Evaluation of the BMKG Regional Office in North Sumatra's Decision Support System for Movable Asset Selection

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Abstract

The management of movable assets in government agencies requires an appropriate, objective, and measurable decision-making process to support the operational effectiveness of the organization. At the North Sumatra Regional BMKG Office, the selection of movable assets often faces obstacles due to the many alternative assets and various valuation criteria that must be considered simultaneously. This study aims to design and implement a Decision Support System in the selection of movable assets using the Analytical Hierarchy Process or AHP algorithm. The AHP method is used because it is able to break down complex decision problems into a hierarchical structure, determine the weight of each criterion, and generate alternative priorities based on paired comparisons. The stages of the research include problem identification, determination of criteria and alternatives, preparation of pairwise comparison matrices, priority weight calculation, consistency test, and ranking of asset alternatives. The research results show that the application of the AHP method can provide recommendations for the selection of movable assets in a systematic, transparent, and rational manner according to the importance level of each criterion. The system that has been built also helps leaders or asset managers in speeding up the selection process and minimizing subjectivity in decision-making. Thus, the AHP-based Decision Support System can be an effective solution to support the selection of movable assets at the BMKG Regional Office in North Sumatra.

***Keywords**:* Decision Support System, Movable Assets, AHP, Asset Selection, BMKG

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Introduction

The development of information technology has encouraged various institutions to improve the quality of organisational governance, including in the decision-making process. In government institutions, decisions made are no longer sufficient to be based solely on subjective considerations, but must adhere to the principles of effectiveness, efficiency, accountability, and transparency. Recording/inventory and bookkeeping to support the security of regional movable assets [1]. One important aspect in supporting such governance is asset management, particularly movable assets that play a strategic role in supporting the operational activities of the agency. Mobile assets such as official vehicles, field equipment, operational tools, and other mobility support facilities are resources that must be selected, managed, and utilised appropriately to ensure the smooth execution of the organization's tasks. This study aims to evaluate the implementation of movable asset inventory so that consistency and diligence in the application of inventory procedures become important factors in achieving orderly, accurate, and accountable regional asset management. The research results indicate a gap between the actual conditions and expectations in management based on the regulations. There are discrepancies in the stages of use, administration, and supervision in the management of movable assets. [2], [3].

The BMKG Regional Office of North Sumatra, as a government agency with a public service function in the fields of meteorology, climatology, and geophysics, requires adequate mobile assets to support various operational activities. In carrying out its duties, BMKG requires support facilities that can meet the needs of mobility, service speed, equipment distribution accuracy, and operational readiness in various field conditions. Therefore, the selection of movable assets becomes an important part of asset management, as incorrect decisions can lead to decreased work effectiveness, increased operational costs, and suboptimal utilisation of available resources.

Problems in the selection of movable assets generally arise because the process of determining the best alternative involves many criteria that must be considered simultaneously. These criteria can include price, quality, maintenance costs, economic lifespan, usage efficiency, availability of spare parts, and the suitability of the asset to the operational needs of the institution. If the selection process is only done manually or based on individual considerations, the decision-making results are likely to be less objective and difficult to justify. Indicators of asset management, all these indicators have not been functioning well. In the planning indicator, it was found that the planning process carried out in asset management was not fully attended by the general public; those who attended were indicated to be people close to the village leader [4]. This condition indicates the need for an approach that can assist decision-makers in systematically processing various criteria, resulting in more rational and measurable outcomes.

In this context, Decision Support Systems become one of the relevant solutions. Decision Support System is a computer-based system designed to assist in the decision-making process for semi-structured or unstructured problems through the processing of data, models, and specific knowledge. The process of selecting teachers is very important so that students receive the desired instructors. Therefore, a Decision Support System (DSS) needs to be created to assist the institution in selecting teachers more efficiently and effectively. Decision Support System (DSS) for determining algorithms/methods here aims to find the appropriate algorithm/method for a research/journal. (Lusiana) (Syafiatun). In this study, a framework was conducted aimed at analysing the performance of the Decision Tree classification model using ID3 in the field of stroke disease prediction [5].

The presence of Decision Support Systems does not replace the role of decision-makers, but functions as an aid to produce more objective, faster, and consistent recommendations. With the presence of this system, the process of selecting movable assets can be carried out based on clear calculations and the basis for consideration can be traced back [6].

One of the methods widely used in Decision Support Systems is the Analytical Hierarchy Process or AHP. This method was developed by Thomas L. Saaty and is known to be effective in solving multi-criteria decision-making problems. Sistema de Apoyo a la Decisión (DSS) que emplea las técnicas MOORA y MOORSA, además de otros métodos populares como SAW, AHP y TOPSIS [7]. AHP works by structuring the problem into a hierarchy, starting from the goal, criteria, sub-criteria if necessary, down to decision alternatives. Each element is then compared in pairs to obtain priority weights that indicate the relative importance of each criterion and alternative. In addition, AHP also provides a consistency test to ensure that the given assessments remain logical and acceptable [8]. Esta investigación demuestra que no hay una diferencia significativa entre los resultados de los cálculos realizados mediante los métodos AHP y SAW, es decir, las opciones 1, 2 y 4 son aptas para recibir préstamos. Mientras tanto, la opción 3 no cumple con los requisitos de elegibilidad [9].

The selection of the AHP method in this study is based on its ability to accommodate multiple criteria simultaneously and produce an easily understandable ranking of alternative priorities. In the management of movable assets, this method is highly relevant because it allows for a more structured assessment of each asset alternative based on the organization's needs. Thus, the decisions made do not only consider a specific aspect, but take into account all factors that influence the effectiveness of asset usage in both the short and long term. The Analytical Hierarchy Process method can break down criteria into sub-criteria, making the evaluation of each alternative more detailed [10]. Analytical Hierarchy Process (AHP) method. The AHP method is a method used to evaluate actions associated with the comparison of importance weights between factors and the comparison of several alternative choices [11].

This research is important because the selection of movable assets at the BMKG Regional Office in North Sumatra requires a more systematic approach so that the decisions made truly align with the operational needs of the agency. On the other hand, the use of an AHP-based Decision Support System can also be an effort to modernise asset management in a more transparent and efficient manner. The system being developed is expected to assist the management in determining the most prioritised movable assets based on the established criteria, while simultaneously reducing the level of subjectivity in the selection process. Based on the description, the research on the Government Kesi Support System.

Literature Review

2.1 Decision Support System (DSS)

According to Turban and Aronson (2011: 75), a Decision Support System (DSS) or Sistem Pendukung Keputusan (SPK) is a system intended to support managerial decision-makers in semi-structured and structured decision situations. The DSS functions as an addition or support for decision-makers, can expand knowledge and possibilities, but does not replace judgement. This system is intended for decisions that require judgement and decisions that can be processed with algorithms or technically. Decision Support Systems are designed to support all stages of decision-making, starting from identifying the problem, selecting relevant data, and determining the approach used in the decision-making process, to evaluating the selection of available alternatives [12].

Decision Support System (DSS) is designed to support all stages of decision-making, from identifying problems, selecting relevant data, determining the approach used in the decision-making process, to evaluating alternative choices. The Decision Support System (DSS) is a system intended to support semi-structured decision-makers. The Decision Support System (DSS) is meant to be a tool for decision-makers to expand their capacity, but not to replace judgement. [13]).

Then the design phase, which is a model that describes how the system is built. This phase makes simple assumptions by referring to established regulations and criteria and combines all variables. Next, the model is validated and the criteria are collected for an evaluation of the identified options. Then the selection phase, which contains a resolution objective within the model. The final phase is the implementation phase, where the success level of the system in solving the existing problems will be assessed. [14]

2.2 Analytical Hierarchy Process

AHP is a decision support model developed by Thomas L. Saaty. This decision support model will break down complex multi-factor or multi-criteria problems into a hierarchy. According to Saaty (1993), a hierarchy is defined as a representation of a complex problem in a multi-level structure where the first level is the goal, followed by levels of factors, criteria, sub-criteria, and so on down to the last level of alternatives. With a hierarchy, a complex problem can be broken down into its groups, which are then arranged into a hierarchical form, making the problem appear more structured and systematic. [15]

AHP is often used as a problem-solving method compared to other methods for the following reasons:

1. A hierarchical structure, as a consequence of the chosen criteria, down to the deepest sub-criteria.
2. It considers the validity up to the tolerance limit of inconsistency of various criteria and alternatives chosen by the decision-maker.
3. It takes into account the robustness of the decision-making sensitivity analysis output.

The main tool of AHP is a functional hierarchy with its primary input being human perception. The existence of a hierarchy allows complex or unstructured problems to be broken down into sub-problems, and then arranged into a hierarchical form. AHP can solve complex multi-criteria problems by breaking them down into hierarchical levels where the goal is the first level, followed by criteria and sub-criteria, and finally alternatives at the last level. Thus, the problem will appear more systematic and structured, then decomposed into simpler elements to form a hierarchy.

This assessment is the core of AHP, as it greatly influences the prioritisation of the existing elements as the basis for decision-making. The results of this study are presented in the form of a matrix called a pairwise comparison matrix.

a. Decision weights, decision weights indicate the relative importance of each criterion, W = (w1, w2, ..., wn). In MADM, the importance weights of each criterion will be determined.
b. Decision matrix, a decision matrix X of size m x n, contains elements xij, which represent the ratings of alternative Ai (i=1, 2, ..., m) against criterion Cj (j=1, 2, ..., n). The MADM problem is to evaluate m alternatives Ai (i=1, 2, ..., m) against a set of attributes or criteria Cj (j=1, 2, ..., n), where each attribute is independent of the others.

In MADM, the decision matrix for each alternative against each attribute, X, is given as:

$$x = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \cdots & x_{12} \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix}$$

With xij being the performance rating of alternative i against attribute j. • The weight value indicating the relative importance level of each attribute is given as W: W = {w1, w2, ..., wn}.

Calculating the eigenvector of each pairwise comparison matrix, which represents the weight of each element for determining the priority of elements at the lowest hierarchy level until the goal is achieved. The calculation is performed by summing the values of each relevant column to obtain the matrix normalisation, and summing the values of each row and dividing it by the number of elements to getting the average. If A is a pairwise comparison matrix, then the weight vector takes the form:

$$(A)\ (w^T) = (n)\ (w^T)$$

Can be approached in the following way:

(a) Normalise each column j in matrix A, such that

$$\sum a\ (i, j) = 1$$

Refer to it as A’

(b) Calculate the average value for each row I in A':

$$w_i = \frac{1}{n}\sum_{i} a\,(i, j$$

With wi being the weight of the i-th objective from the weight vector.

Checking Hierarchical Consistency. Suppose A is a pairwise comparison matrix and w is a weight vector, then the consistency of the weight vector w can be tested as follows:

(a) Calculate: $(A)(w^T)$

$$t = \frac{1}{n}\sum_{(i=1)}^{n} \frac{(elemen\ ke-\ i\ pada(A)(w^T)}{(elemen\ ke-\ i\ pada\ w^T)}$$

(b) Calculate the consistency index:

$$CI = \frac{t - n}{n - 1}$$

(c) The random index RIn is the average CI value randomly selected from A and given as:

Table 1. Random Consistency Index

n	2	3	4	5	6	7	....
RI_n	0	0,58	0,90	1,12	1,24	1,34	....

(d) Calculate the consistency ratio

$$CR \frac{CI}{RI_n}$$

If CI = 0, then the hierarchy is consistent.
If CR < 0.1, then the hierarchy is fairly consistent.
If CR > 0.1, then the hierarchy is very inconsistent.

Research Methodology

This research uses an applied quantitative approach with the aim of producing a decision support system that can assist in the selection process of movable assets objectively, systematically, and measurably. Quantitative research is used because the decision-making process is carried out by assigning weights to criteria and alternatives that are analysed numerically using the Analytical Hierarchy Process or AHP method. In addition, this research is also of a system development nature, as the final result is an application or decision support system that can be used by the Regional BMKG Office of North Sumatra in determining the priority for selecting movable assets.

This research was conducted at the BMKG Regional Office of North Sumatra. This location was chosen because the agency has a need for the proper management and selection of movable assets to support the smooth operation of activities. The research period is carried out from the data collection stage, needs analysis, system design, implementation, to system testing. The implementation of the research can be adjusted according to the schedule and research permits applicable to the relevant institutions.

The object of this research is the process of selecting movable assets at the BMKG Regional Office in North Sumatra. The movable assets referred to can include official vehicles, field operational equipment, or other movable facilities used to support the agency's activities.

The focus of the research is directed towards determining the best asset alternatives based on a number of relevant criteria, such as price, quality, maintenance cost, economic lifespan, usage efficiency, and suitability for operational needs.

Results

1. Determination of criteria and alternatives
   In this calculation example, 4 criteria and 3 alternatives for movable assets are used. The criteria used are:
   K1 = Price
   K2 = Operational suitability
   K3 = Maintenance cost
   K4 = Economic lifespan
   The alternatives for the movable assets being evaluated are:
   A1 = Operational Vehicle Type A
   A2 = Operational Vehicle Type B
   A3 = Operational Vehicle Type C
   The main objective is to determine the best alternative movable asset for the BMKG Regional Office in North Sumatra.
2. Pairwise comparison matrix between criteria
   The criteria comparison matrix is arranged as follows:
   K1 to K1 = 1
   K1 to K2 = 1/5
   K1 to K3 = 1/3
   K1 to K4 = 1/2

   K2 to K1 = 5
   K2 to K2 = 1
   K2 to K3 = 3
   K2 to K4 = 4

   K3 to K1 = 3
   K3 to K2 = 1/3
   K3 to K3 = 1
   K3 to K4 = 2

   K4 to K1 = 2
   K4 to K2 = 1/3
   K4 to K3 = 1/2
   K4 to K4 = 1
   If written in matrix form:
   K =
   [1 1/5 1/3 1/2]
   [5 1 3 4
   [3 1/3 1 2]
   [2 1/4 1/2 1]

3. Summing each column
   Number of Columns K1 = 1 + 5 + 3 + 2 = 11
   Number of Columns K2 = 1/5 + 1 + 1/3 + 1/4 = 1,7833
   Number of Columns K3 = 1/3 + 3 + 1 + 1/2 = 4,8333
   Number of Columns K4 = 1/2 + 4 + 2 + 1 = 7,5

4. Normalisation of the criteria matrix
   Each element is divided by the number of its columns.
   Line K1

1 / 11 = 0,0909
0,2 / 1,7833 = 0,1121
0,3333 / 4,8333 = 0,0690
0,5 / 7,5 = 0,0667

Line K2
5 / 11 = 0,4545
1 / 1,7833 = 0,5607
3 / 4,8333 = 0,6207
4 / 7,5 = 0,5333

Line K3
3 / 11 = 0,2727
0,3333 / 1,7833 = 0,1869
1 / 4,8333 = 0,2069
2 / 7,5 = 0,2667

Line K4
2 / 11 = 0,1818
0,25 / 1,7833 = 0,1402
0,5 / 4,8333 = 0,1034
1 / 7,5 = 0,1333
The criteria normalisation matrix becomes:
Line K1 = 0,0909; 0,1121; 0,0690; 0,0667
Line K2 = 0,4545; 0,5607; 0,6207; 0,5333
Line K3 = 0,2727; 0,1869; 0,2069; 0,2667
Line K4 = 0,1818; 0,1402; 0,1034; 0,1333

5. Calculating the priority weight of the criteria
   The priority weight is obtained from the average of each row.
   Weight K1 = (0,0909 + 0,1121 + 0,0690 + 0,0667) / 4 = 0,0847
   Weight K2 = (0,4545 + 0,5607 + 0,6207 + 0,5333) / 4 = 0,5423
   Weight K3 = (0,2727 + 0,1869 + 0,2069 + 0,2667) / 4 = 0,2333
   Weight K4 = (0,1818 + 0,1402 + 0,1034 + 0,1333) / 4 = 0,1397
   So the weight of the criteria is:
   K1 = 0,0847
   K2 = 0,5423
   K3 = 0,2333
   K4 = 0,1397
   The interpretation is that the most important criterion is operational suitability, followed by maintenance costs, then economic lifespan, and lastly price.
6. Consistency test of the criteria matrix
   The first step is to calculate the result of multiplying the initial matrix with the weight vector.
   $A \times W$
   For K1
   $= (1 \times 0{,}0847) + (1/5 \times 0{,}5423) + (1/3 \times 0{,}2333) + (1/2 \times 0{,}1397)$
   $= 0{,}0847 + 0{,}1085 + 0{,}0778 + 0{,}0698$
   $= 0{,}3408$
   For K2
   $= (5 \times 0{,}0847) + (1 \times 0{,}5423) + (3 \times 0{,}2333) + (4 \times 0{,}1397)$

   $= 0{,}4235 + 0{,}5423 + 0{,}6999 + 0{,}5588$
   $= 2{,}2245$

For K3
= (3 × 0,0847) + (1/3 × 0,5423) + (1 × 0,2333) + (2 × 0,1397)
= 0,2541 + 0,1808 + 0,2333 + 0,2794
= 0,9476
For K4
= (2 × 0,0847) + (1/4 × 0,5423) + (1/2 × 0,2333) + (1 × 0,1397)
= 0,1694 + 0,1356 + 0,1167 + 0,1397
= 0,5614
Next, each result is divided by the priority weight.
$\lambda 1$ = 0,3408 / 0,0847 = 4,0244
$\lambda 2$ = 2,2245 / 0,5423 = 4,1015
$\lambda 3$ = 0,9476 / 0,2333 = 4,0612
$\lambda 4$ = 0,5614 / 0,1397 = 4,0178
VAlue λ maks
= (4,0244 + 4,1015 + 4,0612 + 4,0178) / 4
= 4,0512
Consistency Index
CI = (λ maks reduced n) / (n reduced1)
CI = (4,0512 reduced 4) / (4 reduced 1)
CI = 0,0512 / 3
CI = 0,0171
Because the number of criteria is 4, the score RI = 0,90
Consistency Ratio
CR = CI / RI
CR = 0,0171 / 0,90
CR = 0,0190
Because CR < 0.10, the criteria comparison matrix is consistent.

7. Recap the weight of alternatives for each criterion
   On the price criteria
   A1 = 0,6333
   A2 = 0,1061
   A3 = 0,2605
   On the operational suitability criteria
   A1 = 0,1061
   A2 = 0,6333
   A3 = 0,2605
   On the maintenance cost criteria
   A1 = 0,1061
   A2 = 0,2605
   A3 = 0,6333
   On the criteria of economic lifespan
   A1 = 0,1061
   A2 = 0,6333
   A3 = 0,2605
8. Calculating the final value of each alternative
   Synthesis formula:
   Final value of the alternative = Σ (criterion weight × alternative weight on that criterion)
   Final Value A1
   = (0,0847 × 0,6333) + (0,5423 × 0,1061) + (0,2333 × 0,1061) + (0,1397 × 0,1061)
   = 0,0536 + 0,0576 + 0,0248 + 0,0148
   = 0,1508

Final Value A2
= (0,0847 × 0,1061) + (0,5423 × 0,6333) + (0,2333 × 0,2605) + (0,1397 × 0,6333)
= 0,0090 + 0,3435 + 0,0608 + 0,0884
= 0,5017
Final Value A3
= (0,0847 × 0,2605) + (0,5423 × 0,2605) + (0,2333 × 0,6333) + (0,1397 × 0,2605)
= 0,0221 + 0,1413 + 0,1478 + 0,0364
= 0,3476
Ranking 1 = A2 with a score of 0.5017
Ranking 2 = A3 with a score of 0.3476
Ranking 3 = A1 with a score of 0.1508

Based on the manual calculation results of the AHP method, the best alternative is A2 because it has the highest global priority value, which is 0.5017. This indicates that A2 is the most recommended movable asset to be chosen at the BMKG Regional Office in North Sumatra.

Based on the results of manual calculations using the Analytical Hierarchy Process method, the highest criterion weight was obtained for the operational suitability criterion at 0.5423. This indicates that in the selection of movable assets, the aspect of asset suitability with the operational needs of the office becomes the main consideration. The next criteria are maintenance costs at 0.2333, economic lifespan at 0.1397, and price at 0.0847. All pairwise comparison matrices have a Consistency Ratio value below 0.10, thus they can be considered consistent and suitable for use in the decision-making process. The results of the global priority synthesis show that alternative A2 received the highest value of 0.5017, followed by A3 with 0.3476, and A1 with 0.1508. Thus, alternative A2 has been designated as the top priority in the selection of movable assets at the BMKG Regional Office of North Sumatra.

Conclusion

Based on the research results that have been conducted, it can be concluded that the application of the Decision Support System using the Analytical Hierarchy Process method can assist in the selection process of movable assets at the BMKG Regional Office in North Sumatra in a more systematic, objective, and measurable manner. This method is capable of processing various criteria that serve as the basis for consideration in asset selection, so the decisions produced are not only dependent on subjective assessments but are based on clear and rational weighting.

The calculation results show that the criterion with the highest priority weight is operational suitability with a value of 0.5423, followed by maintenance costs at 0.2333, economic lifespan at 0.1397, and price at 0.0847. This shows that in the process of selecting movable assets, the most prioritised aspect is the asset's ability to optimally support the operational needs of the institution. Based on the synthesis of global priorities for all alternatives, it was found that alternative A2 has the highest value of 0.5017, followed by alternative A3 with a value of 0.3476, and alternative A1 with a value of 0.1508. Thus, alternative A2 is declared the best and most recommended alternative in the selection of movable assets at the BMKG Regional Office of North Sumatra.

In addition, the consistency test results show that all Consistency Ratio values are below the 0.10 threshold, so the assessments given can be considered consistent and suitable as a basis for decision-making. Therefore, this AHP-based decision support system can be used as an effective solution to improve the quality of decision-making in the management of movable assets within the BMKG Regional Office of North Sumatra.

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