Implementation of Analytical Hierarchy Process (AHP) and Simple Additive Weighting (SAW) methods in the process of determining teacher certification participants

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Abstract. Teacher certification is a process of improving the quality and competency testing of educators regulated by the government through ministry of education. The education office, which it provides teacher certificates that have been declared to meet professional standards. It would not happen if the assessment is carried out using an effective method in selecting teacher certification participants. The purpose of this research is to make a decision support system by applying 2 methods, namely Analytical Hierarchy Process (AHP) and Simple Additive Weighting (SAW) methods.

1. Introduction

On the background of the previous research, the research entitled Decision Support System for Determination of Teachers Who Are Entitled to Receive Certification Using the Analytical Hierarchy Process (AHP) Method [1], research related to the Application of the SAW Method in the Decision Support System for Determining Scholarship Recipients [2,3], then the Research Collaboration of the SAW and AHP Methods for the Laboratory Assistant Performance Assessment Decision Support System [4], the authors were inspired to examine the assessment of teacher eligibility in following teacher certification by combining two methods. Research conducted has a difference with previous research conducted by researchers, both from the criteria used and the concept of merging the AHP and SAW methods. Previous studies compared the results of using two methods.

There are several things to consider in the selection of teacher certification. Among the recipient's capacity, fulfillment of the requirements in the form of a file, as well as following the Teacher Professional Education (PPG) and several other criteria in accordance with the provisions stipulated by the Education Office for the selection of teacher certification and in determining the participants all data was assessed and entered by the committee into the file storage [5,6]. Recapitulating files and assessing them takes a long time and allows for errors and data manipulation. The final goal of this research is to solve the problem above by applying 2 methods, namely the Simple Additive Weighting (SAW) method for calculating teacher performance in the teaching field because the data is in the form of quantitative data so the SAW method is more appropriate to be used and the Analytical Hierarchy Process (AHP) method for calculations in the form of qualitative data which will then be converted into quantitative data [7,8]. The two methods are interconnected because the final calculation result using AHP will be accumulated with the number of teacher certification eligibility calculations that have previously been calculated using the SAW method.
2. Methodology
In developing a Decision Support System using these two collaborative methods by applying research methods: 1) Data collection, 2) Data analysis and Determination of Performance Assessment Criteria, 3) Systems Development Method. At the stage of data collection in the form of interviews, questionnaires and field surveys [9].

AHP Method and Calculation Steps AHP is a method of solving complex problems in an unstructured situation into component parts [8]. Arranging this part or variable into a hierarchical arrangement, then providing numerical values for subjective assessment of the relative importance of each variable and synthesizing the assessment for which variable has the highest priority that will affect the resolution of the situation [10]. AHP combines personal judgment and judgment in a logical way and is influenced by imagination, experience, and knowledge to compile a hierarchy of problems based on logic, intuition and experience to give consideration. AHP is a process of identifying, understanding and providing estimates of overall system interaction. With AHP, complex processes can be broken down into smaller decisions that can be handled easily. In addition, the AHP also tests the consistency of the assessment if there are deviations that are too far from the value of perfect consistency, then this indicates the assessment needs to be improved, or the hierarchy must be restructured.

While the Simple Additive Weighting Method (SAW) is a system development method with the weighted sum method [7,11]. The basic concept of the SAW method is to find a weighted sum of the performance ratings for each alternative on all attributes. The SAW method can help in making a case decision, but calculations using this SAW only produce the greatest value that will be selected as the best alternative. The calculation will be in accordance with this method if the chosen alternative meets the specified criteria. The SAW method is more efficient because the time required in calculations is shorter.

3. Results and discussion
3.1. Calculation analysis of AHP method
There are three principles in solving problems with the Analytical Hierarchy Process, namely the principle of compiling a hierarchy (Decomposition), the principle of determining priorities (Comparative Judgment), and the principle of logical consistency (Logical Consistency) [8]. The hierarchy in question is the hierarchy of the problem to be solved to consider criteria or components that support the achievement of objectives [12]. In the process of determining objectives and goal hierarchy, it is important to consider whether the set of objectives along with the relevant criteria are appropriate for the problem at hand [1].

In general, the basic steps of AHP can be summarized in the following explanation:

- Define the problem and set goals. If AHP is used to choose alternatives or alternative priorities, then at this stage an alternative development will be carried out.
- Arrange problems in a hierarchical structure. Each complex problem can be reviewed in terms of detail and structured.
- Establish priorities for each element of the problem at the hierarchical level. This process produces the weight of the element towards the achievement of objectives, so the element with the highest weight has priority handling. The first step at this stage is to compile a pairwise comparison that is transformed into a matrix, so that this matrix is called a pairwise comparison matrix [10].

AHP method calculation testing is done by calculating the value of Consistency Index (CI) and Consistency Ratio (CR). The calculation of the Consistency Index (CI) is intended to determine the consistency of the answers that will affect the results of the CI Formula error:
To find out whether a certain amount of CI is good enough or not, we need to know the Consistency Ratio (CR) that is considered good, that is, if CR < 0.1, while the CR formula [12]:

\[ CR = \frac{CI}{RI} \]  

(2)

At this stage data processing will be carried out by implementing the Analytical Hierarchy Process (AHP) method. In processing this data, in general the calculation procedure is to make a paired matrix between the criteria used then determine the level of priority or importance between each evaluation criteria by referring to the Saaty scale. The terms of the target scale can be seen in Table 1:

| Level of Importance | Definition                        | Information                                    |
|---------------------|-----------------------------------|------------------------------------------------|
| 1                   | Equally Important                 | Both elements have the same effect.            |
| 3                   | A little more important           | The one element is slightly more important than its partner. |
| 5                   | More important                    | The one essential or very important element is more important than the other elements. |
| 7                   | Very important                    | One element proved to be very well liked and practically its dominance was very real, compared to its partner element. |
| 9                   | Absolute More Important           | One absolute element is more important than the other elements |
| 2, 4, 6, 8          | Middle value                      | The values between the two considerations are close together. |
| The opposite        | If activity i gets a number when compared to an activity j. Then j has the inverse value when compared with activity i |

The following hierarchical structure of AHP decision support systems for eligibility of teacher certification participants:

![Diagram of AHP structure](image)

**Figure 1.** AHP structure of determine teacher certification participants.
The hierarchical structure in this study consists of goals, criteria and alternatives. The goal or goal in this hierarchy is a decision support system for the eligibility of teacher certification participants. There are 6 (six) criteria used for assessment in this system:

| Criteria (C) | Information |
|-------------|-------------|
| C1          | NUPTK (Unique Numbers of Educators and Educational Personnel) |
| C2          | Pretest PPG (Teacher Professional Education) |
| C3          | Last education |
| C4          | Employee Status |
| C5          | Years of service |
| C6          | Age |

### 3.2. Calculation analysis for the Simple Additive Weighting method

The SAW method is a method known as the weighted sum method where the normalization process of the decision matrix is needed to a scale that can be compared with all available alternatives, it is also a method that is widely used in decision making that has many attributes. This method requires the decision matrix normalization process \((X)\) to a scale that can be compared with all existing alternative ratings. The Simple Additive Weighting method recognizes the existence of 2 (two) attributes, namely the profit criteria and the cost criteria. The fundamental difference between the two criteria is in the selection of criteria when making decisions.

\[
\begin{align*}
    r_{ij} &= \begin{cases} 
        \frac{X_{ij}}{\max X_{ij}} & \text{if } j \text{ is the profit attribute} \\
        \frac{\min X_{ij}}{X_{ij}} & \text{if } j \text{ is the cost attribute}
    \end{cases} \\
\end{align*}
\]

(3)

Information:
- \(r_{ij}\) = normalized performance rating value
- \(X_{ij}\) = attribute value that is owned from each criterion
- \(\max X_{ij}\) = the greatest value of each criterion
- \(\min X_{ij}\) = the smallest value of each criterion
- benefit = if the biggest value is the best
- cost = if the smallest value is the best

where \(r_{ij}\) is a normalized performance rating of alternative \(A_i\) on the \(C_j\) attribute; \(i = 1, 2, ..., m\) and \(j = 1, 2, ..., n\). The preference value for each alternative \((V_i)\) is given as:

\[
V_i = \sum_{j=1}^{n} W_j r_{ij}
\]

(4)

Information:
- \(V_i\) = rank for each alternative
- \(W_j\) = the weight value of each criterion
- \(r_{ij}\) = the weight value of each criterion
- A greater value of \(V_i\) indicates that the alternative \(A_i\) is preferred [13].

At this stage data processing will be carried out using the Simple Additive Weighting (SAW) method. In general, the calculation phase using the SAW method is the first step taken is to fill each criteria weight in each alternative. Next is the initial initiation [7].

- Determination of Criteria for the Simple Additive Weighting Method
- To make this decision there are objects that will be discussed or goals, criteria and alternatives.
The preference value of each alternative, the final step is to sort the preference value from the largest to the smallest to rank. The final results of the SAW method calculation can be seen in the following Table 3.

**Table 3.** The final results of calculations using the SAW method.

| No | Alternative Code | Results of the SAW Method |
|----|------------------|---------------------------|
| 1  | A8               | 0.921                     |
| 2  | A5               | 0.921                     |
| 3  | A3               | 0.911                     |
| 4  | A6               | 0.89                      |
| 5  | A7               | 0.89                      |
| 6  | A1               | 0.879                     |
| 7  | A2               | 0.79                      |
| 8  | A9               | 0.692                     |
| 9  | A4               | 0.606                     |
| 10 | A10              | 0.596                     |

3.3. Implementation of AHP and SAW methods

Based on the final results of the calculation of AHP and SAW methods below are the final results of the calculation of the two methods which can be seen in the following Table 4.

**Table 4.** Comparison of AHP and SAW method results.

| No | Alternative Code | Final Result Manual Count | Final Result System Count |
|----|------------------|----------------------------|---------------------------|
| 1  | A8               | 0.921                      | 0.923                     |
| 2  | A5               | 0.921                      | 0.923                     |
| 3  | A3               | 0.911                      | 0.912                     |
| 4  | A6               | 0.89                       | 0.89                      |
| 5  | A7               | 0.89                       | 0.89                      |
| 6  | A1               | 0.879                      | 0.88                      |
| 7  | A2               | 0.79                       | 0.792                     |
| 8  | A9               | 0.692                      | 0.693                     |
| 9  | A4               | 0.606                      | 0.606                     |
| 10 | A10              | 0.596                      | 0.595                     |

From the results of the calculation of the AHP and SAW methods to determine the eligibility of teacher certification participants showed the same results from both calculation methods, namely manual and from the system. In determining the eligibility of teacher certification participants use 6 criteria, namely NUPTK, PPG Pretest, Latest Education, Employee Status, Years of Service and Age.

By calculating the accuracy of the results of the implementation of the two methods can be seen how accurate AHP and SAW to be used in this problem. The formula for calculating accuracy is:

$$\text{Accuracy} = \frac{\text{Document Match Number Correct}}{\text{Overall Data}} \times 100\%$$  \hspace{1cm} (5)

Used 10 sample data and found the same data with the results of manual calculation of 10 sample data, then the accuracy:

$$\text{Accuracy} = \frac{10}{10} \times 100\% = 100$$  \hspace{1cm} (6)

The accuracy calculation results show the value of 100, which means that from 10 sample data there are the same final results obtained from both types of calculations, namely manual calculations and system calculations.
3.4. Discussion
AHP method is a method that is best used for unstructured problems, because the type is hierarchical and comparing, whereas the SAW method is a method known as the weighting method. Finding priority criteria weights using the AHP method has the advantage of solving complex problems by structuring a hierarchy of criteria. While the drawback is that the AHP method is very dependent on the main input in the form of a decision maker's perception so that it involves subjectivity, if the value is wrong then the result becomes meaningless.

4. Conclusion
From 10 sample data, 10 data were obtained that showed the same results from the calculation of the two methods used, namely AHP and SAW. Then after a manual calculation is carried out by implementing both methods then the accuracy value is calculated and the results show 100%.

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