

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

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Abstract

This research is the design of a decision support system (DSS) to determining the student as scholarship recipients of the STMIK Pelita Nusantara, Medan, Indonesia, with the approach of Fuzzy Multi Attribute Decision Making (FMADM) with TOPSIS method. Approach to Fuzzy Multiple Attribute Decision Making (FMADM) by specifying the values of the weights for each of the criteria or attributes and TOPSIS method for selecting student scholarship recipients. Implementation of a decision support system that can show the interaction of the user with the software application built using Visual Basic 2008 programming language. Conclusion the results obtained from the discussion shows that the approach with FMADM TOPSIS give final value calculation results ordered that can help decision makers determine the student deserves the scholarship. The existence of a decision support system that has been designed so the process of determining a student scholarship recipients more accurately, quickly, 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 the student who has a high achievement and with the lower economic level of parents with scholarship. The financial of the scholarship is not a self fund or parents' donation but it financed by government, private company, embassy, university and not from

the lecturer or researcher. Scholarship is provided to the right recipients based on classification, quality and competency of the recipients.

Decision in determining the student as recipient of scholarship at STMIK Pelita Nusantara Medan is made conventionally namely by held a meeting with Foundation, Chairperson, Head of Education

Program and Academic Counselor lecturer. The criteria of student who receive the scholarship is a student who has cumulative achievement index (IPK) not less than 3.0. The determining process of the recipients of the scholarship is not objective, need a long time and is not accurate [8].

This research is focus on designing of decision support system by Fuzzy Multi Attribute Decision Making (FMADM) approach by TOPSIS method. FMADM approach by give a weight score for each criteria and TOPSIS method to select the recipient 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 required best solution. This method is applied in decision making practically because its concept is simplest and easy to understand, its

computation is efficient and measure the relative performance from any decision alternatives [9].

The implementation is by developing a decision support system that indicates the interaction between users and the built software. The application is designed by using Visual Basic 2008 programming. The decision support system (DSS) is defined as a system that support a work of manager or group of manager in solve semi structure problem by give any information or suggestion lead to the decision [10].

2. Methodology

The below figure shows a process flow chart of a support decision system in determining student as recipient of scholarship by Fuzzy Multi Attribute Decision Making (FMADM) approach by TOPSIS method as shown in Figure 1.

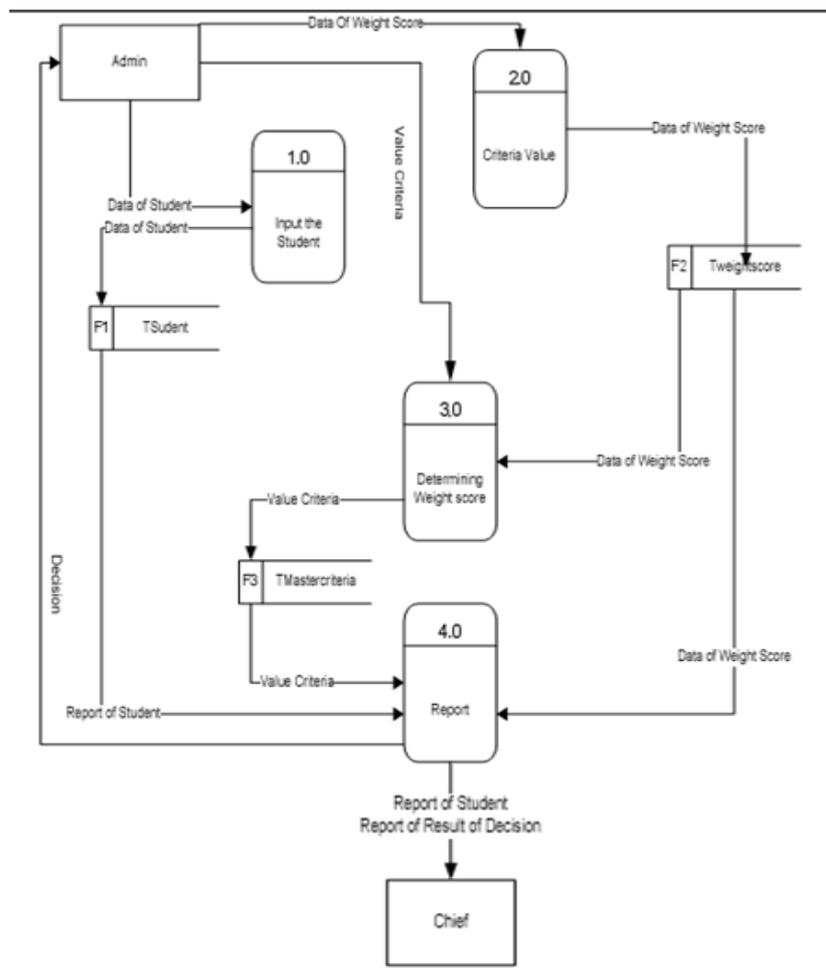


Fig. 1. Process flow chart of selection of student as recipients of scholarship by FMADM approach with TOPSIS method

2.1 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, 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)

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

TOPSIS was introduced in the first time by Yoon and Hwang in 1981 as one of method ion solve the multi-criteria problem. TOPSIS give a solution of any alternatives by compare each alternative to the best and bad alternatives among the available problem alternatives. This method applies distance to do the comparison. Yoon and Hwang develop a TOPSIS method based on the concept the best alternative and not only has the shortest distance from the positive ideal solution but also it has the longest distance from the negative ideal solution in the view point of geometric using Euclidean distance.[3]

TOPSIS method will rank the alternative based on relative nearest score priority of alternative to positive ideal solution. The ranked alternatives will be references to the decision maker in chose the required best solution. This method is used to solve the decision making practically because its concept is simplest and easy to understand, its computation is efficient and can measure the relative performance of any decision alternatives. In classic TOPSIS method, the weight score of each criterion

had known clearly. Each weight score of criteria is determined based on its necessity level according to the decision maker.

The following is the procedure of TOPSIS method are:

1. TOPSIS began by build a decision matrix. The decision matrix X refers to m alternatives will be evaluated based on n criteria. Decision matrix X is as follows :

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

where a_i ($i = 1, 2, 3, \dots, m$) is possible alternative, x_j ($j = 1, 2, 3, \dots, n$) is attribute in which the alternative performance is measured, x_{ij} is alternative performance a_i by refer to attribute x_j .

2. Normalized decision matrix

Each element of the matrix X is normalized to obtain the normalization matrix R. Each normalized value r_{ij} can be calculated as follows:

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

where $i = 1, 2, 3, \dots, m$; dan $j = 1, 2, 3, \dots, n$;

3. Weighted normalized matrix has given weight $W = (w_1, w_2, \dots, w_n)$, so the weighted normalized matrix V can be calculated as follows:

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

where $i = 1, 2, 3, \dots, m$; dan $j = 1, 2, 3, \dots, n$;

4. Determine the positive ideal solution and negative ideal solution

Positive ideal solution A^+ and A^- negative ideal solution can be determined based on normalized weighted rating (Y_{ij}):

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

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

5. Calculating Separation Measure

Separation measure is a measurement of the distance of an alternative to the positive ideal solution and negative ideal solution. Mathematical calculation is as follows:

- a. Separation measure to the positive ideal solution :

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

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

- b. Separation measure to the negative ideal solution

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

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

6. Calculating the relative closeness to the positive ideal. Relative closeness of the alternative A^+ to A^- ideal solution represented by:

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

Where, $i = 1, 2, 3, \dots, m$

7. Sorting Preference

Alternatives can be ranked based on the order of A_i . The best alternative is the one that is shortest to the longest and is the ideal solution to the negative ideal solution.

Alternative with the higher C^+ is a best solution

3. Requirement Analysis For FMADM.

Problem-solving and computation scholarship selection with TOPSIS method described as:

Phase I : Collect the number of alternatives that will be used and some of the attributes or criteria. There are six criterias used as a basis for making decisions in the selection of scholarship. The criteria are:

C1 = Grade Point Average (GPA)

C2 = Attitude

C3 = discipline

C4 = Tidiness

C5 = Narcotic and drugs

C6 = Activity in campus organization

Phase II : The criteria data is transformed into the crisp score by weight of each criteria as shown in the below the table.

TABLE I
FUZZY NUMBER FOR CRITERIA OF GPA

| Score GPA | Variable | Crisp Score |
|--------------------------------|-----------|-------------|
| $0 \leq \text{GPA} < 2,0$ | Very Poor | 0 |
| $2,0 \leq \text{GPA} < 2,5$ | Poor | 0,25 |
| $2,5 \leq \text{GPA} < 3,0$ | Enough | 0,5 |
| $3,0 \leq \text{GPA} < 3,5$ | Good | 0,75 |
| $3,5 \leq \text{GPA} \leq 4,0$ | Excellent | 1 |

TABLE II
FUZZY NUMBER FOR CRITERIA OF ATTITUDE

| Attitude | Variable | Crisp Score |
|----------------------------------|-----------|-------------|
| $80 \leq \text{Weight} \leq 100$ | Very Poor | 0 |
| $60 \leq \text{Weight} < 80$ | Poor | 0,25 |
| $40 \leq \text{Weight} < 60$ | Enough | 0,5 |

| | | |
|------------------------------|-----------|------|
| $20 \leq \text{Weight} < 40$ | Good | 0,75 |
| $0 \leq \text{Weight} < 20$ | Excellent | 1 |

TABLE III
FUZZY NUMBER FOR CRITERIA OF DISCIPLINE

| Discipline | Variable | Crisp Score |
|----------------------------------|-----------|-------------|
| $80 \leq \text{Weight} \leq 100$ | Very Poor | 0 |
| $60 \leq \text{Weight} < 80$ | Poor | 0,25 |
| $40 \leq \text{Weight} < 60$ | Enough | 0,5 |
| $20 \leq \text{Weight} < 40$ | Good | 0,75 |
| $0 \leq \text{Weight} < 20$ | Excellent | 1 |

TABLE IV
FUZZY NUMBER FOR CRITERIA OF TIDINESS

| Tidiness | Variable | Crisp Score |
|----------------------------------|-----------|-------------|
| $80 \leq \text{Weight} \leq 100$ | Very Poor | 0 |
| $60 \leq \text{Weight} < 80$ | Poor | 0,25 |
| $40 \leq \text{Weight} < 60$ | Enough | 0,5 |
| $20 \leq \text{Weight} < 40$ | Good | 0,75 |
| $0 \leq \text{Weight} < 20$ | Excellent | 1 |

TABLE V
FUZZY NUMBER FOR CRITERIA OF NARCOTIC AND PROHIBITED ITEM

| Narcotic and Prohibited Item | Variable | Crisp Score |
|----------------------------------|-----------|-------------|
| $80 \leq \text{Weight} \leq 100$ | Very Poor | 0 |
| $60 \leq \text{Weight} < 80$ | Poor | 0,25 |
| $40 \leq \text{Weight} < 60$ | Enough | 0,5 |
| $20 \leq \text{Weight} < 40$ | Good | 0,75 |
| $0 \leq \text{Weight} < 20$ | Excellent | 1 |

TABLE VI
FUZZY NUMBER FOR CRITERIA OF ACTIVITY IN CAMPUS ORGANIZATION

| Activity | Variable | Crisp Score |
|----------------------------------|-----------|-------------|
| $0 \leq \text{Weight} < 20$ | Very Poor | 0 |
| $20 \leq \text{Weight} < 40$ | Poor | 0,25 |
| $40 \leq \text{Weight} < 60$ | Enough | 0,5 |
| $60 \leq \text{Weight} < 80$ | Good | 0,75 |
| $80 \leq \text{Weight} \leq 100$ | Excellent | 1 |

Phase III : To determine the student who receive the scholarship based on TOPSIS method by consider the decision table that consist of feasible or not. The terms of feasible or not is based on the final score as shown in the below the table.

TABLE VII
DECISION

| Score | Remark |
|--|--------------|
| $0,00 \leq \text{Final Score} < 0,50$ | Not Feasible |
| $0,50 \leq \text{Final Score} \leq 1,00$ | Feasible |

| NIM | V(i,1) | V(i,2) | V(i,3) | V(i,4) | V(i,5) | V(i,6) |
|-----------|---------|---------|---------|---------|---------|---------|
| 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 |

4. Implementation and Results of Research

The steps of data analysis on this research is based on the flow chart of FMADM by TOPSIS method in which the score of fuzzy had converted into crisp score as shown in the table VIII by take 5 (five) sample of student.

TABLE VIII
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 |

1. To determine its decision matrix (X)

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

2. Normalization of Matrix (R) :

| 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 | 0,9486833 |

3. 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 |

4. To determine the positive ideal solution (A⁺) and negative ideal solution (A⁻) as shown in the below the table.

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

5. To determine separation or alternative distance and relative closeness of each alternative to the positive ideal solution (c_i⁺) as follows:

| 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 |

6. The final result of of TOPSIS methods for achievement Scholarship.

| NIM | Name | Level | Prodi | Value of closeness of coefficients of the alternatives. | 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 |

Implementation of Result



Fig. 2. Form Login

Figure 2 shows the display before enter to the application in which user must login previously. In form login, the user input the user name and password. If the username or password is error, the next process is not continued. There are two types of user, i.e. admin and user. It difference is the data only input by user admin.

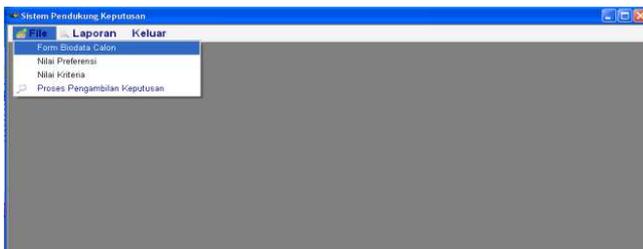


Fig. 3. Form Main Menu

Figure 3 shows the display of Main Menu after user had login. In the main menu display, there are option of Personal data Form of candidate, Criteria Score and Decision Making Process.

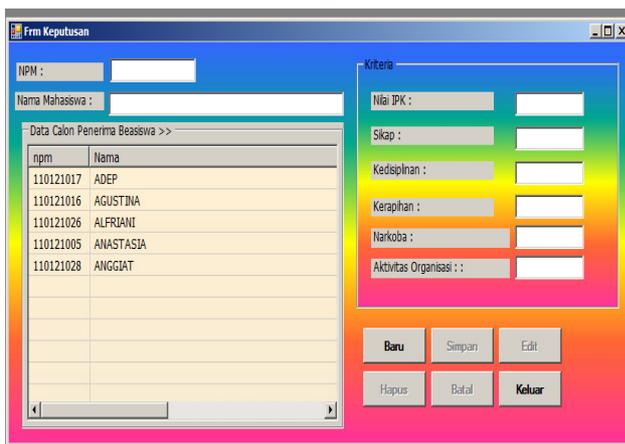


Fig. 4. Data Entry Form of Student and Criteria Score

Figure 4 shows the display to enter the data of student and determined criteria. The data of student will be entered are name and register number of

student. And the criteria data will be entered is 6 (six) determined attribute, i.e: GPA, weight of attitude, weight of discipline, weight of tidiness, weight of narcotic and prohibited items and weight of organization activity.

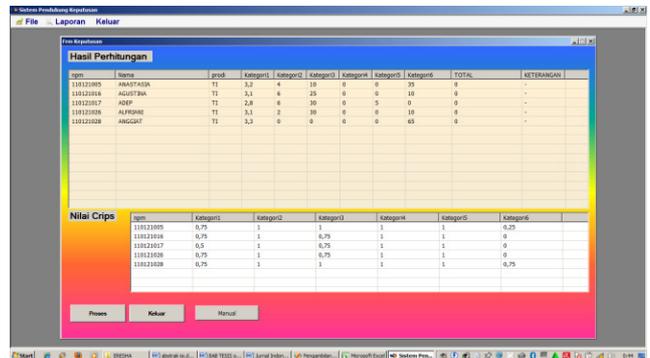


Fig. 5. Form of TOPSIS calculation process

Figure 5 shows the display of TOPSIS calculation process. After to enter the data of student and criteria of 6 (six) attributes as shown in figure 3, its calculation is processed to get the fuzzy value of each criteria.

Furthermore, the TOPSIS calculation can be processed on the display by matrix normalization, weighted normalized matrix, to calculate the positive ideal solution and negative ideal solution, to calculate the alternative distance and to display the results of calculation.

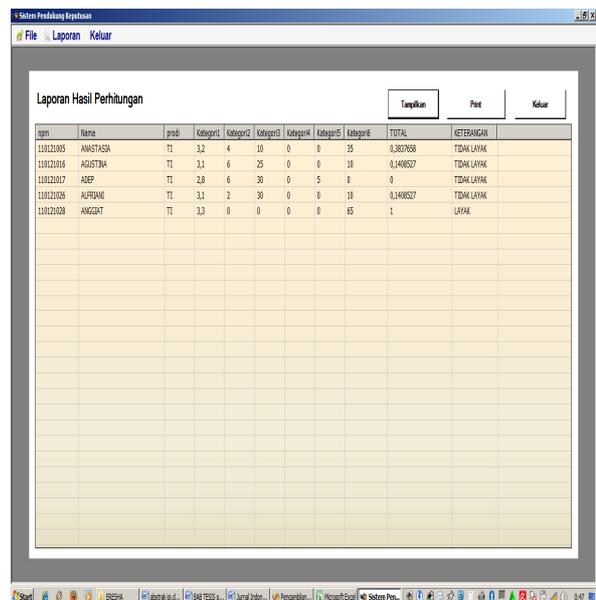


Fig. 6. Form of Report of determining the student as recipient of scholarship

Figure 6 shows the display of report of selection of student as recipients of scholarship. The report is consist of Register Number of student, name of student and education program of student. The report also display the weight score of criteria and result of calculation by TOPSIS method of each criteria. On the remark column it show whether the student is feasible or not as recipient of scholarship that enable the chief as decision making in determining the student as recipient of scholarship

5. Conclusion

This research formulates an application in determining the student as recipient of scholarship by Fuzzy Multi Attribute Decision Making (FMADM) approach with TOPSIS method. By this application, the result and information related to determining the student who receives the scholarship quickly, rightly and accurately. The result of this research indicates an implication that there is approach as base to determine student as recipients of scholarship namely Fuzzy Multi Attribute Decision Making (FMADM) with TOPSIS method.

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