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# Application Of Intelligent Decision Support Systems (Idss) To Calculate The Number Of Sectors For Security Operations In The East Sea Indonesia

Hozairi[1], Ketut Buda Artana[2], Masroeri[3], M.Isa Irawan[4]
[1](Department Of Ocean Enggineering, Fakulty of Marine Technology, ITS, Indonesia)
[2] (Department of Mathematics, Fakulty Mathematics and Science, ITS, Indonesia)

***ABSTRACT**: This study discusses the implementation of Fuzzy Analytical Hierarchy Process (FAHP) as part of the Intelligent Decision Support Systems (IDSS) for determining the number of marine security operations sector of eastern Indonesia. There are two types of variables used in this study is a quantitative and qualitative. Quantitative variables were used in conjunction with the ship (C5) is the speed, size, wave height and coverage area. Qualitative variables used are weapons (C1), sector (C2)), logistics (C3) and infrastructure (C4). There are 7 decision alternatives used in this study, to determine the optimal number of operational sectors are A1 = 4 sectors, sectors A2 = 5, A3 = 6 sectors, sector A4 = 7, A5 = 8 sectors, A6 and A7 = 9 sectors = 10 sectors. The calculation of the variable weights of 5 criteria using FAHP obtained as follows: C1 = 0.26; C2 = 0.24; C3 = 0:21; C4 = C5 = 0:17 and 0:12. The weight will be multiplied by the weight of sub-criteria of each alternative weighting criteria to produce a decision. Some Navy leaders also give the value of the criteria and sub-criteria for each of the proposed number of sectors with a range of values 50-100. The end result of this research is A1 = 45.843, A2 = 46.134, A3 = 46.008, A4 = 46.201, A5 = 46.232 A6 = 46.015 and A7 = 46.083. Based on calculations FAHP is recommended for the development of the number of sectors in ARMATIM from 7 to 8 sectors that can be monitored and secured by the fleets of the Republic of Indonesia.*

***Keywords:** FAHP, IDSS, Sector, Armatim*

## I. INTRODUCTION

Republic of Indonesia is an archipelago consisting of 17,504 islands and has a beach along the 81,290 kilometers *(Dishidros TNI-AL, 2003).* As an island nation with 80% of the sea area and 20% of the land, the threat to the sovereignty and territory of Indonesia is in the sea. The threats are higher because the position of Indonesia is the geography of world trade traffic. The high number of crimes and violations that occurred in Indonesia such as the sea, illegal fishing, illegal logging, illegal mining, illegal migrants, human trafficking and smuggling, this suggests that the weakness of Indonesia's marine security. This is due to the limited number of owned fleet so the extent of the area to be secured, lack of budget, lack of achievement Indonesian warship coverage area and have not optimized the amount of the security zone (sector operations) Indonesian sea.

Based on the above conditions need to do some study and development of decision models capable of working in a dynamic and uncertain environment quickly and accurately. Decision support systems (DSS) is an application of technology that can help leaders determine the Navy's decision to utilize existing data and models to solve unstructured and semi-structured.

This research aims to design and create an application Intelligent Decision Support System (IDSS) to be able to provide alternative solutions that are easy to adapt to a dynamic environment, the method chosen to build the IDSS is Fuzzy Analytical Hierarchy Process (F-AHP), IDSS is built not to replace the role and function of the human but to help provide an alternative decision. F-AHP is a decision support method is quite popular and has been reliable in addressing the issue in accordance with the criteria of selection of objects is measured qualitatively and quantitatively. F-AHP is one of the ranking methods. F-AHP is a combination of AHP with fuzzy concept approach (Raharjo et al, 2002). F-AHP cover the weaknesses contained in the AHP, the problem of the subjective nature of the criteria that have more. Uncertainty is represented by the sequence numbers of the scale. To determine the degree of membership in F-AHP, use the rules function in the form of triangular fuzzy numbers or Triangular Fuzzy Number (TFN) which is based on the set of linguistics. Thus, the numbers in the level of intensity of interest in AHP is transformed into a set of scales TFN.

## II. LITERATURE REVIEW

### 2.1. IDSS

Intelligent decision support system (IDSS) is the development of decision support systems using the knowledge *(the rules of the nature and elements of the problem)* such as fuzzy systems, neural networks and genetic algorithm (Sadly 2007). This goal is to help users to access, view, understand, and manipulate data more quickly and easily to help in making decisions. So with intelligent decision support systems can be used to make optimal decisions to approach learning and reasoning ability and the ability of a system grounded in choosing a solution, as was done by an expert in making decisions that will get consistent and effective solution. The process consists of sub-systems organizational system input, sub-systems and sub-structuring problems simulation system state and determining the best solution. The output of Intelligent Decision Support Systems is in the form of reporting solutions, forecasting the impact of its decisions on input and suggestions and explanations effects. Input has a feedback output to obtain an optimal solution in making decisions on effective and efficient.

### 2.2. AHP

Analytical Hierarchy Process (AHP) is a flexible model that allows individuals or groups to form ideas and limit problems with their own assumptions and generate solutions for them *(Thomas L. Saaty, Decision Making for*

*Leaders; The Analytical Hierarchy Process for Decision in Complex World, 1988)*. AHP was developed in the early 1970's by Saaty and has been used to assist decision makers from different countries and companies. According to Saaty (1993, p23) AHP is a flexible model that provides an opportunity for individuals or groups to develop ideas and define problems in a way to make their own assumptions and obtain her desired solution. AHP include considerations and values logical.

The working principle of AHP is to simplify the complex problem of unstructured, strategic and dynamic into its parts, as well as arranging the variables in a hierarchy (levels). Then the variable interest rate subjectively assigned a numerical value on the relative importance compared to other variables. From various considerations are then carried out the synthesis to define variables that have the highest priority and role is to influence the outcome of the system. The difference between AHP models with other models of decision-making lies in the type of input use AHP model of human perception is considered 'expert or experts' as the primary input. Criteria experts here are people who understand the real problem, feeling the effects of a problem or have an interest in this. Qualitative measurement of things is very important given the increasingly complex problems of the world and a higher degree of uncertainty. If there are deviations which are too far from the value of a perfect consistency an assessment needs to be repaired or re-structured hierarchy of need.

Analytic hierarchy process (AHP) is a multiple criteria decision-making approach that has been used in most applications related with different areas including evaluation, allocation, selection, benefit-cost analysis, allocation, planning and development, priority and ranking, and decision-making *(Korpela, KylaKaheiko, Lehmusvaara & Tuominen, 2002; Crary, Nozick & Whitaker, 2002; Badri, 2001; Beynon, 2002)*. However, traditional AHP seems inadequate to capture customer values with linguistic expressions and determine the relative importance weight of customer's needs accurately (Kahraman, Cebeci, and Ulukan, 2003). And AHP method is often criticized due to its use of unbalanced scale of judgments and its inability to adequately handle inherent uncertainty and imprecision in the pair-wise comparison process (Deng, 1999). Hence, fuzzy analytic hierarchy process (FAHP) was developed to solve these shortcomings and decision-makers usually are more confident to give interval judgments than fixed value judgments.

### 2.3. F-AHP

F-AHP is a decision-making tool typically aimed to accommodate conflict of opinion and subjectivity of assessment of several different people. Unlike simple decisions (which consists of only one criterion), the real world must have a lot of criteria and alternatives involved in the decision making. This makes the decision process more complicated because of the conflict of opinion about opinions like inequality priority level of each criterion. Therefore, AHP is capable of breaking a complex problem into elements smaller hierarchy in the form of a simpler assessed can be used for decision making by the number of criteria of more than one or often called multi-criteria decision making.

But on further development of AHP was assessed as having few weaknesses is the inability to capture the vagueness *(vagueness)*, uncertainty, imprecision and subjectivity in the assessment made by some people. M Buckley (Hsieh, 2004) developed the concept of Fuzzy AHP (FAHP) is the development of the AHP by integrating fuzzy AHP with synthetic evaluation (FSE). In FAHP use ratio to replace the fuzzy AHP and the exact ratio is also used mathematical operations and fuzzy logic to replace the usual mathematical operations on AHP. Users rate at FAHP fuzzy AHP inability to accommodate the inaccuracy factor (imprecision) and subjectivity in the process of pair wise comparison or paired comparisons for each criterion and alternative. Therefore, the ratio is used which consists of three fuzzy values are the highest values (values above), the average (median) and the lowest value (lower value). The ratio of three fuzzy membership values is usually called triangular fuzzy number (TFN).

There are several variations of FAHP types have been developed:

1. Var Laarhoven and Pedrycz (1983) apply fuzzy triangular number on pair wise comparison ratio. This is what started the emergence of fuzzy AHP method.
2. Kristianto (2002) proposed a model based on Fuzzy FAHP quantification theory in which the aspirations of the evaluators who shaped crisp converted to a fuzzy membership function to look for. This model was considered crisp and aspirations evaluator quantization method involves complex computational operations.
3. Rahardjo (2002) proposed a model with a model FAHP weighted non-additive which is a combination of the weight and the weight of prior information. The weight is the weight of the prior development of AHP and fuzzy weights of weighted fuzzy information entropy. The model uses a weighted fuzzy evaluator and it involves a complicated computing operations.
4. Singgih (2005) have put forward a model that is an extension of the FAHP from Rahardjo (2002) which can use more than one evaluator.

## III. FUZZY - AHP

### 3.1. DEGREES OF MEMBERSHIP AND SCALE OF FUZZY TRIANGLE

Fuzzy AHP method provides a systematic procedure for selecting and justifying the alternatives by using the concept of fuzzy logic and hierarchical structure inherited from traditional AHP method. Moreover, fuzzy AHP method is a popular approach for multiple criteria decision-making and has been widely used in the literature.

Chang (1996) applied triangular fuzzy number to construct the fuzzy pair-wise comparison matrix in AHP and used the extent analysis method for obtaining the synthetic values of the pair-wise comparisons. Sheu (2004) combined fuzzy AHP with fuzzy multi-attribute decision-making approach for identifying global logistics strategies. Kahraman, Cebeci, and Ruan (2004) applied the fuzzy AHP to the comparison of catering firms via customer satisfaction. Chang's extent analysis method (Chang, 1996) provides an easier way to construct fuzzy reciprocal comparison matrix and derive the weight vectors for individual levels of the hierarchical requirements without weight overlapping than the other fuzzy AHP and traditional AHP approaches. In this study, Chang's extent analysis method (Chang, 1996) is applied to evaluate the relative importance weights of customer relational benefit attributes for searching appropriate relationship marketing strategies.

F-AHP is a combination of methods to approach the concept of Fuzzy AHP (Raharjo, 2002). FAHP cover the weaknesses contained in the AHP, the problem of the subjective nature of the criteria that have more. Uncertainty is represented by the sequence numbers of the scale. Determine the degree of membership of F-AHP developed by Chang using triangular membership function (Triangular Fuzzy Number / TFN). Triangular membership function is a combination of the two lines (linear). Graph triangle membership functions described in terms of triangular curve, such as Figure 1.

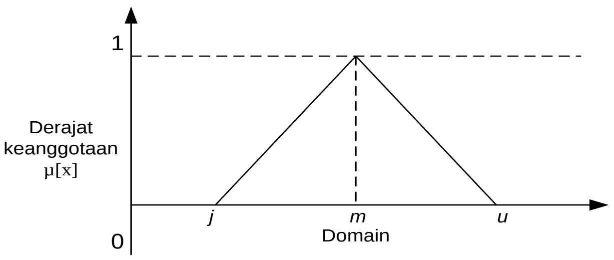



**Figure 1**. Triangular Membership Function *(Chang, 1996)*

(Chang, 1996) mendefinisikan nilai intensitas AHP ke dalam skala fuzzy segitiga yaitu membagi tiap himpunan fuzzy dengan dua (2), kecuali untuk intensitas kepentingan satu (1). Skala fuzzy segitiga yang digunakan Chang dapat dilihat pada tabel 1.

Tabel 1. Skala Nilai Fuzzy Segitiga

### 3.1. STEP-BY-STEP FUZZY–AHP

Different methods have been proposed in the literatures that one of most known of them is Fuzzy Extent Analysis proposed by Chang (1996). The steps of extent analysis can be summarized as follows:

a. computing the normalized value of row sums (i.e. fuzzy synthetic extent) by fuzzy arithmetic operations:
b. Creating a hierarchical structure and the issues to be resolved between the pairwise comparison matrix to determine the scale criteria TFN
c. Determining the value of fuzzy sitesis ($S_i$) priority using the following formula:

$$Si = \sum_{j=1}^{m} M_i^j \; x \; \frac{1}{\sum_{i=1}^{n}\sum_{j=1}^{m} M_i^j} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where

$$\sum_{j=1}^{m} M_i^j = \sum_{j=1}^{m} il, \sum_{j=1}^{m} mj, \sum_{j=1}^{m} uj \quad \ldots\ldots\ldots \quad (2)$$

While

$$\frac{1}{\sum_{j=1}^{n}\sum_{j=1}^{m} M_i^j} = \frac{1}{\sum_{i=1}^{n} ui, \sum_{i=1}^{n} mi, \sum_{i=1}^{n} li} \quad \ldots\ldots\ldots\ldots \quad (3)$$

d. Determining the value of the vector (v) and the ordinate value Defuzifikasi (d').
If the results obtained in each matrix fuzzy, $M_2 \geq M_1$ ($M_2 = (l_2, m_2, u_2)$ and $M_2 = (l_1, m_1, u_1)$ the value of the vector can be formulated as follows:
$V(M_2 \geq M_1) = sup\ [\mu M_1(x), min\ (\mu M_2(y)))]$

Or equal to the following equation:

$$V(M2 \geq M1) = \begin{cases} 1, & if\ m2 \geq m1 \\ 0, & if\ l1 \geq \mu 2 \\ \dfrac{l_1 - \mu_2}{(m_1 - m_2) - (m_1 - l_1)}, & more \end{cases}$$

If the results of fuzzy values, is greater than k, $M_i$ *(i=1,2,,,k)* the value of the vector can be defined as follows:

$V(M \geq M_1, M_2, \ldots, M_k) = V(M \geq M_1)$ and
$V(M \geq M_2, M_2)$ and
$V(M \geq M_k) = min\ V(M \geq M_1)$ .......................... (5)

Assume that:

$d'(A_i) = min\ V(Si \geq Sk)$ ................................ (6)

to $k = 1,2,,,n;\ k \neq i$, then obtained weight value vector.

$W' = (d'(A_1), d'(A_2), \ldots, d'(A_n))^T$.......................... (7)

where $Ai = 1,2,\ldots,n$ is n elements of the decision.

e. Normalized weights fuzzy vector *(w)*
After normalization of the equation (7), then the value of the normalized weight vector is as the following formula:

$W = (d(A_1), d(A_2), \ldots, d(A_n))^T$ ........................... (8)

Where W is a non-fuzzy numbers

## IV. DISCUSSION

### 4.1. Criteria and Sub Criteria

After doing the test interviews with the management of the Navy in particular KOARMATIM then obtained criteria and sub-criteria used in determining the number of sectors of maritime security operations in eastern Indonesia, as follows:

**Table 1.** Criteria and Sub Criteria

| No | Criteria | Name Of Criteria | Sub Criterie |
|---|---|---|---|
| 1 | C1 | Weapons | ▪ Coverage<br>▪ Ammunition<br>▪ Maintenance<br>▪ Operational |
| 2 | C2 | Sector | ▪ Vulnerability<br>▪ Coordination<br>▪ Potentiality<br>▪ SDAB |
| 3 | C3 | Logistic | ▪ Refuiling<br>▪ Repair<br>▪ Berth<br>▪ Fresh Water<br>▪ Groceries |
| 4 | C4 | Infrastructure | ▪ Land<br>▪ Manufacture<br>▪ Treatment |
| 5 | C5 | Ship | ▪ Coverage Area<br>▪ Speed<br>▪ Type<br>▪ Endurance |

Once the criteria and sub-criteria is obtained, further troubleshooting using the F-AHP method.

### 4.2. FUZZY- AHP

#### 4.2.1. Hierarchy

Hierarchical structure of the problem of determining the optimal number of operational sectors to secure the sea east of the Republic and can be seen figure 2.

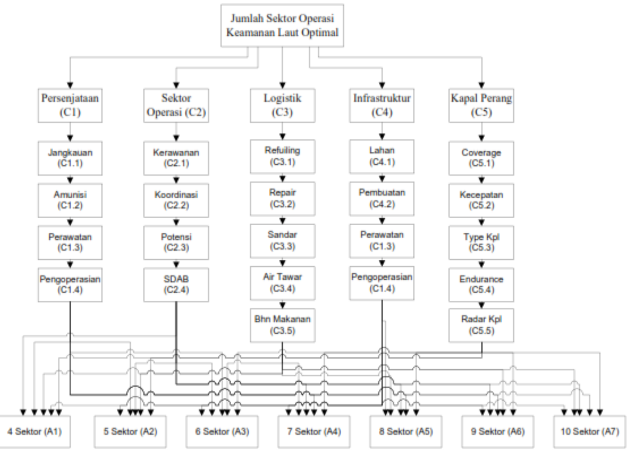



**Figure 2.** Hierarchical Structure Determination of Total Marine Security Operations Sector Eastern Indonesia

#### 4.2.2. Step By Step F-AHP

The calculation of the value of fuzzy synthesis leads to the approximate total value of each of the criteria, sub-criteria and alternatives in want.

Input value to generate pair-wise assessments use the Chang. However, for ease of calculation then multiplied by 2. For example, the input (0.5, 1; 1.5) will be (1, 2, 3) and so on. Examples of data entry can be seen in Table 2 below:

**Table 2.** Pair-wise comparison matrix of criteria F-AHP

EVALUASI KRITERIA

Kriteria Evaluasi

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SENJATA | 1 | 1 | 1 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| SEKTOR | 0,333 | 0,5 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| LOGISTIK | 0,333 | 0,5 | 1 | 0,333 | 0,5 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 1 | 2 | 3 |
| INFRASTRUKTUR | 0,333 | 0,5 | 1 | 0,333 | 0,5 | 1 | 0,333 | 0,5 | 1 | 1 | 1 | 1 | 1 | 2 | 3 |
| KAPAL | 0,333 | 0,5 | 1 | 0,333 | 0,5 | 1 | 0,333 | 0,5 | 1 | 0,333 | 0,5 | 1 | 1 | 1 | 1 |

The next step, the system forms FSE matrix resulting from arithmetic operations rows and columns in table 2, and the resulting matrix in table 3 below:

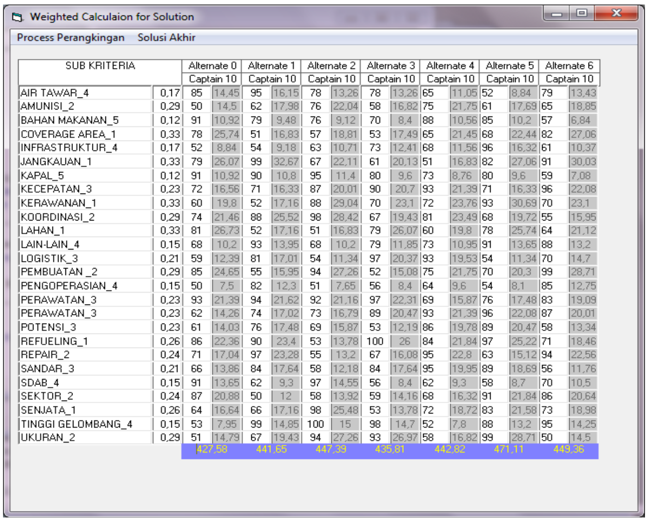
**Table 3.** Calculation of fuzzy synthetic extents (FSE)

Fuzzy Synthetic Extend

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SENJATA | 5 | 9 | 13 | 15,99 | 27 | 40 | 0,025 | 0,037 | 0,063 | 0,125 | 0,333 | 0,819 |
| SEKTOR | 4,333 | 7,5 | 11 | 15,99 | 27 | 40 | 0,025 | 0,037 | 0,063 | 0,108 | 0,278 | 0,693 |
| LOGISTIK | 3,666 | 6 | 9 | 15,99 | 27 | 40 | 0,025 | 0,037 | 0,063 | 0,092 | 0,222 | 0,567 |
| INFRASTRUKTUR | 2,999 | 4,5 | 7 | 15,99 | 27 | 40 | 0,025 | 0,037 | 0,063 | 0,075 | 0,167 | 0,441 |
| KAPAL | 2,332 | 3 | 5 | 15,99 | 27 | 40 | 0,025 | 0,037 | 0,063 | 0,058 | 0,111 | 0,315 |

The next step, the system forms FSE matrix resulting from arithmetic operations rows and columns in table 2, and the resulting matrix in table 3 below. Of the matrix is to be generated FSE variables such as eigen-vectors, the degree of probability and the normalized matrix. The last step will be generated where the emphasis criteria. These steps are repeated as many times as there sub-criteria.

Before continuing this process it will be calculated IR (Index Ratio) resulting from the division of numbers CI (Consistency Index) and CR (Consistency Ratio) when it is in accordance with the formula Sa'aty then the system will store the data. And so on so that the calculation process is complete until the last sub-criteria. Figure 3 below shows the results of the final weighting generated by the system.


Weighted Calculaion for Solution

Process Perangkingan Solusi Akhir

| SUB KRITERIA | | Alternate 0 | | Alternate 1 | | Alternate 2 | | Alternate 3 | | Alternate 4 | | Alternate 5 | | Alternate 6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Captain 10 | | Captain 10 | | Captain 10 | | Captain 10 | | Captain 10 | | Captain 10 | | Captain 10 | |
| AIR TAWAR_4 | 0,17 | 85 | 14,45 | 95 | 16,15 | 78 | 13,26 | 78 | 13,26 | 65 | 11,05 | 52 | 8,84 | 79 | 13,43 |
| AMUNISI_2 | 0,29 | 50 | 14,5 | 62 | 17,98 | 76 | 22,04 | 58 | 16,82 | 75 | 21,75 | 61 | 17,69 | 65 | 18,85 |
| BAHAN MAKANAN_5 | 0,12 | 91 | 10,92 | 79 | 9,48 | 76 | 9,12 | 70 | 8,4 | 88 | 10,56 | 85 | 10,2 | 57 | 6,84 |
| COVERAGE AREA_1 | 0,33 | 78 | 25,74 | 51 | 16,83 | 57 | 18,81 | 53 | 17,49 | 65 | 21,45 | 68 | 22,44 | 82 | 27,06 |
| INFRASTRUKTUR_4 | 0,17 | 52 | 8,84 | 54 | 9,18 | 63 | 10,71 | 73 | 12,41 | 68 | 11,56 | 96 | 16,32 | 61 | 10,37 |
| JANGKAUAN_1 | 0,33 | 79 | 26,07 | 99 | 32,67 | 67 | 22,11 | 61 | 20,13 | 51 | 16,83 | 82 | 27,06 | 91 | 30,03 |
| KAPAL_5 | 0,12 | 91 | 10,92 | 90 | 10,8 | 95 | 11,4 | 80 | 9,6 | 73 | 8,76 | 80 | 9,6 | 59 | 7,08 |
| KECEPATAN_3 | 0,23 | 72 | 16,56 | 71 | 16,33 | 87 | 20,01 | 90 | 20,7 | 93 | 21,39 | 71 | 16,33 | 96 | 22,08 |
| KERAWANAN_1 | 0,33 | 60 | 19,8 | 52 | 17,16 | 88 | 29,04 | 70 | 23,1 | 72 | 23,76 | 93 | 30,69 | 70 | 23,1 |
| KOORDINASI_2 | 0,29 | 74 | 21,46 | 88 | 25,52 | 98 | 28,42 | 67 | 19,43 | 81 | 23,49 | 68 | 19,72 | 55 | 15,95 |
| LAHAN_1 | 0,33 | 81 | 26,73 | 52 | 17,16 | 51 | 16,83 | 79 | 26,07 | 60 | 19,8 | 78 | 25,74 | 64 | 21,12 |
| LAIN-LAIN_4 | 0,15 | 68 | 10,2 | 93 | 13,95 | 68 | 10,2 | 79 | 11,85 | 73 | 10,95 | 91 | 13,65 | 88 | 13,2 |
| LOGISTIK_3 | 0,21 | 59 | 12,39 | 81 | 17,01 | 54 | 11,34 | 97 | 20,37 | 93 | 19,53 | 54 | 11,34 | 70 | 14,7 |
| PEMBUATAN _2 | 0,29 | 85 | 24,65 | 55 | 15,95 | 94 | 27,26 | 52 | 15,08 | 75 | 21,75 | 70 | 20,3 | 99 | 28,71 |
| PENGOPERASIAN_4 | 0,15 | 50 | 7,5 | 82 | 12,3 | 51 | 7,65 | 56 | 8,4 | 64 | 9,6 | 54 | 8,1 | 85 | 12,75 |
| PERAWATAN_3 | 0,23 | 93 | 21,39 | 94 | 21,62 | 92 | 21,16 | 97 | 22,31 | 69 | 15,87 | 76 | 17,48 | 83 | 19,09 |
| PERAWATAN_3 | 0,23 | 62 | 14,26 | 74 | 17,02 | 73 | 16,79 | 89 | 20,47 | 93 | 21,39 | 96 | 22,08 | 87 | 20,01 |
| POTENSI_3 | 0,23 | 61 | 14,03 | 76 | 17,48 | 69 | 15,87 | 53 | 12,19 | 86 | 19,78 | 89 | 20,47 | 58 | 13,34 |
| REFUELING_1 | 0,26 | 86 | 22,36 | 90 | 23,4 | 53 | 13,78 | 100 | 26 | 84 | 21,84 | 97 | 25,22 | 71 | 18,46 |
| REPAIR_2 | 0,24 | 71 | 17,04 | 97 | 23,28 | 55 | 13,2 | 67 | 16,08 | 95 | 22,8 | 63 | 15,12 | 94 | 22,56 |
| SANDAR_3 | 0,21 | 66 | 13,86 | 84 | 17,64 | 58 | 12,18 | 84 | 17,64 | 95 | 19,95 | 89 | 18,69 | 56 | 11,76 |
| SDAB_4 | 0,15 | 91 | 13,65 | 62 | 9,3 | 97 | 14,55 | 56 | 8,4 | 62 | 9,3 | 58 | 8,7 | 70 | 10,5 |
| SEKTOR_2 | 0,24 | 87 | 20,88 | 50 | 12 | 58 | 13,92 | 59 | 14,16 | 68 | 16,32 | 91 | 21,84 | 86 | 20,64 |
| SENJATA_1 | 0,26 | 64 | 16,64 | 66 | 17,16 | 98 | 25,48 | 53 | 13,78 | 72 | 18,72 | 83 | 21,58 | 73 | 18,98 |
| TINGGI GELOMBANG_4 | 0,15 | 53 | 7,95 | 99 | 14,85 | 100 | 15 | 98 | 14,7 | 52 | 7,8 | 88 | 13,2 | 95 | 14,25 |
| UKURAN_2 | 0,29 | 51 | 14,79 | 67 | 19,43 | 94 | 27,26 | 93 | 26,97 | 58 | 16,82 | 99 | 28,71 | 50 | 14,5 |
| | | 427,58 | | 441,65 | | 447,39 | | 435,81 | | 442,82 | | 471,11 | | 449,36 | |

**Figure 3**. Final calculation

The solution provided by the system can be seen in the display form of the figure 4 below:

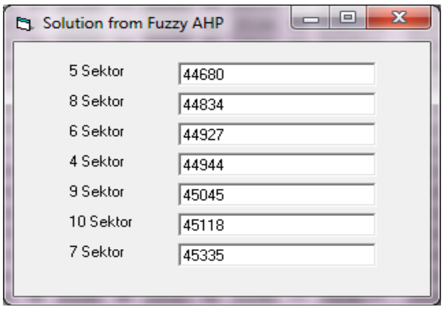



**Figure 4**. Solution frim Fuzzy AHP

#### 4.2.3. Data Flow Diagram

Data flow diagram of the system is illustrated below:

a. DFD Level 0

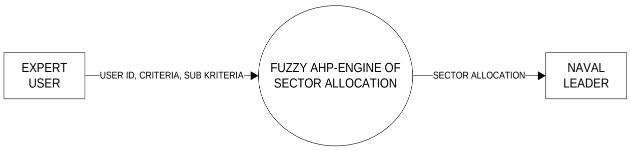



**Figure 5**. DFD Level 0

Users of this system divided by 2 is Admin and Expert. System provides the AHP calculation to completion ranging from matrix calculations FAHP until normalization process if the user entered the category admin. System generates the final weights of all sub-criteria as well as providing the final calculation in which the ship's captain is authorized to enter a value.

b. DFD Level 1 = User Login

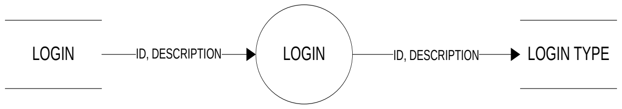



**Figure 6.** DFD Level 1 for user login

Users of this system divided by 2 is Admin and Expert. System provides the AHP calculation to completion ranging from matrix calculations FAHP until normalization process if the user entered the category admin. System generates the final weights of all sub-criteria as well as providing the final calculation in which the ship's captain is authorized to enter a value.

DFD Level 1 = F- AHP

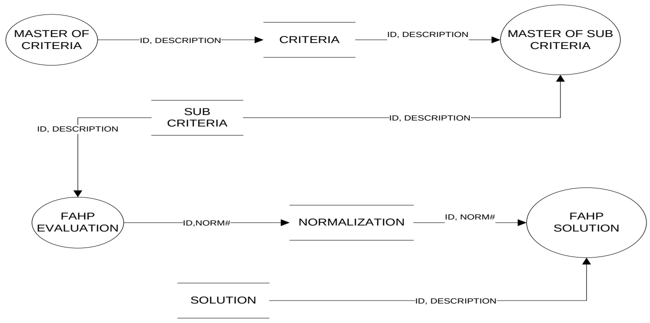



**Figure 7**. DFD Level 1 for Fuzzy AHP

The system will provide to users who log in with the admin user types allowed for input, edit, add and delete the data on the criteria and sub-criteria are shown in Figure 5.

c. DFD Level 2 = F-AHP

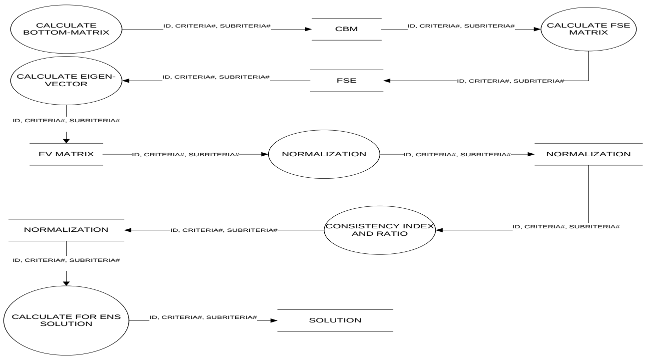



**Figure 8**. DFD Level 2 for Fuzzy AHP

The system will provide to users who log in with the user as a kind of expert is allowed to perform the calculations step by step in fuzzy AHP are shown in Figure 5 above

DFD above shows the the process of the system FAHP made in this study. The resulting solution is very dependent on the perception of expert user of the criteria and sub-criteria that have been provided.

## V. Conclusion

Based on the calculation of the fuzzy AHP designed this study are obtained as follows:

1. Infrastructure is the highest criterion value of 0.67. This means that the system is suggested to Armatim to make infrastructure improvements each sector. Including ship infrastructure.
2. Coverage Area is the highest sub-criteria with a value of 0.33. This means that the system is suggested to Armatim to expand the reach of the patrol boat. This resulted in the renewal of the vessel which supplies both weapons, radar and its cargo could be accounted for reliability. Since the addition of the sector is tantamount to increasing the ability of ships and personnel.
3. Finally, the system prompts the Armatim to increase the number of sectors to be 7 with a value of 45,335. For the current state of the system does not propose an increase but the improvement of the infrastructure sector and ship technology.

## References

[1] Ade Supriyanto Sinaga and Ketut Buda Artana, (2012). *Application Of Multiple Attribute Decision Making (MADM) Spread The Planning Naval Base In Eastern Indonesia.* Essay, Department Of Ocean Enggineering, Fakulty Of Marine Technology, ITS.

[2] Chang, D.Y., (1996). *Application of the extent analysis method on fuzzy AHP. European Journal of operational Research 95,* 649-655

[3] Jasril, Elin Haerani and Lis Afrianty, (2011). *Decision Support Systems Employee Selection Method Using FAHP, Seminar on Information Technology Applications 2011,* ISSN: 1907-5022. F36 – F43.

[4] Kahraman, Cengiz, Ufuk Cebeci, and Da Ruan., (2004). *Multi Attribute Comparison of Catering Service Companies Using Fuzzy AHP: The Case of Turkey, International Journal Of Production Economics 87*, 171-184.

[5] Lee, H. S., (2009). *Using Fuzzy AHP to Develop Intellectual Capital Evaluation Model For Assessing their Performance Contribution in a University, Expert System with Application.* xxx,xxx-xxx

[6] Mikhailov.L and Tsvetiniv.P., (2004). *Evaluation of services using a Fuzzy Analytic Hierarchy Process. Applied Soft Computing 5,* 22-23

[7] Satty, T. L., 1980. *The Analytical Hierarchy Process: Planning, PrioritySetting, Resource Allocation*. New York: McGraw-Hill

[8] Saaty. T.L. 1991. *Pengambilan Keputusan Bagi Para Pemimpin.* PT. Pustaka Binaman Pressindo Jakarta

[9] Saaty, T.L. 1993. *The Analytical Hierarchy Process,* McGrraw-Hill, New York. 1993.

[10] Saaty, T. L. 2001. The seven pillars of the analytic hierarchy process. Multiple Criteria Decision Making in the New Millennium. M. Koksalan and S. Zionts. 507: 15-37.

[11] Sadly, M. (2007). *Utilization of Technology Assessment Knowledge-based Expert System in the Management of Natural Resources,*