4thICITB

IMPLEMENTATION OF FUZZY TOPSIS METHOD FOR ADMISSION SELECTION SYSTEM IN ACCELERATION CLASS

Nina Mutmainah[1)], Yulmaini[2)]

[1]Institut Informatika dan Bisnis Darmajaya, [2]Institut Informatika dan Bisnis Darmajaya
[1]nina.mut8@gmail.com, [2]yulmaini@darmajya.ac.id

ABSTRACT

Acceleration class is the class known as Kelas Siswa Cerdas Istimewa (SCI). This class facilitates special students who take the Senior High School for 2 years. The selection of the Acceleration Class at State Senior High School 9 Bandar Lampung uses the average score through Microsoft Excel. The problem statement of this research was that the final result of this selection was printed, announced on the announcement board, or announced directly to students who passed the test so that the selection process was inefficient and unobjective. This problem raised the idea to make the systems for the selection process of this Acceleration Class. The method used in this research was the Fuzzy TOPSIS with the certain criteria i.e., the average score of UN, the average report card, the IQ test, the specialization test, the achievement, and the financial condition. The result of this research showed that 8 of 20 students successfully passed to the acceleration class by the consideration that the students who reached the passing grade was > = 0.7 and the students who did not reach the passing grade was < 0.7. Therefore, this research was also successfully generated the website-based system for the admission selection systems in the Acceleration Class.

Keywords: Fuzzy TOPSIS, selection, acceptance, acceleration class

INTRODUCTION

Acceleration Class is the class known as *Kelas Siswa Cerdas Istimewa (SCI).*This class accommodates student with special intelligent who take the Senior High School for 2 years. Acceleration Class arranged by Minister of Education and Culture regulations in 2014.

At this time, the selection of Acceleration Class at State Senior High School 9 Bandar Lampung uses the average score through Microsoft Excel. The final result of the selection was printed and announced on the announcement board or announced directly to students who passed the test of this selection.

Because a lot of student who accepted at State Senior high School 9 Bandar Lampung, it makes the selection process inefficient so that a manual system has some weakness i.e. the time needed for writing and interview selection, the un-objective and inaccurate assessment and difficulties in receiving information on selection results.
Therefore, a Decision Support System is needed to determine the best student who take the Senior High School for 2 years.

Decision Support System is the process of selecting a several alternatives based on certain criteria. There are several methods used to design the Decision Support System (DSS) using FMADM (Fuzzy Multi Attribute Decision Making) i.e. Simple Additive Weighting Method (SAW), Weighted Product (WP), ELECTRE, Technique For Order Preference by Similarity to Ideal Solution (TOPSIS), and Analytic Hierarchy Process (AHP). This research uses Fuzzy TOPSIS method as a decision support.

LITERATURE REVIEW

Prior Research

1. Application of TOPSIS Method in Decision Support System to Determine the Winner of Village Competition (Arfida, 2013)
   This research resulted that the existing criteria is the most important factor for the decision-making process in the winners of Village Competition. As for the similarities of this research are using TOPSIS Method as the method of decision making process and web-based Decision support system application. Besides, the differences are this research object is the village and the method was not used fuzzy logic.
2. Implementation of Fuzzy TOPSIS Method for Employee Admission Selection (Lestari & Priyodiprodjo, 2011).
   This research resulted that the comparison of TOPSIS method and Weight Product Model (WPM) shows different values but the ranking shows the same result. As for the similarities of this research are Using Fuzzy TOPSIS method and the method used for Decision support system in admission selection. Besides, the differences are this research object is the employee and the stages of the selection process using a method comparison.
3. Decision support system for scholarship recipients with *Technique for Order Preference Similarity for Ideal Solution* at University of Sam Ratulangi Manado (Wijaya et al., 2015).
   This research resulted that TOPSIS method was objectively assisted the decision support process of scholarship recipient base on criteria that can be easily modified. The TOPSIS method represents systematic, objective, and flexible functions for student and scholarship program so that provide optimal results. As for the similarities of this research are

using TOPSIS method for decision support system and web based system. Besides, the differences are the research object is the student at University of Sam Ratulangi Manado, the criterion can be modified based on the arrangement of the school and the method was not used fuzzy logic.

4. Comparative analysis using AHP, TOPSIS, and AHP-TOPSIS methods for decision support system in student acceleration program (Nur, Purnomo, Widya, & Kom, 2013).
   This research resulted that Based on the report card value which is a success parameter of acceleration students and as the parameter for determine the recommendation method, the AHP method is the best method in the recipient of acceleration students program. As for the similarity of this research is the research object is the recipient of student acceleration program. Besides, the difference is uses complex method comparisons.
5. Decision Support System for Scholarship in Bali State Polytechnic using AHP and TOPSIS (Gusti et al., 2015).
   This research resulted that Applying AHP as a determinant of weight for each criterion, then the weight obtained is processed using the TOPSIS method by calculating the closeness value to the positive ideal solution and farthest to the negative ideal solution. The final result is an alternative ranking based on the closeness value. the best value will be the top priority for scholarship. As for the similarity of this research is uses TOPSIS method as decision support. Besides, the differences are the research object is the student at Polytechnic of Bali, uses AHP method for determine the weight of criteria and uses TOPSIS method for the final ranking, and this research was not used fuzzy logic.

Decision Support System

Decision Support System is an interactive information system. In Decision Support System, the system provides information, modelling, and data manipulation. Decision Support System used to make a conclusion and get decisions in unstructured situations where no one knows the exact situation of how decision should be made (Kusrini,2007). The stages of Decision Support System according to Kusrini (2007) include Intelligence, Design, Choice, Implementation.

Fuzzy Logic

Fuzzy Logic was invented by Prof. A. Zadeh as one of the founder of soft computing in 1965. Fuzzy logic is considered as a black box that connects the input space into output space (Gelley, 2000). The black box contains the method used to process input into output in the form of information.

Fuzzy Sets (aka uncertain sets)

Crisp sets, membership values of an item x in set A, crisp set A of X is defined as function $\mu_{A(x)}$, has two possibilities, that is:

a. One (1), which means that X is an element of A.
b. Zero (0), which means that X is not an element of A.

Membership Function

Membership Function is a curve that represents input points into membership values that have intervals 0 to 1. One of the method used to get membership value is by approaching function. The following statement are some function that can be used (Sri Kusumadewi, 2013) i.e.

a. Linear Representation

In linear representation, the mapping of inputs to the membership degree is described as s straight line. There are 2 fuzzy sets in linear representation i.e. the first, straight lines starting from domain values with the highest membership degrees on the left side then decreasing to domain values which has lower membership values as shown in **Figure 1.**

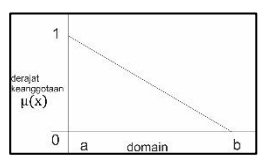

Figure 1. Linear Representation decreases.

$$\mu(x) = \begin{cases} \frac{b-x}{b-a}; & a \le x \le b \\ 0; & x \ge b \end{cases} \text{.....(1)}$$

The second, straight lines starting from domain values that has a zero membership degree (0) moves to the right toward the domain values that has higher membership function as shown in **Figure 2.**

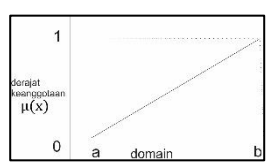

Figure 2. Linear Representation Increases.

$$(x) = \begin{cases} 0; & x \le a \\ \frac{(x-a)}{b-a}; & a \le x \le b \\ 1; & x \ge b \end{cases} \text{.....(2)}$$

b. Triangle Representation

Triangle representation is a combination of 2 linear lines. Linear lines increases and linear lines decreases as shown in **Figure 3.**

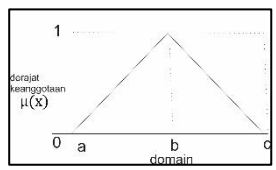

Figure 3. Triangle Representation

$$\mu(x) = \begin{cases} 0; & x \leq a \; atau \; x \geq c \\ \frac{x-a}{b-a}; & a \leq x \leq b \\ \frac{c-x}{c-b}; & b \leq x \leq c \end{cases} \quad \text{.....(3)}$$

Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

TOPSIS was first introduced by Yoon and Hwang in 1981. The principle of TOPSIS is that the chosen alternative should have the shortest distance to the positive ideal solution and have the farthest distance from the ideal negative solution. A positive ideal solution is the best value of each attribute and the negative ideal solution is the worst value for each attribute. So that TOPSIS examine the distance between positive ideal solutions and negative ideal solutions by getting relative closeness toward positive ideal solutions.
The following statements are the stages of TOPSIS algorithm i.e.

1. Calculate the normalized decision matrix
   $rij = \frac{xij}{\sqrt{\sum_{i=1}^{m} xij^2}}$ .....(4)
   Where i=1,2,.....m and j=1,2,.....n
2. Calculate the weighted normalized decision matrix
   $yij = wi \cdot rij$ ..... (5)
   Where Wi is the weighted of the *i criteria or attribute* .
3. Determine positive ideal solution and negative ideal solution
   A positive ideal solution is denoted by A^+ and the negative ideal solution is denoted by A^-. The ideal solution can be determine based on weighted normalized decision matrix (yij) .
   $A^+ = (y_1^+, y_2^+, \ldots\ldots\ldots\ y_n^+)$ .....(6)
   $A^- = (y_1^-, y_2^-, \ldots\ldots\ldots\ y_n^-)$ ..... (7)
   Where:
   y_j^+ is:
   - Max *yij* if *j* is the benefit attribute (benefit)
   - Min *yij* if *j* is the cost attribute (cost)

   y_j^- is:
   - Min *yij* if *j* is benefit attribute (benefit)

- Max *yij* if *j* is cost attribute (cost)

4. Calculate alternatif distance from the positive ideal solution and negative ideal solution, as follows:
   Alternative distance Ai with positive ideal solutions:
   $D_i^+ = \sqrt{\sum_{j=1}^{n}\left(y_i^+ - y_{ij}^+\right)^2}$ ..... (8)
   Alternative distance Ai with negative ideal solutions:
   $D_i^- = \sqrt{\sum_{j=1}^{n}(y_{ij}^- - y_i^-)^2}$ ..... (9)
5. Calculate the relative closeness to the ideal solution for each alternative (Vi)
   $Vi = \frac{D_j^-}{D_i^- + D_i^+}$ ....(10)
   The rangking order of all alternatives can be obtained according to their relative closeness. So that a larger Vi value indicates that alternative Ai is preferred as an ideal solution.

RESEARCH METHOD

Data Collection Methods

a. Liiterature Research : data collection by reading books related to discussion material through literature and other scientific books.
b. Reporting : the main alternative to making direct measurements is to collecting data which is related to research object such as sample data, criterion data, and other supporting data through :
   1. Interviews
      Interviews are used to collect data related to the object of research to the Counseling Guidance Coordinator and Deputy Principal in the Curriculum field at States Senior High School 9 Bandar Lampung to obtain the information needed.
   2. Direct Observations
      Making direct measurements is the most accurate method for many variables that support system requirements as material for testing and reporting.

FINDINGS AND DISCUSSION

TOPSIS Algorithm

1. Determine the Fuzzy Sets

Fuzzy sets is a group that represents a certain condision in a fuzzy variable. Fuzzy sets in this research summarized in **Table 1.**and **Table 2.**

Table 1. Fuzzy Sets

No	Criteria Name	Universe of Discourse	Fuzzy Sets	Domain
1.	The Average Score of UN (C1)	[70 100]	Poor Good Very Good	[70 85] [75 100] [85 100]
2.	The Average Report Card (C2)	[70 100]	Poor Good	[70 85] [75 100]

Table 2. Fuzzy Sets(2)

No	Criteria Name	Universe of Discourse	Fuzzy Sets	Domain
3.	The IQ Test (C3)	[80 120]	Very Good Normal Brigth Normal Superior	[85 100] [80 100] [90 120] [100 120]
4.	The Specialization Test (C4)	[70 100]	Poor Good Very Good	[70 85] [75 100] [85 100]
5.	The Achievement (C5)	[0 1]	Null Local National International	[0] [0.5] [0.75] [1]
6.	Financial Condition (C6)	[7500 20000]	Poor Good Very Good	[7500 15000] [10000 20000] [15000 20000]

2. Determine the Membership Function

a. The Average Score of UN

Membership function in the average score of UN consist of triangular representation and linear representation as shown in **Figure 4.**

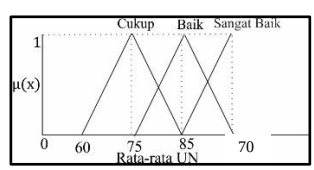

Figure 4. The Average Score of UN.

b. The Average of Report Card (C2)

Membership function in the average of Report Card consist of triangular representation and linear representation as shown in **Figure 5.**

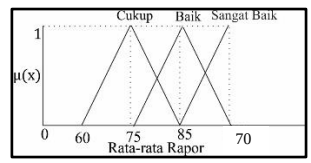

Figure 5. The Average of Report Card.

c. The IQ Test (C3)

Membership function in the IQ Test consist of triangular representation and linear representation as shown in **Figure 6.**

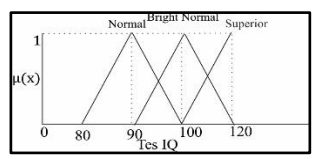

Figure 6. The IQ Test.

d. The Specialization Test (C4)

Membership function in the Specialization Test consist of triangular representation and linear representation as shown in **Figure 7.**

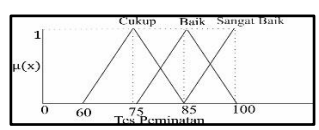

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Figure 7. The Specialization Test.

e. The Achievement (C5)

Membership function in the Achievement consist of triangular representation and linear representation as shown in **Figure 8.**

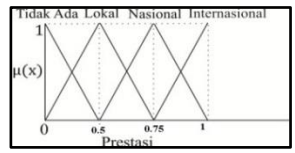

Figure 8. The Achievement.

f. Financial Condition (C6)

Membership function in the Financial Condition consist of triangular representation and linear representation as shown in **Figure 9.**

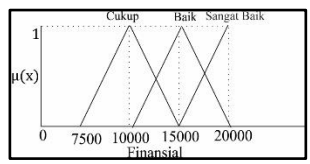

Figure 9. Financial Condition.

3. Determine Alternative Values for Each Criteria (Xij)

The alternative value is crisp from a sample of research data that has not been processed into fuzzy sets matrix. The research data of alternative is inputted into the matrix X based on each criteria.

4. Weight of Each Criteria (W)

Admission Selection System in Acceleration Class at States Senior High School 9 Bandar Lampung has criteria with weights i.e. Poor (C) =1, Important (P) =2, and Very Important (SP) =3 as summarized in **Table 3.**

Table 3. Weight of Each Criteria.

Criteria	C1	C2	C3	C4	C5	C6
Weight	C	C	SP	SP	P	P
Weight Values	1	1	3	3	2	2
Benefit/Cost	B	B	B	B	B	C

5. Fuzzy Numbers Conversion Matrix

Fuzzy numbers conversion matrix **Table 4.** is an alternative value that has converted into fuzzy numbers based on the equation in the Membership Function in **Figure 4.** until **Figure 9.**

Table 4. Fuzzy Numbers Conversion Matrix.

Name	C1	C2	C3	C4	C5	C6
A1	1.000	1.000	0.500	1.000	0.00	0.600
A2	0.500	0.500	1.000	0.500	0.75	0.200
A3	0.067	0.067	0.750	0.067	1.00	0.400
A4	1.000	1.000	0.600	1.000	0.75	0.000
A5	0.400	0.400	0.650	0.400	0.50	0.080
A6	0.067	0.500	0.800	0.800	0.50	1.000
A7	0.267	1.000	0.750	0.100	0.75	1.000
A8	0.400	1.000	0.600	1.000	0.00	0.200
A9	0.200	0.400	0.850	0.400	0.50	0.540
A10	0.500	0.067	0.650	0.067	0.50	0.540
A11	1.000	0.267	0.900	0.267	0.75	0.500
A12	0.133	0.400	0.800	1.000	0.50	1.000
A13	0.800	0.200	0.600	0.500	0.00	0.200
A14	0.100	0.500	0.650	1.000	0.00	1.000
A15	1.000	1.000	0.800	0.500	0.50	0.200
A16	0.400	0.400	0.750	0.067	0.75	0.540
A17	0.067	0.500	0.600	1.000	1.00	0.500
A18	0.267	1.000	0.850	0.133	1.00	1.000
A19	1.000	0.067	1.000	0.800	0.50	0.200
A20	0.500	1.000	0.750	0.100	0.50	1.000

6. Normalized Decision Matrix (Rij)

Normalized Decision Matrix (Rij) is the result of (equation (4)). The following are examples,

$$\sqrt{\sum_{i=1}^{m} xij^2} = \sqrt{\begin{matrix} 75^2 + 80^2 + 86^2 + 85^2 + 79^2 + 86^2 + 89^2 + 79^2 + 77^2 + 80^2 \\ +85^2 + 87^2 + 83^2 \\ +76^2 + 85^2 + 79^2 + 86^2 + 89^2 + 75^2 + 80^2 \end{matrix}}$$

$$= 367.48$$

$$R_{11} = \frac{75}{367.48} = 0.003$$

$$R_{12} = \frac{80}{367.48} = 0.001$$

$$R_{13} = \frac{86}{367.48} = 0.000$$

$$R_{14} = \frac{85}{367.48} = 0.003$$

$$R_{15} = \frac{79}{367.48} = 0.001$$

7. Weighted Normalized Decision Matrix (Yij)

Calculating the normalized matrix is weighted by multiplying the value of the normalized decision matrix (Rij) by the weight of each criterion (W) according to (Equation (5)).

8. Determine the Ideal Solutions (A)

Solusi The positive ideal solution is denoted by A+ and the negative ideal solution is denoted by A-. Ideal solutions can be determined based on weighted normalized (Yij) rankings with (Equation (6)) for positive ideal solutions and (Equation (7)) for negative ideal solutions. The results are shown in **Table 5.**

Table 5. Ideal Solutions.

A+	0.0027	0.0002	0.0060	0.0082	0.7155	0.000000
A-	0.0002	0.0027	0.0030	0.0005	0.0000	0.000043

9. Determine the Ideal Solution Distance (D)

The ideal solution distance is the distance between the positive ideal solutions for each alternatives (equation (8)) and the negative ideal solution for each alternative (equation (9)). The results of each alternative distance in the ideal solution are shown in **Table 6.**

Table 6. The Ideal Solution Distance of Each Alternative

Name	D+	D-
A1	0.7155	0.0085
A2	0.1789	0.5367
A3	0.0086	0.7155
A4	0.1789	0.5367
A5	0.3578	0.3578
A6	0.3578	0.3578
A7	0.1791	0.5367
A8	0.7155	0.0082
A9	0.3578	0.3578
A10	0.3579	0.3578
A11	0.1790	0.5367
A12	0.3578	0.3579
A13	0.7156	0.0041
A14	0.7156	0.0078
A15	0.3578	0.3578
A16	0.1791	0.5367

A17	0.0037	0.7156
A18	0.0075	0.7155
A19	0.3578	0.3578
A20	0.3579	0.3578

10. Preference Value for Each Alternative

Table 7. is the result of relative closeness so that the conclusion is as much as a sample of 20 students who took the test 8 of them were declared to have passed the selection with consideration if the value > = 0.7 was declared to pass and if the value <0.7 was declared to fail the selection.

Table 7. Preference Value

Name	V	Result
A1	0.0112	Failed
A2	0.7499	Passed
A3	0.9886	Passed
A4	0.9205	Passed
A5	0.5000	Failed
A6	0.5000	Failed
A7	0.7498	Passed
A8	0.0107	Failed
A9	0.5000	Failed
A10	0.4999	Failed
A11	0.7499	Passed
A12	0.5001	Failed
A13	0.0065	Failed
A14	0.0108	Failed
A15	0.5000	Failed
A16	0.7498	Passed
A17	0.9949	Passed
A18	0.9891	Passed
A19	0.5001	Failed
A20	0.4999	Failed

CONCLUSION

Based on 20 alternative student data, there were 8 students who successfully passed the selection by the consideration that the students who reached the passing grade was <=0.7 and the students who did not reach the passing grade was <0.7. Therefore, this research was also successfully generated the website-based system for the Admission Selection Systems in the Acceleration Class. The students can see the announcement of the selection on website everywhere.

The weakness point in this system is a problem beyond Fuzzy TOPSIS that could be found on the results should be decided by school administrator, if there identical assessments between several students who pass the selection beyond the quota provided, then the final decision is held by school administrator of the Acceleration Class Selection.

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