ANALYSIS OF SELECTION OF ARSENAL WAREHOUSE LOCATIONS TO SUPPORT KRI OPERATIONS IN THE KOARMADA II AREA

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ABSTRACT

The global dynamics that are uncertain is one of the main factors affecting the success of achieving the goals and interests in the field of national defense. This reflects how important it is for stakeholders in the defense sector, to understand the dynamics of the strategic environment which presents a series of opportunities, obstacles to threats to the existence of the Republic of Indonesia, which in the end will obtain strategic steps to overcome them. The consideration of the development of the strategic environment that is constantly changing will affect the planning process for the development of the Indonesian Navy, one of which is increasing the operational capability supported by logistical capabilities. In particular, the need for ammunition and weapons that are included in the class V provision to support KRI in an operation. Therefore, it is very necessary to have an Arsenal area warehouse specifically for the Koarmada II region. The speed and accuracy of class V supply support for the KRI elements of the Koarmada II region can be seen from the huge function and role of logistical support, especially in the field of ammunition logistics support distribution, a thought is needed to establish another Arsenal regional warehouse to assist the duties and roles of Arsenal Batu Poron. The choice of location determination has several factors that need to be considered so that it is categorized in a multicriteria decision environment, so the proposed model is the right methodology to accommodate the criteria divided into qualitative and quantitative by using the Fuzzy MCDM (Multi Criteria Decision Maker) approach. Qualitative criteria for selecting the best warehouse location in Arsenal area include security criteria, transportation access, and warehouse support facilities, while quantitative criteria include distance to enemies, distance to settlements and earthquake factors that affect the construction of Arsenal area warehouses. In this study, from five alternative locations, namely Lantamal V Surabaya, Lantamal VI Makassar, Lantamal VII Kupang, Lantamal VIII Manado and Lantamal XIII Tarakan.

Keywords: *Strategic Environment, Arsenal area warehouse, Fuzzy MCDM, facility design.*

1. INTRODUCTION

The global dynamics that are uncertain is one of the main factors affecting the success of achieving the goals and interests in the field of national defense. This reflects how important it is for stakeholders in the defense sector, to understand the dynamics of the strategic environment which presents a series of opportunities, obstacles to threats to the existence of the Republic of Indonesia, which in the end will obtain strategic steps to overcome them.

The Indonesian Navy has the main task of carrying out the duties of the TNI in the maritime sector of defense, enforcing the law and maintaining security in the maritime territory of national jurisdiction in accordance with the provisions of national law and international law that have been ratified. Carrying out the diplomatic duties of the Navy in order to support the foreign policy set by the government, carry out TNI duties in the development and development of the strength of the marine dimension, and carry out the empowerment of the marine defense area. (Law No. 34 on TNI, 2004). The Indonesian Navy can mobilize elements of the KRI (Battleship of the Republic of Indonesia) in order to maintain defense, state sovereignty, law enforcement and security at sea.

The Indonesian Navy is strongly influenced by several components, such as the strength structure, the level of readiness, the level of sophistication or technological sophistication and the operational

durability of its Alutsista. The synergy of the four components of strength is very much determined by the country's ability to build and maintain the ability of the defense equipment. Ships of the Republic of Indonesia (KRI) as one of the components of the Integrated Fleet Weapon System. is a vital force at the forefront of Indonesia's defense to guard the maritime territory of the Republic of Indonesia (NKRI). The direct correlation of the increase in defense equipment, of course, must be balanced between the level of need and support capacity so that it can directly improve operational capabilities in the field. Where the operational readiness of the unit can only be done optimally if it is supported by optimal logistics availability. One of them is through the logistical support role of weapons and ammunition from Arsenal (TNI AL's arsenal of weapons and munitions) to meet the needs of KRI.

Currently, Arsenal do not have a regional warehouse and there is only one central warehouse in Surabaya. The wide working area of Koarmada II, of course, requires a large number of KRI elements. The same should be true for other supporting facilities. Arsenal really need regional warehouses to be able to increase KRI's operational support in the Koarmada II working area. This is necessary considering the implementation of operations at sea requires a very high presence of KRI. So that if there is a need for ammunition supplies, the process of supplying them can be carried out quickly.

Currently meeting the needs for KRI ammunition and weapons is carried out at Arsenal. Arsenal has a role in storing, maintaining and distributing under the Indonesian Navy (Dissenlekal) Weapons and Electronics Service Task Force. Some of Arsenal's functions are listed in KASAL Decree Number: Kep / 31 / VII / 1997.

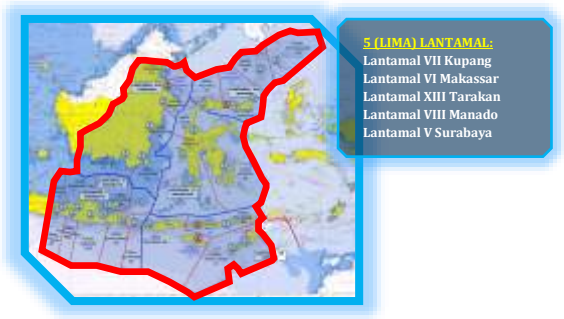


Figure 1.1 Koarmada II Working Area
Source: Sops Koarmada II

In carrying out operations at sea, it is demanded the presence of KRI elements that are very high in the sea. So that if there is a need for ammunition supplies, the process of supplying them must be carried out quickly and precisely. In the wide working area of Koarmada II, which requires a number of elements of the presence of KRI in the operational area and so should other supporting facilities such as Arsenal, so that one more ammunition warehouse location is needed in the Koarmada II work area so that it is better able to support the operations of KRI elements. munitions, the process of supplying them must be carried out quickly and precisely. In the wide working area of Koarmada II, which requires a number of elements of the presence of KRI in the operational area and so should other supporting facilities such as Arsenal, so that one more ammunition warehouse location is needed in the Koarmada II work area so that it is better able to support the operations of KRI elements. The absence of supporting facilities and only one Arsenal ammunition warehouse will certainly be a loss if the presence of KRI elements in the operating area is disrupted by the implementation of ammunition logistical support at Arsenal Surabaya.

Figure 1.2 The TNI AL Weapons and Ammunition Distribution System

Source: Sops Koarmada II.

2. MATERIAL

2.1 Fuzzy Theory.

The concept of fuzzy theory was initiated by Lotfi A. Zadeh in 1965 with his seminary paper "Fuzzy Sets" (Zadeh, 1965). Before working with fuzzy theory, Zadeh used control theory. He developed the concept of "state", which is the basic form of modern control theory. Fuzzy theory shows that all theories can be used as the basic concept of fuzzy or continues membership function. Broadly speaking, fuzzy theory can be classified into five main areas, namely:*Fuzzy Mathematics*,

Fuzzy Logic & Artificial Intelligence, where estimates for classical logic are introduced and expert systems are developed based on fuzzy information and thought forecasts;

a. *Fuzzy System*, which includes fuzzy control and fuzzy approach with processing and communication signals;*Uncertainty and Information*,

b. *Fuzzy Decision Making*, where consideration exists for optimization problems.*Fuzzy* Keanggotaan.

2.2 Membership function

Is a curve that shows the mapping of data input points into their membership values (often called membership degrees) which have an interval of 0 to 1. One way that can be used to obtain membership values is through the function approach.

There are several functions that can be used:

a. Represeniasi Linear

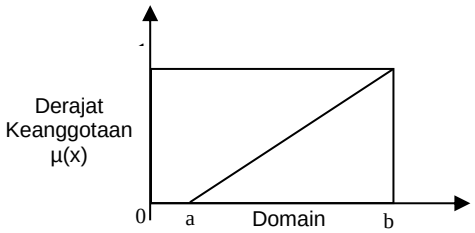


Figure 2.1 Upward Linear Representation

Membership function:

$$\mu[x] = \begin{cases} 0; & x \le a \\ (x-a)/(b-a); & a \le x \le b \\ 1; & x \ge b \end{cases} \quad ..(2.3)$$

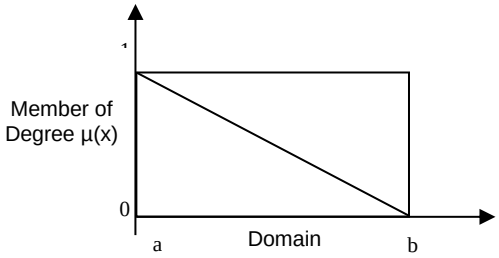


Figure 2.2 Derivative Linear Representation

Membership function:

$$\mu[x] = \begin{cases} (b-x)/(b-a); & a \le x \le b \\ 0; & x \ge b \end{cases} \quad ..(2.4)$$

b. Representasi Kurva Segitiga

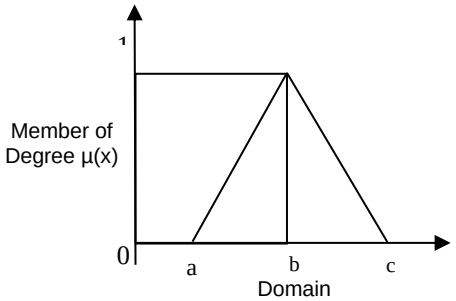
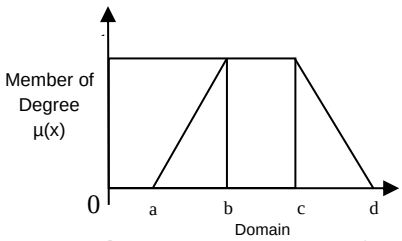


Figure 2.3 Triangular Curve

Membership function:

$$\mu[x] = \begin{cases} 0; & x \le a \; atau \; x \ge c \\ (x-a)/(b-a); & a \le x \le b \\ (c-x)/(c-b); & b \le x \le c \end{cases} \quad .. \; (2.5)$$

c. Trapezoid Curve Representation



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Member Function:

$$\mu[x] = \begin{cases} 0; & x \le a \text{ atau } x \ge d \\ (x-a)/(b-a); & a \le x \le b \\ 1; & b \le x \le c \\ (d-x)/(d-c); & c \le x \le d \end{cases}$$

2.3 Triangular Fuzzy Number (TFN)

In TFN, every single value (crisp) has a membership function consisting of three values, each of which represents the lower value, the middle value and the upper value. Graphically the membership function with TFN can be illustrated as in the following figure:

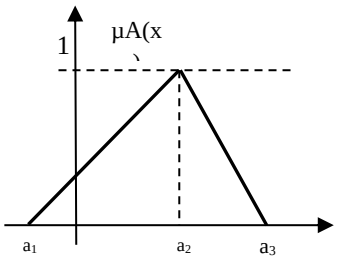

Figure 2.5 Triangular Fuzzy Number

$$A = (a_1, a_2, a_3)$$

The membership function for TFN in the picture above is as follows:

$$\mu[x] = \begin{cases} = 0 & \text{untuk } x < a_1 \\ = \frac{x-a_1}{a_2-a_1} & \text{untuk } a_1 < x < a_2 \\ = \frac{a_3-x}{a_3-a_2} & \text{untuk } a_2 < x < a_3 \end{cases} \quad \text{.....2.7}$$

2.3 Defuzzifikasi value

Defuzzification is a process of converting and fuzzy quantity into a definite quantity, where the output and fuzzy process can be a logical combination of two or more fuzzy membership functions defined in accordance with the universe of discussion. Defuzzy input and process is a fuzzy set obtained from the composition of fuzzy rules, while the resulting output is a number in the domain of the fuzzy set. There are several defuzzification methods that are commonly used as follows:

a. Centroid Method (Center Of Gravity / COG)
b. Bisector Method
c. Mean of Maximum (MOM) method
d. Largest of Maximum (LUM) method
e. Smallest of Maximun (SOM) Method

2.4 Linguistik Variabel

Linguistic variables are variables that have a description in the form of fuzzy numbers and more generally a word that is represented by a fuzzy set. For example, descriptions of linguistic variables for temperature can be LOW, MEDIUM and HIGH where the descriptions are expressed as fuzzy values. (Tsoukalas, 1997). Like algebraic variables that use numbers as their values while linguistic variables use words or sentences as their values which form a set called a set of "terms", each value of the "term" is a fuzzy variable defined based on the base variable. Meanwhile the base variable defines the universe of speech for all fuzzy variables in the set of "terms" (Jantzen, 1998).

2.5 Multiple Criteria Decision Making (MCDM)

Multi-Criteria Decision Making (MCDM) is a decision-making method consisting of theories, processes, and analytical methods for decision making that involves uncertainty, dynamics, and multi-criteria aspects of decisions. Multi-Criteria Decision Making (MCDM) is the terminology used in solving problems where the MCDM approach is expected to get the best alternative.

3. METHODS

3.1 Data processing.

After obtaining data from each expert, the next step is to recapitulate the results of the questionnaire and perform data processing. The processing of data uses the MCDM fuzzy algorithm (Liang & Wang, 1994):

a. Table weighting results of the qualitative criteria level assessment to obtain the aggregate weight value.

b. Tables the results of the assessment rating or preferences for each alternative based on existing qualitative criteria.

c. Determine the mean value of fuzzy numbers, by adding the values that appear at each level of the linguistic scale and then dividing the sum by jumlah kriteria yang the value is included in the level of linguistic assessment. The mathematical notation is as follows:

$$a_t = \frac{\sum_{i=1}^{k} \sum_j T_{ij}}{\sum_{i=1}^{k} n_{ij}}$$

a_t = Mean fuzzy number for level

T = the rating level is very low, low, medium, high and very high.

n = the sum of the scaling factors of the linguistic scale T for the 1st alternative of the i-factor

T_{ij} = numerical value of the linguistic scale T for the 1st alternative of the j-factor.

d. Determine the lower limit value and the upper limit value of fuzzy numbers, where the lower limit value (ct = b (i - 1)) is equal to the middle value of the level below, while the upper limit value (bt = b (i - 1)) is the same with the middle value of the level above it.

e. Determining the aggregate weight of each qualitative criterion, because in this study a form of linguistic assessment is used that already has a triangular fuzzy number definition, the aggregation process is carried out by finding the aggregate value of each lower limit value (c), the middle value (a) and the upper limit value (b), which can be modeled as follows:

$$c_t = \frac{\sum_{j=1}^{n} c_{tj}}{n} \qquad a_t = \frac{\sum_{j=1}^{n} a_{tj}}{n} \qquad b_t = \frac{\sum_{j=1}^{n} b_{tj}}{n}$$

Where:

c_{tj} = the value of the lower limit of the t-th qualitative criteria by the j-th decision maker

a_{tj} = the mean value of the t-qualitative criterion by the j-decision maker

b_{tj} = the upper limit value of the t-th qualitative criterion by the j-th decision maker

n = number of appraisers (decision makers)

The aggregate value is N = (cj, aj, bj

Where:

Nt.= aggregation weight values for the t-qualitative criteria

f. Calculating the preference value of each alternative based on qualitative criteria. In calculating the aggregate weight of each alternative for each criterion, the aggregate fuzzy value can be found using the following model:

$$q_t = \frac{\sum_{j=1}^{n} q_{tj}}{n} \quad o_t = \frac{\sum_{j=1}^{n} o_{tj}}{n} \quad p_t = \frac{\sum_{j=1}^{n} p_{tj}}{n}$$

q_{itj} = the alternative lower bound value for the t-th qualitative criterion by the j-th leader.

o_{itj} = the mean value of alternatives for the qualitative criterion t by the jth decision maker.

o_{itj} = the value of the alternative upper bound for the t-th qualitative criterion by the j-th leader.

n = number of appraisers (decision makers).

The aggregate value is $M_{itj} = (q_{it}, o_{it}, p_{it})$

Where :

M_{itj}= the aggregation weight value for the i-th alternative for the t-qualitative criteria.

g. Calculating the fuzzy index value from the results of the assessment of each alternative

for the qualitative criteria denoted by G_i. First, get a value M_{it} and N_t, to get the match index value *fuzzy* G_i for each subjective criterion. Here G_i is not a number *fuzzy triangular*, it's numbers *fuzzy*:

$G_i = (Y_i, Q_i, Z_i, H_{i1}, T_{i1}, H_{i2}, U_{i1}), \quad i = 1,2,.....m$

The fuzzy index value is obtained by operating each element of the triangular fuzzy number from the results of numbers 2 and 4 with the following notation:

$$T_{i1} = \frac{\sum_{t=1}^{k}(o_{it-}\, q_{it})(a_{t-}\, c_t)}{k}$$

$$T_{i2} = \frac{\sum_{t=1}^{k}[q_{it}(a_{t-}\, c_t) + c_t(o_{it-}\, q_{it})}{k}$$

$$U_{i1} = \frac{\sum_{t=1}^{k}(p_{it-}\, o_{it})(b_{t-}\, a_t)}{k}$$

$$U_{i2} = \frac{\sum_{t=1}^{k}[b_t(o_{it-}\, p_{it}) + p_t(a_{t-}\, b_t)}{k}$$

$$H_{i1} = \frac{T_{i2}}{2T_{i1}}$$

$$H_{i2} = -\frac{U_{i2}}{2U_{i1}}$$

$$Y_i = \frac{\sum_{t=1}^{k} q_{it} c_t}{k}$$

$$Q_i = \frac{\sum_{t=1}^{k} o_{it} a_t}{k}$$

$$Z_i = \frac{\sum_{t=1}^{k} p_{it} b_t}{k}$$

h. Calculate the utility value of each alternative for the qualitative criteria.

$$U_t(G_t) = \frac{1}{2}\left[H_{i2} - \left({H_{i2}}^2 + \frac{X_R - Z_i}{U_{i1}}\right)^{\frac{1}{2}} + 1 + H_{i1} - \left({H_{i1}}^2 + \frac{X_L - Y_i}{T_{i1}}\right)^{\frac{1}{2}}\right]$$

$$X_R = \frac{1}{2}\left\{2x_1 + 2H_{i2}(x_2 - x_1) + \frac{(x_2 - x_1)^2}{U_{i1}} - (x_2 - x_1)\left[\langle 2H_{i2} + \frac{(x_2 - x_1)^2}{U_{i1}} + 4\frac{x_1 - z_1}{U_{i1}}\rangle\right]^{\frac{1}{2}}\right\}$$

$$X_L = \frac{1}{2}\left\{2x_2 + 2H_{i1}(x_2 - x_1) + \frac{(x_2 - x_1)^2}{T_{i1}} - (x_2 - x_1)\left[\langle 2H_{i2} + \frac{(x_2 - x_1)^2}{T_{i1}} + 4\frac{x_1 - z_1}{T_{i1}}\rangle\right]^{\frac{1}{2}}\right\}$$

The first step is to find the defuzzification value of the criteria and alternative preferences against the criteria, where the defuzzification method used is the centroid method. The formula for the criteria defuzzification is as follows:

Defuzzifikasi N_{it}

$$= \frac{\left[\left[\int_{c_t}^{a_t} \frac{(x - c_t)}{(a_t - c_t)} x dx + \int_{a_t}^{b_t} \frac{(x - b_t)}{(a_t - b_t)} x dx\right]\right]}{\left[\left[\int_{c_t}^{a_t} \frac{(x - c_t)}{(a_t - c_t)} dx + \int_{a_t}^{b_t} \frac{(x - b_t)}{(a_t - b_t)} dx\right]\right]}$$

Where : t = Criteria 1,2,3.....n

Meanwhile, the formula for determining the defuzzification value for alternative preferences to qualitative criteria is as follows:

Defuzzifikasi M_{it}

$$= \frac{\left[\left[\int_{q_{it}}^{o_{it}} \frac{(x - q_{it})}{(o_{it} - q_{it})} x dx + \int_{o_{it}}^{p_{it}} \frac{(x - p_{it})}{(a_t - p_{it})} x dx\right]\right]}{\left[\left[\int_{q_{it}}^{o_{it}} \frac{(x - q_{it})}{(o_{it} - q_{it})} dx + \int_{o_{it}}^{p_{it}} \frac{(x - p_{it})}{(a_t - p_{it})} dx\right]\right]}$$

Where : i = alternative 1,2,3,.....m;
t = Criteria 1,2,3.....n

i. Calculating the ranking value of each alternative based on qualitative criteria using the following formula:

$$ST_i = \frac{U_T(G_i)}{\sum_{i=1}^{m} U_T(G_i)}$$

Where :

ST_i = the ranking value of alternative i based on qualitative criteria.

j. Calculate the ranking value of each alternative based on quantitative criteria using the following formula:

$$OT_i = \frac{\sum_{j=1}^{p}\left[T_{ij}\, l\left(\sum_{i=1}^{m} T_{ij}\right)\right]}{p}$$

Where :

T_{ij} = the score (score) of the i-th alternative for the j-th quantitative criterion

M = number of alternatives

p = number of quantitative criteria

OT_i = the ranking value of alternative i based on quantitative criteria

k. Calculate the total (final) ranking value of each alternative for the qualitative criteria and the quantitative criteria using the following formula:

$$FT_i = \frac{ST_i + OT_i}{\sum Vk} \qquad ,0 \leq x \leq 1$$

Where :

ST_i = the ranking value of alternative i based on qualitative criteria.

OT_i = the ranking value of alternative i based on quantitative criteria

ΣV_k = number of variables

FT_i = total ranking value for alt i

l. Choose the best alternative based on the highest ranking value.

4. RESULT AND DISCUSSION

4.1 Alternative Arsenal warehouse locations

a. Lantamal VII Kupang

Domiciled in East Nusa Tenggara (NTT) which is directly adjacent to East Timor.

b. Lantamal VI Makassar.

Domiciled in Makassar City or Ujung Pandang, South Sulawesi.

c. Lantamal XIII Tarakan

Domiciled in the City of Tarakan, East Kalimantan.

d. Lantamal VIII Manado

The main base of the Indonesian Navy VIII Manado, domiciled in Manado City, North Sulawesi.

e. Lantamal V Surabaya.

Located directly under Koarmada II, the main task is to develop strength and ability to carry out logistical and administrative capabilities, conduct maritime security patrols in the Lantamal V work area, and empower marine areas.

4.2 Criteria Data in each Alternative

a. Quantitative Criteria

1) Distance to operating field.

The alternative distance to the operating field is an important thing to pay attention to considering the KRI which will carry out the loading of ammunition from the operating area to the alternative warehouse in the Arsenal area requires a short time to return to the field of operation quickly..

Table 4.1 Alternative Distance to the Operation Area

ALTERNATIF	SUB KRITERIA	
	DISTANCE ALKI II	DISTANCE AMBALAT
Lantamal VII Kupang	99 NM	702 NM
LantamalVI Makassar	1108 NM	1670 NM
Lantamal XIII Tarakan	872 NM	535 NM
Lantamal VIII Manado	350 NM	398 NM
Lantamal V Surabaya	700 NM	140 NM

2) Distance to city center.

Based on the standardization of the arsenal of weapons and ammunition in the Indonesian Navy, it is stated that for security from the impact of an explosion for some reason, the location of the ammunition warehouse for vital civilian and military objects is not less than 200m. (Perkasal No. Perkasal/100/XII/2010, 2010). Here are the Alternative distances to the city center and the closest settlement:

Table 4.2 Distance of alternative locations to City Center and Settlements

ALTERNATIF	SUB KRITERIA	
	DISTANCE PUSAT KOTA	DISTANCE PEMUKIMAN
Lantamal VII Kupang	1,2 KM	290 M
Lantamal VI Makassar	13 KM	210 M
Lantamal XIII Tarakan	5,5 KM	135 M
Lantamal VIII Manado	5,6 KM	250 M
Lantamal V Surabaya	4,8 KM	205 M

3) The threat of an earthquake

Table 4.3 Value of Alternative Location Gravitational Acceleration

Source**:** (Kementrian Pekerjaan Umum, 2010)

N0	Alternatif Lokasi	PGA
1.	Lantamal VII Kupang	0,25
2.	Lantamal VI Makassar	0,50
3.	Lantamal XIII Tarakan	0,25
4.	Lantamal VIII Manado	0,15
5.	Lantamal V Surabaya	0,05

b. Qualitative Criteria

In determining the qualitative criteria for determining the location of Arsenal's warehouse area, based on references to the Final Project Marine Major (E) Dwi, Marine Major Final Project (P) I Komang and discussion of researchers with Arsenal expert staff on the basis of Perkasal No. 17.

4.3 Data Processing

Data processing using fuzzy MCDM, requires people who are experts in determining the scoring of the questionnaire that has been compiled by the researcher. Among these experts:

a. Kaarsenal as an expert in the field of warehousing and weapons,

b. Kadissenlekal as an expert in weapons and ammunition,

c. Kadisfaslanal as an expert in the field of base facilities throughout Indonesia, and

d. Asops Koarmada II as an expert in the operational field of the Koarmada II area.

1) Table the results of the weighted criteria level assessment.

There are two scales for the weighting results in the assessment, namely the numerical scale. Rating for a numeric scale between 1-10.

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Criteria Expert Data

Source: Expert Data

NO	KRITERIA	SUB KRITERIA	EXPERT 1	EXPERT 2	EXPERT 3	EXPERT 4
			N	N	N	N
	Kualitatif					
1.	Keamanan	aman dari musuh	9	10	10	10
		bebas konflik sosial	9	8	8	8
2.	Akses trans portasi	pelabuhan militer	10	10	10	10
		pelabuhan umum	7	5	5	8
		bandar udara	8	5	5	7
3.	Sarana pendukung	fas. kom	8	8	10	9
		fas. listrik	7	8	8	7
		fas. air	6	8	8	6
		fas. angkutan	9	9	10	9
		fasharkan	9	9	8	8
	Kuantitatif					
1.	Jarak medan operasi	ALKI 2	9	8	6	10
		AMBALAT	10	8	8	10
2.	Jarak pusat kota	pusat kota	9	9	7	10
		pemukiman	10	9	9	10
3.	Ancaman gempa		10	10	10	10

Keterangan : N = Numerik

2) Table the results of alternative rating ratings.

The labeling of the alternative rating results can be seen in table 4.8 with the same scale as the assessment criteria, namely the linguistic scale and the numerical scale.

Table 4.8 Expert Data Recapitulation for Assessment of Alternative Locations

Source: Expert Data Collection

NO	KRITERIA	SUB KRITERIA	ALTERNATIF	*EXPERT 1*	*EXPERT 2*	*EXPERT 3*	*EXPERT 4*
				N	N	N	N
1.	Keamanan	aman dari musuh	LANT. VII	8	6	6	7
			LANT. VI	9	8	6	6
			LANT. XIII	8	10	8	8
			LANT. VIII	5	4	6	7
			LANT. V	8	6	7	7
		bebas konflik	LANT. VII	7	6	6	6
			LANT. VI	8	8	6	7
			LANT. XIII	6	6	8	6
			LANT. VIII	7	8	5	5
			LANT. V	8	8	5	6
2.	Akses transportasi	pel. Militer	LANT. VII	9	8	7	9
			LANT. VI	6	10	6	7
			LANT. XIII	7	10	7	6
			LANT. VIII	8	10	6	7
			LANT. V	9	6	6	7
		pel. umum	LANT. VII	9	8	6	8
			LANT. VI	9	6	6	8
			LANT. XIII	9	8	7	9
			LANT. VIII	8	8	5	8
			LANT. V	8	8	5	8
		bandar udara	LANT. VII	9	6	5	7
			LANT. VI	8	6	5	7
			LANT. XIII	9	8	6	8
			LANT. VIII	8	6	5	8
			LANT. V	8	6	5	7
3.	Sarana pendukung	fas. komunikasi	LANT. VII	7	8	6	6
			LANT. VI	7	8	6	6
			LANT. XIII	7	8	8	8
			LANT. VIII	7	8	6	6
			LANT. V	7	8	6	6
		fas. listrik	LANT. VII	8	6	6	7
			LANT. VI	8	6	6	7
			LANT. XIII	8	8	7	8
			LANT. VIII	8	6	6	8
			LANT. V	8	4	6	8
		fas. air	LANT. VII	6	8	6	7
			LANT. VI	7	8	6	7
			LANT. XIII	7	8	6	6
			LANT. VIII	8	8	6	7
			LANT. V	8	8	6	7
		fas. angkutan	LANT. VII	6	8	6	8
			LANT. VI	7	8	6	9
			LANT. XIII	8	8	7	6
			LANT. VIII	8	8	6	6
			LANT. V	8	8	6	6
		Fas harkan	LANT. VII	6	8	7	7
			LANT. VI	6	4	5	6
			LANT. XIII	7	8	7	9
			LANT. VIII	6	8	7	9
			LANT. V	7	4	5	6

3) Determine the mean value of a fuzzy number.

The fuzzy middle number is the number obtained from the sum of the values that appear at each level of the linguistic scale divided by the number of these scales with the formula (3.1). The results of these calculations are then used to make TFN.

Table 4.9 TFN Expert for Assessment of Location Criteria

NO	LEVEL LINGUISTIK	EXPERT 1			EXPERT 2			EXPERT 3			EXPERT 4		
		ct	at	Bt	ct	At	Bt	Ct	at	bt	ct	at	bt
1	Sangat rendah												
2	Rendah												
3	Sedang	1,00	6,00	7,50	1,00	5,00	7,83	1,00	5,00	6,86	1,00	6,00	7,60
4	Tinggi	6,00	7,50	9,10	5,75	7,83	9,43	5,00	6,86	9,83	6,00	7,60	9,78
5	Sangat tinggi	7,50	9,10	10,00	7,83	9,43	10,00	6,86	9,83	10,00	7,60	9,78	10,00

Source: Data Processing

Where: c_t = lower limit of assessment criteria

a_t = the middle limit of assessment criteria

b_t = upper limit of assessment criteria

Table 4.10 is a TFN expert for the assessment of each alternative based on qualitative criteria. It can be shown in the graph of the membership function of each expert for alternative assessments. Where the value of each expert is shown in the lower limit value, the middle value and the upper limit value, according to equation (3.1).

Table 4.10 TFN Expert for the Assessment of Each Alternative Based on Qualitative Criteria

NO	LEVEL LINGUISTIK	EXPERT 1			EXPERT 2			EXPERT 3			EXPERT 4		
		q_t	o_t	p_t	q_t	o_t	p_t	q_t	o_t	p_t	q_t	o_t	p_t
1	Sangat rendah												
2	Rendah				1,00	4,00	6,00						
3	Sedang	1,00	5,80	7,59	4,00	6,00	8,00	1,00	5,74	7,25	1,00	5,84	7,41
4	Tinggi	5,80	7,59	9,00	6,00	8,00	8,00	5,74	7,25	10,00	5,84	7,41	9,00
5	Sangat tinggi	7,59	9,00	10,00	8,00	8,00	10,00	0,00	0,00	0,00	7,41	9,00	10,00

Source: Data Processing

Information : q_{it} = lower limit of qualitative based alternative assessment

o_{it} = qualitative based alternative assessment middle limit

p_{it} = the upper limit of the qualitative based alternative assessment

5) Determine the aggregate weight of each qualitative criterion.

Respondents evaluated each selection criterion by using a linguistic scale to obtain a weight level for the sake of the criteria. The expert weight scores for criteria on the linguistic scale are shown in table 4.7 and then evaluated against the TFN expert for criterion assessment (table 4.9) using equations (3.2), (3.3), and (3.4), namely :

Table 4.11 Aggregate Weight Qualitative Criteria

Source: Data Processing

NO	SUB KRITERIA	RATA-RATA BOBOT		
		c_t	a_t	b_t
1	Aman dari musuh	7,448	9,535	10,000
2	Bebas konflik	6,063	7,848	9,760
3	Pelabuhan militer	7,448	9,535	10,000
4	Pelabuhan umum	3,500	6,275	8,392
5	Bandar udara	3,500	6,275	8,392
6	Faskom	6,552	8,736	9,632
7	Fasilitas listrik	5,688	7,448	9,535
8	Fasilitas air	3,188	6,673	8,590
9	Fasilitas angkutan	7,448	9,535	10,000
10	Fasharkan	6,583	8,246	9,903

6) Calculating prefensi alternative criterion

Calculating the value of the preferences of each alternative based on qualitative criteria. In the calculation of the aggregate weight of each-masing alternatives for each criterion, look equation (3.5), (3.6) dan (3.7).

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Alternative prefensi value

Source: Author Data

NO	SUB KRITERIA	ALT	RATA RATA		
			q_{it}	o_{it}	p_{it}
1	Aman Dari Musuh	1	4,209	6,686	8,313
		2	3,898	7,169	8,166
		3	6,394	7,564	9,500
		4	2,234	5,763	7,461
		5	5,394	7,064	9,000
2	Bebas Kon Flik	1	2,975	6,317	7,916
		2	4,709	7,186	8,313
		3	2,934	6,272	8,252
		4	3,475	6,817	7,916
		5	3,475	6,817	7,916
3	Pel. Militer	1	6,686	8,313	9,500
		2	2,750	6,394	8,064
		3	5,159	7,195	9,103
		4	3,984	6,763	8,461
		5	4,633	7,038	8,563
4	Pel. Umum	1	5,133	7,538	8,563
		2	4,633	7,038	8,563
		3	5,502	7,934	8,813
		4	3,484	6,763	7,961
		5	4,709	7,186	8,313
5	B. Udara	1	4,633	7,038	8,563
		2	4,209	6,686	8,313
		3	5,133	7,538	8,563
		4	4,209	6,686	8,313
		5	4,209	6,686	8,313
6	Fas. Kom	1	3,475	6,817	7,916
		2	3,475	6,817	7,916
		3	5,894	7,564	9,000
		4	3,475	6,817	7,916
		5	3,475	6,817	7,916
7	Fas. Listrik	1	4,209	6,686	8,313
		2	4,209	6,686	8,313
		3	5,894	7,564	9,000
		4	5,894	7,564	9,000
		5	3,459	6,186	7,813
8	Fas. Air	1	3,484	6,763	7,961
		2	4,709	7,186	8,313
		3	3,475	6,817	7,916
		4	4,709	7,186	8,313
		5	4,709	7,186	8,313
9	Fas. Ang	1	3,484	6,763	7,961
		2	5,078	7,583	8,563
		3	4,659	7,195	8,603
		4	3,475	6,817	7,916
		5	3,475	6,817	7,916
10	Fasharkan	1	4,669	7,141	8,648
		2	1,000	5,394	7,064
		3	6,263	7,961	9,250
		4	5,038	7,538	8,898
		5	2,225	5,817	7,416

7) Calculating the fuzzy index value from the assessment results of each alternative for the qualitative criteria (G_i).

Here Gi is not a number *fuzzy triangular*, it's numbers *fuzzy*. $G_i = (Y_i, Q_i, Z_i, H_{i1}, T_{i1}, H_{i2}, U_{i1})$, with the formula (3.10), to (3.18) in searching G_i.

Table 4.13 Value Forming Evaluation

Source: Data Processing

INDEX	ALTERNATIF				
	1	2	3	4	5
Yi	24,79	21,51	30,02	22,47	22,49
Qi	56,19	54,59	58,92	54,83	54,16
Zi	78,82	76,75	83,05	77,38	76,71
Hi1	2,11	2,60	2,86	3,98	2,76
Ti1	5,98	5,11	4,14	4,34	4,62
Hi2	6,31	6,09	6,92	6,57	6,36
Ui1	1,95	1,98	1,88	1,86	1,92
Ti2	25,21	26,55	23,66	25,86	24,47
Ui2	-24,59	-24,15	-26,01	-24,40	-24,48

8) Calculate the utility value of each alternative for the qualitative criteria

Before calculating the utility value, the defuzzification process is carried out first with the method used is the centroid method. By using equations (3.24) and (3.25). So that it is produced:

Table 4.14 Defuzzification of the weights of qualitative and alternative criteria

Source: Data Processing

NO	KRITERIA		SUB KRITERIA	DEFUZZY BOBOT	DEFUZZIFIKASI ALTERNATIF				
					ALT 1	ALT 2	ALT 3	ALT 4	ALT 5
I	Keamanan	1	Aman dari musuh	9,124	5,683	5,728	7,456	4,222	5,956
		2	Bebas konflik	7,281	4,856	6,184	4,881	5,356	5,355
II	Akses transportasi	3	Pel. Militer	8,569	7,784	4,956	6,621	5,769	6,061
		4	Pel. Umum	5,225	6,554	6,054	6,919	5,352	6,182
		5	Bandar udara	5,225	6,054	5,683	6,554	5,683	5,682
III	Sarana pendukung	6	Faskom	7,743	5,356	5,356	7,068	5,356	5,355
		7	Fas. Listrik	6,938	5,683	5,683	7,068	7,068	5,050
		8	Fas. Air	5,169	5,352	6,183	5,356	6,184	6,182
		9	Fas. Angkutan	8,569	5,352	6,538	6,217	5,356	5,355
		10	Fasharkan	7,707	6,217	3,403	7,415	8,010	4,225

Description: ALT = Alternative

The total of the multiplication of the weight of the criteria for each alternative is then divided by the number of criteria, in this case there are 10 qualitative criteria. So that the resulting performance values for each alternative are shown in the table below:

Table 4.15 Alternative Performance Values

Source: Data Processing

ALTERNATIF	G_i
Lantamal VII Kupang	42,144
Lantamal VI Makassar	40,013
Lantamal XIII Tarakan	46,478
Lantamal VIII Manado	40,387
Lantamal V Surabaya	39,984

From the count G_i and f$G_i(x)$ then we can know the value x_1 = 40,013 and value x_2 = 46,478, Where x_1 is a value G_i minimum, whereas for x_2 is value G_i maximum. Score x_1 and x_2 This is used to calculate the utility value of each alternative.

Inside the formulation $U_t(G_i)$ need to find the value first X_R and value X_L. As for the results of calculating the value of other alternative utilities using Microsoft Excel. The utility value of each alternative is shown in the following table:

Table 4.16 Utility Forming Index

Source: Data Processing

ALTERNATIF	$U_t(G_i)$
Lantamal VII Kupang	1,041
Lantamal VI Makassar	0,883
Lantamal XIII Tarakan	0,988
Lantamal VIII Manado	0,913
Lantamal V Surabaya	0,900

9) Calculating the ranking value of each alternative based on qualitative criteria.

Using equation (3.26) a ranking is generated:

Table 4.17 Alternative Rankings Based on Qualitative Criteria

Source: Data Processing

RANGKING	S_{ti}
Lantamal VII Kupang	0,220
Lantamal VI Makassar	0,187
Lantamal XIII Tarakan	0,209
Lantamal VIII Manado	0,193
Lantamal V Surabaya	0,191

From the ranking results based on the qualitative criteria above, it can be seen that of the five alternative locations, the first alternative, namely Lantamal I Belawan, is the best choice with a value of 0.220.

10) Calculating the alternative ranking values based on quantitative criteria

Before calculating the ranking value, it is necessary to carry out an evaluation of the weight of the expert scores for quantitative criteria on the linguistic scale shown in table 4.7. By using equations (3.2), (3.3), and (3.4), the aggregate weight of the quantitative criteria is produced, as shown in the following table:

Table 4.18 Aggregate Weight Quantitative Criteria

Source: Data Processing

NO	KRITERIA	RATA_RATA BOBOT		
		C_t	A_t	b_t
1	Jarak daerah ops. ALKI 2	6,463	8,31	9,815
2	Jarak daerah ops Ambalat	6,088	7,91	9,59
3	Jarak pusat kota	6,983	8,79	9,958
4	Jarak pemukiman	7,448	9,53	10,00
5	Ancaman gempa	7,448	9,53	10,00

Note: c_t = lower limit, a_t = middle boundary, b_t = upper limit

From the aggregate weight data table of the quantitative criteria above, the defuzzification method is carried out using the centroid method. By using equation (3.24) so that the defuzzification value for the quantitative criteria is obtained in the following table, then unit normalization is carried out:

Table 4.19 Defuzzification of Quantitative Criteria

Source: Data Processing

NO	KRITERIA	BOBOT KRITERIA	
1	Jarak daerah operasi ALKI 2	7,62	0,19
2	Jarak daerah operasi Ambalat	7,27	0,182
3	Jarak pusat kota	8,055	0,201
4	Jarak pemukiman	8,54	0,213
5	Ancaman gempa	8,54	0,213

The weights of the quantitative criteria above are then multiplied against the quantitative data of Arsenal's warehouse area below.

Table 4.20 Quantitative Criteria Data Recapitulation

KRITERIA	ALTERNATIF				
	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5
Daerah ops ALKI 2	99	1108	672	350	700
Daerah ops Ambalat	702	1670	535	398	140
Pusat Kota	1,2	13,00	6,50	2,9	4,8
Pemukiman	0,03	0,05	0,15	0,2	0,06
Ancaman Gempa	0,25	0,50	0,25	0,15	0,05
	NORMALISASI SATUAN				
Daerah ops ALKI 2	0,242	0,161	0,180	0,222	0,194
Daerah ops Ambalat	0,199	0,129	0,211	0,221	0,240
Pusat Kota	0,042	0,458	0,229	0,102	0,169
Pemukiman	0,062	0,103	0,309	0,412	0,113
Ancaman gempa	0,198	0,146	0,198	0,219	0,240

Source:Disfaslanal

ALT = Alternatively, the sea distance unit uses NM, the land distance unit uses KM, and the earthquake threat uses PGA (Peak Ground Activity)

Furthermore, using equation (3.27) can be calculated the ranking value for the quantitative criteria.

Table 4.21 Ranking of Alternatives Based on Quantitative Criteria

Source: Data Processing

ALTERNATIF	O_{ti}
Lantamal VII Kupang	0,146
Lantamal VI Makassar	0,199
Lantamal XIII Tarakan	0,227
Lantamal VIII Manado	0,238
Lantamal V Surabaya	0,190

Based on the quantitative criteria in the table above, it can be seen that of the five alternatives, the fourth alternative has the highest-ranking value with a ranking value of 0.238.

11) Calculate the total (final) ranking value of each alternative for the qualitative criteria and the quantitative criteria.

With equation (3.28) the total ranking value for the best alternative can be calculated in the table below:

Table 4:22 Total Alternative Warehouse Location Ranking Value

Source: Data Processing

ALTERNATIF	F_{ti}	RANGKING
Lantamal VII Kupang	0,183	**V**
Lantamal VI Makassar	0,193	**III**
Lantamal XIII Tarakan	0,218	**I**
Lantamal VIII Manado	0,216	**II**
Lantamal V Surabaya	0,190	**IV**

12) Choose the best alternative based on the highest-ranking value.

From the table 4.23 above, it can be seen that choosing the best alternative with the highest total ranking value. The best alternative warehouse in the Arsenal area in the Koarmada II area is the third alternative, namely Lantamal XIII Makassar with a total value of 0.218.

5. CONCLUSIONS

After carrying out the entire research process, conclusions can be formulated based on the results of research methods and data processing and analysis, so the following conclusions can be drawn:

a. The decision-making process for determining the location of the Arsenal area can be modeled by applying the *Fuzzy Multi Criteria Decision Maker* model

b. Based on the results of literature studies and consultation with experts in determining the location of the Arsenal area for the Koarmada II area based on qualitative and quantitative criteria as consideration, the best location is obtained from alternative locations in the region.

c. The decision-making process in determining the location of Arsenal's warehouse was carried out by several experts as decision makers, namely Kadissenlekal, Kadisfaslanal, Kaarsenal and Asops Koarmada II, so that each decision maker will provide a different subjective assessment of the available alternative locations. Fuzzy algorithm is applied to the determination of warehouse location in Arsenal area, because it can eliminate the fuzziness or fuzziness of qualitative criteria data which have high subjective value.

d. Based on data processing using the Fuzzy MCDM method, the best location for the Arsenal warehouse location is Lantamal XIII Tarakan with the highest total ranking value of 0.218 then Lantamal VII Manado with a value of 0.216 and Lantamal VI Makassar with a value of 0.192.

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