2015 [3].

Research conducted is an alternative used in this study based on the average value of learning outcomes, attendance presentations, parent income, and the number of parental dependents. The research is done by finding the weight value for each attribute, then conducted the ranking process that determines the optimal alternative, that is the best and the best student regarding the scholarship recipients achievement [4]. Another study also on decision making strategic value with wisdom local base [5]. However, this research creates a decision support system in determining the best Vocational High School ranking in Lampung Tengah. The method used is the Weighted Product method. To determine the weight value of each attribute, then proceed with the ranking process and select the alternatives already given. Based on the background above can be formulated problems to be solved, namely how to design a decision support system using Fuzzy Weighted Product. To rank based on ability and quality by using a method to help determine rank so much easier and efficient.

2. Theoretical review

2.1 Decision-making system
Decision Support System as a computer-based system that helps in the decision-making process. DSS as an adaptive, interactive, flexible, computer-based information system specifically developed to support the solution of unstructured management issues to improve the quality of decision making [6], [7]. Thus one can draw a definition of DSS, which is an adaptive, flexible, and interactive computer-based system used to solve unstructured problems thereby increasing the value of decisions taken [8], [9].

2.2 Fuzzy multiple attribute decision making
Fuzzy Multiple Attribute Decision Making (FMADM) is a method used to find the optimal alternative of some alternatives with specific criteria [10][11]. The core of FMADM is to determine the weight value for each attribute, then proceed with the ranking process that will select the alternatives already given. There are 3 approaches to finding attribute weight value that is subjective approach, objective approach, and approach of integration between subjective and objective. Each approach has its advantages and disadvantages. In a subjective approach, the weighted value is determined by the subjectivity of the decision-makers, so that several factors in the alternative ranking process can be determined freely. Whereas in the objective approach, the weight value is calculated statistically makes it ignore the subjectivity of the decision maker. Some method to solve FMADM problems among others [12].
- Simple Additive Weighting Method (SAW)
- Weighted Product (WP)
- ELECTRE
- Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)
- Analytic Hierarchy Process (AHP)

2.3 Vocational High School
Vocational High School is one of the secondary educations with specialization preparing its graduates to be ready to work. Vocational education has a variety of meanings but can be seen a red thread. According to Evans in defines that vocational schools are part of the educational system that prepares a person to be better able to work in a workgroup or one field of work than in any other field of work. With the understanding that every field of study in vocational education as long as the field of study is studied more deeply and the depth is intended as a provision to enter the world of work [13].
3. Discussion

3.1 Weighted Product (WP)

Weighted Product (WP) is one of the methods used to solve the problem of Multi-Attribute Decision Making (MADM). The Weighted Product (WP) method uses multiplication to associate attribute values (criteria), where the value of each attribute (criteria) must be raised first with the corresponding attribute weight (criteria) [14]–[18].

Preferences for alternative Ai are given as follows:

\[ S_i = \prod_{j=1}^{n} X_{ij}w_j \] (1)

Notes:
• i: 1, 2, ...
• w j: 1, 2, ...n.
• \( \Pi \): product
• \( S_i \): score/value of each alternative
• \( X_{ij} \): the alternative value to the jj attribute
• \( W_j \): the weight of each attribute

A positive-valued rank is for a profit attribute and a negative value is for the cost attribute. A ranking/searching is for the best alternative, which is done with the following formula:

\[ v_i = \frac{\prod_{j=1}^{n} X_{ij}w_j}{\prod_{j=1}^{n} \left( X_{ij} \right)w_j} \] (2)

Notes:
• \( V_i \): Alternative preference results to – i
• \( X_{ij} \): Alternate rating per attribute
• \( W_j \): Weight attribute
• i: Alternative
• j: Attribute

3.2. Weighted Product

In this study, we have the weight and criteria needed to determine the ranking of Vocational High School.

| Criteria Code | Criterion Provision |
|---------------|---------------------|
| C1            | Facilities          |
| C2            | Accreditation       |
| C3            | Quality             |
| C4            | HR Student          |
| C5            | Cost                |
| C6            | HR Teachers         |

3.3. Weight Value of Fuzzy and Alternative Numbers Tested

From each of these criteria will be determined the value of weight. Each weight consists of six fuzzy numbers, are very low (SR), low (R), medium (S), middle (T1), high (T2), and very high (ST) [19][20].
Table 2. Weight value

| Weight | Value |
|--------|-------|
| SR     | 0     |
| R      | 0.2   |
| S      | 0.4   |
| T1     | 0.6   |
| T2     | 0.8   |
| ST     | 1     |

Notes:
- SR: very low
- R: low
- S: medium
- T1: middle
- T2: high
- ST: very high

Figure 1. Fuzzy number

Table 3. The alternatives tested

| Alternative | Criteria |
|-------------|----------|
|             | C1  | C2  | C3  | C4  | C5  | C6  |
| A1          | 0.4 | 0.2 | 0.2 | 0.2 | 0.4 | 0.4 |
| A2          | 0.6 | 0.8 | 0.4 | 0.4 | 0.8 | 0.8 |
| A3          | 0.4 | 1   | 0.8 | 0.6 | 0.4 | 1   |

Calculation of WP method which begins by determining the improvement of weight value, that is \( W = [0.18; 0.22; 0.23; 0.2; 0.08; 0.09] \)

3.4. Determining the vector value
Calculating the vector S by multiplying the data of each alternative value of positive rank from the results of the weighting of data calculation of the vector value S of each alternative can be seen as follows:

\[
\begin{align*}
S_1 &: (0.4^{0.18}) (0.2^{0.22}) (0.2^{0.23}) (0.2^{0.2}) (0.4^{0.08}) (0.4^{0.09}) = 0.254912 \\
S_2 &: (0.6^{0.18}) (0.8^{0.22}) (0.4^{0.23}) (0.4^{0.2}) (0.8^{0.08}) (0.8^{0.09}) = 0.563843 \\
S_3 &: (0.4^{0.18}) (1^{0.22}) (0.8^{0.23}) (0.6^{0.2}) (0.4^{0.08}) (1^{0.09}) = 0.675891
\end{align*}
\]

The value of the vector to be used in ranking can be calculated to obtain the highest alternative value of each vector value \( V \), and yield the following value:
From these results can be concluded that alternative ranking in determining the best vocational High School is \( V_3 = 0.452208 \).

4. Conclusion

Based on the results of testing the Decision-Making System determines the best Vocational High School in Lampung Tengah using Multiple Attribute Decision Making with Weighted Product method using various criteria weighting and calculation that there can be concluded that \( V_3 \) or Alternative is the best alternative with a weighted value score 0.452208.

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