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APPLICATION OF ANALYTIC NETWORK PROCESS (ANP) METHOD BASED ON ESTABLISHED CRITERIA IN THE SELECTION OF THE LOCATION OF MAKO LANTAMAL VI

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ABSTRACT

This study discusses the degradation condition of the Makassar VI Naval Base which has experienced a decline in its function as an operational support center for the Indonesian Navy. So that it has an impact on the optimality of the implementation of base duties. Through the application of the Analytic Network Process (ANP) method, this study aims to determine the best alternative in choosing the location of Mako Lantamal VI. The alternative involves Lanal Mamuju, Lanal Kendari, Lanal Baubau, and Lanal Palu which are work units under Lantamal VI Makassar which are located in the Sea Route of the Islands II (ALKI II). Criteria and subcriteria in determining the best alternative include, geography, resources, and socio-cultural aspects. As a result, this research is expected to be a strategic foundation in preparing a plan for projecting the strength of the Indonesian Navy in the future. Where is the urgency in this research, so that the function of the base according to its principles can still be carried out. This study intends to select the location of Mako Lantamal VI due to the degradation of the base function which results in the main functions and tasks of the base being constrained, The solution of this study will use the Analytical Network Process (ANP) method where the results of data processing are obtained by the weight of geography criteria (0.47433), socio-cultural (0.13536), and resource criteria (0.237890).

Keywords : *Decision making, Multi Citeria Decision Making (MCDM), ANP-MOORA Naval Base.*

1. INTRODUCTION

The Main Base of the Indonesian Navy VI Makassar in carrying out its duties to support the operations of the Indonesian Navy is currently experiencing a decline in its basic function, this condition occurs, especially related to the impact of the Makassar New Port (MNP) development reclamation project (Kamaruddin et al., 2020). Although Lantamal VI has an important responsibility in providing administrative and logistical support, its condition is not optimal due to various factors such as budget limitations, inadequate pier facilities, and lack of human resources. The impact of economic growth and the MNP project also includes changes in the morphology of the surrounding region (ACHSAN, 2015), resulting in problems such as limited ship maneuvering space and acceleration of siltation in the Lantamal VI pier pool (Kamaruddin et al., 2020).

The plan to build the TNI Navy's strength in the future has a significant impact on the Lantamal VI berth facilities, especially related to the lego anchor area. In addition, the dense population settlement around Lantamal VI is also a factor that affects the existence and development of the base (Musbawati et al., 2022). The importance of maintaining the function of the Naval Base as a point for resupplying the KRI, safeguarding the stability of state integration, and deterring threats from other countries through the sea and coast (Mardhani et al., 2020). To determine alternative locations that consider potential vulnerabilities in the region, the *Anlitic Network Proces* (ANP) (Hondro, 2018).

The urgency in this study is to continue to maintain the role and function of the Base according to its basic function as a place for the development of sea power to the area of operation or *"deployment forces position"* will have an important meaning in supporting the operational tasks of the Indonesian Navy as a security operation unit at sea (Suharyo, 2017). In addition, the base as *"Home Base"* has functional criteria in accordance with the 5 R's, namely: *Rest, Refresh, Refuel,*

Repair and Replenishment, In addition, the role of the Base as a waiting point and a place for the development of forces to the sea is very much needed, besides that Lantamal VI is located in the Indonesian Archipelago Sea (ALKI) II channel including the Sulawesi Sea, Makassar Strait, Lombok Strait, and Flores Sea, which connects shipping routes, international trade from Africa to Southeast Asia and Japan, and from Australia to Singapore, China, and Japan, so it is highly expected that the existence and function of the Base will be optimal. (Suharjo & Suharyo, 2019).

Where the results are, this study aims to provide strategic input in compiling the projection of the strength of the Indonesian Navy in the future by considering the impact of environmental conditions, and changes in the use of the defensive area around Lantamal VI. This method ANP is used to be able to solve the problem of decision-making in determining the location of Mako Lantamal VI (Singh, 2017) in maintaining the function and strategic role of the TNI Navy Main Base (Puspitasari & Pradoto, 2013).

2. MATERIAL AND METHOD

2.1. Multi Citeria Decision Making (MCDM)

In daily life, humans are often faced with various problems and challenges. One of the challenges that is commonly faced is how to make the right decision in the midst of many options (alternatives) and criteria (attributes) that must be considered (Muanley et al., 2022). Humans are always looking for the best way or solution to solve this problem, and as a result, various methods and solutions have been developed. One of the methods that is often used to overcome this decision-making challenge is the Decision-Making Method with Multiple Criteria *(Multiple Criteria Decision Making* - MCDM) (Purnomo et al., 2020). This method helps humans to detail and understand in various factors that need to be considered when facing complex decisions. With MCDM, we can conduct a better and more informed analysis to choose the alternative that best suits our goals and needs (Ardielli, 2020).

2.2. Method *Analytic Network Process* (ANP)

Analytic Network Process Method (ANP) is a development of the *Analytical Hierarchy Process* (AHP) (Tuzkaya et al., 2008). The ANP method is able to correct structural differences in AHP in the form of the ability to accommodate the relationship between criteria or alternatives. There are two types of linkages in the ANP method, namely linkages in a set of elements (*inner dependence*) and the interconnection between different elements (*outerdependence*) (Pane & Erwansyah, 2020). The basic principle of the *Analytic Network Process* (ANP) is to think analytically, in order to make a decision in a methodology *Analytic Network Process* (ANP) based on the following principles:

a. Preparation of network structure

Network preparation is a step to define complex problems into clusters and their elements, as well as identify the relationships of interaction and dependency that exist in them. This structure is prepared based on the views of parties who have expertise and knowledge in the relevant field.

b. Prioritization

Prioritization consists of criteria elements that can be seen as the weight or contribution of these elements to the decision-making objectives. ANP conducts element priority analysis using the paired comparison method between two elements. This priority is determined based on the views of experts and interested parties on the decision, either directly (interview) or indirectly (questionnaire).

c. Logical Consistency

The consistency of the respondents' answers in determining the priority of the elements is a basic principle that will determine the validity of the data and the results of decision-making. In general, respondents should have consistency in the comparison of elements.

The *Analytic Network Process* (ANP) method in the decision-making process has stages or steps in making ANP. The following are the steps to make an ANP according to Saaty (1999):

a. Step One: Model construction and problem structuring. The construction of the model is made based on the existing problem, so it is necessary to clearly describe the problem, and form it into a network.

b. Step Two: A paired comparison matrix showing the linkages. The pairwise comparison of ANP was carried out by comparing the level of importance of each element to its control criteria. The scale used for comparison according to Saaty (1999) with the assessment as shown in Table 2.1.

c. Step Three: Calculate the weight of the element (Eigenvector Value). After the paired comparison matrix is carried out, the eigenvalue of the matrix is then determined. The eigenvector calculation is by summing the values of each column from the matrix then dividing each column cell value by the total column and summing the values from each row and dividing by n. The eigenvector value is calculated by equation 1.

$$Xi = \frac{\sum_{j=1}^{n} (\frac{Wij}{\sum wj})}{n} \quad \text{..... (1)}$$

Information:

X : eigenvector (weight) line i

i; j :line; column

Wij : value in a single line i (j = 1.2, ... n)

ΣWj : the total number of columns j (j = 1,2, ... n)

n : size of the order matrix

e. Step Four: Calculate the Consistency Ratio.After getting the eigen, then check the consistency ratio, the consistency ratio is a ratio that states whether the assessment given by the experts is consistent or not. The first step is to find the value λmax using the 2nd (two) equation.

$$\lambda max = \sum_{ij=1}^{n} (\sum Wj * X1) \quad \text{.....(2)}$$

Information:

wj : the total number of columns j (j = 1, 2, ... n)

Xi : eigenvector (weight) line i

After obtaining the maximum lambda, then the Consistency Index (CI) of a comparison matrix is calculated by the third equation:

$$C1 = \frac{\lambda \max - n}{n-1} \quad \text{.....(3)}$$

The consistency ratio (CR) can be obtained by comparing the value of the consistency index with the value of the random consistency index (RI) in equation 4 (four).

$$C1 = \frac{CI}{RI} \quad \text{.....(4)}$$

Information:

λmax : The largest eigenvalue of the paired comparison matrix n x n: The number of items being compared (matrix size)

C*I* : Consistency Index

RI: Random Index

Table 2.1 Nialai Random Index Table

N	1	2	3	4	5	6	7	8	9
RI	0	0	0,58	0.9	1,12	1,24	1,32	1,41	1,45

f. Fifth Step: Super matrix formation. A super matrix is a matrix consisting of sub-sub-matrices that are composed of a set of relationships between two levels contained in the model. There are three levels of super matrix that must be completed in the ANP model, namely:

1). Unweighted super matrix Each column in an unweighted super matrix contains one vector eigen, so in total, a single column will have more than 1 vector eigen.

2). The weighted super matrix is obtained by multiplying all vector eigens in the unweighted super matrix by the weights of their respective clusters.

3). *Limit super matrix* The limit contains global priority weights in a weighted super matrix that has converged and is stable. The value is obtained by weighted super matrix multiplied by 2k + 1, where k is a large number. Selection of the Best Alternatives.

After obtaining the value of each element in the limit matrix, the next step is to perform a calculation on the value of these elements according to the ANP model created. The alternative with the highest global priority is the best alternative.

2.3 Methodology

In the design stage of data collection and processing methods, the following activities are carried out:

a. Primary and secondary data sources

Primary Data; The data is in the form of a multi-level assessment questionnaire regarding the distribution transformer insertion program. Secondary Data; Secondary data is existing data regarding the condition of a base, customer potential, and ease of execution as a complement to data to support decision-making. Data collection of the Management Questionnaire, Determination of alternative criteria by conducting discussions with experts in the fields of Operational Staff, planning, and logistics staff at Lantamal VI Makassar through the Group Discussion Forum (FGD) followed by primary data collection. The primary data was obtained by providing a questionnaire assessment of the multi-level comparison criteria regarding decision-making in determining the prioritization of the location of transformer inserts. The expert respondents were selected based on the following qualifications: a) Are TNI Navy officers serving in Lantamal VI Makassar.

b. Carrying out duties in the Planning section, the field of logistics and engineering.

c. Employees with a working experience of more than 15 years with the rank of Lieutenant Colonel and above.

d. Experienced in Base location, distribution and maritime potential.

3. RESULT AND DISCUSSION.

3.1 Criteria Data

In this study, the ANP method is used in describing the relationship that occurs between the criteria obtained by Referring to the Decree of the Naval Base Number: Skep/1771/XII/2013 concerning the standardization of the TNI Navy Base, the base as part of the SSAT component must be able to perform its function optimally to provide the logistical support needed in the operation of other SSAT components, such as ships or KRI, aircraft, and Marines. Then collect data with questionnaires for experts/experts (Nurjanah et al., 125 C.E.). The assessment carried out is a pair comparison with a scale to describe the influence of the relationship between one criterion and the other criteria and obtain the weight value of the criterion by the ANP method to obtain the ranking value of the alternative that has been determined (Arsita et al., 2021). The existing criteria and sub-criteria that have been considered in this study are as seen in Table 1.2 (one) as follows.

Table 3.1 Criteria and subcriteria

NO	CRITERION	SUB CRITERIA	DEFINITION
1	**GEOGRAPHY**	**Cruise Flow**	Explain the condition and situation of the waters heading to a port area where it will later be used as a reference for shipping routes from ships and it is hoped that the route is a safe area from all forms of navigation hazards.
		Shipping Navigation Aids (SBNP)	It is a means and facility that can help in shipping activities in the shipping channel, either in the form of beacon signs, flare buoys or other signs that help ships to be able to carry out activities safely.
		Types of seabed	It is a state and condition that explains the type of material that exists on the seabed in a certain area.
		Coastal Morphology	A condition that explains a condition around the beach and explains the relief of the beach itself, be it a beach formation such as a sandy beach, coral or a stretch of mangroves, including there also the relief of the beach itself which concerns the steepness or slope of the beach.
		Sea Depth	A condition that describes how deep the seabed in the Gulf is an alternative choice, which is related to the ship's ability to dock.
		Landing Area	It is an area/land that can be used as a landing place for amphibious ships and amphibi camps to be used as a coastal support area in a sea operation.
		Military Training Area	It is an area/location that can be used as a military training area for both water ship training activities, submarines or marine forces.
2	**RESOURCES**	**Land availability**	Explain about a condition of the land/area available to be used as a dock and mako lanal location.
		Staples Support Facilities	The available facilities include facilities and base supports such as foodstuffs, fuel, fresh water and the existence of traditional markets and building materials or materials.
		Maritime Industry Support Facilities	It is a condition for facilities that allow the availability of support for the maritime industry, be it in the form of opportunities for dock development, the availability of ship spare parts, workshop facilities and even the availability of experts/technicians in the maritime and shipping sectors.
3	**SOCIO-CULTURE**	**Educational Facilities**	It is about something related to the condition of educational institutions, school facilities
		Health Facilities	Explaining health support facilities, both from the Puskesmas to the hospital level and explaining the ability to provide services in the health sector itself.

		Socio-Cultural Conditions	It is a community environment that reflects the local social conditions of settlements, government centers, development efforts in the near future, and the existence of locations with military institutions and the National Police
		Political Conditions	It is a location that is prone to conflict or safe, and reflects the living situation of the community and the state of the community.
		Transportation	It is a means of supporting transportation in an area, be it land, sea or air transportation facilities there.
		Means of Communication	It is a means of supporting communication both between regions and between islands, in this case it also concerns telephone networks, the internet and radio communication.

In the criteria obtained by Referring to the Decree of the Naval Base Number: Skep/1771/XII/2013 concerning the standardization of the TNI Naval Base , a weighting questionnaire was carried out using the ANP (Analytical Network Process) multiple comparison method (Rizaldi, Yunita, & Rodiah, 2020).

3.2 Weighting Criteria

The assessment of the criteria in the ANP is calculated through a double or pairwise comparison questionnaire filled out by 6 (six) experts who are currently serving as Commanders, deputy commanders of operational staff, planning staff, logistics staff, and the Head of the Lantamal VI Makassar base facilities office. As seen in Table 3.2 below.

Table 3.2 Criterion Weighting Questionnaire.

Criterion (A)	Intensity of Interest																	Criterion (B)
Geography	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Insecurity
Geography	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Social Culture
Geography	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Source power
Insecurity	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Social Culture
Insecurity	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Source power
Social Culture	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Source power

3.3 Data Processing

At this stage, to get the weighting of the ANP, a questionnaire was conducted on 6 (six) respondents. The answers from the questionnaire filled out by the respondents are then normalized with the geomaen formula a = which will be $\sqrt[n]{a1 * a2 * an}$ input in the super decision software of the ANP method. Respondents will be asked to choose a comparison of values from 1 to 9 where the

value of 1 has the same meaning and the greater the value of filling, the greater the value of importance according to the Saaty scale. As seen in figure 3.1 below.

Figure 3.1 Comparison of Alternative Clusters with Criteria using Super Decision Software

Each pairwise comparison consistency ratio value of each comparison must be less than 0.1. If the overall paired comparison on all nodes is consistent (the consistency ratio is below 0.1), then a weight will be obtained for each criterion. As shown in figure 3.2.

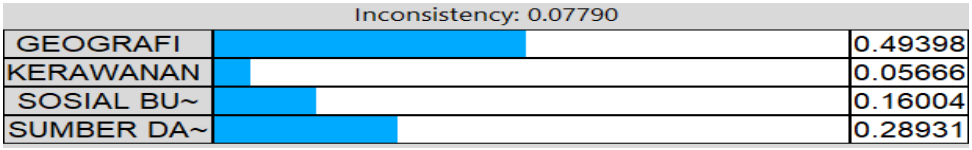

Figure 3.2 Normalized weighting results using *Super Decision*

As seen in the figure above, the inconsistency value of the paired comparison on all nodes is consistent (the consistency ratio is below 0.1) where the value is (0.07790).

3.4. Weighting Criteria

At this stage, to get the ANP weighting, a questionnaire was carried out on the calculation of the double comparison weighting in this study assisted by using the Expert Choice application by entering the questionnaire scores from 6 (six) expert respondents.

NO	CRITERION	PRIORITY WEIGHT
1	Geography	0,47433
2	Socio-Cultural	0,13536
3	Resources	0,23780
4	Cruise Flow	0,09676
5	Training District	0,03504
6	Landing Area	0,02710
7	Types of seabed	0,02325
8	Sea Depth	0,10638
9	Coastal Morphology	0,11615
10	Means of Navigation	0,69533

11	Health Facilities	0,28610
12	Educational Facilities	0,28545
13	Political Conditions	0,07841
14	Socio-Cultural Conditions	0,14147
15	Means of Communication	0,19374
16	Transportation	0,01484
17	Maritime Industry Facilities	0,14763
18	Logistics Facilities	0,34110
19	Land Availability	0,51127

3.5. Criterion Weighting Analysis with the AHP Method

In this study, a limit of 4 (four) Mako Lantamal VI location plans was given as an alternative option. The initial stage in determining location priority is to conduct an FGD (Focus Group Discussion) to determine criteria, alternatives and continue with a questionnaire to 6 (six) expert respondents in the field of Base to compare the criteria calculated with the ANP method. The results of the respondent questionnaire were found to be inconsistent below 10%, which means that it can be used for the next stage.

Based on the data from the results of the ANP Weighting Prioritization Order, it was found that the Geography criterion (0.47433) was the most dominant criterion to be considered in the selection of the location of Mako Lantamal VI, then the criteria with a weight of (0.23780) and Socio-cultural with a weight (0.13536) where all of these need to be considered in making a decision in obtaining the best solution.

3.6. Sensitivity Analysis

Sensitivity analysis was carried out in this study with the aim of ansicipating the possibility of a change in criteria that resulted in a change in the order of prioritization of alternatives, a change in the ranking of alternative priorities did not occur when a change was made in 10% and in the priority alternatives did not have a significant change in the ranking order. Changes will occur if the increase or decrease in the criteria is above 50%. Thus, it can be concluded that the results of the weight increase sensitivity analysis in the ANP method can be used as a reference.

4. CONCLUSION

From the results of data collection and processing, as well as the analysis and interpretation of data processing results from the previous chapter that has been carried out, the conclusions that can be drawn in this study are: where the results of processing using a decision-making model using the *Analytic Network Process* (ANP) method using *Super Decision Software* then the weight of the criteria is obtained, namely geography (0.47433), socio-cultural (0.13536), and resource criteria (0.237890). while the sensitivity analysis was carried out in this study with the aim of anticipating the possibility of a change in criteria that resulted in a change in the order of prioritization of alternatives, changes in the ranking of alternative priorities did not occur when a

change was made in 10% and in the priority alternatives did not have a significant change in the ranking order. Changes will occur if the increase or decrease in the criteria is above 50%. Thus, it can be concluded that the results of the weight increase sensitivity analysis in the ANP method can be used as a reference.

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