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Decision Support System for Election and Evaluation of Assistant Lecturer Using Analytical Hierarchy Process and Simple Additive Weighting: case study Faculty of Information Technology Tarumanagara University

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Abstract. *Decision Support System is a system that is able to solve problems and is able to communicate to problems with semi-structured and unstructured conditions. This paper uses a decision support system using methods Analytical Hierarchy Process (AHP) and Simple Additive Weighting (SAW). AHP method is used to calculate the weight of each criterion, while the SAW method is used to rank each alternative individual. The case study used to conduct a decision support system is the case to decide and evaluate Asistant Lecturer at Faculty of Information Technology Tarumanagara University.*

Keywords: Analytical Hierarchy Process, Assistant Lecturer, Decision Support System, Simple Additive Weighting.

1. Introduction

Teaching and learning activities at Tarumanagara University Faculty of Information Technology always involves the involvement of the teaching assistant to help the lecturer in the teaching and learning process. Faculty of Information Technology (FTI) every semester conducts registration of assistant lecturers for certain subjects, the selection of assistants at FTI UNTAR is still done manually and the absence of an assistant selection decision support system, to get optimal results in supporting decision of assistant selection and avoiding the existence of subjectivity in the selection of assistants needed a support system decision to choose an assistant. Decision Support System (DSS) is a system that is able to provide solutions to problems and abilities in communication with problems with semi-structured and unstructured conditions [6]. In the selection of assistants using criteria that are adjusted to the selection of assistants conducted manually at FTI UNTAR such as GPA, course scores, test scores, additional criteria such as recommendation. To get the performance evaluation of each assistant, a system that can help in making a performance evaluation decision for every assistant in FTI UNTAR needs to be a benchmark between assistants, which can improve the quality of an assistant and the quality of the assistant. Some criteria that will be used in assessing assistant performance such as verbal ability, accuracy, patience, punctuality, and problem solving.

The system of selecting and evaluating lecturer assistant performance will be built using a collaboration of two methods namely Analytical Hierarchy Process (AHP) and Simple Additive Weighting (SAW), AHP method will be used to determine each weighting criteria that will be used in the SAW method which functions to rank each alternative. Weighting uses the AHP method because the AHP method provides measurement scales and methods to get priority, and considers logical consistency in assessing priorities, the weighting result of the AHP method acts as a preference weight in the SAW method, because the SAW method works with the weighted sum of performance ratings in each alternative on all attributes, so that a ranking of



each alternative is obtained so that the best alternative from a number of alternatives can be determined [3]. The results of the assistant selection decision support system are ranking assistants who have the highest to lowest value, and the results of the assistant performance appraisal decision support system are ranking assistants who have the highest to lowest scores and the performance evaluation results of each assistant.

2. Method and materials

2.1. Data Used

Testing the results of the assistant selection system will be carried out using 2018 odd semester selected assistant data for each course, whereas for the assessment of assistant performance will be carried out using a sample of 2019 elected assistant semester odd semester.

2.2. Method

1. Analytical Hierarchy Process

Analytical Hierarchy Process (AHP) developed by Thomas L. Saaty (Kadarsyah, 1998) is an Analytical Hierarchy Process with additive weighting because arithmetic operations to get the total weight are addition [5]. In the AHP Method, there are three points that must be considered, viz

1. The principle of compiling the hierarchy
2. The principle of determining priorities
3. The principle of logical consistency

The steps in the Analytical Hierarchy Process method are [1]:

1. Define the problem and determine the desired solution, then arrange the hierarchy of the problems faced.
2. Determine the priority of elements
 - a) The first step in determining the priority of elements is to make pairwise comparisons, that is to compare elements in pairs according to the given criteria.
 - b) Paired comparison matrices are filled in using priority level paired comparisons to present the relative importance of one element to the other elements. Matrix K is a pairwise comparison matrix between criteria.

$$K = \begin{matrix} & \begin{matrix} K_1 & K_2 & \dots & K_n \end{matrix} \\ \begin{matrix} K_1 \\ K_2 \\ \vdots \\ K_n \end{matrix} & \begin{bmatrix} k_{11} & k_{12} & \dots & k_{1n} \\ k_{21} & k_{22} & \dots & k_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ k_{m1} & k_{m1} & \dots & k_{mn} \end{bmatrix} \end{matrix}$$

3. Synthesis

Considerations of pairwise comparisons are synthesized to obtain overall priority. The things done in this step are:

- a) Add up the values of each column in the K matrix.
- b) Divide each value from the column by the total column concerned to obtain the normalization matrix.
- c) Add the values of each row in the normalization matrix and divide by the number of elements to get the priority weight value.

4. Measuring Consistency

In making decisions, it is important to know how good the consistency is to get optimal results, the things done in this step are as follows

- a) Calculate the maximum value of lamda (λ_{maks}) by adding up the product of the sum of each column K with its priority weight value.

5. Calculate the Consistency Index (CI)

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

6. Calculate the Consistency Ratio (CR)

$$CR = \frac{CI}{RI} \quad (2)$$

7. Check the Consistency of Hierarchy

If the value is more than 0.1, then the assessment data in the pairwise comparison table must be corrected. However, if the Consistency Ratio (CR) is less or equal to 0.1, then the calculation results can be declared correct so that the resulting solution is optimal.

2. Simple Additive Weighting

The Simple Additive Weighting method, or better known as the SAW method, is a weighted sum method. The basic concept of the SAW method is the weighted sum of the performance ratings for each alternative on all attributes. The SAW method requires the decision matrix normalization process (X) to a scale that can be compared with all available alternative ratings. The equation for matrix normalization if the attribute is a benefit criterion is as follows [2]:

$$R_{ij} = \frac{x_{ij}}{\max_i x_{ij}} \quad (3)$$

The equation for normalizing the matrix if the attribute is the cost criteria as follows:

$$R_{ij} = \frac{\min_i x_{ij}}{x_{ij}} \quad (4)$$

The preference value for each alternative (v_i) is given the following formula:

$$V_{ij} = \sum_j^i w_j r_{ij} \quad (5)$$

3. Confusion Matrix

Confusion matrix is a tool for testing or analyzing classification results. Evaluations are carried out using a confusion matrix table to make comparisons between actual and predicted categories. Variables in confusion matrix have the following meanings. To calculate accuracy obtained like the following equation [4]:

$$Accuracy = \frac{(TP+TB)}{(TP+FP+FN+TN)} \quad (6)$$

3. Results and discussion

3.1. Assistant Consistency Selection Consistent Results

Based on a survey for pairwise comparisons conducted on 4 respondents namely lecturers who have assistants, for comparison between the criteria for selecting assistants, the results of the consistency ratio can be seen in Table 1.

Table 1 Assistant Consistency Selection Consistent Results

Responder	Consistency Ratio	Consistency Value
A	0,00084	99,99916%
B	0,1395	86,05%
C	0,0812	91,88%
D	0,07299	92,70%

From the results of Table 1, the consistency ratio values that meet the requirements of the AHP method are responder A, C, and D with a consistency ratio value ≤ 0.1 . Because responder A has the smallest consistency ratio, the selection of assistants uses weights obtained from a comparison between the criteria filled in by responder A with a weight value table that can be seen in Table 2.

Table 2 Assistant Selection Weight Value

Criteria	Weight Value
GPA	0,057
Course Scores	0,441
Test Scores	0,061
Recommendation	0,441

3.2. Assistant Consistency Performance Assessment Consistency Results

Based on a survey for pairwise comparisons conducted on 4 respondents namely lecturers who have assistants, for comparison between the criteria for assessing assistant performance, the results of the consistency ratio can be seen in Table 3.

Table 3 Assistant Consistency Performance Assessment Consistency Results

Responder	Consistency Ratio	Consistency Value
A	0,063	93,7%
B	0,118	88,2%
C	0,0825	91,75%
D	0,1135	88,65%

From the results of Table 3, the consistency ratio values that meet the requirements of the AHP method are responder A and C with a consistency ratio value ≤ 0.1 . Because responder A has the smallest consistency ratio then for the assessment of assistant performance using weights obtained from the comparison between the criteria that have been filled by responder A with a weight value table that can be seen in Table 4.

Table 4 Assistant Performance Rating Weight Weights

Criteria	Weight Value
Verbal Ability	0,322
Accuracy	0,108
Patience	0,163
Punctuality	0,085
Problem Solving	0,322

3.3. Alternative Ranking Accuracy Results for each course

After getting the weight of each criterion, ranking using the SAW method, the selection of assistants was tested using 2018 assistant semester data, with C ++, Oracle, VB.Net, PBO Java 1, PBO Java 2, PBO Java 2, Multimedia, PHP, Game Development , LAN, WAN, Android, Python and Linux. The results of the selection of assistants for each course compared with the 2019 assistant semester reality data which is calculated using the confusion matrix can be seen in Table 5.

Table 5 Accuracy Results of Assistant Election System Based on Specific Subjects

No	Courses	Accuracy
1	C++	69,23%
2	Oracle	69,23%
3	VB.Net	83%
4	PBO Java 1	42,85%
5	PBO Java 2	100%
6	Multimedia	100%
7	PHP	100%
8	Game Development	100%
9	LAN	60%

10	WAN	60%
11	Android	100%
12	Python	50%
13	Linux	100%

The results of the assistant selection system have worked well for decision support in the selection of assistants in PBO Java 2, Multimedia, PHP, Games Development, Android, and Linux courses with 100% accuracy, other than that the results have not been maximized due to the frequent practicum schedules that clash with the course schedules taken by the assistant.

3.4. Assistant performance assessment results

Assistant performance appraisal decision support system, based on the pre-determined weights using the AHP method, ranking system using the SAW method with alternative data used is 2019 odd semester assistant data, each assistant is assessed by 20 students who are assisted from the eye C ++ lectures (4 assistants), Oracle (4 assistants), Python (4 assistants), PBO Java 2 (4 assistants), Vb.Net (3 assistants), and WAN (2 assistants) produce assistant performance evaluations as follows:

1. Evaluation Results of the C ++ Assistant Performance Assessment

Table 6 Evaluation Results of the C ++ Assistant Performance Assessment

Alternative	Total Value	Rank	Result
A1	1	1	Very Good
A2	0.9861	2	Very Good
A3	0.9434	3	Very Good
A4	0.9101	4	Very Good

2. Evaluation Result of the Oracle Assistant Performance Assessment

Table 7 Evaluation Results of the Oracle Assistant Performance Assessment

Alternative	Total Value	Rank	Result
A1	0.9885	1	Very Good
A2	0.9844	2	Very Good
A3	0.9663	3	Very Good
A4	0.9579	4	Very Good

3. Evaluation Result of the VB.Net Assistant Performance Assessment

Table 8 Evaluation Results of the VB.Net Assistant Performance Assessment

Alternative	Total Value	Rank	Result
A1	0.9956	1	Very Good
A2	0.9867	2	Very Good
A3	0.9468	3	Very Good

4. Evaluation Result of the PBO Java 2 Assistant Performance Assessment

Table 9 Evaluation Results of the Oracle Assistant Performance Assessment

Alternative	Total Value	Rank	Result
A1	0.9871	1	Very Good
A2	0.9849	2	Very Good
A3	0.9682	3	Very Good
A4	0.9637	4	Very Good

5. Evaluation Result of the WAN Assistant Performance Assessment

Table 10 Evaluation Results of the WAN Assistant Performance Assessment

Alternative	Total Value	Rank	Result
A1	1	1	Very Good

A2	0.9560	2	Very Good
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6. Evaluation Result of the Python Assistant Performance Assessment

Table 11 Evaluation Results of the Python Assistant Performance Assessment

Alternative	Total Value	Rank	Result
A1	0.99668	1	Very Good
A2	0.98078	2	Very Good

Based on the evaluation of several sample subjects to get an assessment of the assistant using odd semester 2019 data where each assistant is assessed by 20 students who assisted in evaluating very Good.

4. Conclusion

The results of the research that have been carried out a collaboration of two methods, namely Analytical Hierarchy Process and Simple Additive Weighting, have been successfully implemented into decision support system for Election and Evaluation of Assistant Lecturer at Faculty of Information Technology Tarumanagara University. The result of weighting using the AHP method depends on the user's perception of the comparison of the importance level of each criterion, so that each user can produce different weights, to determine the best user choice measured by the consistency level of the smaller ratio (close to 0). Based on the testing that has been done, the application of the AHP and SAW methods on the system obtained significant results on the teaching assistants at FTI UNTAR in harmony with the selection of teaching assistants conducted manually.

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