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Implementation of The Analytical Hierarchy Process (AHP) Method for The Selection of The Most Outstanding Students at Universitas Nahdlatul Ulama Sunan Giri

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Abstract

Universitas Nahdlatul Ulama Sunan Giri (UNUGIRI) has many students who have achievements. The number of outstanding students is a problem in determining the decision-making of outstanding students. One of the effective decision-making methods for solving problems in selecting outstanding students is the Analytical Hierarchy Process (AHP) method. The AHP method in this study considers four criteria: Grade Point Average, Writing Paper, Achievement (Non-Academic), and SPEKMA points. Out of 73 UNUGIRI students who had achievements, a ranking was carried out into ten alternative students. The results of calculating ten alternatives based on four criteria with the AHP method obtained the highest score of 0.1437 for students with the name PWA. Based on these results, PWA can be designated as outstanding students for the 2021/2022 academic year.

INTRODUCTION

Higher education requires student achievement to realize its vision and mission in improving the quality of its implementation. The institutions must be objective, transparent, and accurate in selecting outstanding students. Every student also has the same right to participate in the selection of outstanding students, so the selection must be carried out openly and fairly. However, this implementation can cause a large number of registrars, which can make it challenging to manage data and grades without the help of a qualified system.

Universitas Nahdlatul Ulama Sunan Giri (UNUGIRI) is a higher education located in Bojonegoro, East Java, with many outstanding non-academic students. UNUGIRI already has a system for recording the achievements of its students called SPEKMA. SPEKMA (student extracurricular assessment system) is a system for assessing students' knowledge, achievements, and experience based on criteria set by the campus, such as obtaining a champion and a certificate from each activity that has been carried out. The number of active students who have achievements at this university is our consideration in researching the selection of the most outstanding students.

UNUGIRI has selected outstanding students during the achievement week through SPEKMA data but has yet to choose the best one among the many students. Therefore, the most outstanding students will be selected in this study using the decision-making method. The method used must be a method that can provide award-winning results in competency. The selection of

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outstanding students requires a system that can make decisions quickly and accurately based on computers by utilizing data and decision models. The concept of a decision support system (DSS) was first described in the early 1970s by Michael S. Scott Morton with the term Management Decision System. The system is designed to assist decision-makers by presenting information and interpretations about various decision-making alternatives [1].

One of the best methods for making a decision is the Analytical Hierarchy Process (AHP) method. The AHP method is a framework for effective decision-making in complex problems by simplifying and accelerating the decision-making process through pair-wire comparisons to find the best alternative among many possibilities by creating a matrix that hierarchically represents the comparison of one element to another. This study aims to implement the Analytical Hierarchy Process (AHP) method in the selection process of outstanding students to facilitate the decision-making of who is selected as the most outstanding student.

The Analytical Hierarchy Process (AHP) method has previously been carried out in a study conducted by Kurniawan et al. [2]. This study explains how ELECTRE and TOPSIS use the AHP method to select the best students to determine each criterion's weight value. The AHP method is used to rank and compare the results of the AHP method. The AHP method was then studied by Wibowo & Sholeh [3]. They discuss the analysis and measurement of performance by computing the AHP method and ranking it using the OMAX (factual matrix) and SCOR (supply chain operation references) methods. In addition, the AHP (Analytical Hierarchy Process) method was also carried out in research conducted by Irawan [4]. This study uses the AHP method to assess student learning outcomes at the 167 New Week State Elementary School. Student achievement in school uses the value entry process. Based on several studies that have been carried out, it is concluded that the Analytical Hierarchy Process (AHP) method is effectively used to select high-outstanding students.

The selection of outstanding students in previous studies has not been targeted at the level of college students, especially students at Universitas Nahdlatul Ulama Sunan Giri. In addition, the assessment criteria in the AHP method used in this study have never been discussed before, which includes the Grade Point Average, Writing Paper, Achievement (Non-Academic), and SPEKMA. This election is essential to spur competition for non-academic achievements between students to be the best every year. In addition, selected students can also be included in the competence of outstanding students at regional and national levels.

METHOD

In this study, the authors apply quantitative research. The research method used is the Analytical Hierarchy Process (AHP) method which aims to solve the decision-making problem of outstanding students at the Universitas Nahdlatul Ulama Sunan Giri [5]. The AHP method by Saaty et al. [6] is the right approach to deal with complex systems related to making decisions from several alternatives and providing options that can be considered. This method solves problems in each section by arranging them in a hierarchy, giving value to subjective considerations as a consideration in setting the highest priority that can affect the results of the problem. In addition to selecting outstanding students, the AHP method is used in making several decisions. As in the

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case of choosing new employees, recruiting teachers, determining the quality of goods, selecting the best employees, etc.

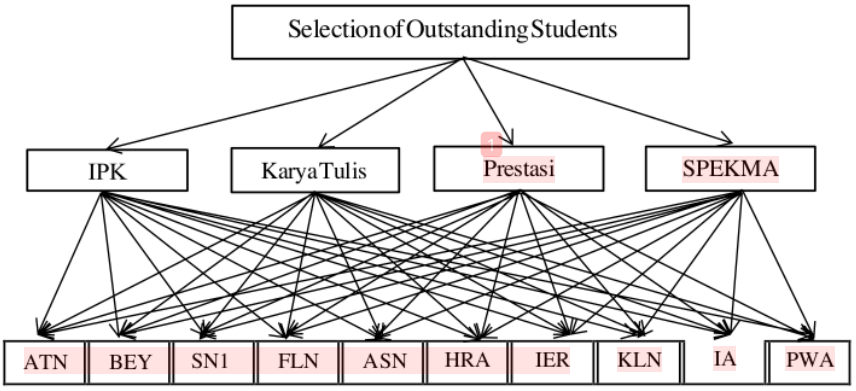

Figure 1. Decomposition Chart 4 Criteria

The subjects in this study were taken from the Outstanding Students of Nahdlatul Ulama University Sunan Giri for the 2021/2022 Academic Year, a total of 73 students. From a total of 73 students, a ranking was carried out so that only ten student names were selected, which would be selected for outstanding students using the AHP method. The data collection technique in this study was carried out by literature study by examining articles relevant to the research subject, direct observation of the research subject, and interview tests at the student and religious bureau. The data analysis technique used in this research uses the Analytical Hierarchy Process (AHP) method. In solving problems using the Analytical Hierarchy Process (AHP) method, several principles must be understood, including the following:

1. Decomposition
   A complex system that can be understood with complete problem solving into components that are easier to understand. Then arranged hierarchically, as shown in Figure 1.

2. Comparative judgment
   In comparative assessment, this means assessing the relative importance of two items at a given level relative to the above level. Pairwise comparisons carried out criteria and alternatives. According to Saaty [7], for various problems, a scale of 1 to 9 is the optimal scale for expressing opinions on various issues. The value and definition of qualitative thought from the current comparison scale can be measured using an analysis table such as Table 1.

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Table 1. Pairwise Comparison Rating Scale

Intensity of interest	Information
1	The two elements are equally important
3	One element is slightly more important than the other
5	One element is more essential than the other elements
7	One element is more important than the other elements
9	One element is more essential than the other elements
2,4,6,8	The middle value between two considerations that are close to each other
Opposite	If element i has a higher value than element j, then element j has the compared to element i

3. Synthesis of priority

   In determining the priority of several criteria elements, this can be seen as the weight/contribution of these elements to the decision-making objectives. The synthesis method differs depending on the type of hierarchy. Through the compositing process by sorting the elements according to their relative importance. AHP performs element priority analysis using a pairwise comparison method between two elements so that all existing elements are included. This priority is determined based on the views of experts and interested parties on decision-making, either directly (discussion) or indirectly (questionnaire).

4. Logical Consistency

   According to Kosasi [8], Consistency has two meanings. First, similar objects can be grouped according to uniformity and relevance. Second, it concerns the level of relationship between objects based on specific criteria. In general, here are the steps in solving problems using the AHP method [9]:

   1. Define the problem, determine the required solution, and then create a hierarchy of the issues encountered.
   2. We are determining the priority of an element.
      a. The first step in determining the priority of an element is pairwise comparison, where items are compared in pairs according to the specified criteria.
      b. The pairwise comparison matrix is filled with numbers representing one element's relative importance over another. The K matrix can be interpreted as a pairwise comparison matrix between one criterion and another.

$$K = \begin{array}{c} \\ K_1 \\ K_2 \\ \vdots \\ K_n \end{array} \begin{array}{c} \begin{array}{cccc} K_1 & K_2 & \cdots & K_n \end{array} \\ \begin{bmatrix} K_{11} & K_{12} & \cdots & K_{1n} \\ K_{21} & K_{22} & \cdots & K_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ K_{m1} & K_{m1} & \cdots & K_{mn} \end{bmatrix} \end{array} \quad (1)$$

   Matrix K is a pairwise comparison matrix of each criterion.

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3. Synthesis
   The considerations for the couple are combined to get the overall priority. The steps in the synthesis stage are:
   a. Sum the values in each column of the matrix.
   b. Divide each column value by the appropriate number of columns to get a normalized matrix.
   c. Add up the values for each row and divide by the number of elements to get the priority weight value.

4. Consistency measurement
   In making decisions, it is essential to know how consistent the rater is because, in the assessment, it is hoped that there will not be a decision based on an inconsistent evaluation. Here are the steps taken in this stage:
   a. Each value of the first column is multiplied by the priority weight of the first element. Each value of the second column is multiplied by the priority weight of the second element, and so on.
   b. Sum each row (Σ row).
   c. The result of the row addition operation is divided by the corresponding priority element, resulting in lambda (λ).

$$\lambda = \frac{\sum row}{priority} \tag{2}$$

   d. Add lambda (λ), and the result is divided by the number of elements. The result is called λ_{max}.

$$\lambda_{max} = \frac{\sum \lambda}{n} \tag{3}$$

   With $\boldsymbol{n}$ is, several elements compared.
   e. Calculating the Consistency Index (CI) using the formula:

$$CI = \frac{(\lambda_{max} - n)}{n-1} \tag{4}$$

   With $\boldsymbol{n}$ is, several elements compared.
   f. Calculate the Consistency Ratio (CR) using the formula:

$$CR = \frac{CI}{RC} \tag{5}$$

   The value of Random Consistency (RC) has been found based on a comparison matrix whose size is formed and can be presented in Table 2.

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Table 2. Random Consistency (RC) Values

rix	RC Values
1,2	0.00
3	0.58
4	0.90
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10	1.49
11	1.51
12	1.48
13	1.56
14	1.57
	1.59

g. Checking hierarchy consistency
The data judgment assessment must be corrected if the value is more than 10%. However, if the Consistency Ratio (CI/RC) is less or equal to 0.1, the calculation results can be declared correct [10].

RESULTS AND DISCUSSION

This study aims to determine the results of applying the Analytical Hierarchy Process (AHP) method in selecting outstanding students. This research was conducted at Universitas Nahdlatul Ulama Sunan Giri. Alternatives and criteria are needed to fulfill the selection process. The chosen alternative is ten, with the highest score of 73 alternatives in the data processing. In discussing the results of data processing, the steps for selecting outstanding students using the AHP method are:

1. Determining Priority Criteria

At this stage, the goal is to obtain a method to assess the competence of outstanding students. The evaluation criteria were selected and tested using the Analytical Hierarchy Method. The first tested criteria were four, as shown in Table 3.

Table 3. Goals and Criteria for 4 Criteria

Goal	Criteria
Selection of Outstanding Students	Grade Point Average (GPA) Papers Performance SPEKMA

The criteria in Table 3 are entered into the comparison table of the two paired criteria in Table 4.

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Table 4. Comparison between 2 Criteria

Criteria	Comparison	Criteria
Grade Point Average	5	SPEKMA
Papers	3	Performance
Performance	1	Papers
SPEKMA	7	Grade Point Average

Table 4 shows that the grade point average and the achievement ability are comparable on a 5-point scale. It means that the ability to achieve the Grade Point Average is more important than achievement. Comparison of Writing with the Grade Point Average is on a scale of 3, which means that the Grade Point Average is the same as being more important than writing. Comparison of Achievement with Writing has a scale of 1, meaning that Achievement ability is slightly more important than writing. Meanwhile, the comparison between SPEKMA and the Grade Point Average has a scale of 7 which means the Grade Point Average is critical compared to SPEKMA.

2. Determine the criterion value matrix

Determining the criteria value in the analysis of the comparison of the results of the referenced Table 5 are as follows:

Table 5. Criteria in the Performance Rating Scale

Criteria	GPA	Papers	Performance	SPEKMA
GPA	1	0.33	0.2	0.14
Papers	3	1	0.6	0.42
Performance	5	1.67	1	0.71
SPEKMA	7	2.33	1.4	1
Total	16	5.33	3.2	2.27

In the assessment of the paper compared to the paper, it produces a comparison value of 1 with the intention that the paper has a scale value of 3/3 = 1, then compares SPEKMA with the written work (papers) and gets a value of 2,33, which comes from 7/3 = 2.33 and compare until all criteria are met to obtain a normalized weight. Then find the average for each criterion, as in the following Table 6 calculations:

Table 6. Calculation Results of λ_{max} in Achievement Assessment

Criteria	GPA	Papers	Performance	SPEKMA	Eigen	λ	λ_{max}
GPA	0.0625	0.0619	0.0625	0.0616	0.0621	0.9943	3.9861
Papers	0.1875	0.1876	0.1875	0.1850	0.1869	0.9962	
Performance	0.3125	0.3133	0.3125	0.3127	0.3127	1.0008	
SPEKMA	0.4375	0.4371	0.4375	0.4405	0.4381	0.9946	
Total	1	1	1	1			

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In Table 6, the value of 0,0625 is obtained from a ratio of 1/16 = 0,0625. The value is derived from the column and row values of the GPA divided by the number of columns of the GPA in table 5 and continued by comparison until all criteria.

3. Consistency Ratio Calculation

The calculation results are obtained in table 6:

Eigen = 0,0625 + 0,0619 + 0,0625 + 0,0616 = 0,062146

λ = 0,062146926 × 16 = 0,994350

λ_{max} = 0,9943 + 0,9962 + 1,0008 + 0,9946 = 3,986101

So the calculation of the Consistency Index (CI) is as follows:

$$CI = \frac{\lambda_{max} - n}{n-1} = \frac{3,986101206 - 4}{4-1} = -0,004632931333$$

The calculation of the Consistency Ratio (CR) is as follows:

$$CR = \frac{CI}{RI} = -\frac{0,00463293133}{0,9} = -0,000514770148$$

If the Consistency Ratio value is more than 10%, then the pairwise comparison assessment in the criteria matrix is inconsistent or must be corrected. Therefore, in case of inconsistency, the pairing matrix value must be repeated for each criterion, criterion, and alternative element. However, if the Consistency Ratio (CI/CR) is less than or equal to 0.1, it is said to be true.

4. Determining priority criteria with each alternative

Table 7. Comparison Matrix Calculation on GPA Criteria

GPA	ATN	BEY	SN1	FLN	ASN	HRA	IER	KLN	IA	PWA
ATN	1	1.090	1	1	1	1	1	1	1	0.923
BEY	0,916	1	0,916	0,9166	0,9166	0,916	0,916	0,916	0,916	0,846
SN1	1	1.090	1	1	1	1	1	1	1	0.923
FLN	1	1.090	1	1	1	1	1	1	1	0.923
ASN	1	1.090	1	1	1	1	1	1	1	0.923
HRA	1	1.090	1	1	1	1	1	1	1	0.923
IER	1	1.090	1	1	1	1	1	1	1	0.923
KLN	1	1.090	1	1	1	1	1	1	1	0.923
IA	1	1.090	1	1	1	1	1	1	1	0.923
PWA	1.083	1.181	1.083	1.083	1.083	1.083	1.083	1.083	1.083	1
Total	10	10.90	10	10	10	10	10	10	10	9.230

Comparison Matrix Calculation Based on the Criteria for the Grade Point Average (GPA) in Table 7 is generated from the distribution of scores between alternative one and the alternative concerned. For example, ATN and ATN have one from the calculation of 12/12 = 1, while the BEY alternative has a comparison value of 0.916 from the calculation of 11/12 and continues with

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all alternatives.

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Table 8. Matrix Normalization Calculation on GPA Criteria

GPA	ATN	BEY	SN1	FLN	ASN	HRA	IER	KLN	IA	PWA	Eigen
ATN	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
BEY	0.091	0.09	0.091	0.091	0.091	0.091	0.091	0.09	0.09	0.091	0.091
SN1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
FLN	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
ASN	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
HRA	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
IER	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
KLN	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
IA	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
PWA	0.108	0.10	0.108	0.108	0.108	0.108	0.108	0.10	0.10	0.108	0.108
Total	1	1	1	1	1	1	1	1	1	1	

In Table 8, to obtain the normalized relative weights, the operation is performed by dividing the alternative elements of the pair**ing** matrix by the number of values for each alternative element. In the calculation of the normalization of ATN with BEY, the comparison value of 0.1 is obtained from 1.090/10,909 = 0.1. The calculation of ATN with FLN produces a value of 0.1**,** obtained from 1/10 = 0.1. And so on for the other values. Sub-criteria calculation is carried out for the sub- sub-criteria of each criterion. In this case, there will be **four** sub-criteria priority calculations from each criterion, according to 4 criteria.

Table 9. Value of Comparison Matrix of All Criteria and Priority Eigen

	GPA	Papers	Performance	SPEKMA	Priority Eigen
ATN	0.1	0.020	0.169	0.088	0.0621
BEY	0.0916	0.142	0.112	0.132	0.1869
SN1	0.1	0.162	0.091	0.073	0.3127
FLN	0.1	0.125	0.091	0.132	0.4381
ASN	0.1	0.020	0.132	0.102	
HRA	0.1	0.101	0.064	0.058	
IER	0.1	0.101	0.064	0.044	
KLN	0.1	0.020	0.112	0.117	
IA	0.1	0.122	0.060	0.088	
PWA	0.108	0.183	0.101	0.161	
Total	1	1	1	1	

Table 9 shows steps to find the total ranking using the row results of each alternative eigenvalue multiplied by the priority eigenvalue column. The calculation of PWA is $(0.108 \times 0.0621) + (0.183 \times 0.1869) + (0.101 \times 0.3127) + (0.161 \times 0.4381) = 0.1437$ and continued until the alternative IER in order to obtain values results in ranking.

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Table 10. Ranking of All Assessments Criteria

	Score	Order
PWA	0.143718037	1
BEY	0.125385929	2
FLN	0.116278456	3
ATN	0.101574259	4
SN1	0.097555214	5
KLN	0.096641217	6
ASN	0.096574651	7
IA	0.086481946	8
HRA	0.071107783	9
IER	0.064664118	10

Table 10 explains that students who meet the criteria are **by** the needs of higher education institutions in outstanding competency assessments of GPA, Achievement, Scientific Work, and SPEKMA. The highest score from the calculation of outstanding students using the Analytical Hierarchy Process (AHP) method was achieved by PWA being the main rank with a total score of 0.14371, BEY with a value of 1253, FLN with a value of 0.1162, ATN obtaining a value of 0.11015, SN1 with a value of 0.0975, KLN has a value of 0.0966, ASN with a value of 0.0965, IA with a value of 0.0864, HRA with a value of 0.0711, and the last order is IER with a value of 0.0646.

Based on the research results, it can be seen that the ten best student nominations are based on ranking. The ten students came from various study programs at Universitas Nahdlatul Ulama Sunan Giri. After calculating with the AHP method for the ten nominations, it is known that the student with the best achievement is PWA. This result is evidenced by data in the field that PWA has the highest GPA and three times achievement in writing scientific papers at the national championship level. These results answer this study's problems and new findings in **selecting** outstanding students at UNUGIRI. This result is also the best selection process based on calculations using the mathematical method based on the four criteria.

CONCLUSIONS

Based on the research results, implementing the Analytical Hierarchy Process (AHP) method in selecting the most outstanding students at the Universitas Nahdlatul Ulama Sunan Giri for the 2021/2022 Academic Year resulted in a student's decision to be selected as an outstanding student. The calculation of the four criteria obtained the highest score of 0.1437 on behalf of PWA as students who were selected in the selection of outstanding students. Therefore, PWA can be declared eligible as an outstanding student. Students with the name PWA can be sent to represent UNUGIRI in student achievement events at a higher level. Recommendations for further research are to develop research on the selection of outstanding students by adding sub-criteria such as daily values, behavior, activity, etc.

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