ANALYSIS OF THE SELECTION OF THE ALKI STATES FOR HANDLING CRIMINAL ACTIONS OF VIOLATIONS BY THE MULTI CRITERIA DECISION MAKING APPROACH (CASE STUDY ALKI II)

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ABSTRACT

The incidents of criminal offenses at sea that often occur in Indonesian waters greatly affect the credibility and authority of the Indonesian people in the eyes of the international community. Based on existing data, the number of criminal offenses at sea in Indonesian waters is the largest in the world, especially in ALKI II waters. This condition of course has a negative impact on the Indonesian government. There are several studies that take the theme of selecting locations with the Analytic Hierarchy Process (AHP) and Geographic Information System (GIS) methods. Wang (2009) states, although the AHP method is more widely used in building a decision-making system, this method has drawbacks, namely that it does not consider uncertainties and doubts in decision making. Therefore, Fenton & Wang (2006) argue that fuzzy-set theory can be used to overcome the limitations of AHP. This study assesses the location selection using Fuzzy AHP and TOPSIS to reduce decision uncertainty. This research can help determine the best Indonesian Navy base from several existing bases, especially those around ALKI II waters. This base will then serve as an aju base for KRI and personnel carrying out maritime security operations in the context of handling criminal offenses at sea. In the research area which is limited to ALKI II waters, there are 7 Indonesian Navy bases that can be used as alternatives, namely Lanal Palu, Lanal Kendari, Lanal Tolitoli, Lanal Nunukan, Lanal Sangatta, Lanal Kota Baru, Lanal Banjarmasin. From the weighting and ranking results, the Banjarmasin Navy Base was selected as the best Aju base, namely from a scale of 0-1, with a weight value of 0.8442.

Keywords : *Selection of Indonesian Navy bases, Fuzzy AHP, Topsis*

1. INTRODUCTION

The incidents of criminal offenses at sea that often occur in Indonesian waters greatly affect the credibility and authority of the Indonesian people in the eyes of the international community. Based on existing data, the number of criminal offenses at sea in Indonesian waters is the largest in the world, especially in ALKI II waters. This condition of course has a negative impact on the Indonesian government. Offenses at sea such as piracy and piracy have increased drastically in recent years and are estimated to cost the global economy more than $ 7 billion per year (Ploch 2010). This has caught the attention of the United Nations, thus providing an international statement that the main motivation for pirate attacks is the financial gain obtained either through piracy and theft of cargo or ransoms collected after the kidnapping of ships and crew (Hastings 2009). A number of approaches to combat piracy have been implemented by various parties (Rengelink 2012). For example, the October 2008 UN Security Council resolution provided a legal basis for pursuing pirates into Somali territorial waters. UN sanctions in 2008 and a statement by the US president in 2010 prohibit ransom payments to lists of individuals known to be involved in piracy. Although various efforts have been made to reduce the crime of violations at sea, observers state that these efforts have not provided evidence of success (Shortland & Vothknecht 2010). Thus, the ability to create new strategies that aim to reduce criminal offenses at sea such as piracy and piracy is needed.

So far, various efforts to overcome criminal acts of violations at sea have been carried out by the Indonesian government, both repressive and preventive. However, the efforts that have been made have not got maximum results because they have not gone through good planning and only take advantage of ships operating in these waters. A reliable intelligence capability and support is needed, both in terms of information accuracy and base readiness to be used as a starting point for the movement of ships and personnel in maritime security operations. A law enforcement operation at sea is said to be successful if the objectives can be achieved with minimal losses on one's part. There are several Indonesian Navy bases located in ALKI II waters. These bases include Lanal Palu, Lanal Kendari, Lanal Tolitoli, Lanal Nunukan, Lanal Sangatta, Lanal Kota Baru, Lanal Banjarmasin. Each of these bases has advantages and disadvantages with regard to the ability to provide support to KRI and personnel who are carrying out Marine Security Operations activities.

In this study, the authors used a method to consider the alternative selection of the Indonesian Navy Base that would serve as aju base based on qualitative and quantitative criteria. The Multi Criteria Decision Making combination model used is the weighting method with Fuzzy AHP (Analytical Hierarchy Process) and the ranking method with Technique For Others Reference by Similarity to Ideal Solution (TOPSIS).

2. ANALYTICAL METHODS

2.1. Decision Making Theory

This process is for determining and resolving organizational problems. The decision-making process in the human brain is basically choosing an alternative from many alternatives based on a number of criteria for a problem.

There are several methods in making decisions, including:

a. Decision analysis - deterministic.

b. Multi Criteria Decision Making (MCDM).

c. Analytical Hierarchy Process (AHP).

d. Analytical Network Process (ANP).

[Kadarsah Suryadi, 2000,138].

2.2 Selection of Bases

Determination of a strategic base is expected to be able to provide solutions in solving problems / obstacles faced in current conditions. In this paper, the authors use two models in determining strategic locations, namely Fuzzy AHP (Analytical Hierarchy Process) ranking method with Technique For Others Reference by Similarity to Ideal Solution (TOPSIS). This is intended so that the research conducted can obtain maximum results. Given that each model has a different function in solving the problems that will be raised in completing this paper. The Fuzzy AHP and TOPSIS methods emphasize the selection of an alternative to the Indonesian Navy Base which can be used as the most effective base.

2.2.1 Fuzzy Analytic Hierarchi Process (Fuzzy AHP)

According to Indradewi (2008), AHP fuzzy steps are:

a. Changing linguistic variables in the form of fuzzy numbers.

Questionnaire data in the form of linguistic variables are converted into fuzzy numbers. Examples of fuzzy numbers for triangular fuzzy numbers (Triangular Fuzzy Number or TFN) are shown in

Table 1. Where the linguistic variables are converted into three fuzzy levels, namely low (c); medium (b); and high (b).

Linguistic Scale	**Firm Value AHP**	**Scale *TFN fuzzy* (a, b, c)**	***Inverse***
The two elements are	1	(1,1,1+Δ)	(1,1,1/1+ Δ)

equally important			
One element approximates little more than the other	3	(3-Δ,3,3+Δ)	(1/3+Δ,1/3,1/3-Δ)
One element approaches more importance than the other	5	(5-Δ,5,5+Δ)	(1/5+Δ,1/5,1/5-Δ)
One element approaches absolute more importance than the other	7	(7-Δ,7,7+Δ)	(1/7+Δ,1/7,1/7-Δ)
One element is absolutely more important than any other	9	(9-Δ,9,9)	(1/9,9,1/9-Δ)
The value between two adjacent considerations	2,4,6,8		

b. Compile a pairwise comparison matrix between all elements / criteria in the dimensional hierarchy system based on the assessment of linguistic variables.

$$\tilde{A} = \begin{pmatrix} 1 & \tilde{a}_{12} & \cdots & \tilde{a}_{1j} \\ \tilde{a}_{21} & 1 & \cdots & \tilde{a}_{2j} \\ \vdots & \ddots & & \vdots \\ \tilde{a}_{i1} & \cdots & \cdots & 1 \end{pmatrix} = \begin{pmatrix} 1 & \tilde{a}_{12} & \cdots & \tilde{a}_{1j} \\ 1/\tilde{a}_{21} & 1 & \cdots & 1/\tilde{a}_{2j} \\ \vdots & \ddots & & \vdots \\ 1/\tilde{a}_{i1} & \cdots & \cdots & 1 \end{pmatrix} \quad (2.1)$$

$$\tilde{a}_{ij} = \begin{cases} \tilde{1},\tilde{3},\tilde{5},\tilde{7},\tilde{9} & \text{Criteria } i \text{ relatif important to } j \\ 1 & \text{Criteria } i \text{ same important to } j \\ \tilde{1}^{-1},\tilde{3}^{-1},\tilde{5}^{-1},\tilde{7}^{-1},\tilde{9}^{-1} & \text{Criteria } i \text{ less important to } j \end{cases}$$

c. Calculate the geometric mean of the respondents' ratings.

The next step is to recap the results of the assessment of all respondents and calculate the geometric mean of the lower limit value (c); middle value (a); the upper limit value (b) of all respondents. The following formula is used to calculate the geometric mean.

c = $\sqrt[n]{c1, c2, \ldots.cn}$ (2.2)

a = $\sqrt[n]{a1, a2, \ldots.an}$ (2.3)

b = $\sqrt[n]{b1, b2, \ldots.bn}$ (2.4)

d. Defuzzification

After calculating the geometric mean, the result is defuzzified to get the crisp value of the geometric mean value of fuzzy numbers to be reprocessed in AHP. One of the defuzzification techniques is Center Of Gravity (COG). The formula for defuzzification is as follows:

$$\textbf{COG} = \frac{\frac{1}{(a-c)}\left[\frac{1}{3}x^3 - \frac{c}{2}x^2\right]_c^a + \frac{1}{(a-b)}\left[\frac{1}{3}x - \frac{b}{2}x^2\right]_c^b}{\frac{1}{(a-c)}\left[\frac{1}{3}x^2 - cx^2\right]_c^a + \frac{1}{(a-b)}\left[\frac{1}{3}x^3 - bx^2\right]_c^b} \quad (2.5)$$

e. Calculating the weight with AHP

The weight calculation is carried out if the results of the questionnaire prove consistent, that is, if the Consistency Ratio (CR) value is <0.1. To get CR, the Consistency index (CI) is calculated first. Here's the formula for calculating CI:

CI = $\frac{\lambda maks - n}{n-1}$ (2.6)

Where :

λmaks = maximum eigenvalues

n = size of the matrix

CI = Consistency Index*x*

The CI value is compared with the Ratio Index (RI) value according to the matrix size so that the Consistency Ratio (CR) value is obtained.

The matrix is declared consistent if the CR value is not more than 0.1.

Table 2. : *Ratio Index (RI)*

n (ukuran matriks)	1	2	3	4	5	6	7	8	9	10
RI (Ratio Index)	0	0	0,58	0,9	1,12	1,24	1,32	1,41	1,45	1,49

2.2.2 Technique For Others Reference by Similarity to Ideal Solution (TOPSIS)

The steps for the TOPSIS method are as follows:

a. Create a normalization matrix

The rij elements resulting from the normalization of the R matrix are:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad (2.7)$$

b. Calculate the weight of the normalized matrix

With the weight W = (w1, w2,… .., wn), then the normalized weight of the matrix V is :

$$V = \begin{pmatrix} w_1 r_{11} & w_2 r_{12} & w_x a_{1n} \\ w_1 r_{21} & & \\ \vdots & & \\ w_1 r_{m1} & w_2 r_{m2} & w_n r_{mn} \end{pmatrix}$$

c. Determine the ideal solution and the ideal solution negative. Positive ideal solution is denoted by (A +), while negative ideal solution is denoted by (A-):

$$A^{+} = \{(\max v_{ij} \mid j \in J), (\min v_{ij} \mid j \in J'),$$
$$i = 1,2,3,...,m\} = \{v_1^{+}, v_2^{+}, ..., v_n^{+}\}$$
$$A^{-} = \{\min v_{ij} \mid j \in J), (\max v_{ij} \mid j \in J'),$$
$$i = 1,2,3,...,m\} = \{v_1^{-}, v_2^{-}, ..., v_n^{-}\}$$

d. Calculating the separation

The alternative distance from the ideal positive solution (Si +) and the ideal negative solution (Si-) is defined as:

$$S_{i^+} = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^{+})^2}, \text{ dengan } i = 1,2,3,...,m \quad (2.8)$$

$$S_{i^-} = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^{-})^2}, \text{ dengan } i = 1,2,3,...,m \quad (2.9)$$

e. Calculates the relative proximity to an ideal solution.

$$A = \frac{S_{i^-}}{S_{i^+} - S_{i^-}}, 0 < A < 1 \text{ dan } i = 1,2,3,...,m \quad (2.10)$$

f. Alternative Ranking

Alternatives can be ranked based on the order of A, therefore, the best alternative is the one that is the shortest distance from the ideal positive solution and the farthest distance from the ideal negative solution. Basically TOPSIS does not have a specific input model in solving a case, TOPSIS uses an input model adapted from other methods (for example: AHP, ELECTRE, etc.).

3. RESULT AND DISCCUSION

3.1 Fuzzy AHP method.

3.1.1. Data collection.

Questionnaire data is the main input used as calculation input to determine the priority of the Indonesian Navy Base in the Koarmada II working area which will be used as an auxiliary base for carrying out operational tasks using the Fuzzy Analytical Hierarchy Process (FAHP) method. These respondents already have sufficient competency expertise from academic provisions and official experience, especially regarding the handling of criminal offenses at sea.

3.1.2 Data processing

a. Compile questionnaire data in the form of AHP pairwise comparison matrix

Table 3. Example of a pairwise comparison matrix

Perbandingan ANTAR KRITERIA			CR = 0,04
Baris / Kolom	Umum	Taktis	Teknis
Umum	1	1/5	1/8
Taktis	5	1	1/3
Teknis	8	3	1

b. Converting linguistic variables in the form of fuzzy numbers

Table 4. Example of the TFN value comparison matrix

Perbandingan ANTAR KRITERIA									CR = 0,04
Baris / Kolom	Umum			Taktis			Teknis		
Umum		1		1/6	1/5	1/4	1/9	1/8	1/7
Taktis	4	5	6		1		1/4	1/3	1/2
Teknis	7	8	9	2	3	4		1	

c. Calculates the geometric mean of respondents' ratings

Table 5. Example of geometric mean data for all respondents

Perbandingan ANTAR KRITERIA							CR	=	0,04
Baris / Kolom	Umum			Taktis			Teknis		
Umum		1,00		1,36	1,68	2,10	1,14	1,43	1,78
Taktis	0,48	0,60	0,73		1,00		0,61	0,70	1,32
Teknis	0,56	0,70	0,88	1,15	1,43	2,49		1,00	

d. Defuzzification

Table 6. Examples of defuzzification results

Antar Kriteria			
	Umum	Taktis	Teknis
Umum	1,00	0,30	0,28
Taktis	0,21	1,00	0,26
Teknis	0,23	0,31	1,00

e. Calculating weights with AHP

Table 7. Results of Weighted Criteria and Alternatives

Peringkat	Subkriteria	Bobot
1	KOORDINASI	0,1206
2	LETAK	0,1156
3	OPSKAMLA	0,1074
4	PENYIDIKAN	0,1046
5	KERAWANAN	0,1016
6	DUKUNGAN	0,0988
7	MOBILITAS	0,0980
8	BHY NAV	0,0819
9	ALUR	0,0816
10	KOMUNIKASI	0,0464
11	KEAMANAN	0,0434
	Jumlah	1,0000

Sumber : Pengolahan data

Pa		gkat
Banjarmasin	0,2660	1
Nunukan	0,2056	2
Palu	0,1718	3
Kendari	0,0961	4
Sangata	0,0918	5
Kota baru	0,0911	6
Tolitoli	0,0776	7

3.2 TOPSIS Method.

a. Determine ideal solutions and negative ideal solutions:

A+	0,2981	0,2969	0,3400	0,2728	0,2604	0,2362	[illegible]	[illegible]	0,3409	0,3225	0,2883
A-	0,0467	0,0388	0,0416	0,0428	0,0403	0,0462	[illegible]	[illegible]	0,0541	0,0515	[illegible]

b. Calculate the ideal alternative distance

Pangkalan	Si+	Si-
Banjarmasin	1,44387	7,82407
Kota baru	7,32869	1,81116
Nunukan	3,75735	5,54414
Palu	4,50833	4,71899
Sangata	7,42772	1,80355
Tolitoli	8,13271	0,81909
Kendari	7,20275	1,84159

c. Create Alternative rankings

Pangkalan	Bobot	Peringkat

Banjarmasin	0,8442	1
Nunukan	0,5960	2
Palu	0,5114	3
Kendari	0,2036	4
Sangata	0,1982	5
Kota baru	0,1954	6
Tolitoli	0,0915	7

4. CONCLUSIONS

4.1 Selected Indonesian Navy Bases Based on Criteria and Sub-criteria.

From the results of data processing using the Fuzzy AHP method, then it is analyzed according to the hierarchical structure to produce the following weights:

a. Based on the data collected from all respondents, the General Criteria have the highest weight rating (0.3868), the second rank is Technical Criteria (0.3183) and the third rank is Tactical criteria (0.2949). The factors of base position, mobility, ability to provide support and security from the monitoring of perpetrators of criminal offenses at sea were seen by respondents as factors that greatly influence the implementation of Opskamla. So that for the alternative selection of the Indonesian Navy Base to be used as a base, these factors must be considered.

b. Based on the data processing of the results of the questionnaire, the results of the weight of the Sub-criteria were obtained based on each of the criteria, namely the General Criteria for the sub-criteria of Location (0.2103), Mobility (0.2179), Support (0.3377) and Security (0.2341). Tactical Criteria, Hazard Level (0.3935), Groove (0.1706), Navigation Hazard (0.1858) and Communication (0.2501). Technical Criteria, Sub-criteria for Coordination Ability (0.4559), Investigation Ability (0.1876) and Opskamla Ability (0.3565). Sub-criteria Support for general criteria, sub-criteria The level of vulnerability on the tactical criteria and the sub-criteria for coordination capabilities on the technical criteria each rank 1 for the selection of the TNI AL Aju base. When viewed from the weighting results above, to accommodate the other criteria, it can be seen that the selection of a TNI AL base is expected to pay attention to the factors of location, level of vulnerability and coordination ability.

c. Based on the results of data processing, the final weight value of the sub-criteria as a whole is rank 1 coordination ability (0.1344), 2. support (0.1306), 3. vulnerability (0.1253), 4. Opskamla ability (0.1051) , 5. Security (0.0906). 6. Mobility (0.0834), 7. Location (0.0813), 8. Communication (0.0794), 9. Navigation Hazard (0.0591), 10. Investigative ability (0.0553) and 11. Flow (0.0543).

4.2 Alternative Naval Base Selected Based on Rank.

From the results of data processing using the Fuzzy AHP method, then ranking using the TOPSIS method, the following results were obtained :

a. For alternative results, the selected Indonesian Navy Base is the Banjarmasin Navy Base (0.8419), the Nunukan Navy Base (0.5891), the Palu AL TNI Base (0.5092), Kendari Navy Base (0.2003), Sangata Base (0.1964), Pangkalan TNI AL Kota Baru (0.1961) and Pangkalan TNI AL Tolitoli (0.0894). The Banjarmasin Navy Base was chosen as a base for handling criminal offenses at sea. This is because of the 11 sub-criteria used, Lanal Banjarmasin ranks 1 in 7 sub-criteria, namely mobility, support, navigation hazards, communication, coordination skills, investigative skills and opskamla abilities. So that in order to make Lanal Banjarmasin a base in handling criminal offenses at sea, the 7 sub-criteria can be made a top priority in improving its quality.

b. In the sensitivity analysis to determine the change in ranking of the alternatives if there is a change in the weight of the criteria, it is found that the critical criteria for weight change are the location criteria (at + 0.5 weight changes) and the safety criteria (at + 0.5 changes). Changes in the weight of these two criteria resulted in changes in ranks 5 and

6, namely at the Sangata Navy Base and the New City Navy Base.

The results of the interviews and identification of problems were then carried out by arranging a hierarchy. The first level is the goal to be achieved, the second level is the criteria which are the determining factors in the process of determining the base, while the next level is the sub-criteria. At the last level, an alternative to the Indonesian Navy Base will be chosen. To determine the rank of each Pangkalan TNI AL alternative, the TOPSIS method is used by using the principle that the chosen alternative must have the closest distance from the positive ideal solution and the furthest from the negative ideal solution from a geometric point of view. A positive ideal solution is defined as the sum of all the highest scores that can be achieved for each criterion, while a negative ideal solution consists of all the lowest scores achieved for each criterion.

c. There are 7 (seven) Indonesian Navy bases along ALKI II which are used as alternative Aju bases, namely Lanal Banjarmasin, Lanal Nunukan, Lanal Palu, Lanal Kendari, Lanal Sangata, Lanal Kota Baru and Lanal Tolitoli. The Banjarmasin Navy Base has the highest score based on the overall criteria with a value of 0.8842, so it is very appropriate to be used as a base for handling criminal offenses at sea. The weights generated in data processing for the seven bases have a significant difference in ranks 1 to 4. While for ranks 5 to 7 the resulting differences are relatively small.

ACKNOWLEDGEMENTS

The authors greatly acknowledge the support from Indonesian Naval Insitute of Technologyand Indonesian Navy Institution for providing necessary resources to carry out this research work. The authors are also grateful to the anonymous reviewers and journal editorial board for their many insightful comments, which have significantly improved this article.

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