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Determining the location of the arsenal in an effort to increase the carrying capacity of marine forces in the critical area of the North Natuna sea

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Abstract

Strategic environmental dynamics in the North Natuna Sea area raises potential threat spots to the territory of the Republic of Indonesia where the Indonesian Navy needs to determine a maritime security strategy where one of the things that must be prepared is the distribution of logistics in the form of ammunition and weapons through development *warehouse* Arsenal. Through this research, an alternative strategic location was determined as an Arsenal warehouse as a storage place for ammunition supplies used to support the KRI carrying out operational tasks. Alternative construction locations for Arsenal are Lanal Bintan, Lanal Ranai, Lanal Bangka Belitung and Lantamal IV Pontianak. Based on Perkasal No. 17 of 2008 The criteria used and the absolute requirements for determining the location are security, transportation access and supporting facilities. Data collection for this research was carried out using the method of distributing questionnaires and conducting interviews *expert*. The Delphi method was used in this research to determine and agree on relevant and valid criteria and sub-criteria to be researched at the next stage. Next Method *Analytic Network Process* (ANP) is used to determine the best alternative with pdata processing process uses *Software Super Decision*. Then the structure of complex cause and effect relationships is visualized using a matrix and images using the method *Decision Making Trial And Evaluation Laboratory (DEMATEL)*. The results of this research show that the priority of the alternative Arsenal warehouse location is Lanal Bintan with a weight value of 0.536308. Security criteria and sub-criteria for being safe from enemy attacks are the most dominant criteria in determining Arsenal warehouse location decisions.

Keywords

ANP, Arsenal, Dematel, Delphi, Site selection Arsenal

INTRODUCTION

The development of strategic environmental issues in the North Natuna Sea has created a potential threat spot for the territory of the Republic of Indonesia where the government needs to determine a national maritime security strategy.[1] One strategy is through the role of logistical

[1]. Ramdhan Muhaimin, "Kebijakan Sekuritisasi Dan Persepsi Ancaman Di Laut Natuna Utara [The Policy Of

support for weapons and ammunition from the Arsenal (weapons and ammunition warehouse) in meeting the KRI's operational needs. Arsenal is the technical implementation element (UPT) of Dissenlekal which is tasked with carrying out material support for weapons, ammunition and special weapons to all elements/units using the Indonesian Navy.

Currently there is only one main Arsenal warehouse located at Lanal Batuporon Mako Koarmada II Surabaya. This is considered to be very ineffective if a national conflict occurs, especially in the critical area of the North Natuna Sea where the threat position is very far from Arsenal's main warehouse. This disadvantageous position is very vulnerable to threats if conflict occurs, with one main warehouse it will be very easy to destroy and paralyze logistics routes, especially ammunition.

Ammunition is one part of the class V provisions for the Indonesian Navy's weapons system, so it needs to be prepared as optimally as possible in order to achieve timely levels of speed in providing class V provisions and operational effectiveness.[2] Location theory is a science that investigates the spatial layout of economic activities, or a science that investigates the geographical allocation of potential resources, as well as their relationship with or influence on the existence of various other businesses/activities, both economic and social.[3]

The Delphi method is defined as a group decision-making process that involves interaction between researchers and a group of experts related to a particular topic, which is usually done with the help of a questionnaire. According to Scheele (1975), giving describes the Delphi process with the following six stages:[4]

1. Identify group members whose consensus of opinion is needed. The composition of the group must be able to represent various points of view proportionally.

Securitization And Threat Perception In North Natuna Sea]," *Jurnal Politica Dinamika Masalah Politik Dalam Negeri Dan Hubungan Internasional* 9, no. 1 (2018): 17–38; Kuncoro Arry Prasetyo, Lukman Yudho Prakoso, and Dohar Sianturi, "Strategi Pertahanan Laut Pemerintah Indonesia Dalam Menjaga Keamanan Maritim," *Jurnal Strategi Pertahanan Laut*, 2019; Novar Kurnia Wardana, "Pengerahan Kekuatan Laut Dalam Menghadapi Ancaman Di Laut Natuna Utara," *Keamanan Maritim* 6, no. 2 (2020): 203–29.

[2] Herry Sudaryanto, Suhirwan, and I Wayan Warka, "Strategi Sistem Distribusi Pada Pengiriman Logistik Bekal Kelas V Tni Angkatan Laut Ke Wilayah Kerja Komando Armada I," *Jurnal Strategi Perang Semesta* 6, no. 2 (2020): 179–207.

[3] Muhammad Zulkifli et al., "Determining The First Priority Of The First Arsenal Location To Support The Operation Of The Indonesian Warship In Safety Of The East Indonesian Sea Region With Ahp Methods," *JOURNAL ASRO* 10, no. 2 (2019): 42–53; Frances M Lussier et al., *Army Air and Missile Defense: Future Challenges*, vol. 335 (Rand, 2002).

[4] Muzammilatul Wachidah, "Repository Dan Evaluasi Framework Forensika Digital Menggunakan Daubert Criteria" (Universitas Islam Indonesia, 2020); Irlan Adiyatma Rum and Ratni Heliati, "Modul Metode Delphi," *Universitas Padjajaran, Bandung, Indonesia, Modul, Hal*, 2018, 1–15.

2. The first questionnaire was conducted to ask each member to write down goals, considerations, or issues related to the expected consensus goal. Next, the information that has been obtained is organized so that it is easy for group members to understand. Next, prepare a second questionnaire with a more structured format so that an assessment can be carried out.
3. In the second questionnaire, each group member was asked to provide an assessment of the results of compiling the information in the first step.
4. Furthermore, the third questionnaire will show the results of the second questionnaire in the third questionnaire, including the consensus results from each section, and which sections differ from the group. In the third questionnaire, each panelist provided reasons and brief explanations for their opinions.
5. In the fourth questionnaire, the results of the third questionnaire are displayed in the fourth questionnaire, including changes from the first consensus results, and each panelist is asked again to provide an assessment and ranking for the third time which is the final assessment stage, as well as giving reasons for deciding to be in a different position from the group .
6. The results of the fourth questionnaire were tabulated and presented as group consensus results.

The Analytic Network Process (ANP) method is a development of the Analytical Hierarchy Process (AHP) method.[5] 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 within a set of elements (inner dependence) and links between different elements (outerdependence). The existence of this relationship causes the ANP method to be more complex than the AHP method.

The Analytic Network Process (ANP) method in the decision making process has stages or steps in creating the ANP. The following are the steps for making ANP according to Saaty (1999):[6]

1. First Step: Model construction and problem structuring. Model construction is based on existing problems, so it is necessary to describe the problem clearly and form it into a network.

[5] Hamed Taherdoost and Mitra Madanchian, "Analytic Network Process (ANP) Method: A Comprehensive Review of Applications, Advantages, and Limitations," *Taherdoost, H., & Madanchian, M.(2023). Analytic Network Process (ANP) Method: A Comprehensive Review of Applications, Advantages, and Limitations. Journal of Data Science and Intelligent Systems*, 2023; Sanjay Jharkharia and Ravi Shankar, "Selection of Logistics Service Provider: An Analytic Network Process (ANP) Approach," *Omega* 35, no. 3 (2007): 274–89.

[6] Keith Coulter and Joseph Sarkis, "Development of a Media Selection Model Using the Analytic Network Process," *International Journal of Advertising* 24, no. 2 (2005): 193–215.

2. Second Step: Pairwise comparison matrix showing relationships. Pairwise comparisons in ANP are carried out by comparing the level of importance of each element against the control criteria.
3. Third Step: Calculation of element weights (Eigenvector Values). After carrying out the pairwise comparison matrix, the next step is to determine the eigenvalues of the matrix. Eigenvector calculation by adding the values of each column of the matrix then dividing each column cell value by the column total and adding the values of each row and dividing by n.
4. Fourth Step: Consistency Ratio Calculation. After getting the eigenvalue, then check the consistency ratio. The consistency ratio is a ratio that states whether the assessment given by the experts is consistent or not.
5. Fifth Step: Formation of super matrix. A super matrix is a matrix consisting of sub-sub matrices which are composed of a set of relationships between the two levels contained in the model.

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

The DEMATEL method was developed by the Science and Human Affairs Program of the Battelle Memorial Institute of Geneva between 1972 and 1976 in a Swiss Research Center project (Geneva Research Center) to evaluate and solve complex problems (Moghadam et al, 2010). The steps for using the Dematel method are divided into 6 stages as follows:

1. Stage 1 Create a direct linkage matrix.

   The matrix is obtained by carrying out pairwise comparisons between the criteria.

2. Stage 2 normalizes the linkage matrix directly.

The basic direct linkage matrix (e.g. matrix A) can be made into a direct linkage matrix (e.g. matrix M) which has been normalized using equations (2.10) and (2.11). Where the main diagonal element is equal to zero.

$$M = k.THE \quad \text{.....(2.10)}$$

$$k = Min\left(\frac{1}{\sum_{j=1}^{n} |a_{ij}|}, \frac{1}{\sum_{i}^{n} |a_{ij}|}\right) \quad \text{.....(2.11)}$$

3. Stage 3 Obtain the total linkage matrix.

After obtaining the normalized direct linkage matrix, namely matrix M, the total linkage matrix (for example matrix S) can be obtained from the equation where matrix I is the identity

matrix (Li & Tzeng, 2009)

$$S = M + M^2 + M^3 + \ldots = \sum_{i=1}^{\infty} M^i.$$

$$= M(I - M)^{-1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2.12)$$

4. Step 4 Calculate the dispatcher group and receiver group.

Criteria with a positive D-R value have a greater influence than other criteria and are assumed to be the main priority, usually called dispatchers. Meanwhile, criteria with negative D-R values receive greater influence than other criteria and are assumed to be the last priority, usually called receivers.

5. Stage 5 Set the threshold value and get the impact-diagraph map. The threshold value is determined by the decision maker or an expert person by means of discussion. Impact-digraph maps can be obtained by mapping the values (D+R, D-R), where the horizontal axis is the value of D+R and the vertical axis is the value of D-R (Li & Tzeng, 2009).

In responding to this problem, it is necessary to add an Arsenal Warehouse in the North Natuna Sea region. If the current threat is considered, the location of the Arsenal Warehouse must be considered based on critical areas in the waters of the North Natuna Sea to facilitate the distribution of ammunition to anticipate conflict. The addition of this location is expected to be able to overcome the problems currently occurring at the Arsenal where the storage location will be wider and able to accommodate a larger amount of ammunition. The distribution and loading time for ammunition and missiles will also be shorter and faster and will be able to accommodate many ships that will load ammunition and missiles simultaneously. Apart from that, the addition of this location is expected to be able to support the KRI's need for ammunition and missiles in carrying out maritime operations in an effort to anticipate possible threats to critical areas in the future.

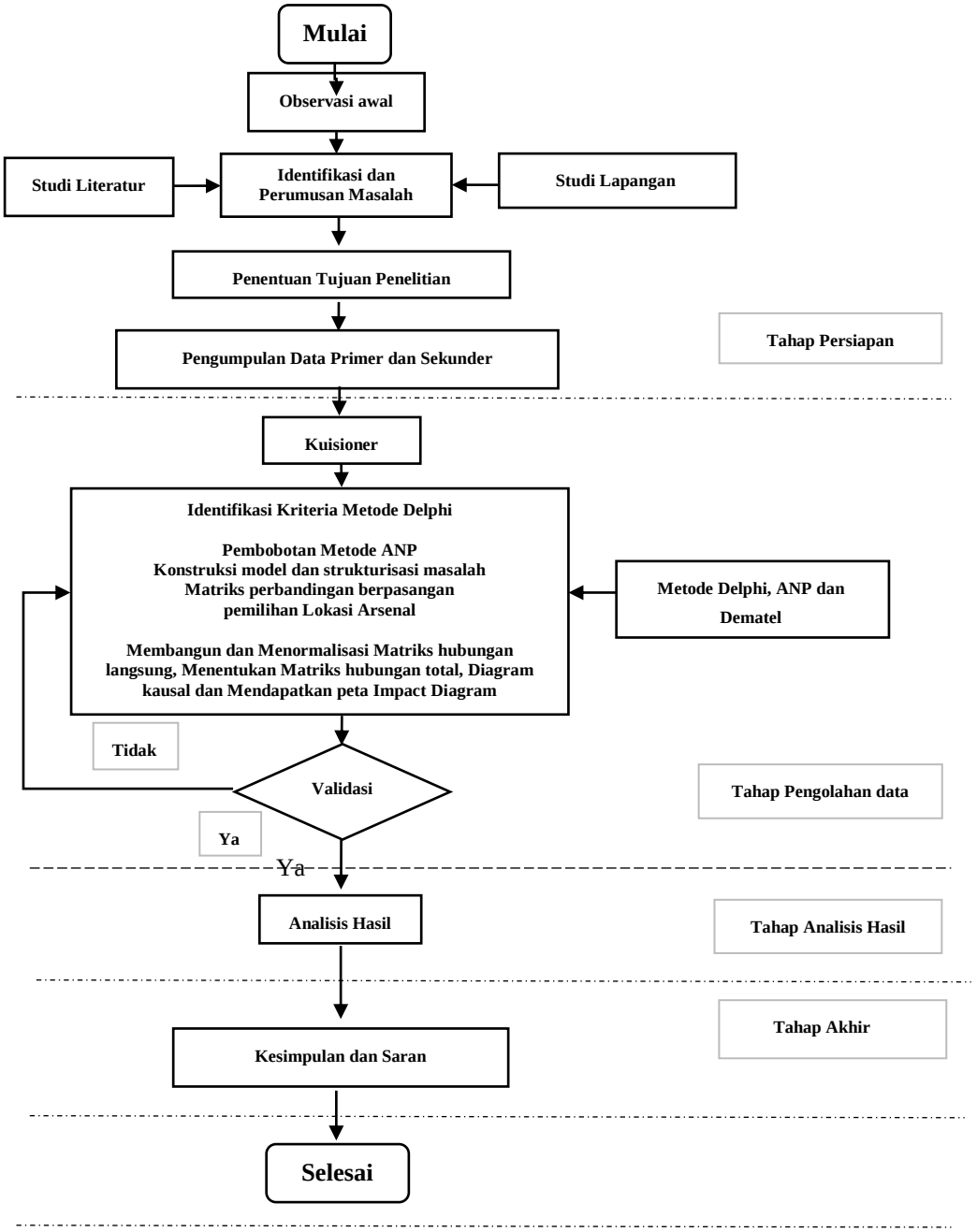
METHOD

This research uses a qualitative approach where in its implementation data is taken from measurement results and based on existing variables. The data source for this research comes from primary data from all relevant officials who still serve in Arsenal. Secondary data from this research comes from data that has been obtained or previously collected by other researchers from literature, articles, journals and sites on the internet relating to the research being carried out.

The research began with the method used, the Delphi method as a tool for identifying research criteria. The next step is to carry out weighting and ranking using the ANP method. Then, to determine the relationship (cause and effect factors) between variables, analysis using the

DEMATEL method is used to determine which variable is more dominant over the other variables.

Research subjects refer to individuals or groups of people who are actively involved in research, act as sources and data providers. Research subjects are agencies or organizations directly involved in the research. The objects in this research are the KRI, Arsenal and the Indonesian Navy base located in the area around the North Natuna Sea.



RESULTS AND DISCUSSION

The use of Arsenal technology in increasing the carrying capacity of sea forces in the critical sea area of North Natuna has significant potential in increasing the safety and security of Indonesia's maritime areas. The North Natuna sea area has a strategic role in monitoring and controlling sea traffic, and has great potential in developing marine resources. Therefore, efforts need to be made to increase the carrying capacity of sea power in this area so that it can be more effective in maintaining the security and safety of the sea area. Arsenal as a technology that can help increase the carrying capacity of sea power in the critical sea area of North Natuna has

various advantages. In this case, Arsenal can help improve maritime traffic detection and surveillance capabilities, as well as improve maritime defense capabilities. Apart from that, Arsenal can also help improve communication and coordination capabilities between maritime defense units, so as to increase the operational efficiency and effectiveness of maritime defense. In developing Arsenal technology to increase the carrying capacity of sea forces in the critical sea area of North Natuna, it is necessary to carry out analysis and evaluation of various factors that influence the use of this technology. These factors include, among others, regional geographical and climatological conditions, potential maritime threats, as well as technical capabilities and available resources. In this way, more effective and efficient planning can be carried out in the use of Arsenal technology to increase the carrying capacity of sea power in the critical sea area of North Natuna.

Identify Criteria

Table 4. 1 Table of Sub Criteria Criteria

CRITERIA	SUB-CRITERIA	REFERENCE
Security	Safe from enemy attacks	Kasal Decree No.17 of 2008
	Safe from border conflicts	Kasal Decree No.17 of 2008
	Safe from social conflict	Kasal Decree No.17 of 2008
	Safe from natural disasters	Kasal Decree No.17 of 2008
	Safe from Illegal Activities	Wawancara, Turgut, et all,2011
	Safe from shipping accidents	Wawancara, Turgut, et all,2011
	Safe from shipping channels	Wawancara, Turgut, et all,2011
Transportation Access	Military Harbor available	Kasal Decree No.17 of 2008
	Public Harbor Available	Kasal Decree No.17 of 2008
	Public Airport Available	Kasal Decree No.17 of 2008
	Guide/Pilot available	Wawancara, Turgut, et all,2011
	Public Transportation Available	Wawancara, Turgut, et all,2011
	Tugboats available	Wawancara, Turgut, et all,2011
Supporting facilities	Communication facilities are available	Kasal Decree No.17 of 2008
	Electrical Facilities Available	Kasal Decree No.17 of 2008
	Water facilities are available	Kasal Decree No.17 of 2008
	Transportation facilities are available	Kasal Decree No.17 of 2008
	Fasharkan available	Kasal Decree No.17 of 2008
	Heavy Equipment Available	Wawancara, Turgut, et all,2011
	General Workshop Available	Wawancara, Turgut, et all,2011
	Shipyard available	Wawancara, Turgut, et all,2011
	Land Available	Wawancara, Turgut, et all,2011

(Source: Author's data processing)

In the last survey round, the Experts' opinions led to a compromise answer, indicating Acceptance for several Criteria. The average value obtained from the Expert responses was removed from the data. The results of this survey formulated the 12 best criteria out of 22 criteria based on the respondents' views/preferences. Statistical analysis of the implementation of this

methodology as well as opinions on the importance weight values for each criterion can be described in the results of the Delphi method analysis.

The criteria resulting from data analysis processing using the Delphi method include the criteria for perceived security, transportation access and supporting facilities. 12 (eight) criteria were obtained that were suitable to be developed in further research analysis. The twelve sub-criteria are as follows:

1. Safe from enemy attacks
2. Safe from Border Conflicts
3. Safe from Social Conflict
4. Safe From Disaster
5. Military Harbor available
6. Public Port available
7. Public Airport Available
8. Communication Facilities Available
9. Electrical Facilities Available
10. Water Facilities Available
11. Transportation Facilities Available
12. Fasharkan available

Analytic Network Process (ANP) Relationship Structure

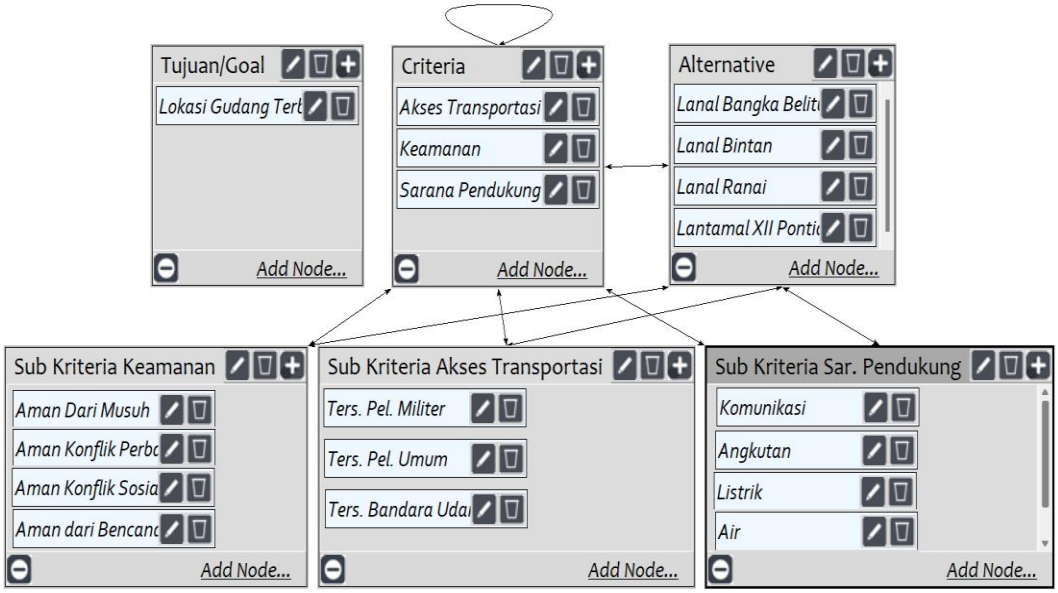


Figure 4. 1 ANP Model in Super Decisions Software

The author has carried out a model validation through expert validation carried out by

experts in their field, in this case the officials of the Head of Batuporon Arsenal and the Headquarters Base Facilities Service, in this case represented by the Head of the Planning Section who is competent in the Arsenal Warehouse Standardization study.

Geomatric Mean Calculation

After the consistency of the questionnaire testing results from each expert has been tested, the filling results are suitable to be combined through the geometric average of each question.

Table 4. 3 Results of Comparison Values Between Criteria and Geomaen Values

No.	Security - Alternative	E1	E2	E3	E4	E5	E6	E7	Geomaen
1	Lanal Bangka - Lanal Bintan	3	3	2	3	3	4	4	3
2	Lanal Bangka - Lanal Ranai	2	3	4	3	5	4	3	3
3	Lanal Bangka - Pontianak	3	3	2	2	3	2	2	2
4	Lanal Bintan - Ranai	3	4	3	3	4	3	4	3
5	Lanal Bintan - Pontianak	2	4	3	3	5	4	4	3
6	Lanal Ranai - Pontianak	5	5	5	3	4	4	3	4

Pairwise Comparison Value between Criteria and Sub-criteria

Filling in the Pairwise comparison values for each category was obtained from a questionnaire from experts in determining the Arsenal Warehouse. After obtaining one pairwise comparison value for each relationship, local priority weights are calculated. The local priority weighting that must be taken into account is that the value of inconsistency cannot exceed the value of 0.1. The ANP questionnaire is processed using super decision software version 3.2.0. The output is the final calculation result in the form of the priority weight value of each alternative, as shown in Figure 4.6.

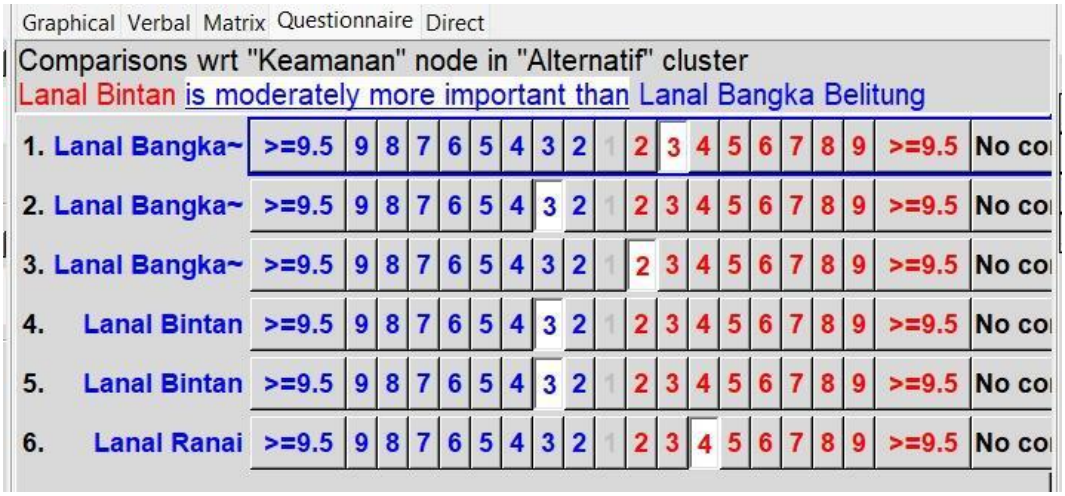
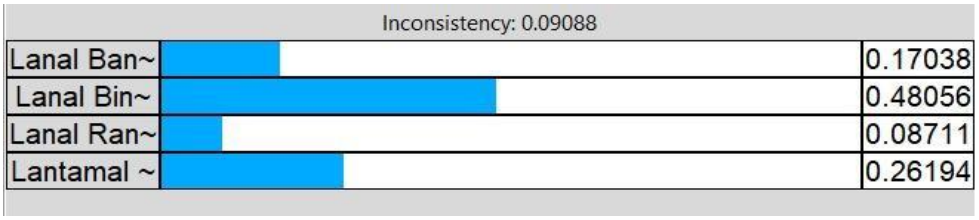


Figure 4. 2 Comparison of Security Criteria with Alternatives

(Source: data processed by Super Decision)

From the pairwise comparison table between criteria and Alternatives in the Security criteria, it shows an inconsistency index of 0.09088. Where this value is still below 10% or 0.1, which means this shows that all the answers given to respondents in this research questionnaire are consistent.

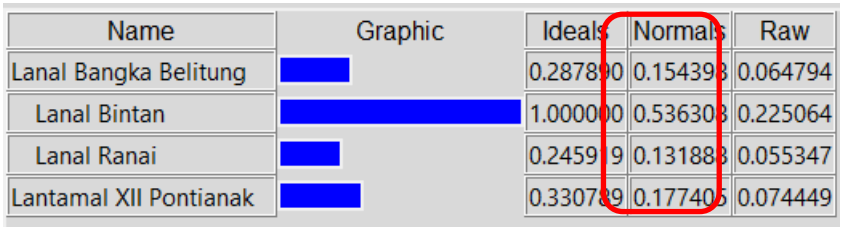
Table 4. 4 Normalization weighting results using Super Decision Software



Determining Alternative Priorities for Determining Arsenal Warehouse Locations

After obtaining the results of the priority weights of the criteria, from the results of processing the data in the form of a questionnaire, as well as checking the inconsistency index for all criteria and sub-criteria in the local priority weights, the software will carry out all stages of the ANP method by running Synthesize, then it will obtain the criteria weights. as exemplified in figure 4.9 below.

Table 4. 5 Alternative Weights



After the results of the geometric average value have been input or completely entered into matrix format in the Super Decision software, as well as checking the inconsistency index for all criteria and all sub-criteria in the local priority weights, the software will automatically carry out or carry out the entire data processing stages in the ANP method process, then the weight values of all criteria can be obtained by running Computations, as exemplified in table 4.7 below.

Table 4. 6 Criteria Weight Values for Alternatives

	Transportation Access	Security	Supporting facilities
Lanal Bangka Belitung	0,094248	0,110880	0,088213
Lanal Bintan	0,301525	0,312739	0,387505
Lanal Ranai	0,049930	0,056689	0,229600
Lantamal XII Pontianak	0,164622	0,170466	0,044500

From Table 4.8, the priority sequence for alternatives is obtained based on the weight value of each alternative as follows:

1. Priority 1 is the Lanal Bintan alternative with a weight value of 0.536308.
2. Priority 2 is the Lantamal XII Pontianak alternative with a weight value of 0.177405.
3. Priority 3 is the Lanal Bangka Belitung alternative with a weight value of 0.154398.
4. Priority 4 is the Lanal Ranai alternative with a weight value of 0.131888.

Pengolahan Data Metode DEMATEL (Decision Making Trial And Evaluation Laboratory)

The relationship between variables is by getting the Dispatcher vector (D_i) and Receiver vector (R_i) namely by adding the elements of each column and row in the total relationship matrix. From these calculations, the results obtained are as in Table 4.14.

Table 4.14 Calculation Results (D+R) and (D-R)

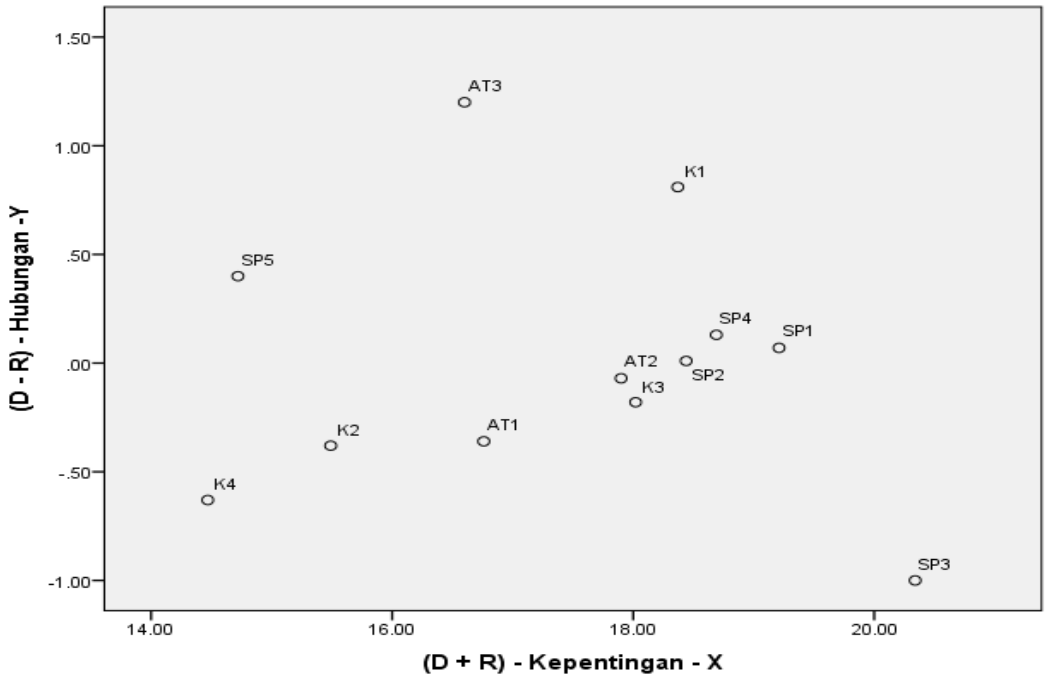
No.	Criteria	Sub Criteria	Code	D	R	D + R	D - R	Information
1	Security	Safe from enemy attacks	K1	9.59	8.78	18.37	0.81	Dispatcher
2		Safe from Border Conflicts	K2	7.56	7.94	15.49	-0.38	Receiver
3		Safe from social conflict	K3	8.92	9.10	18.02	-0.18	Receiver
4		Safe from natural disasters	K4	6.92	7.55	14.47	-0.63	Receiver
5	Transportation Access	Availability of military ports and transportation access	AT1	8.20	8.56	16.76	-0.36	Receiver
6		Availability of public ports and transportation access	AT2	8.92	8.98	17.90	-0.07	Receiver
7		Availability of airports and transportation access	AT3	8.90	7.70	16.60	1.20	Dispatcher
8	Supporting facilities	Availability of communication facilities	SP1	9.64	9.57	19.21	0.07	Dispatcher
9		Availability of electricity facilities	SP2	9.22	9.21	18.44	0.01	Dispatcher
10		Availability of water facilities	SP3	9.67	10.67	20.34	-1.00	Receiver
11		Availability of transportation facilities	SP4	9.41	9.28	18.69	0.13	Dispatcher
12		Availability of maintenance and repair facilities (Fasharkan)	SP5	7.56	7.16	14.72	0.40	Dispatcher

(Source: Processed researcher data using Ms.Excel, 2024)

The calculation results (D-R) show the strength of influence between sub-criteria in determining the location of arsenal warehouses in an effort to increase the carrying capacity of sea power in the critical area of the North Natuna sea. The (D-R) value is positive indicating that the sub-criteria for determining the location of the arsenal warehouse has a greater influence than determining the location of other arsenal warehouses and can be assumed to be the main priority, and is called a dispatcher. So the main priority in the security criteria is represented by 1 sub-criteria "Safe from enemy attacks", then the main priority in the transportation access criteria is represented by 1 sub-criterion "Availability of airports and transportation access" and the main priority is in the supporting facilities criteria represented by 4 sub-criteria "Availability of communication, electricity, transportation and maintenance and repair (Fasharkan) facilities".

A negative (D-R) value means that the sub-criteria for determining the location of the arsenal warehouse receives greater influence and can be assumed to be the last priority, called the receiver. So the last priority in the security criteria is represented by 2 sub-criteria "Safe from Border Conflict, Social and Natural Disasters", then the last priority in the transportation access criteria is represented by 2 sub-criteria "Availability of military and public ports, as well as transportation access" and the last priority in criteria for supporting facilities represented by 1 sub-criterion "Availability of water facilities"

The mapping in the diagram uses (D+R) as a horizontal line and (D-R) as a vertical line. (D+R) shows the overall level of risk events that influence each other and (D-R) shows the relationship which means that different levels of risk events will be influenced and influence each other.



CONCLUSION

From the results of data collection and processing, as well as analysis and interpretation of the results of data processing that has been carried out, the conclusion that can be drawn in this final assignment is that the main criteria that are taken into consideration in determining alternative Arsenal Warehouses are the Security criteria with a weight value of 0.43917 then priority the second is the Transportation Access criterion with a weight value of 0.28482 and the third priority is the Supporting Facilities Criteria with a weight value of 0.27601. The chosen alternative in determining the location of the Arsenal Warehouse from this paper is Lanal Bintan

with a weight of 0.536308. The Bintan Lanal is located in Bintan Regency within the Batam Lantamal IV work area. Meanwhile, the second to fourth alternatives respectively are Lantamal XII Pontianak (weight 0177405), Lanal Bangka Belitung (weight 0.154398) and Lanal Ranai (weight 0.131888). Security Criteria and sub-Criteria for being safe from enemy attacks are the most dominant criteria in determining Arsenal Warehouse location decisions.

Suggestions that can be given to the Indonesian Navy and for the development of further research from the results of the research that has been carried out are: Suggestions for Indonesian Navy decision makers are to request that socio-cultural and economic criteria be added to Perkasal No. 18 of 2008 as another consideration in selecting an Arsenal location. In the next research, please add experts in other fields related to the research, such as regional officials and other stakeholders, so that determining the location of the Arsenal can be more integrated, precise and comprehensive.

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