Journal of Theoretical and Applied Information Technology
10th August 2013. Vol. 54 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

THE IMPLEMENTATION OF MULTI-ATTRIBUTE APPROACH IN DECISION MAKING FOR DEFENSE SEA REGION MODELS

[1]PUDJI SANTOSO, [2]KETUT BUDA A, [3]MASROERI, [4]M. ISA IRAWAN, [5]AAB. DINARIYANA

[1,2,3,5] Institute of Technology Sepuluh November, Department of Marine, Surabaya

[4]Institute of Technology Sepuluh November, Department of Mathematics, Surabaya

E-mail: [1]pudji2013@gmail.com, [2]ketutbuda@its.ac.id, [3]masroeri@gmail.com, [4]mii@its.ac.id, [5]dinar@its.ac.id

ABSTRACT

This paper discusses the concept of decision-making on the model of territorial sea defense system to resolve cases of violations in Indonesia's marine territory by foreign vessels, illegal fishing and illegal logging. The violation also shows that Indonesia has not fully monitored its marine areas by the patrol ships. The lack of Navy patrol boats owned causes mutual-conflicst in decision-making.

From the three zones of the qualitative attributes, relative weight is searched by the Analytical Hierarchy Process (AHP). Then, the value of the Relative weight is converted to normalize relative weight, basic probability assignment, and the total probability assignment, so the degree of preference is obtained from the qualitative attributes. Then, the preference degree of qualitative attributes is combined with the preference degree of the quantitative attributes with the entropy method resulting a rank that shows the optimal alternatives deployment of nine zones of base stations. The result of calculation using the entropy method shows that the highest entropy value is 0.89.

Keywords: *Zones Re-Evaluation, AHP, MADM, Mutual Conflict, Territorial Defense*

1. INTRODUCTION

Republic of Indonesia that is an archipelago with the area that most or two-thirds of the sea area which is gathered cluster of islands has a geographical constellation waters that are not homogeneous but have a high heterogeneity and complexity. It has three archipelagic sea lanes (ALKI) are freely used as a point transportation by other countries in the interest of trade and military interests, consequently Indonesia should be able to control and secure the entire area of the sea in accordance with its provisions in the United Nations Convention on The Law Of the Sea [7], with the region in such sea large, many cases of violations, such as violations of territory by a foreign vessel, illegal fishing, and illegal logging emerge in Indonesia.

The violation of territory by foreign countries-illegal fishing and illegal logging- shows that Indonesia has not supervised well its marine area conducted by Navy patrol boats. It happens because the lack of Navy patrol boats and the limited budget provided by the Government. On the other hand, the demand in securing Indonesia territory cannot be postponed. Thus, the model of decision-making related to the water defense for patrol boats in operational sectors must be made. Navy have a duty to conduct the policy of the water defense that is to defend the nation's sovereignty, territorial integrity, and the nation's dignity by conducting military operations at the waters of Indonesia. Thus, the waters are divided into zones.

Zoning is related to the division of the Navy base as the bases of power operation development to the remote operational areas, called 'deployment forces position,' in order to support the duty of Navy's maritime operations in Indonesia. In this study, the planned zoning tasks of Navy patrol boats are divided into three alternatives of deployment; they are five, seven and nine zones.

Journal of Theoretical and Applied Information Technology
10th August 2013. Vol. 54 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Geography Map Of Constellation Indonesian Waters

Area of Waters : 5.800.000 Km^2
Area of Territorial : 3.100.000 Km^2
Area of ZEEI : 2.700.000Km^2
Length of coastline : 80.791 Km
Base line length : 13.179 Km
Number of islands : 17.499 Island

Figure 1. Geography Map of Constellation IW

The data or information of the violations occured in marine national jurisdiction Indonesia shows that Indonesia has not fully supervised its waters from both illegal logging, illegal fishing, and illegal fuel selling, is as shown in Figure 2 [5] :

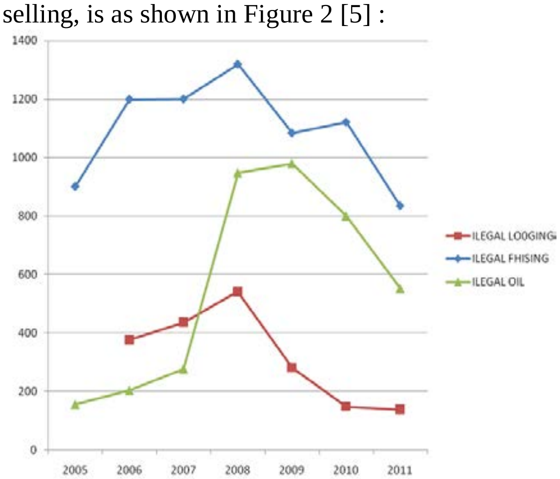

Figure 2. Violations Data successfully captured the Year 2005 – 2011

The research results of national fish stocks Commission state losses due to illegal fishing is estimated that nearly 2 billion dollars per year and the Minister of Forestry MS Ka'ban revealed illegal logging activities resulting in state losses of Rp 30 trillion per year. (Source TEMPO Interactive, Jakarta week, 14 November 2004 11:54 PM) also Ali Masykur Musa CPC Member for Natural Resources, Infrastructure and Environment in a discussion entitled "Combating Illegal Logging" in the Secretariat Foundation Jalan Telaga Dewi Sartika No. Wise. 201 Cawang Jakarta, Thursday (29/07/2010) deliver state losses from illegal logging illegal logging alias of Rp 83 billion per day or Rp 30.3 trillion per year.

Data coverage area patrol boats are sea areas (Nautical Miles square) that can be achieved by the composition of patrol boats in the security in the maritime security sector throughout the year. The greater range of coverage area means ships will patrol more often roam the archipelago sea patrolling for security, so more able to detect and capture crimes and violations the sea areas under national jurisdiction Indonesia as in Table 1.

Table 1. Data Coverage Area KRI and Number Violation in Catch [5]

No	Year	*Coverage Armatim The Secured Area (N M2)*	*The Patrol Boat Coverage Achieved Within One year (N M2)*	*The large numbers of violations in Catch*
1	2005	1.130.442	60.566.750	1520
2	2006	1.130.442	68.901.373	1779
3	2007	1.130.442	74.6673.20	1914
4	2008	1.130.442	74.6673.20	2809
5	2009	1.130.442	74.6673.20	2345
6	2010	1.130.442	74.6673.20	2069
7	2011	1.130.442	74.6673.20	1524

This research will find out the solution related to the task problem and the placement of the Navy patrol boats operating in the sector with the concept of maritime security operations management degree. The concept of maritime security management operations hat can be applied by the Navy consists of several alternative methods such as Fuzzy Logic, Method Analytical Hierarchy Process (AHP), Multiple Criteria Decision Making (MCDM) or the combination of several methods.A clear distinction between the concept of the alternative method of maritime security operations management degree is needed to determine the advantages and disadvantages of each method, so it will be easier to determine the appropriate method for the operations.

The concept of Fuzzy Logic is a mathematical concept of the human way of thinking that will be implemented in the machine and its development; fuzzy logic can be used to all fields. In mathematics, fuzzy logic is expressed in the form of fuzzy set; the advantage is its ability to express some uncertainty or lack of clarity in the way of human thinking and its subjectivity. Furthermore,

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

fuzzy logic also overcomes the weaknesses of the theory of two logical values that divides the state into two possibilities alone are true or false ('1 'or '0') and not give the other possible values. AHP method is a technique to help in solving problems that have varieties in its complexity. In the development of AHP is not only used to determine the priority of choice with lots of criteria, but also in its application that has been extended as an alternative method of settlement kinds of problems.

The accuracy of both comparisons can be counted. Set a quantitative scale from 1 to 9 for the values of the comparison rate interest of the element one another [6].

Multiple Criteria Decision Making (MCDM) is a method that provides an alternative to the use of objective and subjective considerations as the basis of decision-making based on a selected attribute. MCDM Cluster is divided into two, namely Multiple Objective Decision Making (MODM) using optimizational approach, so in getting the reesult, mathematic model must be determined based on the problem occured. Multiple Attribute Decision Making (MADM) using selection approach is obtained from the quantitative attributes and qualitative attributes from the selected criteria.

The selection process is the concept of activity that is full of decision-making considerations made by the leaders of the Navy. Therefore, if those considerations will use the qualitative and quantitative attributes, Multiple Attribute Decision Making (MADM) can provide the right solution at the right time when mutual conflicts occur.

2. RESEARCH METHODS

The Assumptions Used In This Study Are As Follows:

a. Alert III means that the State in a safe and peaceful condition.
b. The task for the patrol boats to the eastern operation sectors of Indonesia archipelago because those areas are more dangerous than the westerns
c. The patrol ships are departed from Surabaya base because the centre of the Navy's ships is in Surabaya.
d. Zoning is divided into three groups, namely five, seven, and nine zones, and this is intended for the evaluation of the existed zones that is seven zones. The determination of the five zones with the consideration of the expansion of the operating area (coverage area) is impossible because of the Navy patrol boat velocity average above 20 knots. However, the decision of the nine zones may still be implemented by increasing Lanal B status that is changed into Lanal A (LANTAMAL) by equipping the necessary facilities.

2.1 MULTIPLE ATTRIBUTE DECISION MAKING (MADM)

Mutiple Attribute Decision Making that is the part of the Multiple Criteria Decision Making (MCDM) is the decision-making method comprising theories processes, analytical methods for decision making involving uncertainty, dynamics and plural aspects of the decision. In daily life, there are times when subjective considerations should be included in the decision making process.

MADM determines the best alternative from a set of alternatives (selection problems) using the alternative reference as attributes in its selection. Because the decision-making defense system model emerges a potential conflict and there is no attribute that dominates others, it can be inferred as the preliminary hypothesis that MADM method can be used in decision-making for sea defense areas [2]; [3] and [4]. For example, the division by zones is beneficial from the perspective of sea-defense operation. However, it will require a lot of funds to support needed facilities in each sector. In addition, MADM Decision allows more than one character who has different preference on the existed alternative in their decision-making sea defense model.

In MADM approach used in this paper, the attributs are divided into two groups, namely the quantitative attributes and qualitattive attribute. The quantitative attribute itself can generally be divided into two types of attributes; cost attribute and benefit attribute [4] and [3]. The benefit attributes is all attributes that provide beneficial effects in the electoral process. Whereas, the cost attributes are all attributes that provide the adverse effects / incurring costs in the electoral process.

For the *benefit attributes*,it can be calculated using the degree of preference [4] below:

$$P_{rk} = \frac{2\,(V_{rk} - V_k^{min})}{V_k^{max} - V_k^{min}} - 1 \qquad (1)$$

Journal of Theoretical and Applied Information Technology
10th August 2013. Vol. 54 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

For all the *cost attributes*, it can be calculated using the degree of preference (Sen 1994) below:

$$P_{rk} = \frac{2(V_k^{min} - V_{rk})}{V_k^{max} - V_k^{min}} - 1 \qquad (2)$$

Where P_{rk} is *preference degree*, V_{rk} is the value of the attribute on the alternative counted, V_k^{min} is the minimum attribute value of the existing alternatives, V_k^{max} is the maximum value of the attributes of the available alternatives, $r = 1,2,\ldots,n$ is the number of alternatives, and k is the number of the quantitative attributes.

The most complicated process in MADM is the process of converting the qualitative attributes into the preference degrees. This conversion process can be facilitated by the evaluation grade. To be reminded, the evaluation grade must be used consistently throughout the electoral process. In this study, the grades of the evaluation that will be used are as in the following table 2:

Table 2 Evaluation Grade

Grade	Name	Value
Bottom	*Poor, (P)*	-1,0
B – M intermediate	*Indifferent, (I)*	-0,4
Middle	*Average, (A)*	0,0
M – T intermediate	*Good (G)*	0,4
Top grade	*Excellent (E)*	1,0

If the preference degree of all attributes for all alternatives has been obtained, the next rank can be determined using the entropy method as follows [3]:

$$\text{Entropy} = -\frac{1}{\ln(m)} \sum_{k=1}^{m} Y_k \ln(Y_k) \qquad (3)$$

Where, m : number of alternatives
Y_k : value of preference degree k-alternative

The algorithm above with more detail has been described and developed by [1]. MADM Flowchart is as shown in Figure 3:

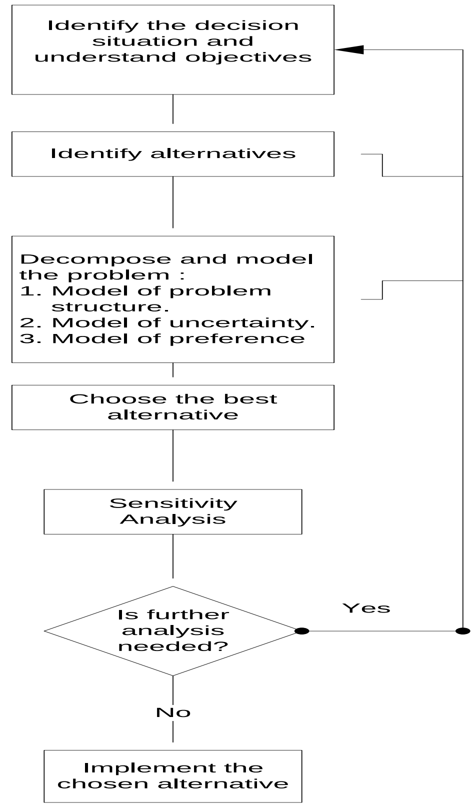

Figure 3. MADM Flowchart

2.2. ALTERNATIVE ZONING DETERMINATION

Indonesia has three grooves Islands (ALKI) that is a biblical region of western Indonesia and two biblical in the eastern part of Indonesia, and it is very beneficial for Indonesia as a Marine Transportation traffic by countries around the world that can have an impact on the welfare of the nation and the state. However, it will give negative effect if the sea is controlled very well because violations from other countries such as legal fishing, illegal logging, and human trafficking emerge. In this paper, the authors focus on the eastern-zone of Indonesia because it is more vulnerable than other Indonesian territories. Thus, three alternatives are presented; they are five, seven and nine zones operating areas as shown below :

A. Alternative I : Five-zones operation
Sector 1 = Sulawesi Sea
Sector 2 = Java Sea
Sector 3 = Banda Sea
Sector 4 = Maluku Sea
Sector 5= Arafura Sea

B. Alternatif II : Seven-zones operation
Sector 1 = Sulawesi Sea
Sector 2 = Java Sea 1
Sector 3 = Java Sea 2
Sector 4 = Banda Sea

Journal of Theoretical and Applied Information Technology
10th August 2013. Vol. 54 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Sector 5 = Maluku Sea
Sector 6 = Pacific Ocean
Sector 7 = Arafura Sea

C. Alternative III :Nine -zones operation
Sector 1 = Sulawesi Sea
Sector 2 = Makassar Strait
Sector 3 = Java Sea
Sector 4 = Seram Sea
Sector 5 = Flores Sea
Sector 6 = Maluku Sea
Sector 7 = Banda Sea
Sector 8 = Arafura Sea
Sector 9 = Pacific Ocean

After classifying the sector is done, the next steps of this research are:

1. Deciding Navy ship assignment model identification
2. Determining the criteria and alternatives
3. Designing the questionnaires and election respondents
4. Weighing using AHP
5. Reporting the results of the re-evaluation of military ship assignment zones
6. Calculating the evaluation grade

The hierarchy of attributes can be shown in Figure 6 :

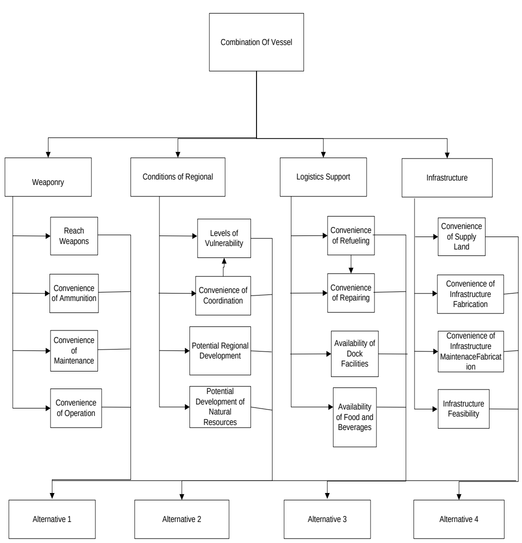

Figure 4 Attribute's

After having the weight value (*relative weight*) of each attribute, the next step is to calculate the *normalize relative weight* with the equation as follows:

$$\lambda = \frac{0.9 x \xi_i}{\xi_{max}} \qquad (4)$$

Where λ is as the *normalize relative weight*, ζ is the relative weight value that is calculated and ζmax is the maximum value of the *relative weight.* For the qualitative attributes, beside the input data of the relative weight, the result of the respondents' simulation, the confidence degree, is needed,too. Each alternative is divided into five fixed-scales, namely poor (P), indifferent (I), average (A), good (G), and excellent (E).

The next step is to calculate the basic probability assignment by multiplying the confidence degree by the weight (relative weight) that has been previously calculated. Where in this study, as the first alternative A5 (eastern sea area is divided in 5 bases), A7 as a second alternative (eastern sea area is divided in 7 bases) and A9 as a third alternative. After the assignment probability of each alternative is found, then the total probability assignment of all alternatives is calculated as shown in Table 3. The calculation of total probability assignment of all alternatives is obtained using matrix calculation from all the attributes of consideration.

Table 3. Total Probability Assignment

Summary of total probability assignment				
		A5	A7	A9
Y5 (Weaponry)	P	0.993	0	0
	I	0	1.000	0
	A	0.004	0	0
	G	0	0	0
	E	0	0	0.4
Y6 (Condition of Regional)	P	3E-08	0	0
	I	0	6E-05	0
	A	0	4E-06	0
	G	0.997	1	2.3789
	E	0	0	2.4548
Y7(Logistics Support)	P	0	0	0
	I	0.162	4E-05	0
	A	0.839	0.8833	0
	G	-0.758	0.9033	1
	E	0	0	0
Y8(Infrastructure)	P	0	0	0.7115
	I	0	0	0
	A	0	0.8711	0
	G	0.953	0	0
	E	0	0	0

From the calculated total probability assignment obtained, it can be calculated the preference degree from each of these qualitative attributes by multiplying each value above with the fixed scales; they are **P**oor (P) - 1, Indifferent (I) - 0.4, **A**verage (a) 0, **G**ood (G) 0.4 and **E**xcellent (E) 1, so the degree of preference results obtained all qualitative attributes is as shown in Table 4.

Journal of Theoretical and Applied Information Technology
10th August 2013. Vol. 54 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Table 4. Preference Degree Of Qualitative Attribute

Preference degree of qualitative attribute			
Attribute	A5	A7	A9
Y5 (Weaponry)	-0.99508141	-0.399999	0.39999
Y6 (Condition of Regional)	0.398986111	0.3999962	0.999978
Y7 (Logistic support)	-0.36791833	0.3681285	0.4
Y8 (Infrastructure)	0.381243597	0	-0.71148051

According to derived preference degrees for each quantitative attribute in Table 5, where the consideration is the cost attribute Y1 and Y4, while the benefits are considered attributes Y2 and Y3.

Table 5. Preference Degree Of Quantitative Attribute

Preference degree of quantitative attribute				
Attribute		A5	A7	A9
Y1	Coverage Area	-1	0.285	1
Y2	Vessel Size	1	0.2	-1
Y3	Speed	1	-0.2	-1
Y4	Wave Height	1	-0.5	-1

2.3 RANKING OF ALTERNATIVE

After obtaining all the values of the preference degree of qualitative attributes and quantitative attributes, the authors rank all alternatives that can be done by using the method of entropy using the 4th equation:

$$\text{Entropy} = -\frac{1}{\ln(m)} \sum_{k=1}^{m} Y_k \ln(Y_k) \qquad (5)$$

Where, m : number of alternatives

Y_k : value of preference degree k-alternative

The algorithm above with more detail has been described and developed by [1]. From the entropy calculation obtained using the 4th equation, the entropy value of each alternative is 1.008 for the alternative of five-zones bases, 1.002 for the alternative of seven-zones bases, and 0.888 for the alternative of nine-zones bases. Entropy calculation results of the third sector can be seen below:

Table 6. The Results Of The Entropy For The 5 Sectors

FIVE SECTORS			
	Y_k	$LN(Y_k)$	$Y_k\,LN(Y_k)$
Y5 (Arming)	-0.995	0.005	-0.005
Y6 (Condition of Area)	0.399	-0.919	-0.367
Y7 (Logistic support)	-0.368	1.000	-0.368
Y8 (Infrastructure)	0.381	-0.964	-0.368
TOTAL	-0.583	-0.878	1.008

Table 7. The Results Of Entropy For The 7 Sectors

SEVEN SECTORS			
	Y_k	$LN(Y_k)$	$Y_k\,LN(Y_k)$
Y5 (Arming)	-0.400	0.916	-0.367
Y6 (Condition of Area)	0.400	-0.916	-0.367
Y7 (Logistic support)	0.368	-0.999	-0.368
Y8 (Infrastructure)	1.000	0.000	0.000
TOTAL	1.368	-0.999	1.002

Table 8. The Results Of Entropy For The 9 Sectors

NINE SECTORS			
	Y_k	$LN(Y_k)$	$Y_k\,LN(Y_k)$
Y5 (Arming)	0.400	-0.916	-0.367
Y6 (Condition of Area)	1.000	0.000	0.000
Y7 (Logistic support)	0.400	-0.916	-0.367
Y8 (Infrastructure)	-0.711	0.340	-0.242
TOTAL	1.088	-1.492	0.888

Therefore, the results shows that the spread of alternative bases in nine-zones are the most optimal alternative with the highest entropy values reaching 89% or 0.89.

2.4 TEST SENSITIVITY

Sensitivity test is done in several scenarios by varying the weighting of the criteria. Variations weighting criteria performed on one group by keeping the weight values of other criteria that are fixed. In the sensitivity test, weights in varied values must be consistent so that the results obtained can be measured objectively. The values used in the variation of the weight at this stage are divided into two groups: 0.7, 0.2 and 0.1 which is a variation of the weights used when in a group, there are three criteria. 0.4, 0.3, 0.2 value and 0.1 is used as a weight variation value if there is one group of four criteria. Fixed rank obtained through MADM software is :

a. Nine-zone deployment is - 0.2444

Journal of Theoretical and Applied Information Technology
10th August 2013. Vol. 54 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

b. Seven-zone deployment is - 0.2447
c. Five-zone deployment is - 0.3641

More clearly, the variation process above could be demonstrated in the following example. The group of the selected criteria is at the coverage level. At this level, there are three criteria: the number of guns, small arms, and missiles. Thus, the scenario used is:

Table 9. 3 Criteria With 3 Scenario

	1's Scenario	2's Scenario	3's Scenario
Guns	0.7	0.2	0.1
Small Arms	0.2	0.1	0.7
Missiles	0.1	0.7	0.2

If the criteria group chosen has four criteria in a group, for example the availability of dock level that has four criteria; the number of navy dock (DT), private dock (DS), Pelindo dock (DP) and KPLP dock (DK), the scenario used is:

Table 10. 4 Dock With 4 Scenario

	1's Scenario	2's Scenario	3's Scenario	4's Scenario
DT	0.4	0.1	0.2	0.3
DS	0.3	0.4	0.1	0.2
DP	0.2	0.3	0.4	0.1
DK	0.1	0.2	0.3	0.4

By varying the value of the weight while maintaining the value of the weight of the other criteria, the results obtained that affect the rank are as follows:

Table 11. Weight Value from 3 Scenario

ZONE	Infrastructure		
	1's Scenario	2's Scenario	3's Scenario
Five -Zone	-0.3641	-0.3641	-
Seven-Zone	-0.241	-0.2388	-
Nine-Zone	-0.244	-0.2444	-
ZONE	Vulnerability		
	1's Scenario	2's Scenario	3's Scenario
Five -Zone	-0.3641	-0.3641	-
Seven-Zone	-0.2447	-0.2447	-
Nine-Zone	-0.2445	-0.2445	-
ZONE	Potential Development Areas		
	1's Scenario	2's Scenario	3's Scenario
Five -Zone	-0.3641	-0.3644	-0.3641
Seven-Zone	-0.2447	-0.2447	-0.2447
Nine-Zone	-0.2444	-0.2444	-0.2444

Table 12. Weight Value From 4 Scenario

ZONE	Potential Development SDAB			
	1's Scenario	2's Scenario	3's Scenario	4's Scenario
Five -Zone	-	-	-	-
Seven-Zone	-	-	-	-
Nine-Zone	-	-	-	-0.2445
ZONE	Ease Of Repair			
	1's Scenario	2's Scenario	3's Scenario	4's Scenario
Five -Zone	-0.3641	-0.3641	-0.3641	-0.3641
Seven-Zone	-	-	-	-
Nine-Zone	-	-	-	-
ZONE	Ease Berth			
	1's Scenario	2's Scenario	3's Scenario	4's Scenario
Five -Zone	-0.3641	-0.3302	-0.3635	-0.3637
Seven-Zone	-	-	-	-
Nine-Zone	-	-	-	-
ZONE	Food Support			
	1's Scenario	2's Scenario	3's Scenario	4's Scenario
Five -Zone	-0.3641	-0.3636	-0.3641	-
Seven-Zone	-	-	-	-
Nine-Zone	-	-	-	-

From all the test of criteria sensitivity, the highest sensitivity value is an infrastructure where the weight variation results from these criteria can change the rank of the alternatives. In other words, these criteria influence the level of rank that are generated, and it needs high accuracy and careful calculation in conducting the assessment toward these criteria.

3. OPTIMIZATION ZONE INDONESIAN NAVY

After conducting the decision-making process based on MADM method above, it can be concluded that the amount of the current spread is the spread in the number seven zones is still less than optimal.

Therefore, it is true that the condition above becomes one of the factors that cause an increase in the numbers of violations by other states in Indonesia's marine territory. By the implementation of MADM approach in the decision-making process involving the qualitative considerations of the Eastern Fleet Command (KOARMATIM) thirty respondents, it can be inferred that the number of naval deployment in the nine-zones bases is the best option.

On the pattern of the spread of the nine-zones, the more systematic and specific distribution is certainly needed in the concept and in the practice. The more the number of naval deployment is expected to have a wider coverage area. The more the number of the base, the better the quality of security achieved because the distribution of the

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

fleet will be maximized. This suggests that the considerations given by the respondents strongly influence the outcome of the optimal value of the distribution. From some of the criteria used as the optional evaluation considerations, some attributes that have the highest weights equivalent weights among others are obtained.

The following table will show the comparison of the weight on the first level of the qualitative attributes.

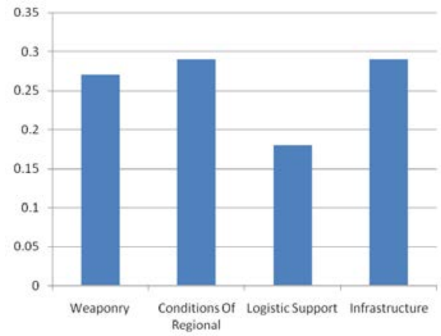

Figure 5. Comparison Of The Weight Of The First Level Of Qualitative Attributes

Figure 5 shows the comparison between the criteria chart ship weapons, regional conditions, logistical support, and infrastructure. From the four criteria, the regional conditions and the defense infrastructure have the highest value among other criteria that weighs 0.28 for both. This shows that the condition of the area and infrastructure criteria are considered highly influential in optimizing the effort in securing the marine areas. The condition of the area is the criteria that is associated with the water conditions that will be secured if the conditions are safe, fairly safe and very dangerous. If the conditions of a region has a very high level of vulnerability, then it takes an effort and a more complex way in determining the naval deployment.

It is very important to be considered in optimizing the deployment of the fleet, ships, and other supporting facilities in the region. Similarly, this applies to the criteria of the infrastructure that has high influence on the decision-making in the deployment of the bases in the region. The infrastructure will greatly affect the daily operations at the base. This is one main reason why the infrastructure criteria becomes one of the important considerations, and it has a high weight in the determination of the number of the naval deployment.

Based on the analysis of MADM methods, there are some major considerations in the plans of the naval deployment. They are:

1. The conditions of the areas which are safe, fairly safe, and very dangerous. This will affect the deployment of the numbers of the boats and the policy applied in those areas.
2. The availability of the infrastructure that is very important for daily operations in the base. Thus, the availability of supporting facilities and infrastructure become the main requirements to maximize the sea defense.

4. CONCLUSION

From this study, it can be concluded that multi-attribute decision making MCDM is very suitable to resolve territorial sea defense system design. Three alternatives concluded that the planned deployment of the alternative bases in nine-zones is the best alternative to be applied in the sea areas of Indonesia.

REFERENCES

[1] Artana, K.B., 2003. *A Research on Marine Machinery Selection Using Hybrid Method of Generalized Reduced Gradient and Decision Matrix*, Dissertation, Kobe University of Mercantile Marine Japan.
[2] Jacquet, L.E., Siskos, J., 1982. Assessing a Set of Additive Utility Functions for Multiple Criteria Decision Making: The UTA Method.European Journal of Operation Research, Vol. 10, p.151-164.
[3] Jian, B.Y., 1995. Multiple Criteria Decision Making in Design Selection and Synthesis.*Journal of Engineering Design*, Vol. 6, No. 3, p. 207-229.
[4] Sen, P., 1994. A General Multi-Level Evaluation Process for Hybrid MADM. *IEEE Transaction*, Vol. 24, No. 10, p. 688-695.
[5] Source Stap Operasi Panglima Armada timur 2011
[6] Thomas L. Saaty and Luis G Vargas 2006 " Decision Making with the Analytic Network Process" Economic, Political, Social and Technological , Applied with Benefits, Opportunities Costs and Risks.
[7] UNCLOS 1982 (Regulation No 17 of 1985 On The Ratification from United Nations Convention on the Law of the Sea)