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# Decision Support System for the INAIMA AIS Officer of the Year Award using AHP-TOPSIS Method

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**ABSTRACT**

The professional organization of the Indonesian Aeronautical Information Management Association always tries to increase the motivation of its members. One of INAIMA's work programs to make this happen is to elect the AIS Officer of The Year. In practice, the selection of AIS Officer of the Year is still carried out by collecting data manually without using a system so that it takes longer time to process the data. Furthermore, the results obtained from the election are also not objective because there is no method of calculating the criteria for evaluating candidates, so a decision support system is needed that can provide objective election results and is able to speed up the evaluation process. The method used in designing this decision support system is the SDLC (Software Development Life Cycle) where the stages include planning, analysis, design, implementation, testing, and maintenance. ). The calculation of the weight value of the criteria and alternatives on the system uses the AHP-TOPSIS method. The result is a web-based decision support system that is able to provide a more precise and objective assessment of candidates.

## 1. Introduction

The Indonesian Aeronautical Information Management Association (INAIMA) is a professional organization[1] for Aeronautical Information Service (AIS)[2] personnel in Indonesia. INAIMA has the responsibility to increase the motivation of AIS personnel as outlined in the organization's work program by selecting members who are able to make the best contribution to the profession and organization which is carried out routinely every year with the title AIS Officer of The Year.

In the selection process that was carried out, several obstacles were found by the coordinator in the field of organization and membership, who was the person in charge of implementing it because it was still done manually. Starting from the process of verifying candidate data and collecting supporting data for the large number of assessment criteria, it takes a long time to complete them and there is a high probability of errors in inputting because the number of officers in charge is limited. At the assessment stage, the officers did not use a special method and only did sums related to the value of each criterion consisting of years of service, level of position, competence, discipline and activeness in the organization, resulting in the emergence of the opinion of members that the results of the selection of AIS Officer Of The Year were not objective.

Based on this background, an AIS Officer of the Year decision support system is needed using a method that is able to speed up the selection process and provide objective recommendations.

## 2. Research Methodology

a. Data Collection Method

Data collection as a reference material for research is carried out by 1) Observation, namely direct observation at the stages of the AIS Officer of The Year selection process at the INAIMA organization. 2) Interviews, namely conducting direct discussions with sources from the INAIMA organization who are in charge of selecting the AIS Officer of The Year. 3) Literature study, namely by tracing references in the form of journals and other scientific writings related to research

b. System Development Method

The system design method for this study uses the SDLC (System Development Life Cycle) method[3] with a waterfall approach[4] whose stages consist of

i. Requirements

At this stage an analysis of system requirements is carried out and described so

that it can be understood by stakeholders and developers.

ii. Design

At this stage the overall system design is produced where the software flow and algorithms are determined in detail.

iii. Implementation

At this stage the entire design is converted into program code in the form of modules which are then integrated into a complete system.

iv. Verify

At this stage testing of the program code is made.

v. Maintenance

At this stage, periodic maintenance and evaluation of system performance is carried out so that the system can run according to its function.

In this research writing develops a website-based system[5]

c. **Decision Support System**

Decision support systems[6] are a form of information systems[7] that are useful for assisting in making a decision by management on semi-structured problems. The purpose of a decision support system is to provide information and direct users to get consideration in making better decisions [8]. Decision support systems are made with a variety of models to make large data simpler so that it can be analyzed by the decision maker [9].

d. *Metode Analytical Hierarchy Process (AHP)*

The AHP[10] model solves problems that have many complicated criteria into a hierarchy. AHP combines the principles of subjectivity and objectivity of decision support system makers [11]. AHP does not weight the criteria at the beginning but the weighting is done by calculating the priority scale with the formula contained in this method [12]. In this study the AHP method has a function for weighting the criteria for the assessment of AIS Officer of the Year which has been set by INAIMA.

The steps in calculating the AHP method[13] include:

i. Define the problem.

ii. Determine the priority of the elements written in the matrix in pairwise comparisons.

iii. Synthesis, namely considering pairwise comparisons to get priority

iv. Measuring consistency

v. Calculating the Consistency Index (CI) with the formula:

$$CI = \frac{\lambda maks - n}{n - 1}$$

vi. Calculate the Consistency Ratio (CR) with the formula:

$$CR = \frac{CI}{IR}$$

vii. Checking the consistency of the hierarchy in the random index table where if the consistency ratio (CI/IR) is ≤ 0.1, then the calculation results can be declared correct.

e. *Metode Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)*

TOPSIS is a decision-making method for problems with a large number of criteria, where the alternative which is the best solution is the alternative that has the shortest distance to the positive ideal solution and the furthest to the negative ideal solution [14]. TOPSIS is a method that is easy to understand because it can measure the efficiency of all alternatives with a simple and effective concept in its calculation method [15]. In this study TOPSIS is used in ranking the alternatives.

The steps in calculating the TOPSIS method[16] include:

i. Determine the normalized decision matrix where the normalized value of rij is calculated by the formula:

$$rij = \frac{Xij}{\sqrt{\sum_{i=1}^{m} \quad X_{ij}^2}}$$

ii. Determine the normalized weight of the decision matrix where the normalized weight is yij, namely

$$y_{ij} = w_{ij} r_{ij}$$

iii. Determine alternative distances with positive ideal solutions using the formula:

$$D_i^+ = \sqrt{\sum_{j=1}^{n} (y_i^+ - y_{ij})^2}$$

iv. Determine alternative distances with negative ideal solutions using the formula:

$$D_i^- = \sqrt{\sum_{j=1}^{n} (y_{ij} - y_i^-)^2}$$

v. Determine the preference value for each alternative, where the highest preference value indicates the preferred alternative. The calculation is carried out by the formula:

$$V_i = \frac{D_i^-}{D_i^- + D_i^+}$$

f. Research Object

The research was conducted at the INAIMA professional organization with the aim of research to assist the organizational and cadre coordinators in selecting the AIS Officer of The Year with the assessment criteria set out in the organization's regulations. The selection process on a running system can be explained as follows:

i. Member registers as a candidate for AIS Officer of The Year nomination.

ii. Admin, in this case the coordinator of the organizational and regeneration fields, receives and validates the data of registered members.

iii. Admin collects supporting data for criteria

iv. Admin conducts an assessment based on the criteria for prospective members who are nominated for AIS Officer of The Year.

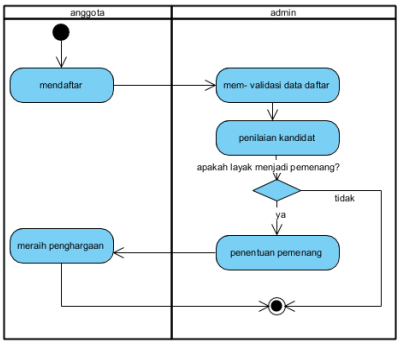


Figure 1. Activity Diagram of the Running System

g. Research Problem

The method used in evaluating the nominations for AIS Officer of the Year is only by adding up the scores of each criterion so that the results are considered not objective and the assessment process takes a long time due to the large amount of data that must be verified and collected.

h. Alternative Problem Solving

Based on the description of the problems above, the authors provide alternative solutions to the problem of determining prospective members of the AIS Officer of The Year as follows:

i. Calculation of the assessment automatically using a web-based computerized system.

ii. Designing a decision support system using the AHP and TOPSIS methods to help facilitate organizations in making decisions objectively, quickly and precisely to determine the winner of the AIS Officer of The Year award so that it fits the predetermined criteria.

## 3. Result and Discussion

a. Data Analisis

The Decision Support System for the selection of AIS Officer of The Year using the AHP-TOPSIS method is carried out through several stages. These stages are:

i. Determine the criteria and the weight of the assessment on each criterion that is useful as a reference in decision making. As an example of a calculation case, the author takes the example of 10 members for the selection of AIS Officer Of The Year candidates, including:

Table 2. Alternative Table

| Code | Name |
|---|---|
| A1 | Yayat Supriatna |
| A2 | Adi Prakoso |
| A3 | Reza Pratama |
| A4 | Suharno |
| A5 | M. Robi |
| A6 | Rabbiah Al Adawiah |
| A7 | Ari Semadi |
| A8 | Rivandi Ali |
| A9 | Denta |
| A10 | Nani |

Meanwhile, the criteria used in the assessment are as follows:

Table 3. Criteria Table

| Code | Criteria |
|---|---|
| C1 | Years of Service |
| C2 | Job Level |
| C3 | Competence |
| C4 | Discipline |
| D5 | Participate |

ii. Perform weighting of the criteria

The weighting of the criteria uses the AHP method which begins by making a pairwise comparison table

Table 1. Comparison Table

| | C1 | C2 | C3 | C4 | C5 |
|---|---|---|---|---|---|
| **C1** | 1 | 2 | 3 | 4 | 5 |
| **C2** | 0.50 | 1 | 2 | 3 | 4 |
| **C3** | 0.33 | 0.50 | 1 | 2 | 3 |
| **C4** | 0.25 | 0.33 | 0.50 | 1 | 2 |
| **C5** | 0.20 | 0.25 | 0.33 | 0.50 | 1 |

Then normalize the pairwise comparison matrix by dividing each input value from the criteria in Table 3 with the total result of the sum of the input values in each column, as follows:

For Criteria for Period of Service (C1)
Service Time = 1/2.28 = 0.44
Position Level = 0.50/2.28 = 0.22
Competence = 0.33/2.28 = 0.15
Discipline = 0.25/2.28 = 0.11
Liveliness = 0.20/2.28 = 0.09

For Position Level Criteria (C2)
Tenure = 2/4.08 = 0.49
Position Level = 1/4.08 = 0.24
Competence = 0.50/4.08 = 0.12
Discipline = 0.33/4.08 = 0.08
Liveliness = 0.25/4.08 = 0.06

For Competency Criteria (C3)
Tenure = 3/6.83 = 0.44
Position Level = 2/6.83 = 0.29
Competence = 1/6.83 = 0.15
Discipline = 0.50/6.83 = 0.07
Liveliness = 0.33/6.83 = 0.05

For Discipline Criteria (C4)
Tenure = 4/10.50 = 0.38
Position level = 3/10.50 = 0.29
Competence = 2/10.50 = 0.19
Discipline = 1/10.50 = 0.10
Liveliness = 0.50/10.50 = 0.05

For Activeness Criteria (C5)
Tenure = 5/15.00 = 0.33
Position Level = 4/15.00 = 0.27
Competence = 3/15.00 = 0.20
Discipline = 2/15.00 = 0.13
Liveliness = 1/15.00 = 0.07

After obtaining the normalized value, the Eigen Vector is calculated by dividing the total sum of the normalized pairwise comparison values in each row by the number of criteria, in which case the number of criteria is 5 with the following calculation:

C1 = (0.44+0.49+0.44+0.38+0.33)/5 = 0.42
C2 = (0.22+0.24+0.29+0.29+0.27)/5 = 0.26
C3 = (0.15+0.12+0.15+0.19+0.20)/5 = 0.16
C4 = (0.11+0.08+0.07+0.10+0.13)/5 = 0.10
C5 = (0.09+0.06+0.05+0.05+0.07)/5 = 0.06

From the calculation above, the Consistency Ratio (CR) is determined using the formula:

$$CR = \frac{CI}{IR}$$

where CI is the Consistency Index and IR is the Index Ratio and in this study the CR value was obtained, namely 0.0175, which means that the weight value is quite consistent because the CR value <0.1 so that the weight value can be determined from the following criteria:

Table 4. Criteria Weight Value

| Code | Name | Value |
|---|---|---|
| C1 | Period of Service | 0.42 |
| C2 | Position Level | 0.26 |
| C3 | Competency | 0.16 |
| C4 | Discipline | 0.10 |
| C5 | Activeness | 0.06 |

iii. Perform alternative calculations and rankings

Ranking of alternatives using the TOPSIS method which begins by comparing the criteria between alternatives from the sample that is owned and converted into according to the criterion value

Table 5. Conversion of Criteria Data Analysis

| | Criteria | | | | |
|---|---|---|---|---|---|
| **Alternative** | **C1** | **C2** | **C3** | **C4** | **C5** |
| **A1** | 4 | 5 | 3 | 3 | 5 |
| **A2** | 3 | 3 | 1 | 3 | 4 |
| **A3** | 4 | 5 | 1 | 4 | 3 |
| **A4** | 5 | 4 | 5 | 2 | 3 |
| **A5** | 1 | 3 | 3 | 5 | 5 |
| **A6** | 3 | 4 | 1 | 4 | 4 |
| **A7** | 2 | 2 | 1 | 2 | 3 |
| **A8** | 4 | 3 | 3 | 3 | 2 |
| **A9** | 1 | 5 | 5 | 5 | 4 |
| **A10** | 3 | 4 | 3 | 5 | 5 |

Next is to determine the normalized decision matrix with the formula:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=0}^{m} x_{ij}^2}}$$

with i = 1, 2,…., m and j = 1, 2,…..,n. In the calculation it is only shown up to X2, for X3 and then up to X5 the calculation method is the same with different values.

1. For criteria of Working Period (X1)

$\mathbf{X_1} = \sqrt{4^2+3^2+4^2+5^2+1^2+3^2+2^2+4^2+1^2+3^2} = \sqrt{5^2+4^2+3^2+3^2+5^2+4^2+3^2+2^2+4^2+5^2} = \sqrt{4^2+3^2+4^2+5^2+1^2+3^2+2^2+4^2+1^2+3^2} = \sqrt{106} = 10.296$

| |
|---|
| $R_{11} = \frac{x_{11}}{\lvert X1\rvert} = \frac{4}{10.296} = 0.389$ |
| $R_{21} = \frac{x_{21}}{\lvert X1\rvert} = \frac{3}{10.296} = 0.291$ |
| $R_{31} = \frac{x_{31}}{\lvert X1\rvert} = \frac{4}{10.296} = 0.389$ |
| $R_{41} = \frac{x_{41}}{\lvert X1\rvert} = \frac{4}{10.296} = 0.486$ |
| $R_{51} = \frac{x_{51}}{\lvert X1\rvert} = \frac{1}{10.296} = 0.097$ |
| $R_{61} = \frac{x_{61}}{\lvert X1\rvert} = \frac{3}{10.296} = 0.292$ |
| $R_{71} = \frac{x_{71}}{\lvert X1\rvert} = \frac{2}{10.296} = 0.194$ |
| $R_{81} = \frac{x_{81}}{\lvert X1\rvert} = \frac{4}{10.296} = 0.389$ |
| $R_{91} = \frac{x_{91}}{\lvert X1\rvert} = \frac{1}{10.296} = 0.097$ |
| $R_{101} = \frac{x_{101}}{\lvert X1\rvert} = \frac{3}{10.296} = 0.291$ |

2. For the criteria for Position Level (X2)

$\mathbf{X_2} = \sqrt{5^2+3^2+5^2+4^2+3^2+4^2+2^2+3^2+5^2+4^2} = \sqrt{5^2+4^2+3^2+3^2+5^2+4^2+3^2+2^2+4^2+5^2} = \sqrt{4^2+3^2+4^2+5^2+1^2+3^2+2^2+4^2+1^2+3^2} = \sqrt{154} = 12.410$

| |
|---|
| $R_{12} = \frac{x_{12}}{\lvert X2\rvert} = \frac{5}{12.410} = 0.403$ |
| $R_{22} = \frac{x_{22}}{\lvert X2\rvert} = \frac{3}{12.410} = 0.242$ |
| $R_{32} = \frac{x_{32}}{\lvert X2\rvert} = \frac{5}{12.410} = 0.403$ |
| $R_{42} = \frac{x_{42}}{\lvert X2\rvert} = \frac{4}{12.410} = 0.322$ |
| $R_{52} = \frac{x_{52}}{\lvert X2\rvert} = \frac{3}{12.410} = 0.242$ |
| $R_{62} = \frac{x_{62}}{\lvert X2\rvert} = \frac{4}{12.410} = 0.322$ |
| $R_{72} = \frac{x_{72}}{\lvert X2\rvert} = \frac{2}{12.410} = 0.161$ |
| $R_{82} = \frac{x_{82}}{\lvert X2\rvert} = \frac{3}{12.410} = 0.242$ |
| $R_{92} = \frac{x_{92}}{\lvert X2\rvert} = \frac{5}{12.410} = 0.403$ |
| $R_{102} = \frac{x_{102}}{\lvert X2\rvert} = \frac{4}{12.410} = 0.322$ |

from the calculation above, the normalized matrix is obtained as follows:

Table 6. Normalized Decision Matrix

| | Criteria | | | | |
|---|---|---|---|---|---|
| **Alternative** | **C1** | **C2** | **C3** | **C4** | **C5** |
| **A1** | 0.389 | 0.403 | 0.316 | 0.252 | 0.403 |
| **A2** | 0.291 | 0.242 | 0.105 | 0.252 | 0.322 |
| **A3** | 0.389 | 0.403 | 0.105 | 0.336 | 0.242 |
| **A4** | 0.486 | 0.322 | 0.527 | 0.168 | 0.242 |
| **A5** | 0.097 | 0.242 | 0.316 | 0.420 | 0.403 |
| **A6** | 0.291 | 0.322 | 0.105 | 0.336 | 0.322 |
| **A7** | 0.194 | 0.161 | 0.105 | 0.168 | 0.242 |
| **A8** | 0.389 | 0.242 | 0.316 | 0.252 | 0.161 |
| **A9** | 0.097 | 0.403 | 0.527 | 0.420 | 0.322 |
| **A10** | 0.291 | 0.322 | 0.316 | 0.420 | 0.403 |

After obtaining the normalized decision matrix, proceed with the weighted normalized decision matrix by multiplying each column of the normalized decision matrix element with the preference weight of each criterion, namely W = (0.42, 0.26, 0.16, 0.10, 0.06). The preference weight is the Eigen Vector value from the calculation of pairwise comparisons of each criterion using the AHP method. Below is the calculation. from the matrix elements of the weighted normalization only on C1 and C2, for C3, C4 and C5 it can be adjusted using the same weighted normalization calculation stages as C1 and C2. the following is the calculation;

$Y_{11}$ = 0.389 x 0.42 = 0.162
$Y_{21}$ = 0.291 x 0.42 = 0.121
$Y_{31}$ = 0.389 x 0.42 = 0.162
$Y_{41}$ = 0.486 x 0.42 = 0.202
$Y_{51}$ = 0.097 x 0.42 = 0.040

$Y_{61}$ = 0.291 x 0.42 = 0.121
$Y_{71}$ = 0.194 x 0.42 = 0.081

$Y_{81}$ = 0.389 x 0.42 = 0.162
$Y_{91}$ = 0.097 x 0.42 = 0.040
$Y_{101}$ = 0.291 x 0.42 = 0.121

From the calculation above, the weighted normalized matrix is obtained as follows:

Table 7. Weighted Normalized Matrix

| | Criteria | | | | |
|---|---|---|---|---|---|
| **Alternative** | **C1** | **C2** | **C3** | **C4** | **C5** |
| **A1** | 0.161 | 0.105 | 0.051 | 0.025 | 0.025 |
| **A2** | 0.121 | 0.063 | 0.017 | 0.025 | 0.020 |
| **A3** | 0.162 | 0.105 | 0.017 | 0.033 | 0.015 |
| **A4** | 0.202 | 0.084 | 0.085 | 0.017 | 0.015 |
| **A5** | 0.040 | 0.063 | 0.051 | 0.041 | 0.025 |
| **A6** | 0.121 | 0.084 | 0.017 | 0.033 | 0.020 |
| **A7** | 0.081 | 0.042 | 0.017 | 0.017 | 0.015 |
| **A8** | 0.162 | 0.063 | 0.051 | 0.025 | 0.010 |
| **A9** | 0.040 | 0.105 | 0.085 | 0.041 | 0.020 |
| **A10** | 0.121 | 0.084 | 0.051 | 0.041 | 0.025 |

Table 8. Distance to Positive Ideal Solution

| Alternative | Distance from Positive Ideal Solution |
|---|---|
| $D1^+$ | 0.055 |
| $D2^+$ | 0.115 |
| $D3^+$ | 0.080 |
| $D4^+$ | 0.034 |
| $D5^+$ | 0.171 |
| $D6^+$ | 0.108 |
| $D7^+$ | 0.155 |
| $D8^+$ | 0.071 |
| $D9^+$ | 0.162 |

Table 9. Alternative Rank

| Ranking | Alternative | Candidate's Name | Preference Value |
|---|---|---|---|
| 1 | D4 | Suharno | 0.841 |
| 2 | D1 | Yayat S. | 0.720 |
| 3 | D8 | Rivandi Ali | 0.643 |
| 4 | D3 | Reza P. | 0.633 |
| 5 | D10 | Nani | 0.530 |
| 6 | D6 | Rabbiah A. | 0.463 |
| 7 | D2 | Adi P. | 0.424 |
| 8 | D9 | Denta | 0.374 |
| 9 | D5 | M. Robi | 0.225 |
| 10 | D7 | Ari Semadi | 0.208 |

Based on the table above it can be concluded that the highest preference value is Suharno (D4) with a value of 0.841, so Suharno will be prioritized to win the award as AIS Office Of The Year INAIMA based on the calculation of 10 other candidates used as samples.

b. Proposed New Procedures

Based on an analysis of the current system for selecting AIS Officer of The Year, it was found that the selection process was carried out manually in collecting and verifying candidate data so that it took a long time and an assessment based only on the sum of scores between criteria was considered to produce an assessment that was not objective. To overcome this, we need a decision support system for selecting the AIS Officer of the Year. This decision support system aims to assist the coordinator of INAIMA's organizational and cadre formation in the selection of AIS Officer of The Year where the design of this system uses UML (Unified Modeling Language), uses the PHP programming language and MySql database.

c. Diagram of System Design

The design of this system is the stage of system design that will be made and is in the form of an overview of the process of the decision support system application for the selection of AIS Officer of The Year.

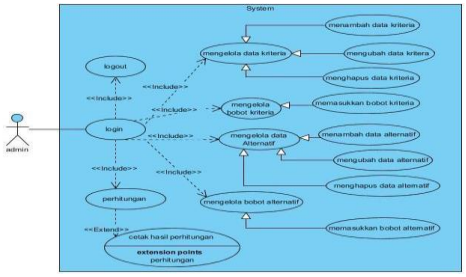


Fig. 2. Use Case Diagram of the proposed system

d. Implementation


Figure 3. Login Form

The Login Form is a Login page that is used to enter the AIS Officer of The Year SPK system where users will be required to enter a username and password to be able to enter the application's main menu.


Figure 4. Main Page

The image above shows the main page that will be displayed after the admin has successfully logged in. On the main page, there are several menus used in the AIS Officer of The Year SPK system, such as the Home menu, Criteria, Alternatives, Calculations and Logout which are used to exit the system.

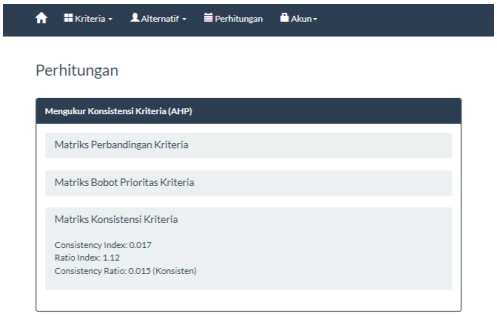


Figure 5. Calculation Page

In the picture above, it is a calculation page that will appear if the admin selects the Calculation menu. On the Calculation page, there are detailed AHP-TOPSIS calculation stages

## 4. Results

a. Result

Based on the results of the research that has been done, the following conclusions can be drawn:

i. The selection of AIS Officer of The Year for INAIMA was carried out without the use of the system so that it took a relatively long time both in data collection and in assessing candidates. In addition, due to the absence of a standard method of assessment, it is assumed that the assessment of the AIS Officer of The Year is not objective

ii. A decision support system for determining the AIS Officer of The Year was successfully created so that the selection can be carried out more quickly, measurably and provides more objective results. The AIS Officer of The Year Decision Support System was created using web-based programming and applying a combination of AHP and TOPSIS methods for its calculations in the selection process

b. Suggestion.

After the design and implementation of the AIS Officer of The Year INAIMA Decision Support System has been implemented, there are several suggestions that can be considered in further system development, namely:

i. Required integration with the support data management system for determining the criteria and data for INAIMA membership so that the process becomes faster.

ii. This SPK can be further developed by adding criteria and sub-criteria in the DSS system so that it can provide better decision-making results.

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