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Selection of Candidates for Academic Scholarships Using Analytical Hierarchy Process (Ahp) and Simple Additive Weighting (SAW) Methods at National University

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ABSTRACT

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The National University administers several scholarships for new students each year. The problem is, the University does not yet have a standard method for determining beneficiaries. They have difficulty in determining prospective scholarship recipients with the same criteria. In fact, sometimes it only relies on people's instincts, which can be subjective. The University should implement a DSS system to overcome this problem. Therefore, in this study, the AHP method is applied and used to weight the criteria and test the level of consistency so that the criteria are in accordance with the type of scholarship. In addition, the SAW method is also used for determining scholarship recipients according to the quota. The results of this study are the priority weights of the importance of each criterion, namely the average value of report cards (0.35), parents' income (0.23), certificates (0.05), affidavits of not working and receiving scholarships (0.15), year of graduation (0.11) and number of certificates (0.10). The consistency ratio value is 0.03741 indicating the weight is consistent. This study also resulted in the best ranking of candidates for academic scholarships, with a result of 0.93. The average value of the application test results using the TAM method is 80.5%.

Keywords: *DSS; AHP method; SAW method; TAM method; student selection;*

I. INTRODUCTION

In every new academic year, there are many new students who have applied for scholarships to continue their studies at the National University. However, scholarship recipients are limited to only one student in each faculty. National Universities must be selective in the selection process so that the recipients are suitable and can complete their studies well. Thus, students who receive these scholarships can also make the university proud and increase its credibility of the university[1].

However, in the process of selecting the scholarship recipients, there are still several problems, including the difficulty of determining the criteria to be used. Currently, it is only based on several criteria whose weights are also not well defined. In fact, sometimes they only rely on instincts and people's judgments, so subjectivity is prone to occur in the selection process.

Therefore, this study uses 6 (six) criteria in the selection of candidates for academic scholarships at the National University, namely, the average value of report cards, parents' income, certificates, and affidavits of not working and receiving other scholarships, year of graduation and number of certificates. Each of these criteria is weighted using the Analytical Hierarchy Process (AHP) method so that the assessment will be accurate and precise[2], [3]. Meanwhile, for the ranking, the Simple Additive Weighting (SAW) method was used so that the recipients matched the existing criteria. In addition, the process of selecting and determining scholarship recipients will be fast and efficient[4], [5].

The application development in this research uses the Unified Modeling Language (UML) tool and utilizes the PHP language and MySQL database [6], [7], [8]. The test uses the Technology Acceptance Method (TAM) method involving the National University as the respondent. In this study, a Decision Support System application using the AHP and SAW methods was produced which could facilitate the National University in selecting scholarship recipients accurately and precisely [9], [10].

Literature Review

According to [11], [12], [13], a decision support system is an approach to support decision making. Decision support systems use data, provide an easy user interface, and can incorporate the thinking of decision makers.

Several previous studies related to the application of a Decision Support System (DSS) for the selection of students receiving assistance have been carried out using the FMADM method. "Decision Support System for Scholarship Recipients Using *Fuzzy Multi Attribute Decision Making* (FMADM) and *Simple Additive Weighting* (SAW)" explained that Based on the results of the research, the *Fuzzy Multi Attribute Decision Making* (FMADM) and Simple Additive Weighting (SAW) methods can provide recommendations for prospective scholarship recipients, where the final result will calculate the highest preference value (Vi) of each alternative. The highest score is made the first priority as a scholarship recipient [14]. Research with the title "Application of the SAW (*Simple Additive Weighting Method*) in a Decision Support System to Determine Scholarship Recipients", explained that from the results of testing using an application that had been made using 15 (fifteen) data on prospective scholarship recipients, the output data obtained was the Total Value of the calculation results. using the SAW method in order from the largest to the smallest and reporting scholarship recipients according to a predetermined quota, namely 10 (ten) scholarship recipients [15]. Hamid et al. (2018) conducted research using the AHP and SAW methods and the title "Application of the AHP and SAW Methods for a Decision Support System for Candidates for Scholarship Recipients at the *Global Science Institute* (GSI) Ternate", explaining that the results obtained from this system will be able to provide an alternative assessment quickly for LPK-GSI regarding whether or not the Scholarship Recipients are eligible to receive Scholarships using the AHP and SAW methods [16]. Other studies related to the AHP and SAW methods have also been carried out [17], [18], [19], [20], [21], dan [22].

From the several studies above, the writer uses the AHP method to weight the criteria and SAW for the ranking of scholarships. The AHP and SAW methods aim to help the National University to find out information about students who are entitled to receive scholarships according to their ranking and based on the calculation of the weight of the criteria.

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II.   METHODOLOGY

2.1 Data Collection Methods

Data collection methods used in this study are:

Interview

Interview is a data collection method that is carried out directly with the National University to obtain information related to research problems and in accordance with the needs of the system to be built.

Observation

Observation or direct observation of the object of research and ongoing activities on the object of research. The observation technique is usually done with a structured observation by preparing a list of data needs and data sources.

Library research

Methods of collecting data obtained by studying, researching and reading books, information from the internet, journals, theses, and theses related to the decision support system that will be discussed.

2.2 Research Methodology

In this research, the whole process must go through several stages. The steps involved include research problems, study reviews, methodology, system design, model making, and system testing. The steps at the stages of implementing the research can be seen in picture 1:
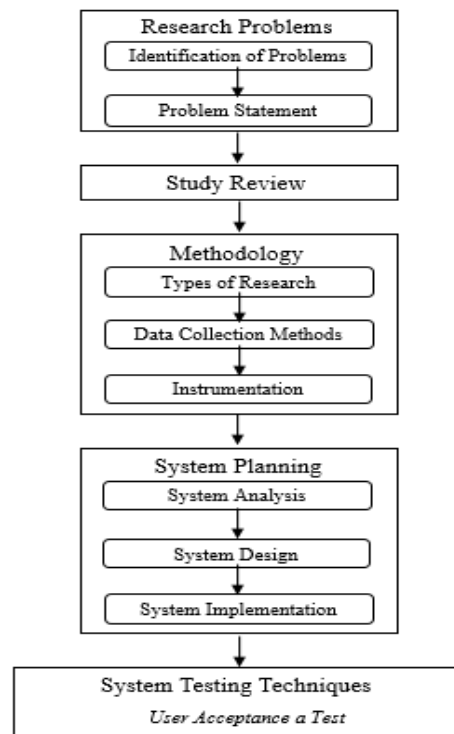

Figure 1. Research methodology of this study

The following is an explanation of the picture of the research steps on figure 1. The following steps are:

Identification of Problems

The first step of this research is to identify the problems regarding the prospective scholarship recipients at the National University. The result of this step is the formulation of the problem.

Problem Statement

Based on the identification of the problem, the formulation of the problem in this study is how to design a modeling decision support system for prospective scholarship recipients at the National University still using the AHP and SAW methods so that they can be used to find scholarship recipients according to the criteria.

Study Review

This study review was conducted to obtain the theory of Decision Support Systems related to the formulation of the problem. The method used by the author is to read various references related to Decision Support Systems. The result of this step is literature related to the formulation of the problem.

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Types of Research

At this stage, the selection of the type of research used in this study will be carried out.

Data Collection Methods

At this stage, the selection of data collection methods that will be used in this study is carried out.

Instrumentation

At this stage, the selection of instruments that will be used in data collection is done.

System Analysis

At this stage, system analysis is carried out, namely the needs of the system to be built.

System Design

At this stage, the system design is carried out by designing the homepage of the system to be built.

System Implementation

At this stage, the system that has been built will be implemented for the user or company.

System Testing Techniques

At this stage, manual calculation testing is carried out and for system performance using Manual Calculation Testing, *User-Acceptance Test*.

III.   RESULTS AND DISCUSSION

3.1 System Analysis

After conducting research on Decision Support Systems for the Selection of Scholarship Recipients Using the *Analytical Hierarchy Process* (AHP) and *Simple Additive Weighting Methods* (SAW)at the National University used the following stages.

Analysis of Current System

Analysis of the current system is an activity to describe a complete and real information system into components aimed at identifying problems that arise so that it leads to a solution for improvement. The current scholarship recipient selection process is shown in Figure 2, are: The university through the MPR (*Marketing Public Relations*) lists students who apply for scholarships; Students who have been registered then fill out the form to apply for a

scholarship; The MPR section verifies the file according to the submission form; MPR recommends to the student bureau and validation according to the data that has been verified. recommendations are assessed using the average verification results with the average method of each criterion being assessed the same

Analysis of the Proposed System

To solve the problem of accuracy in analyzing prospective scholarship recipients at universities, it is necessary to have a decision support system model using the *Analytical Hierarchy Process* (AHP) and *Simple Additive Weighting (*SAW*)*. The method used is expected to be able to weigh the criteria and rank each alternative. The difference with several previous studies is that the criteria used are 6. AHP focuses on weighting while SAW is focused on ranking alternatives with a combined cost and benefits attribute.
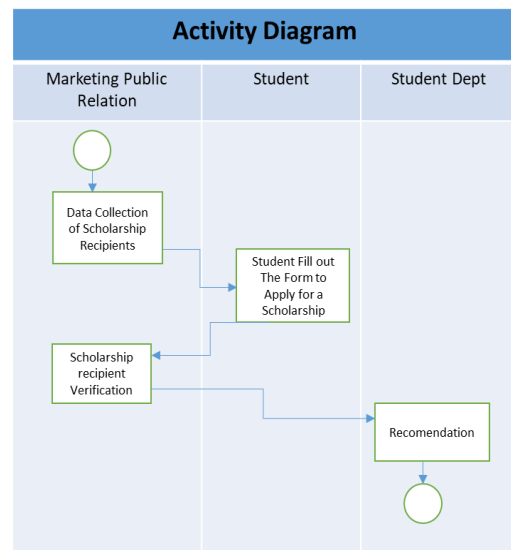

Figure. 2. Analysis of current system in the selection of scholarship recipients at the National University
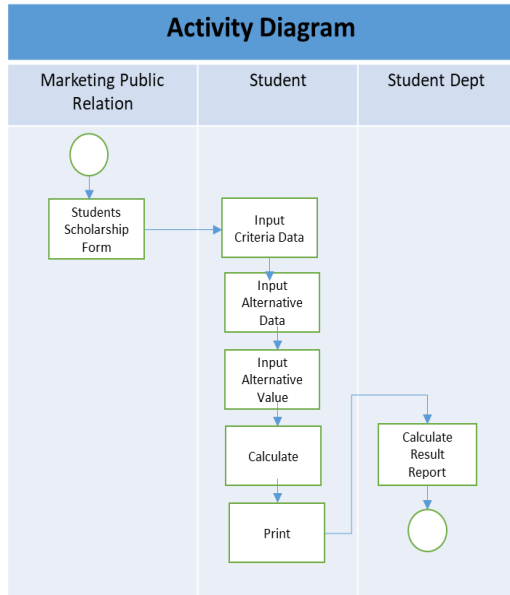
Figure. 3 Analysis of the proposed system in the selection of scholarship recipients at the National University

The admin enters the criteria data and the weighting value that will be used after the criteria weight value is entered, the admin inputs each alternative that will be ranked. The next process enters the weight value of each alternative. calculation of the results of the weight of the criteria and alternatives can be seen in the calculation button and the calculation for alternative weights can be checked whether it is consistent or not, alternative weights can also be seen from the results of the ranking calculation for each alternative.

3.2 Criteria and Alternative

At this stage the selection of criteria and alternatives that will be used is determined, the process of selecting criteria and alternatives is carried out after going through the stages of observation and interviews.

Criteria

To get the criteria that will be used, the writer makes observations and interviews with the section of the *Marketing Public Relation* (MPR) National University and the provisions of the criteria that have been determined are:

Table 1. Criteria Data Criteria Data in the Selection of Scholarship Recipients at the National University

NO	Criteria	Name of Criteria
1	C1	Value Report Card
2	C2	Parents' Income
3	C3	Certificate
4	C4	Statement Letter Not Receiving Other Scholarships or Currently Working
5	C5	Year Graduated
6	C6	Number of Certificates

a. Value Report Card

The report value is the average result from first entering school to graduation and will be determined by the average total score with a range of 0-100.

b. Parents' Income

Parents' income is the amount of income, honorarium or salary obtained from the main job or additional work and the income referred to in this study is the income for a month of work. The provisions of the income of parents in this study are based on the application form and then are given a value based on the level of importance used.

Table 2. Parents' Income Criteria

Parents' Income C2	Variable	Value
C2< Rp. 1.000.000	Very High	5
Rp. 1.000.000 to Rp 2.500.000	High	4
Rp. 2.500.000 to Rp 4.000.000	Medium	3
Rp. 4.000.000 to Rp. 5.500.000	Low	2
C2 > Rp 5.500.000	Very low	1

c. Certificate

The certificate is proof of achievement of the prospective scholarship applicant, which is an achievement in the academic and non-academic fields. The provisions of the certificate in this study are based on the application form and then given a value based on the level of importance used.

Table 3. Certificate Criteria

Certificate C3	Variable	Value
Internasional	Very High	5
Nasional	High	4
Regional	Medium	3
School	Low	2
None	Very Low	1

d. Statement Letter Not Receiving Other Scholarships or Currently Working.

Is a letter filled out by a prospective scholarship applicant to state that he is not receiving another scholarship or is working, signed with a stamp. The provisions of the statement letter of not receiving another scholarship or working on this research are based on the application form and then given a value based on the level of importance used.

e. Year Graduated

The year of graduation is the year the candidate for the scholarship graduated. determined for prospective applicants who graduate in 2019/2020.

Alternative

To obtain the alternative needed, the authors took internal data from applicants for academic scholarships at the National University for the year 2020/2021 by using a *systematic sampling technique*. To take sample data as Table 4 below

Table 4. Alternative Data in the Selection of Scholarship Recipients at the National University

No	Alternative	Gender
1	A1	M
2	A2	F
3	A3	M
4	A4	F
5	A5	M
6	A6	F
7	A7	F
8	A8	M
9	A9	F
10	A10	M

3.3 Analytical Hierarchy Process (AHP) and Simple Additive Weighting (SAW) Methods

1. Analytical Hierarchy Process (AHP) Method

The first step in calculating the AHP in this study is compiling a Comparison Matrix of Criteria, as shown in Table 5:

Table 5. Pairwise Comparison of Criteria in the AHP Method

Matrix	C1	C2	C3	C4	C5	C6
C1	1	2/1	5/1	4/1	3/1	2/1
C2	1/2	1	4/1	2/1	3/1	2/1
C3	1/5	1/4	1	1/3	1/2	1/2
C4	1/4	1/2	3/1	1	2/1	2/1
C5	1/3	1/3	2/1	1/2	1	2/1
C6	1/2	1/2	2/1	1/2	1/2	1

Next, the researcher changed the fraction comparison matrix to decimal. The results are as in Table 6.

Table 6. Pairwise Comparison Matrix in Decimal

Matrix	C1	C2	C3	C4	C5	C6
C1	1	2	5	4	3	2
C2	0.5	1	4	2	3	2
C3	0.2	0.25	1	0.33	0.5	0.5
C4	0.25	0.5	3	1	2	2
C5	0.33	0.33	2	0.5	1	2
C6	0.5	0.5	2	0.5	0.5	1
Total	**2.78**	**4.58**	**17**	**8.33**	**10**	**9.5**

The results in the total column are obtained by adding each criterion in the criteria column. Calculation of each column with the following equation

$$n = \sum_{i=0}^{z} xij \quad (1)$$

Where:
n = The result of the sum of each column
z = number of criteria
i = 1,2,3...z
xij = Value per sell

The details of the calculation results are as follows:
C1=(1 + 0.5 + 0.2 + 0.25 + 0.33 + 0.5)=2.78
C2=(2 + 1 + 0.25 + 0.5 + 0,33 + 0,5)=4.58
C3=(5 + 4 + 1 + 3 + 2 + 2)=17
C4=(4 + 2 + 0.33 + 1 + 0.5 + 0.5)=8.33
C5=(3 + 3 + 0.5 + 2 + 1 + 0.5)=10
C6=(2 + 2 + 0.5 + 2 + 2 + 1)=9.5

From the converted data, the researchers then normalized each column and row. The normalization is by dividing the data for each criterion by the total number of columns. The equation is as follows:

$$m = \frac{xij}{n} \qquad (2)$$

Where:

m = normalization result
xij = value of each cell
n = the sum of each column

For the C1 Report Average Value parameter, the calculation results are:

C1= 1   / 2.78 = 0.36
C2= 0.5   / 2.78 = 0.18
C3= 0.2   / 2.78 = 0.07
C4= 0.25 / 2.78 = 0.09
C5= 0.33 / 2.78 = 0.12
C6= 0.5   / 2.78 = 0.18

For the C2 Parents Income parameter, the calculation results are:

C1= 2   / 4.58 = 0.44
C2= 1   / 4.58 = 0.22
C3= 0.25 / 4.58 = 0.05
C4= 0.5   / 4.58 = 0.11
C5= 0.33 / 4.58 = 0.07
C6= 0.5   / 4.58 = 0.11

For the parameter of Statement Letter Not Receiving Scholarship or Working C3, the calculation results are:

C1= 5   / 17 = 0.29
C2= 4   / 17 = 0.24
C3= 1   / 17 = 0.06
C4= 3   / 17 = 0.18
C5= 2   / 17 = 0.12
C6= 2   / 17 = 0.12

For the C4 Certificate parameter, the calculation results are:

C1= 4   / 8.33 = 0.48
C2= 2   / 8.33 = 0.24
C3= 0.33 / 8.33 = 0.04
C4= 1   / 8.33 = 0.12
C5= 0.5   / 8.33 = 0.06
C6= 0.5   / 8.33 = 0.06

For the C5 Graduation Year parameter, the calculation results are:

C1= 3   / 10 = 0.3
C2= 3   / 10 = 0.3
C3= 0.5   / 10 = 0.05
C4= 2   / 10 = 0.2
C5= 1   / 10 = 0.1
C6= 0.5   / 10 = 0.05

For the C6 Certificate Number parameter, the calculation results are:

C1= 4   / 9.5 = 0.21
C2= 2   / 9.5 = 0.21
C3= 0.33 / 9.5 = 0.05
C4= 1   / 9.5 = 0.21
C5= 0.5   / 9.5 = 0.21
C6= 0.5   / 9.5 = 0.11

The results of normalization of the matrix as a whole, as in Table 7.

Table 7. Normalization Matrix in the AHP Method

Matrix	C1	C2	C3	C4	C5	C6
C1	0.36	0.44	0.29	0.48	0.3	0.21
C2	0.18	0.22	0.24	0.24	0.3	0.21
C3	0.07	0.05	0.06	0.04	0.05	0.05
C4	0.09	0.11	0.18	0.12	0.2	0.21
C5	0.12	0.07	0.12	0.06	0.1	0.21
C6	0.18	0.11	0.12	0.06	0.05	0.11
Total	**1**	**1**	**1**	**1**	**1**	**1**

The next step is to calculate the eigenvector values or priority weights obtained by adding up each row of criteria and then dividing by the total criteria, with the following equation:

$$bp = \frac{\sum_{n=0}^{\infty} xij}{n} \qquad (3)$$

Where:
bp = average result/priority weight (eigenvector)
n = number of criteria
j = 1,2,3…,n
x = value of each cell

Details of the calculation results are as follows:
C1=(0.36+0.18+0.07+0.09+0.12+0.18)/6=0.35
C2=(0.44+0.22+0.05+0.11+0.07+0.11)/6=0.23
C3=(0.29+0.24+0.06+0.18+0.12+0.12)/6=0.05
C4=(0.48+0.24+0.04+0.12+0.06+0.06)/6=0.15
C5=(0.3+0.3+0.05+0.2+0.1+0.05)/6=0.11
C6=(0.21+0.21+0.05+0.21+0.21+0.11)/6=0.1

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Table 8. Calculation Eigenvector values in the AHP Method

Matrix	C1	C2	C3	C4	C5	C6	Weight
C1	0.36	0.44	0.29	0.48	0.3	0.21	0.35
C2	0.18	0.22	0.24	0.24	0.3	0.21	0.23
C3	0.07	0.05	0.06	0.04	0.05	0.05	0.05
C4	0.09	0.11	0.18	0.12	0.2	0.21	0.15
C5	0.12	0.07	0.12	0.06	0.1	0.21	0.11
C6	0.18	0.11	0.12	0.06	0.05	0.11	0.10
Total	**1**	**1**	**1**	**1**	**1**	**1**	**1**

After determining the weights or eigenvectors, the next step is to determine the maximum eigenvalues, this process is used to find out how good the consistency is. Multiplies each value in the first cell with the priority weight, the value in the second cell column with the second priority, and so on. The following Vector Value calculation:

C1=(1*0.35)+(2*0.23)+(5*0,05)+(4*0.15)+(3*0.11)+(2*0.10)
=0.35+0.64+0.25+0.6+0.45+0.22=**2.19**

C2=(0.5*0.35)+(1*0.23)+(4*0.05)+(2*0.15)+(3*0.11)+(2*0.10)
=0.175+0.23+0.2+0.3+0.33+0.2=**1.435**

C3=(0.2*0.35)+(0.25*0.23)+(1*0.05)+(0.33*0.15)+(0.5*0.11)+(0.5*0.10)
=0.07+0.0575+0.05+0.0495+0.055+0.05=**0.3325**

C4=(0.25*0,35)+(0,5*0,23)+(3*0,05)+(1*0,15)+(2*0,11)+(2*0,10)
=0.35+0.46+0.25+0.6+0.45+0.22=**0.9225**

C5=(0.33*0,35)+(0,33*0,23)+(2*0,05)+(0.5*0,15)+(1*0.11)+(2*0,10)
=0.35+0.46+0.25+0.6+0.45+0.22 =**0.6783333**

C6=(0.5*0,35)+(0.5*0,23)+(2*0,05)+(0.5*0,15)+(0,5*0.11)+(1*0,10)
=0.35+0.46+0.25+0.6+0.45+0.22=**0.62**

The result of each row is then divided by the corresponding priority, details of the calculation results are as follows:
C1=2.19/0.35=6.26
C2=1.435/0.23=6.24
C3=0.3325/0.05=6.65
C4=0.9225/0.15=6.15
C5=0.67833333/0.11=6.17
C6=0.62/0/10=6.2

Next, add up each result (λ) from each criterion and then divide by the number of elements like the equation below:

$$\lambda\text{maks}=\frac{\sum\lambda}{n} \quad (4)$$

Where:
λmaks = maximum Eigen
$\sum\lambda$ = total eigen weights
n = number of criteria or elements

The calculation results are:
λmax = (6.26+6.24+6.65+6.15+6.17+6.2)/6
=37.67/6
=6.2783

Next, the researcher calculated the value of the consistency index. The calculation is using the equation:

$$CI=\frac{\lambda maks-n}{n} \quad (5)$$

(*SEQ Equation * ARABIC 5*)

Where:
λmaks = Max Eigen
n = number of criteria or elements

So, the calculation is as follows:
CI = (6.2783-6)/ (6)
= 0.0463833

Finally, the researcher calculates the value of the *Consistency ratio* (CR) obtained by dividing the consistency index (CI) and Ratio Index (RI). for the Consistency Ratio test if the CR result is < 0.1 then it is considered consistent and does not need to be recalculated, but if the CR value is > 0.1 then it is necessary to recalculate.

N	1	2	3	4	5	6	7
RI	0	0	0.58	0.90	1,12	1.24	1.32

$$CR=\frac{CI}{RI} \quad (6)$$

(*SEQ Equation * ARABIC 6*)

Where:
CR=Consistency Ratio
CI=Consistency Index
RI=Ratio Index

So that the detailed calculation results are obtained as follows:

CR=0.0463833/1.24=0.0374103

CR value <0.1 then the data is declared consistent, with consistent testing, the weighting to be used is taken from the eigenvector values

2. Simple Additive Weighting (SAW) Method

The calculation of the SAW method recognizes 2 attributes, namely Cost and Benefit. The value of the AHP weights is then ranked using the SAW method. The first step in calculating the ranking with the SAW method is to determine whether the Cost and Benefit of each criterion, as shown in Table 9

Table 9. Attribute Cost and Benefit of each criterion in the Selection of Scholarship Recipients at the National University

No	Name of Criteria	Attribute
1	Report Card Value	Benefit
2	Parental Income	Cost
3	Statement Letter Not Receiving Other Scholarships And Currently Working	Cost
4	Certificate	Benefit
5	Year Graduate	Cost
6	Number of Certificate	Benefit

For the value of the benefit, the largest is determined to be the best, while the cost is determined if the smallest value is considered the best. The value of the indicator is determined in accordance with:

a. Report Card Value. The indicator used is the average result from first entering school to graduating and will be determined by the average total score with a range of 0-100.

b. Parental Parents. The indicator used is the amount of income, honorarium or salary obtained from the main job or additional work and income.

c. Certificate. Indicators used in determining the selection of candidates for academic scholarships based on their certificates.

d. Statement Letter Not Receiving Other Scholarships Or Currently Working. The indicator used in determining the selection of candidates for academic scholarships is based on a statement that they do not receive other scholarships or are currently working.

e. Year Graduate.

f. Number of Certificates.

After determining the 6 criteria, the next stage is to recap data from the alternatives used. Then, determining the Suitability Rating of Each Alternative On Each Criterion. Next, create decision matrix based on criteria (CI) and finally normalize the matrix that has been made. This stage is used to calculate the costs and benefits of the criteria that have been determined in the table. At this stage, there are two adjusted calculations such as the following equation:

a. If the criteria are benefit:
$$r_{ij} = \frac{Xij}{Max\ Xij} \quad (7)$$

Where:

rij = Normalized performance rating
xij= The attribute value of each criterion
max xij=The largest value of each column

b. .If the criteria are cost:
$$r_{ij} = \frac{Min\ Xij}{Xij} \quad (8)$$

Where:
r_{ij} = Normalized performance rating
x_{ij}= The attribute value of each criterion
min x_{ij}= The smallest value of each column

The alternative data to be processed by the SAW method based on the weight of the criteria obtained by the AHP method are as shown in table 10:

Table 10. Alternative Data in the Selection of Scholarship Recipients at the National University

No	Alternative	C1 Benefit	C2 Cost	C3 Cost	C4 Benefit	C5 Cost	C6 Benefit
1	A1	95.65	1	1	5	1	2
2	A2	92.34	1	1	1	1	1
3	A3	84.21	1	1	1	2	1
4	A4	75.89	1	2	4	2	1
5	A5	82.19	3	1	1	1	1
6	A6	82.81	1	1	1	1	1
7	A7	83.28	1	1	1	1	1
8	A8	83.28	3	1	4	2	5
9	A9	85.23	2	1	1	2	1
10	A10	80.34	1	2	2	1	3

The result of the calculation of the normalization of the matrix is based on the

equation that has been adjusted to the type of attribute. For the criteria for the average value of report cards (benefits), the calculation is as follows:

$$r_{11}=\frac{95.65}{max\ (95.65,92.34,84.21,75.89,82.19,82.81,83.28,83.28,85.23,80.34)}$$
$$=\frac{95.65}{95.65}$$
$$=1.000$$
$$r_{21}=\frac{92.34}{max\ (95.65,92.34,84.21,75.89,82.19,82.81,83.28,83.28,85.23,80.34)}$$
$$=\frac{92.34}{95.65}$$
$$=0.965$$

...

$$r_{101}=\frac{80.34}{max\ (95.65,92.34,84.21,75.89,82.19,82.81,83.28,83.28,85.23,80.34)}$$
$$=\frac{80.34}{95.65}$$
$$=0.840$$

For parents' income criteria (cost), the calculation is as follows:

$$r_{1\ 1}=\frac{min\ (1,1,1,1,3,1,1,3,2,1)}{1}$$
$$=\frac{1}{1}$$
$$=1.00$$
$$r_{2\ 1}=\frac{min\ (1,1,1,1,3,1,1,3,2,1)}{1}$$
$$=\frac{1}{1}$$
$$=1.00$$

....

$$r_{10\ 1}=\frac{min\ (1,1,1,1,3,1,1,3,2,1)}{1}$$
$$=\frac{1}{1}$$
$$=1.00$$

For Statement Letter Not Receiving Other Scholarships or Currently Working criteria (cost), the calculation is as follows:

$$r_{1\ 1}=\frac{min\ (1,1,1,2,1,1,1,1,1,2)}{1}$$
$$=\frac{1}{1}$$
$$=1.00$$
$$r_{2\ 1}=\frac{min\ (1,1,1,2,1,1,1,1,1,2)}{1}$$
$$=\frac{1}{1}$$
$$=1.00$$

...

$$r_{10\ 1}=\frac{min\ (1,1,1,2,1,1,1,1,1,2)}{2}$$
$$=\frac{1}{2}$$
$$=0.5$$

For Certificate Criteria (benefits), the calculation is as follows:

$$r_{11}=\frac{5}{max\ (5,1,1,4,1,1,1,4,1,2)}$$
$$=\frac{5}{5}$$
$$=1.00$$
$$r_{21}=\frac{1}{max\ (5,1,1,4,1,1,1,4,1,2)}$$
$$=\frac{1}{5}$$

.....

$$r_{10\ 1}=\frac{2}{max\ (5,1,1,4,1,1,1,4,1,2)}$$
$$=\frac{2}{5}$$
$$=0.40$$

The criteria for the year of graduation (cost), the calculation is as follows:

$$r_{1\ 1}=\frac{min\ (1,1,2,2,1,1,1,2,2,1)}{1}$$
$$=\frac{1}{1}$$
$$=1.00$$
$$r_{2\ 1}=\frac{min\ (1,1,2,2,1,1,1,2,2,1)}{1}$$
$$=\frac{1}{1}$$

....

$$r_{10\ 1}=\frac{min\ (1,1,2,2,1,1,1,2,2,1)}{1}$$
$$=\frac{1}{1}$$
$$=1.00$$

The criteria for the number of certificates (benefits), the calculation is as follows:

$$r_{11}=\frac{2}{max\ (2,1,1,1,1,1,1,5,1,3)}$$
$$=\frac{2}{5}$$
$$=0.40$$
$$r_{21}=\frac{2}{max\ (2,1,1,1,1,1,1,5,1,3)}$$
$$=\frac{1}{5}$$
$$=0.20$$

....

$$r_{101}=\frac{3}{max\ (2,1,1,1,1,1,1,5,1,3)}$$
$$=\frac{3}{5}$$
$$=0.60$$

The alternative data that have been normalized are as shown in table 11:

Table 11. Normalized Alternative Data in the Selection of Scholarship Recipients at the National University

No	Alternative	Criteria					
		C1	C2	C3	C4	C5	C6
		Benefit	Cost	Cost	Benefit	Cost	Benefit
1	A1	1	1	1	1	1	0.4
2	A2	0.965	1	1	0.2	1	0.2
3	A3	0.880	1	1	0.2	0.5	0.2
4	A4	0.793	1	0.5	0.8	0.5	0.2
5	A5	0.859	0.333	1	0.2	1	0.2
6	A6	0.866	1	1	0.2	1	0.2
7	A7	0.871	1	1	0.2	1	0.2
8	A8	0.871	0.333	1	0.8	0.5	1
9	A9	0.891	0.5	1	0.2	0.5	0.2
10	A10	0.840	1	0.5	0.4	1	0.6

After the normalized value of r is obtained, the next step is to multiply the weight value that has been obtained from the eigenvector calculation with the normalization results, the calculation uses the equation below:

$$vi = \sum_{j=1}^{n} wj\ rij \quad (9)$$

Where:
vi = rank for each alternative
wj = weight value for each criterion
rij = normalized rating value

The details of the calculation are as follows:
V1= (0.35*1.00) + (0.23*1.00) + (0.05*1.00) + (0.15*1.00) + (0.11*1.00) + (0.10*0.40)
=0.35+0.23+0.05+0.15+0.11+0.04
= **0.93**
V2 = (0.35*0.965) + (0.23*1.00) + (0.05*1.00) + (0.15*0.20) + (0.11*1.00) + (0.10*0.20)
=0.33775+0.23+0.05+0.03+0.11+0.02
=**0.777**
V3 = (0.35*0.880) + (0.23*1.00) + (0.05*1.00) + (0.15*0.20) + (0.11*0.50) + (0.10*0.20)
=0.3108+0.23+0.05+0.03+0.055+0.02
=**0.693**

V4 = (0.35*0.793) + (0.23*1.00) + (0.05*0.50) + (0.15*0.80) + (0.11*0.50) + (0.10*0.20)
=0. 2775+0.23+0.025+0.12+0.055+0.020
=**0.7275**

V5 = (0.35*0.859) + (0.23*0.33) + (0.05*1.00) + (0.15*0.20) + (0.11*1.00) + (0.10*0.20)
=0.3006+0.0759+0.05+0.03+0.11+0.02
=**0.587**

V6= (0.35*0.866) + (0.23*1.00) + (0.05*1.00) + (0.15*0.20) + (0.11*1.00) + (0.10*0.20)
=0.3031+0.23+0.05+0.03+0.11+0.02
=**0.7431**

V7 = (0.35*0.871) + (0.23*1.00) + (0.05*1.00) + (0.15*0.20) + (0.11*1.00) + (0.10*0.20)
=0.30485+0.23+0.05+0.03+0.11+0.2
=**0.7448**

V8 =(0.35*0.871) + (0.23*0.33) + (0.05*1.00) +(0.15*0.80) + (0.11*0.50) + (0.10*1.00)
=0.30485+0.0759+0.05+0.12+0.055+0.10
=**0.7064**

V9 = (0.35*0.891) + (0.23*0.50) + (0.05*1.00) + (0.15*0.20) + (0.11*0.50) + (0.10*0.20)
=0.31185+0.115+0.05+0.03+0.055+0.02
=**0.58185**

V10 = (0.35*0.840) + (0.23*1.00) + (0.05*0.50) + (0.15*0.40) + (0.11*1.00) + (0.10*0.60)
=0.294+0.23+0.025+0.06+0.11+0.06
=**0.779**

3. System Design and Implementation
For system design, researchers use the Unified Modeling Language tool. The author makes a use case diagram to see an overview of the application as shown in Figure 4.
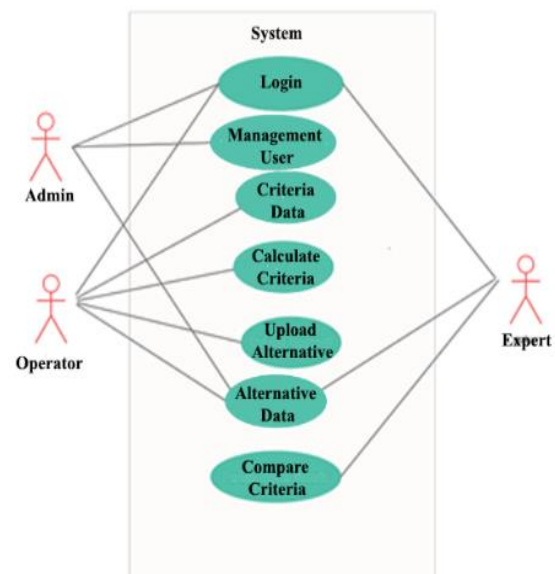

Figure. 4 Use case diagram for DSS system in the Selection of Scholarship Recipients at the National University.

As for implementation, the authors use the PHP programming language and MySQL database to develop web-based applications. The results are as in Figure 5, Figure 6, and Figure 7.

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Figure. 5 Display of Homepage for DSS system in the Selection of Scholarship Recipients at the National University.

Figure. 6 Displays the calculation of the weight of the criteria with the AHP method.

Figure. 7 Displays alternative ranking calculations with the SAW method.

4. System Testing

Finally, the author tested the questionnaire-based TAM method system using a Likert scale with a value of 1 (strongly disagree) to 5 (strongly agree) and was given to 5 respondents, including head and staff of the MPR (Marketing Public Relations) of the National University as system users. The percentage of test scores is also calculated using a Likert scale with intervals as shown in table 12:

Table 12. Application Test

Interval Score	Description
0%-19,99%	Strongly Disagree
20%-39,99%	Do not agree
40%-59,99%	Neutral
60%-79,99%	Agree
80%-100%	Strongly agree

The test results are shown in Table 13.

Table 13. Application Test Result with TAM Method

No	Indicator	Actual Score	Ideal Score	% Actual Score	Description
1	Perceived usability aspect	100	125	80%	Strongly Agree
2	Perceived ease of use aspect	101	125	80.8%	Strongly Agree
3	Perceived user acceptance aspect	101	125	80.8%	Strongly Agree
	Total	**302**	**375**	**80.5%**	**Strongly Agree**

Based on the results of testing the TAM method system with 3 (three) testing aspects, the ideal score for each aspect is 125 because there are 5 questions with a maximum score of 5, and it was assessed by 5 respondents. The result is known that the average value of respondents on the perceived usability aspect is 80%, the percentage of the perceived ease of use aspect is 80.8% and the user acceptance aspect is 80, 8%. The total average value of the overall test results using the TAM method is 80.5%. Based on the Likert scale interval, the user states strongly agrees with this decision support system.

IV. CONCLUSION

Based on the results of research for the selection of candidates for academic scholarships using the Analytical Hierarchy Process (AHP) and Simple Additive Weighting (SAW) methods at the National University, the researchers concluded as follows:
1. This study resulted in priority weights for each criterion using the AHP method, respectively, the average value of report cards (0.35), parents' income (0.23), affidavits of not working and receiving scholarships (0.15), years graduates (0.11), number of certificates (0.10) and certificates (0.05). The value of the consistency ratio is

0.03741 which defines that the weight is consistent. The weight of the criteria is then applied in the SAW method and it is found that the ranking of the best candidates for academic scholarship recipients with a score of 0.93 for A1.

2. Based on the TAM method testing, users consider that this application is very useful and efficient. In the aspect of usability assessment, the average value given by the user is 80% (100 out of 125). This indicates that the combination of a decision support system with the AHP and SAW methods is very suitable for this case study.

3. This research produces a decision support system to select candidates for academic scholarships using the AHP and SAW methods. The average value of the test results on the application using the TAM method is 80.5%. This indicates that the user strongly agrees with this decision support system.

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