Utilizing Analytical Hierarchy Process (AHP) in Developing Decision Support System for Evaluating Teacher Performance

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Abstract

One effort to measure the quality level in schools is by assessing the performance aspects of teachers as professional educators teaching in those schools. The performance aspect of teachers is measured as one of the requirements for promotion to higher positions or as a prerequisite recommendation to participate in teacher certification activities. In order for teacher performance assessment to be conducted objectively, a method that can assist in the process is required. The Analytical Hierarchy Process (AHP) method can be used to aid in decision-making. This is because the AHP method is a model for structured and comprehensive decision-making. Data from the Analytical Hierarchy Process calculation were obtained from 5 questionnaires filled out by respondents, and the final result obtained was C with a superior weight of 0.7604 or 76.04%, the second priority was obtained by B with a weight value of 0.2079 or 20.79%, and the lowest priority was obtained by A with a weight value of 0.0517 or 5.17%.

Keywords: Decision Support System, Teacher Performance Assessment, AHP

1. Introduction

In the dynamic landscape of education, the evaluation of teacher performance stands as a cornerstone, indispensable for upholding and advancing educational standards. With the pivotal role of educators in shaping student outcomes widely acknowledged [1], [2], [3], educational institutions grapple with the perpetual quest for effective methodologies to gauge and enhance teaching quality. Despite this recognition, traditional evaluation methods often prove inadequate in offering comprehensive and unbiased insights into the effectiveness of teachers [4], [5], leaving a palpable gap in the pursuit of educational excellence.

In response to this persistent challenge, the Analytical Hierarchy Process (AHP) emerges as a beacon of hope, heralding a transformative approach to assessment practices. Conceived by Thomas L. Saaty, AHP provides a structured framework for navigating the complexities inherent in multi-criteria decision-making, rendering it particularly well-suited for intricate evaluation scenarios like the appraisal of teacher performance [6], [7], [8]. By systematically deconstructing evaluation criteria and accommodating diverse stakeholder perspectives, AHP lays the groundwork for informed and data-driven decision-making [9], [10], promising a paradigm shift in the realm of teacher assessment.

This research endeavors to delve into the practical application of AHP within the domain of teacher performance evaluation, underscoring the pressing imperative for more objective and systematic assessment methodologies. Through the integration of AHP into a Decision Support System (DSS), the study seeks to forge a potent tool capable of aiding educational administrators in impartially evaluating and augmenting teacher effectiveness.

By embarking on a journey that intertwines theoretical inquiry with hands-on implementation, this research aspires to confront the inherent complexities entwined with the evaluation of teacher performance. Harnessing the analytical prowess of AHP, the study endeavors to furnish educational institutions with invaluable resources aimed at nurturing a culture of continual enhancement in teaching quality, thereby fostering a symbiotic relationship between educators and learners.

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2. Literature Review

In implementing the AHP method within a DSS for assessing teacher performance, several key steps need to be considered. Firstly, the formulation stage of hierarchy criteria and sub-criteria should be conducted meticulously. This involves identifying significant dimensions of teacher performance, such as teaching competency, interaction with students, curriculum development, and participation in extracurricular activities. Subsequently, the relative weighting among criteria and sub-criteria must be established based on expert judgment or relevant stakeholders, to ensure that the most important factors receive appropriate weights in the evaluation process.

Relevant research has supported the use of AHP in the context of teacher performance assessment. For instance, a study by [9] highlights the effectiveness of AHP in prioritizing criteria for assessing teacher performance by considering diverse stakeholder preferences. The results indicate that AHP can provide consistent and measurable solutions in decision-making, which are relevant for enhancing objectivity and transparency in the teacher performance evaluation process.

Furthermore, another study by [11] applied AHP in evaluating teacher performance in secondary schools. They found that AHP could be utilized to develop a more accurate and fair assessment scale, considering various factors that influence teacher performance holistically. These findings emphasize the value of AHP in providing a comprehensive and systematic framework for teacher performance evaluation, which can be adopted by various educational institutions.

However, some studies also highlight challenges associated with implementing AHP in the context of teacher performance evaluation. For example, a study by [12] notes the need for careful consideration in determining criteria and weights in AHP, as errors in this process can lead to inaccurate and biased assessments. Therefore, caution in the design and implementation of AHP within DSS for teacher performance assessment is crucial to ensure that evaluation outcomes are reliable and beneficial for decision-makers in the education field.

3. Method

3.1. Data Collection

The primary data used in this research are teacher assessment data obtained directly. Data collection techniques involve observation and interview processes to ensure comprehensive data acquisition.

3.2. Research Stage

The research stage follows a structured approach as illustrated in Figure 1. This methodology includes quantitative analysis, utilizing statistical techniques to test research hypotheses [13], [14], [15]. A questionnaire based on the AHP was developed to collect data and facilitate analysis.

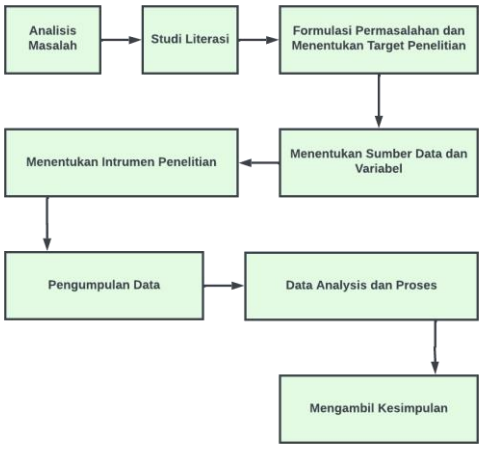

Figure 1. Research Stages

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3.3. Analysis Approach

1) Decomposition

This initial stage involves defining and simplifying the problem into smaller components. The problem is organized into a hierarchy consisting of goals, criteria, and options, providing a systematic framework for analysis [16], [17].

2) Comparative Assessment

Pairwise comparison matrices are constructed to assess the relative importance of elements within criteria and alternatives. Respondents, including principals, vice principals, and administrative staff, fill out questionnaires to provide input. Average comparisons for each element are determined based on feedback from respondents [16], [17].

3) Priority Synthesis

After completing the pairwise comparison matrices, eigenvectors or average values (local priorities) are calculated for each pairwise comparison. This involves steps such as summing the values in columns to obtain a normalization matrix and obtaining average values for each row [16], [17].

4) Consistency

The consistency phase aims to validate the synthesized priorities. Consistency ratios, derived from the consistency index divided by a random index based on the matrix size, are used to assess the reliability of the decision-making process. Higher consistency ratios indicate greater confidence in the decision-making outcomes [16], [17].

3.4. Research Approach Validation

To ensure the validity of the research approach, consistency ratios are evaluated to measure the level of achieved consistency [18]. The goal is to achieve near-perfect consistency, demonstrating strong decision-making outcomes [19]. By adhering to these methodological steps, the research aims to provide a comprehensive and systematic analysis of teacher performance assessment using the AHP approach. The structured approach facilitates objective decision-making processes, contributing to improving educational quality and teacher effectiveness [20].

4. Result and Discussion

Below are the results of teacher performance assessment calculations using the AHP method, based on the basic principles of the AHP method.

4.1. Decomposition

To simplify the problem, a decision hierarchy consisting of three main components, namely goals, criteria, and options, was created. The following is an overview of the decision hierarchy structure used in this research.

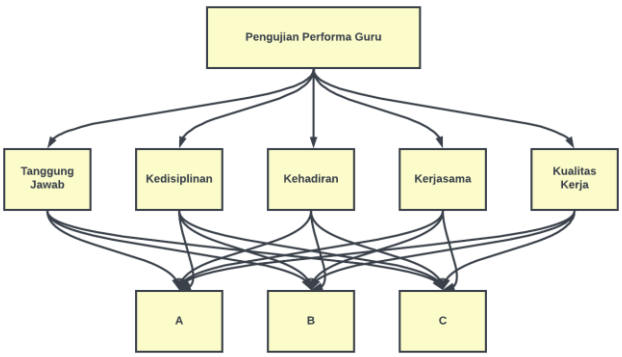

Figure 2: Teacher Performance Assessment Hierarchy

The next step is to create pairwise matrices for the criteria and alternatives defined within the hierarchical structure.

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4.1.1. Criteria and Alternatives Pairwise Comparison (level 1)

After determining the criteria, weighting is performed on the relationships between these criteria. The assessment was conducted by 6 respondents consisting of principals, vice principals, and administrative staff by filling out questionnaires to generate raw data, which can be seen in the appendix. The following are the results of the raw data questionnaire translated into pairwise comparison tables using Microsoft Excel application.

Table 1. Pairwise Comparison Between Variables

Criteria	Responsibility	Discipline	Attendance	Collaboration	Work Quality
Responsibility	1, 1, 1, 1, 1	3,3,3,3,3	5,4,4,5,5	5,5,5,5,5	7,5,5,5,7
Discipline	0.33, 0.33, 0.33, 0.33, 0.33	1, 1, 1, 1, 1	5,4,4,5,5	3,3,3,3,3	5,4,4,5,5
Attendance	0.25, 0.25, 0.25, 0.25, 0.25	0.25, 0.25, 0.25, 0.25, 0.25	1, 1, 1, 1, 1	5,4,4,5,5	5,4,4,5,5
Collaboration	0.25, 0.25, 0.25, 0.25, 0.25	0.33, 0.33, 0.33, 0.33, 0.33	0.25, 0.25, 0.25, 0.25, 0.25	1, 1, 1, 1, 1	3,3,3,3,4
Work Quality	0.15, 0.15, 0.15, 0.15, 0.15	0.25, 0.25, 0.25, 0.25, 0.25	0.25, 0.25, 0.25, 0.25, 0.25	0.33, 0.33, 0.33, 0.33, 0.33	1, 1, 1, 1, 1

After the pairwise comparison results between criteria were inputted into calculation tables to obtain the sum of assessments for each criterion, which is useful for determining the percentage weight for each criterion.

Table 2. Main Criteria Eigen Vector

Criteria	Responsibility	Discipline	Attendance	Collaboration	Work Quality
Responsibility	1	3.0455	4.2111	5.2222	6.1112
Discipline	0.3333	1	5.3221	3.4122	4.7875
Attendance	0.2321	0.2443	1	4.8777	5.0222
Collaboration	0.2444	0.3333	0.2644	1	3.5222
Work Quality	0.1642	0.2411	0.2762	0.3333	1

4.1.2. Alternative Comparison Data Based on Criteria (level 2)

After the criteria comparison data were inputted into Microsoft Excel, the next step is to input the alternative comparison data. The selected alternatives must meet the criteria established beforehand. There are 3 alternative teacher names obtained from interviews with the principal.

4.2. Priority Synthesis

This process is carried out to find the eigenvector or average values (local priorities) of each pairwise comparison matrix. The following are the results of the eigenvector values for level 1 and level 2 for all criteria and alternatives.

4.3. Consistency

The goal of this stage is to determine the accuracy of the eigenvector values obtained from the previous priority synthesis process. This stage is conducted in 2 steps:

1) Determining the Maximum Lambda (**λ**) Value

This step is carried out by multiplying the pairwise comparison matrix with the eigenvector.

The pairwise comparison matrix used is not normalized. The results of these multiplications are then summed to yield a maximum value of 5.2039.

1,0000	0,5944	4,6776	2,2654	4,3423		0,4416	3,6379
0,5207	1,0000	6,7035	2,4916	1,7688		3,8727	4,8445
3,6882	1,9599	1,0000	5,7846	2,3975	X	5,9321	5,6628
1,8295	0,1423	4,2261	1,0000	1,0528		1,8317	0,0128
3,2357	4,7462	2,2975	0,4335	1,0000		6,6297	5,5713

2) Calculating Consistency Ratio

The second step of the consistency process is testing the hierarchy consistency, as follows:

Calculating the consistency index (CI):

$$CI = ((\lambda\, maksimum - n) / (n - 1) \quad (1)$$

Note:

n = number of rows and columns in the pairwise comparison matrix or number of criteria.

Since the matrix consists of 5 main criteria, the obtained consistency index (CI) value is:

$$CI = \frac{\lambda max - n}{(n-1)} = \frac{5{,}2039-5}{(5-1)} = 0{,}0510 \quad (2)$$

Calculate the consistency ratio (CR) by:

$$R = CI / RI \quad (3)$$

$$CR = 0{,}0510 / 1{,}12 CR = 0{,}0455 \quad (4)$$

Note:

RI is a random value obtained from the Random Consistency Index table at a certain n.

Since CR < 0.1 (10%), the weighting preference is consistent. The level 1 pairwise comparison matrix based on the main criteria has been filled with consistent considerations, and the resulting eigenvector can be relied upon. The next step is to calculate in the same manner for each alternative against each criterion so that the final results are obtained as follows:

Table 3. Decision Eigen Vector

	Responsibility	**Discipline**	**Attendance**	**Collaboration**	**Work Quality**	**Average**
A	0,5547	0,5353	0,4994	0,1584	0,2194	0,0517
B	0,1524	0,5018	0,6797	0,5160	0,7344	0,2079
C	0,3095	0,6707	0,7115	0,4805	0,9588	0,7604

The decision eigen vector values indicate that:

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1) A has the highest priority weight of 0.0517

2) B has the second priority weight of 0.2079

3) C has the lowest priority weight of 0.7604

If depicted graphically, the percentage breakdown is as follows:

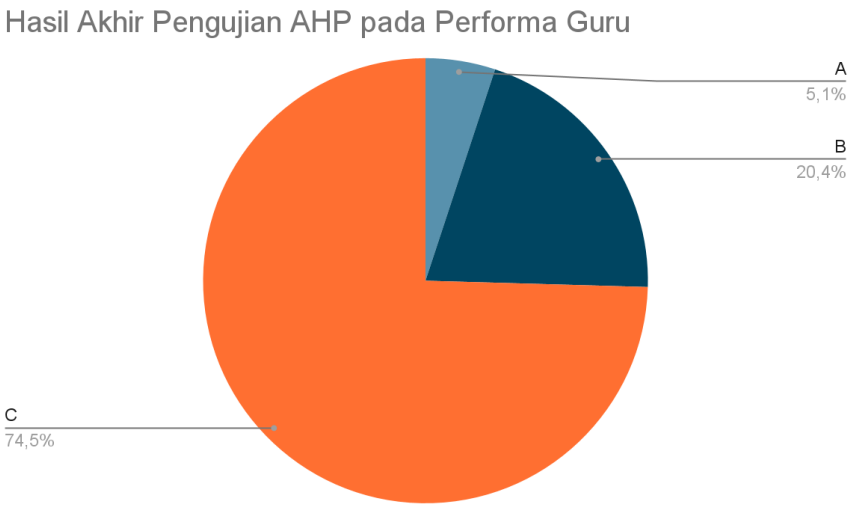

Figure 3. Final Eigen Vector Results for Teacher Performance Assessment

5. Conclusion

The AHP method yields sound decisions in resolving and calculating the criteria values held by teachers, thus ensuring accurate outcomes in the teacher performance assessment process. Based on the AHP calculations, the priority criteria obtained are crucial in evaluating teacher performance, where responsibility, discipline, absenteeism, cooperation, and work quality are prioritized in teacher performance assessment. After computing the Analytical Hierarchy Process method using 4 basic principles in AHP calculations, the highest weighted teacher performance assessment result is obtained by candidate C. Data from the Analytical Hierarchy Process calculation were obtained from 5 questionnaires filled out by respondents, and the final result obtained is C, which excels with a weight of 0.7604 or 76.04%, the second priority is obtained by B with a weight value of 0.2079 or 20.79%, and the lowest priority is obtained by A with a weight value of 0.0517 or 5.17%.

6. Declarations

6.1. Author Contributions

Conceptualization: D.P. and I.M.; Methodology: I.M.; Software: D.P.; Validation: D.P., I.M.; Formal Analysis: D.P., I.M.; Investigation: D.P.; Resources: I.M.; Data Curation: I.M.; Writing Original Draft Preparation: D.P. and I.M.; Writing Review and Editing: I.M. and D.P.; Visualization: D.P.; All authors have read and agreed to the published version of the manuscript.

6.2. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

6.3. Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

6.4. Institutional Review Board Statement

Not applicable.

6.5. Informed Consent Statement

Not applicable.

6.6. Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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