DEVELOPMENT OF DECISION SUPPORT SYSTEM DETERMINING THE STUDENT AS SCHOLARSHIP AWARDEES BY FUZZY MULTI ATTRIBUTE DECISION MAKING (FMADM)

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Abstract

This research is the design of a decision support system (DSS) to determine the student as scholarship awardees of the STMIK Pelita Nusantara, Medan, Indonesia, with the approach of Fuzzy Multi Attribute Decision Making (FMADM) with TOPSIS method. The FMADM is implemented in the system by specifying the values of the weights for each of the criteria or attributes. Whilst, TOPSIS method is used for making the final decision of the scholarship awardees. Both methods are implemented in a decision support application system that indicates the interaction between users and the software interface. The application is designed by using Visual Basic 2008. This research formulates an application in selecting the scholarship awardee using Fuzzy Multi Attribute Decision Making (FMADM) approach and TOPSIS method. By using this application, the result and information related to determining the student who should be granted the scholarship can be done more quickly, rightly and accurately.

Keywords: *Scholarship, Criteria, Selection, FMADM, TOPSIS, DSS*

Abstrak

Penelitian ini mengenai desain sistem pendukung keputusan (DSS) untuk menentukan siswa sebagai penerima beasiswa dari STMIK Pelita Nusantara, Medan, Indonesia, dengan pendekatan Fuzzy multi Attribute Decision Making (FMADM) dengan metode TOPSIS. Pendekatan Fuzzy Multiple Attribute Decision Making (FMADM) dengan menentukan nilai bobot untuk masing-masing kriteria atau atribut dan metode TOPSIS untuk memilih penerima beasiswa mahasiswa. Penerapan sistem pendukung keputusan dapat menunjukkan interaksi pengguna dengan aplikasi perangkat lunak yang dibangun dengan menggunakan bahasa pemrograman Basic 2008 Visual. Kesimpulan hasil yang diperoleh dari diskusi menunjukkan bahwa pendekatan dengan FMADM TOPSIS memberikan hasil perhitungan akhir nilai memerintahkan yang dapat membantu pengambil keputusan menentukan siswa layak beasiswa. Adanya sistem pendukung keputusan yang telah dirancang sehingga proses penentuan penerima beasiswa mahasiswa lebih akurat, cepat, dan akurat.

Kata Kunci: *Beasiswa, Kriteria, Pemilihan, FMADM, TOPSIS, DSS*

1. Introduction

STMIK Pelita Nusantara Medan provides scholarship students who have high achievement and coming from families with low economic level. The financial of the scholarship is not a self fund or parents' donation neither from the lecturer or researcher. The scholarship is supported by government, private company, embassy, and university. Scholarship is provided to the right awardees based on classification, quality and competency of students.

Decision in selecting the student as awardee of scholarship at STMIK Pelita Nusantara Medan is conventionally made by holding several meetings with the foundation, chairperson, head of education program and academic counselor lecturer. The criteria of students who receive the scholarship is students' cumulative achievement index (IPK) should not less than 3.0. The selection process of the awardees of the scholarship is not objective, need a long time and not accurate [8].

This research is focus in designing a decision support system by Fuzzy Multi Attribute Decision Making (FMADM) approach using TOPSIS method. Once the FMADM approach gives a weight score for each criteria then TOPSIS method selects the awardee of scholarship. TOPSIS method applies principle that the chosen alternative must has a nearest distance from the positive ideal solution and far from the negative ideal solution. The ranked alternatives must be references for decision maker to choose the best solution. This method is applied in decision making practically because its concept is quite simple and easy to understand, computationally efficient and is able to measure the relative performance from any decision alternatives [9].

Both methods are implemented in a decision support application system that indicates the interaction between users and the software interface. The application is designed by using Visual Basic 2008. The Decision Support System (DSS) is defined as a system that supports a work of manager or group of managers in solving semi structured problem by giving information or suggestion that lead to the decision [10].

2. Methodology

Figure 1 shows the flow chart of the support decision system in determining student as the scholarship awardee using Fuzzy Multi Attribute Decision Making (FMADM) approach and TOPSIS method.

Fuzzy Multiple Attribute Decision Making (FMADM)

Fuzzy Multiple Attribute Decision Making (FMADM) is a method applied to obtain optimal alternative from any alternatives with certain criteria. The context of FMADM is determining the weight score for each attribute and followed by ranking process in selection of any alternatives. Principally, there are three approaches to determine the weight score of attribute,

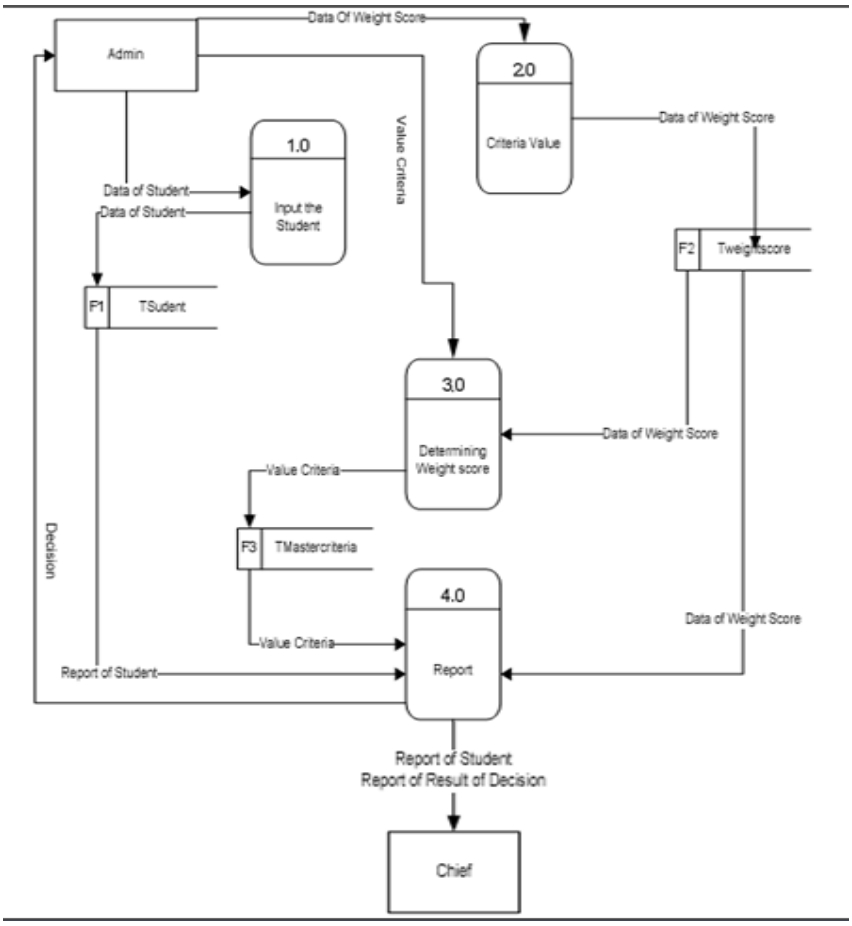

Figure 1. Process flow chard of selection of student as awardees of scholarship by FMADM approach with TOPSIS method

i.e. subjective, objective, and integration between subjective and objective approaches. Each approach has advantages and disadvantages. On subjective approach, the weight score is determined based on subjectivity of the decision maker so any factors in ranking process of alternatives can be determined independently. While in objective approach, the weight score is calculated mathematically that ignore subjectivity of the decision maker [9].

There are any method may be applied to solve the FMADM problem, such as: 1) Simple Additive Weighting (SAW); 2) Weighted Product (WP); 3) Electre; 4) Analytic Hierarchy Process (AHP); 5) Technique for Order Preference by Similarity to Ideal Solution (TOPSIS).

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

TOPSIS was introduced by Yoon and Hwang in 1981 as one of methods to solve multi-criteria problems. TOPSIS gives a solution from given alternatives by comparing each alternative to the best and bad alternatives among the available solution options. This method applies distance to do the comparison. TOPSIS method is developed based on the concept that search for the best alternative that not only has the shortest distance from the positive ideal solution but also has the longest distance from the negative ideal solution in geometric point of view by using Euclidean distance [3].

TOPSIS method ranks the alternatives based on relative nearest score priority of alternative to positive ideal solution. The ranked alternatives become references to the decision maker in determining the best solution. This method is used to practically solve the decision making because its concept is simplest and easy to understand, its computation is efficient and can measure the relative performance of any decision alternatives. In the classic TOPSIS method, the weight score of each criterion is defined. Each weight score of criteria is defined based on its necessity level according to the decision maker.

The following is the procedure of TOPSIS method:

Building a Decision Matrix

TOPSIS is begun by building a decision matrix. The decision matrix X refers to m alternatives that will be evaluated based on n criteria. Decision matrix X is given as equation (1) follows:

$$X = \begin{matrix} a_1 \\ \vdots \\ a_m \end{matrix} \begin{pmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{pmatrix} \quad (1)$$

where a_i $(i = 1, 2, 3, \ldots, m)$ is the set of possible alternatives, x_j *(j =1, 2, 3,…, n)* is the set of attributes by which the alternative performances are measured with, x_{ij} is an alternative performance of a_i by referring to attribute x_j.

Normalized Decision Matrix

Each element of the matrix X is normalized to obtain the normalized matrix R. Each normalized value r_{ij} can be calculated using the equation (2) as follows:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} {x_{ij}}^2}} \quad (2)$$

where $i = 1, 2, 3, \ldots, m$; and $j = 1, 2, 3, \ldots, n$;

Weighted Normalized Matrix

The normalized matrix is then weighted by $W = (w_1, w_2, \ldots, w_n)$. Thus, the weighted normalized matrix V can be calculated using the equation (3) as follows:

$$v_{ij} = w_j \; r_{ij} \quad (3)$$

where $i = 1, 2, 3, \ldots, m$; and $j = 1, 2, 3, \ldots, n$;

Determining the Ideal Solution.

Positive ideal solution A^+ and A^- negative ideal solution can be determined based on normalized weighted rating (Y_{ij}) using the equation (4) and (5).

$$A^+ = \{v_1^+, v_2^+, v_3^+, \ldots, v_n^+\} \quad (4)$$

$$A^- = \{v_1^-, v_2^-, v_3^-, \ldots, v_n^-\} \quad (5)$$

Calculating Separation Measure

Separation measure is a measurement of the distance of an alternative to the positive and negative ideal solution. Mathematical calculation of the separation measurement to the positive ideal solution is shown by equation (6) while the separation measurement to the negative ideal solution is shown by equation (7).

$$S_i^+ = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^+\right)^2} \quad (6)$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^-\right)^2} \quad (7)$$

where $i = 1,2,3,\ldots,m$

Calculating the Relative Closeness

In this step, the relative closeness of alternatives to the positive ideal is calculated. Relative closeness of the alternative A^+ to A^- ideal solution calculated using equation (8):

$$c_i^+ = \frac{s_i^-}{(s_i^- + s_i^+)}, 0 \leq c_i^+ \leq 1 \qquad (8)$$

where, $i = 1,2,3,\ldots,m$

Sorting Preference

Alternatives can be ranked based on the order of A_i.The best alternative is the shortest to the positive solution and the longest to the ideal solution to the negative ideal solution. Alternative with the higher C^+ is a best solution.

FMADM Requirement Analysis

The problem-solving and computation of the scholarship awardee selection with TOPSIS method is described as the following phases.

Phase I

The number of alternatives and some of the attributes or criteria that will be used is defined in this phase. There are six criterion used as a basis for making decisions in the selection of scholarship awardee. Those are:

C1 = Grade Point Average (GPA)
C2 = Attitude
C3 = discipline
C4 = Tidiness
C5 = Narcotic and drugs
C6 = Activity in campus organization

Phase II

The criterion data is transformed into the crisp score by weighting each criteria as shown in the Table 1 to Table 6.

TABLE 1
FUZZY NUMBER FOR CRITERIA OF GPA

Score GPA	Variable	Crisp Score
0 ≤ GPA< 2,0	Very Poor	0
2,0 ≤ GPA < 2,5	Poor	0,25
2,5 ≤ GPA < 3,0	Enough	0,5
3,0 ≤ GPA < 3,5	Good	0,75
3,5 ≤ GPA ≤ 4,0	Excellent	1

TABLE 2
FUZZY NUMBER FOR CRITERIA OF ATTITUDE

Attitude	Variable	Crisp Score
80 ≤ Weight ≤ 100	Very Poor	0
60 ≤ Weight < 80	Poor	0,25
40 ≤ Weight < 60	Enough	0,5
20 ≤ Weight < 40	Good	0,75
0 ≤ Weight < 20	Excellent	1

TABLE 3
FUZZY NUMBER FOR CRITERIA OF DISCIPLINE

Discipline	Variable	Crisp Score
80 ≤ Weight ≤ 100	Very Poor	0
60 ≤ Weight < 80	Poor	0,25
40 ≤ Weight < 60	Enough	0,5
20 ≤ Weight < 40	Good	0,75
0 ≤ Weight < 20	Excellent	1

TABLE 4
FUZZY NUMBER FOR CRITERIA OF TIDINESS

Tidiness	Variable	Crisp Score
80 ≤ Weight ≤ 100	Very Poor	0
60 ≤ Weight < 80	Poor	0,25
40 ≤ Weight < 60	Enough	0,5
20 ≤ Weight < 40	Good	0,75
0 ≤ Weight < 20	Excellent	1

TABLE 5
FUZZY NUMBER FOR CRITERIA OF NARCOTRIC AND PROHIBITED ITEM

Narcotic and Prohibited Item	Variable	Crisp Score
80 ≤ Weight ≤ 100	Very Poor	0
60 ≤ Weight < 80	Poor	0,25
40 ≤ Weight < 60	Enough	0,5
20 ≤ Weight < 40	Good	0,75
0 ≤ Weight < 20	Excellent	1

TABLE 6
FUZZY NUMBER FOR CRITERIA OF ACTIVITY IN CAMPUS ORGANIZATION

Activity	Variable	Crisp Score
0 ≤ Weight < 20	Very Poor	0
20 ≤ Weight < 40	Poor	0,25
40 ≤ Weight 60	Enough	0,5
60 ≤ Weight < 80	Good	0,75
80 ≤ Weight ≤ 100	Excellent	1

Phase III

The determination of the students who will be the scholarship awardees based on TOPSIS method is

Figure 2. Form Login

Figure 3. Form Main Menu

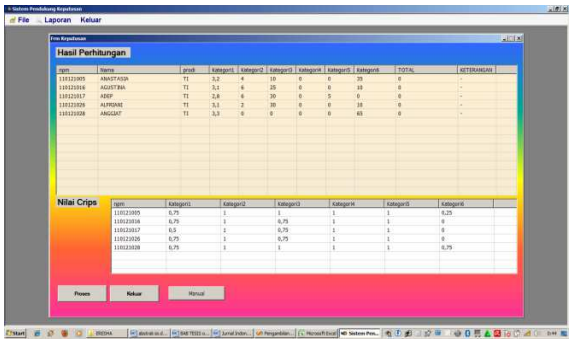

Figure 4. Data Entry Form of Student and Criteria Score

undergone by considering the decision tables that each of which show the feasibility. The terms of feasibility is based on the final score as shown in the Table 7.

TABLE 7
DECISION

Score	Remark
0,00 ≤ Final Score < 0,50	Not Feasible
0,50 ≤ Final Score ≤1,00	Feasible

3. Results and Analysis

The data analysis in this research is based on the flow chart of FMADM using TOPSIS method whose fuzzy score has been converted into crisp score as shown in the Table 8 by taking 5 (five) samples of student. To determine its decision matrix (X), equation (9) is given. The normalization matrix (R) is listed in Table 9. Whereas the normalized decision matrix is shown in Table 10.

TABLE 8
CRITERION DATA AFTER CONVERSION

NIM	C1	C2	C3	C4	C5	C6
110121017	0,5	1	0,75	1	1	0
110121016	0,75	1	0,75	1	1	0
110121026	0,75	1	0,75	1	1	0
110121005	0,75	1	1	1	1	0,25
110121026	0,75	1	1	1	1	0,75

The positive ideal solution (A^+) and negative ideal solution (A^-) as shown in the Table 11. The separation or alternative distance and relative closeness of each alternative to the positive ideal solution (c_i^+) are as shown in Table 12. Whereas, the final result of the scholarship awardee selection using the TOPSIS methods are shown in Table 13.

$$X = \begin{bmatrix} 0,5 & 1 & 0,75 & 1 & 1 & 0 \\ 0,75 & 1 & 0,75 & 1 & 1 & 0 \\ 0,75 & 1 & 0,75 & 1 & 1 & 0 \\ 0,75 & 1 & 1 & 1 & 1 & 0,25 \\ 0,75 & 1 & 1 & 1 & 1 & 0,25 \end{bmatrix} \quad (9)$$

TABLE 9
NORMALIZATION MATRIX

R(i,1)	R(i,2)	R(i,3)	R(i,4)	R(i,5)	R(i,6)
0,316228	0,447214	0,390567	0,447214	0,447214	0
0,474342	0,447214	0,390567	0,447214	0,447214	0
0,474342	0,447214	0,390567	0,447214	0,447214	0
0,474342	0,447214	0,520756	0,447214	0,447214	0,316227
0,474342	0,447214	0,520756	0,447214	0,447214	0,948683

TABLE 10
NORMALIZED DECISION MATRIX

NIM	V (i,1)	V (i,2)	V (i,3)	V (i,4)	V (i,5)	V (i,6)
110121017	0,23717	0,44721	0,39057	0,44721	0,44721	0
110121016	0,35576	0,44721	0,39057	0,44721	0,44721	0
110121026	0,35576	0,44721	0,39057	0,44721	0,44721	0
110121005	0,35576	0,44721	0,52076	0,44721	0,44721	0,23717
110121026	0,35576	0,44721	0,52076	0,44721	0,44721	0,71151

Figure 2 shows the application interface before entering the application. User login is required to use the program. In the login form, user is asked to input the username and password. If the username or password is not correct, it will not be proceeded to the next process. There are two types of user, i.e. admin and user. The difference between the roles is only admin is permitted to do the data imputation.

TABLE 11
POSITIVE AND NEGATIVE SOLUTION

	V (i,1)	V (i,2)	V (i,3)	V (i,4)	V (i,5)	V (i,6)
Ideal Solution	0,237171	0,447214	0,390567	0,447214	0,447214	0
	0,355756	0,447214	0,390567	0,447214	0,447214	0
	0,355756	0,447214	0,390567	0,447214	0,447214	0
	0,355756	0,447214	0,520756	0,447214	0,447214	0,237171
	0,355756	0,447214	0,520756	0,447214	0,447214	0,711512
A^+ (V max)	0,355756	0,447214	0,520756	0,447214	0,447214	0,711512
A^- (V min)	0,237171	0,447214	0,390567	0,447214	0,447214	0

TABLE 12
ALTERNATIVE DISTANCE AND RELATIVE CLOSENESS

i	S(i)+	S(i)-	C(i) = A(i)-/[A(i)+]+[A(i)-]
1	0,7329813	0	0
2	0,7233251	0,1185854	0,140852757
3	0,7233251	0,1185854	0,140852757
4	0,4743416	0,2954008	0,383765792
5	0	0,7329813	1

TABLE 13
THE FINAL RESULT OF TOPSIS METHODS FOR ACHIEVEMENT SCHOLARSHIP

NIM	Name	Level	Prodi	Closeness.	Decision
110121026	Anggiat. S.	S1	TI	1	Feasible
110121005	Anastasia	S1	TI	0,383766	Not Feasible
110121016	Agustina	S1	TI	0,140853	Not Feasible
110121026	Alfriani	S1	TI	0,140853	Not Feasible
110121017	Adep	S1	TI	0	Not Feasible

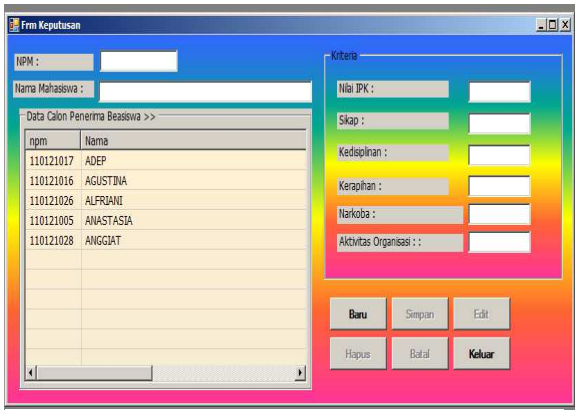

Figure 6. Form of TOPSIS calculation process

Figure 3 shows the interface of the main menu if login attempt is successfully executed. In the main menu, there are option of personal data form of candidate, criteria score and decision making process.

Figure 4 shows the interface to enter the information of student and the determined criterion. The information of student includes name and registration number. The criterion input consist of 6 (six) determined attributes, i.e. GPA, weight of attitude, weight of discipline, weight of tidiness, weight of narcotic and prohibited items and weight of organization activity.

Figure 5 shows the interface of TOPSIS calculation process. Once the data of student and criteria of 6 (six) attributes is input as shown in Figure 3, the calculation involving fuzzy score to each criteria is executed.

Afterwards, the normalization matrix, weighted normalized matrix, the positive and negative ideal solution, the alternative distance and to display the results of calculation using the TOPSIS method.

Figure 6 shows the interface of the report of the selected students as the scholarship awardees. The report consists of the student registration number, name and the education program. The report also displays the weight score of criteria and result of calculation by TOPSIS method of each criteria. The remark column shows whether the student is feasible or not as an awardee of the scholarship. Thus, it helps the chief as the final decision maker in giving the final decision of the scholarship awardee.

4. Conclusion

This research formulates an application in selecting the scholarship awardee using Fuzzy Multi Attribute Decision Making (FMADM) approach and TOPSIS method. By using this application, the result and in-

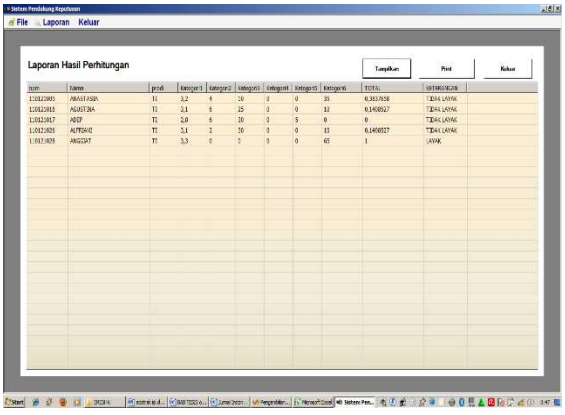

Figure 5. Report of the student as the scholarship awardee

formation related to determining the student who should be granted the scholarship can be done more quickly, rightly and accurately. The result of this research indicates an implication that there is approach as a base to determine students as awardees of scholarship i.e. Fuzzy Multi Attribute Decision Making (FMADM) with TOPSIS method.

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