# IMPLEMENTATION OF ANALYTIC NETWORK PROCESS (ANP) METHOD IN THE ORDER OF SELECTING THE ALTERNATIVE SUBMARINE OF THE INDONESIAN NAVY

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## ABSTRACT

This paper describes the application of the Analytic Network Process (ANP) method in submarine selection as one of the defence equipment with very strategic value, the procurement of submarines is directed at realizing a deterrence strategy and a strategy of balancing with state actors that have the potential to threaten the sovereignty of the Republic of Indonesia. Apart from threats, the procurement of submarines also considers the geographical constellation of the Republic of Indonesia and the government's wishes, such as the interest of the minister of defence during visits to countries that offer their submarines. Therefore, before the procurement, an analysis was made in terms of the selection of submarine alternatives, both analysis of information and identification of various essential and interrelated requirements regarding data from submarine alternatives that would later be selected. In addition to other options, it is hoped that the main criteria for selecting submarines will be known. In submarine procurement decisions, where the existing problems cannot be arranged in a hierarchical form because it involves the interaction and dependence of the higher-level elements on the lower-level elements. Therefore, in this study the ANP method is used, which can accommodate the linkages between criteria or alternatives. The results obtained are the most substantial alternative priority weight on the S-Class submarine made by P-Country of 0.383283. While the results of the importance of the criteria are sequential starting from the sensor criteria of 0.125127, Threat 0.089076, Neighbors power state 0.080153, Geographical conditions 0.75735, Interoperability 0.071664, Weaponry 0.068672, Navigation 0.047301, Platform 0.044235 and finally Machinery 0.020580.

**Keywords:** *ANP method, Submarine, Alternative priority.*

## 1. INTRODUCTION

**Figure 1.** The geographical constellation of Indonesian State

Geography is a fundamental factor in the formulation of a national defence strategy (geostrategy). The basis of this philosophy has been juridically affirmed through Article 3 paragraph 2 of the Republic of Indonesia Law No.3 of 2002 concerning National Defense, namely that "State defence is prepared by taking into account the geographical conditions of Indonesia as an archipelago". Indonesian waters consist of two types of waters, namely shallow waters and oceanic waters. There are two shallow waters, namely the Sunda Shelf in western Indonesian waters and the Sahul Shelf in eastern Indonesian waters. In the blueprint for the development of the Navy force 2005-2024, it is stated that for shallow waters a mining strategy is implemented, while for deep waters with a defence pattern using submarines (Long-term Navy Force Development Plan, 2005-2024). This philosophical and juridical basis should become the rationale for further consistent and systematic translation into the technical field of the military, to obtain the form of an essential strategy to defend an area. The basic strategy must be able to provide a real picture of the kind of defence strategy

referred to on the map so that it can be applied primarily if it is oriented towards wartime.

Selection of truly appropriate submarine alternatives requires analysis of information and identification of various essential requirements regarding data from submarine alternatives which broadly include operational requirements, namely: geographical conditions of Indonesian waters, threats, neighbour power state, and interoperability; as well as the technical requirements of the submarine which includes several primary considerations that support operational requirements. Besides, the government's desire to selecting the type of submarine is also the primary data in choosing the submarine alternative.

In this paper, the Multi-Criteria Decision Making (MCDM) approach will be completed. One method that is widely known and compatible with this kind of conflict is the Analytic Network Process (ANP). The use of ANP is expected to be able to overcome if there is an interdependence between the existing criteria.

In this study, several types of references are used to support research :

a. The research review, for example paper titled Application of Fuzzy AHP for Improving the Accuracy and Effectiveness of Employee Performance Apppraisal (Wiji Setyaningsih, 2018), Fuzzy AHP method is used for Employee performance appraisal by PT Kimora Surabaya in order to obtain the accuracy of determination, the final result is increased, and the effectiveness of assessment process also increases. The fundamental weaknesses of the AHP method, namely only in accordance with the hierarchical relationship model between criteria and not in accordance with the relationship model between criteria and subcriteria which are networked and cross-criteria. Even though in reality, the relationship between criteria is dominated by network relationship.

b. Submarine. The essential functions carried out by submarines include: Surveillance and Reconnaissance, Organizing Anti-Surface Ship Warfare, Conducting Underwater Warfare including Anti-Submarine Warfare, Infiltration Facilities (Infiltration of Special Forces, activities spying, sabotage, Limited Mine Deployment, and Combat SAR). Currently, many modern diesel-electric submarines are capable of nearly matching the capabilities of nuclear submarines, with the development of weaponry technology, modern submarines are increasingly silent with longer endurance and high impact power (nuclear and conventional cruise missiles, long-range torpedoes, mines. and anti-ship surface and air missiles).

*c. Multi-Criteria Decision Making (MCDM)*

In this life, humans are always faced with various problems and problems. One of the definite problems experienced by humans is how to make the right decisions against multiple options (alternatives) and existing criteria. Therefore, to solve this problem various methods and solutions were made. One of these methods that are most often used is the Multi-Criteria Decision Making (MCDM).

d. Analytic Network Process (ANP)

Analytic Network Process (ANP) is a method that produces a framework for overcoming the problems of decision-makers without involving assumptions related to independence between higher and weak levels of elements and independence from items in one level.

- *Feedback Network*

  Many decision problems cannot be arranged hierarchically because they involve the interactions and dependencies of elements at a higher level with elements at a lower level. This feedback structure does not have a straight form from top to bottom as in a hierarchy but is more like a network with cycles

that connect the components inside to the elements themselves.

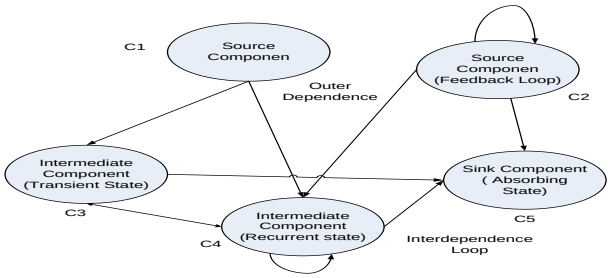



**Figure 2.** Structure of the feedback network

## 2. MATERIAL AND METHOD

### 2.1 Stage of Research

a. Identification Stage

1) Initial observations. The first time an observation was made of the submarine that would be the object of research to investigate the suitability of the research theme being held, the characteristics of the submarine and the criteria for the submarine to get an initial picture of the system being observed. From this step, information and the emergence of the theme raised will be obtained. The research was conducted on 5 (five) types of submarines: K-*Class* made in R-state, G-*Class* made in S-state, C-*Class* made in K-state, R-Class made in T-state and S-*Class* made in P-state.

2) Identification of the problem and research objectives. In this step, the problem to be discussed is formulated, accompanied by the determination of research objectives. This step is useful so that the issues discussed can be more focused, making it easier to carry out research, and there is no deviation from all the original problems to be discussed.

3) Literature study. A literature study is carried out to gather information and obtain supporting theories related to the problems under investigation. This can be obtained from literature or journals that discuss the methods used, or it can be obtained from studies that have been carried out and have almost the same topic.

4) System overview. This step is carried out in conjunction with literature studies to get a clearer picture of the characteristics of the observed system. Discussions with those who study the system are needed to find out in more detail the real problems in the system. By observing and describing the system to be reviewed, the boundaries and scope of the research can be determined.

5) Identification of the methods and data required. From the steps that have been taken, then the appropriate method and information are determined about what data is needed for research. These data will be processed further at later stages.

b. Data collection stage

1) Model making. The next step is to create a model. Here we will identify the existing relationships between criteria and alternatives, as well as the interplay between current criteria.

2) Making a questionnaire. This questionnaire is based on a model of interplay that occurs from the results of discussions and is distributed to experts in their fields. The filled out questionnaires were then withdrawn for processing the questionnaire.

c. Data Processing Stage.

In this study, the data obtained will be processed using the ANP method.

d. Data Analysis Stage.

1) Sensitivity analysis. Used to find changes to the selected alternatives by making changes to the existing criteria weights. If the weights of one or more criteria are increased or decreased, there will be a possibility of changing the alternative priority arrangement.

It can also be used to determine the criteria that have significance to the system formula.

2) Analysis and Interpretation. This stage analyzes the results of data processing that has been done to obtain alternative priorities in accordance with the established criteria.

e. Conclusion Stage.

Is the final result of all the processes that have been carried out. In this conclusion, suggestions are also added for decision-makers as input as well as for other researchers who want to focus on similar fields so that there is a continuous increase in research.

### 2.2 Research Flowchart

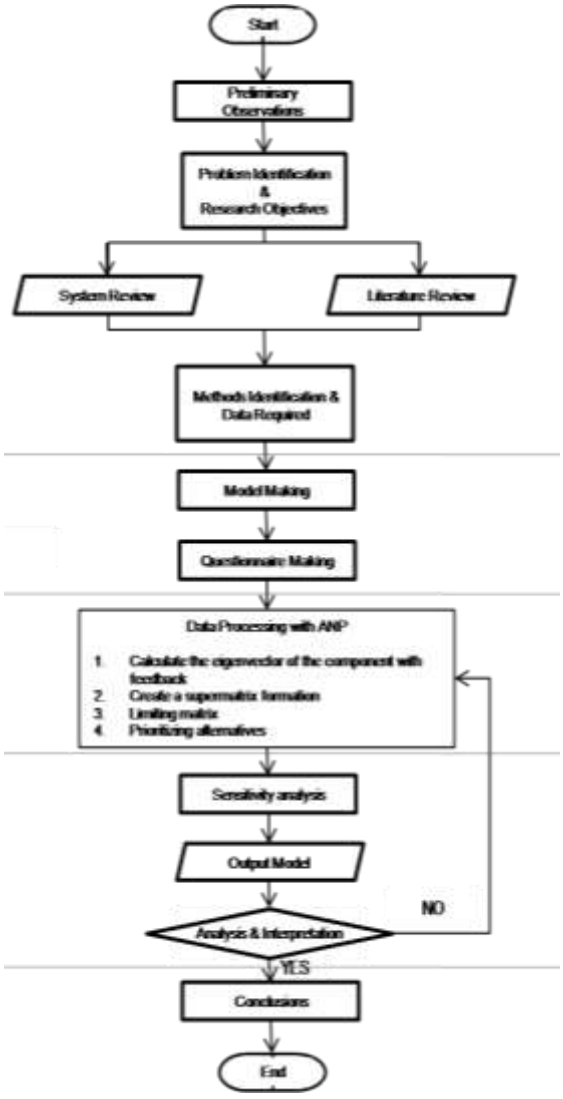



**Figure 3.** Research Flowchart

## 3. RESULT AND DISCUSSION

### 3.1 Data collection

a. Determination of Criteria and Alternative

**Table 1.** Criteria and Sub-Criteria for Submarine Selection

| No. | Subcriteria | Criteria |
|---|---|---|
| 1 | Threat | ***Operational Requirements (Opsreq)*** |
| 2 | *Interoperability* | |
| 3 | Neighbour Power State | |
| 4 | Geographic Conditions | |
| 5 | Navigation | ***Technical Requirements (Techreq)*** |
| 6 | Machinery | |
| 7 | Weaponry | |
| 8 | *Platform* | |
| 9 | Sensor | |

**Table 2.** Alternatives Used

| No. | Persyaratan | K-Class | G-Class | C-Class | R-Class | S-Class |
|---|---|---|---|---|---|---|
| **I** | ***Operational Requirements (Opsreq)*** | | | | | |
| 1 | Threat | √ | √ | √ | √ | √ |
| 2 | Interoperability | √ | √ | √ | √ | √ |
| 3 | Neighbour Power State | √ | √ | √ | √ | √ |
| 4 | Geographic Conditions | √ | √ | √ | √ | √ |
| **II** | ***Technical Requirements (Techreq)*** | | | | | |
| 1 | Navigation | √ | √ | √ | √ | √ |
| 2 | Machinery | √ | √ | √ | √ | √ |
| 3 | Weaponry | √ | √ | √ | √ | √ |
| 4 | *Platform* | √ | √ | √ | √ | √ |
| 5 | Sensor | √ | √ | √ | √ | √ |

note: √ Fulfill the requirements

b. ANP Network Model Making

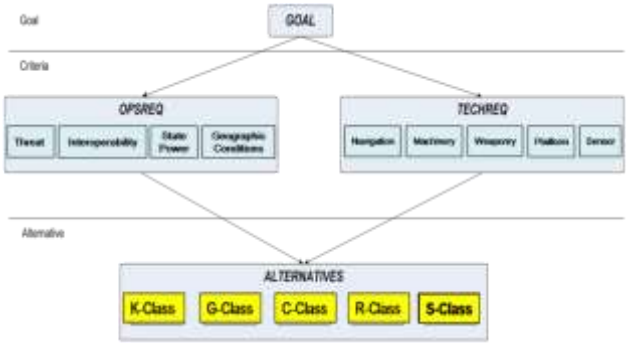



**Figure 4.** ANP Hierarchy Model

c. Innerdependence and Outerdependence relationship

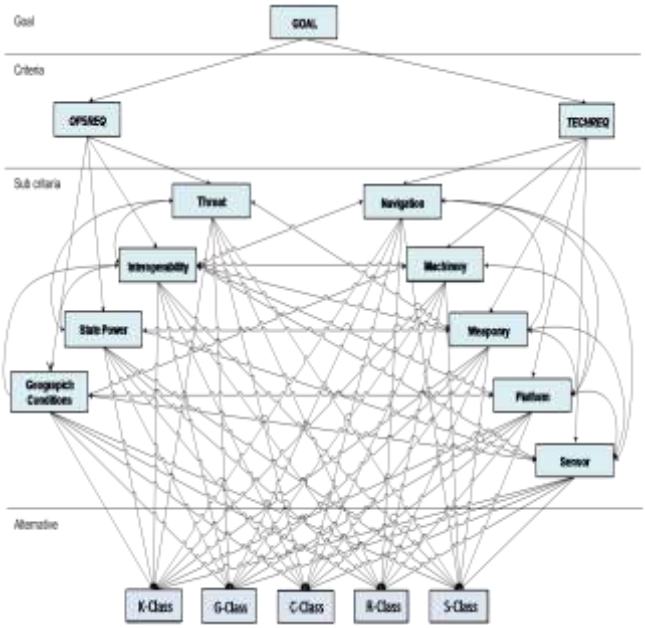



**Figure 5.** ANP Network Model with Innerdependence and Outerdependence Relationships

### 3.2 Data processing.

Data processing is done through the help of Super Decisions software. The data processed is questionnaire data which is the perception of the respondents regarding the selection of submarines.

a. Pairwise Comparison Matrix.

After the network model is created, the pairwise comparison value can be determined between criteria and between alternatives for each sub-criteria. The pairwise comparison values were obtained using a questionnaire. The priority weight values for each category obtained based on pairwise comparison values will be compared to get the final priority weight value.

b. Processing with Super Decisions Software.

After entering all geometric means into the questionnaire format in the Super Decisions software, the software performs all stages of the ANP method by running Synthesize, which contains, among others, the alternative weight values.

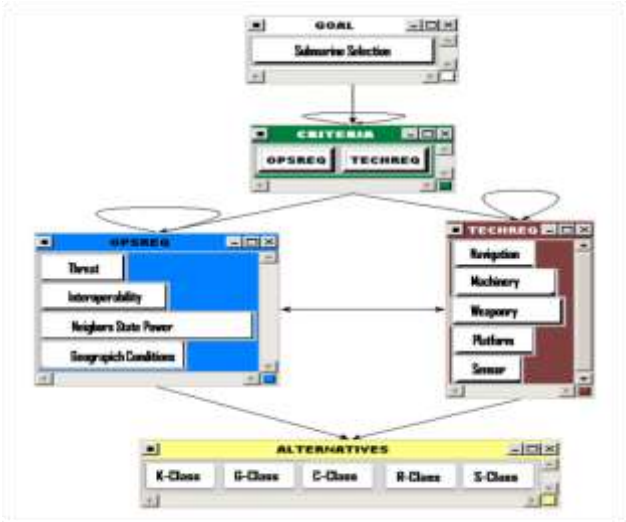



**Figure 6.** ANP Network Model Using Super Decisions Software

**c.** Analysis and Interpretation of Data Processing Results.

At this stage, the results of data processing will be analyzed and interpreted in the previous chapter.

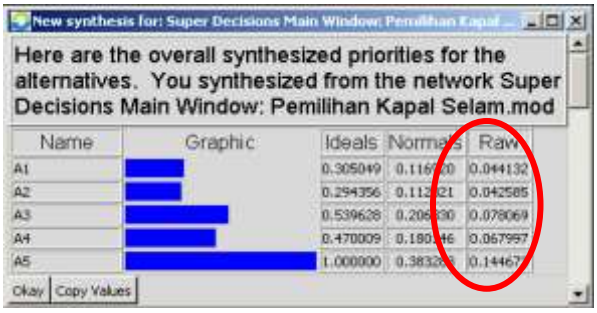
d. Consistency Ratio analysis.

From the results of processing the data in the form of a questionnaire, it can be obtained Consistency Ratio (consistency ratio), where all consistency ratio values are below 10% (0.1), so that according to what Saaty (1990) stated, this scoring system can be called consistent.

e. Alternative Priority Analysis.

In the results of data processing using Super Decisions software, alternative priorities can be seen by looking at the weight value of each alternative obtained from the calculation of the Limiting Supermatrix.

**Table 3**. Alternative Weight Values



From Table 3., the alternative priority order is obtained based on the weight value of each alternative as follows:

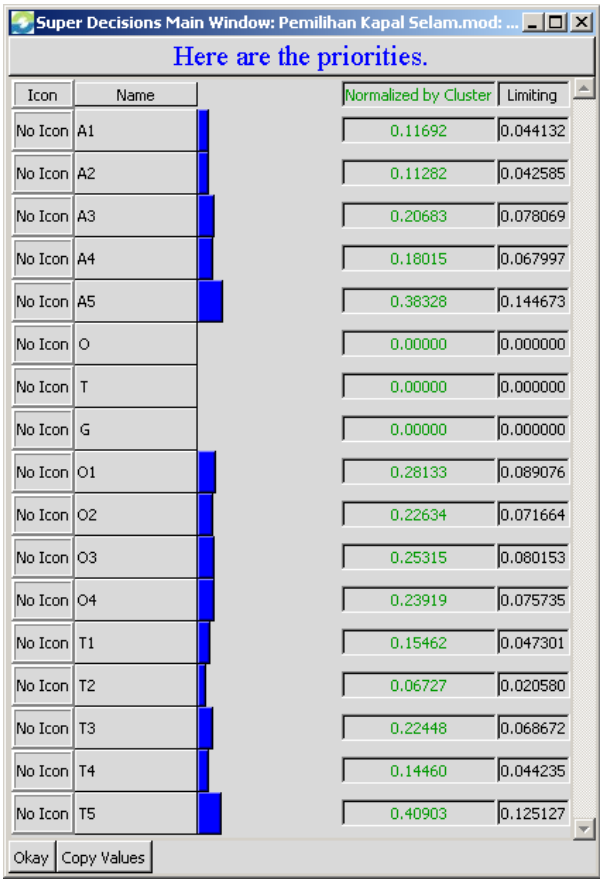
- Priority 1 is alternative 5 (A5) with a weight value of 0.383283.
- Priority 2 is alternative 3 (A3) with a weight value of 0.206830.
- Priority 3 is alternative 4 (A4) with a weight value of 0.180146.
- Priority 4 is alternative 1 (A1) with a weight value of 0.116920.
- Priority 5 is alternative 2 (A2) with a weight value of 0.112821.

In priority 3 (alternative 4 / A4), priority 4 (alternative 1 / A1) and priority 5 (alternative 2 / A2) have a not so big difference in weight values, namely 0.180146; 0.116920; 0.112821, this shows that the results of filling out all respondents in assessing each criterion and each sub-criterion both give a small assessment of alternative 4 / A4, alternative 2 / A2 and alternative 1 / A1.

f. Criteria Priority Analysis

In addition to alternative priorities, the results of data processing using Super Decisions software also contain priority criteria which can be determined by looking at the weight value of each criterion obtained from the calculation of the Limiting Supermatrix.

**Table 4.** Alternative Weight Values and Criteria




As shown in Table 4. The priority order of criteria is based on the weight value of each alternative as follows:

- Priority 1 is the criteria T5 with a weight value of 0.125127.
- Priority 2 is the O1 criterion with a weight value of 0.089076.
- Priority 3 is the O3 criterion with a weight value of 0.080153.
- Priority 4 is the O4 criterion with a weight value of 0.075735.
- Priority 5 is the O2 criterion with a weight value of 0.071664.
- Priority 6 is the T3 criterion with a weight value of 0.068672.
- Priority 7 is the T1 criterion with a weight value of 0.047301.
- Priority 8 is the T4 criterion with a weight value of 0.044235.
- Priority 9 is the T2 criterion with a weight value of 0.020580.

g. Sensitivity Analysis

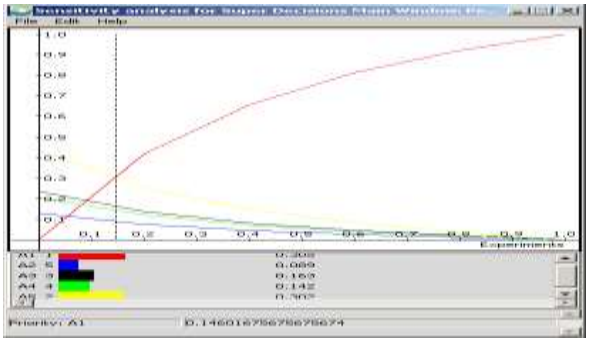


**Figure 7.** Sensitivity Analysis of Alternative 1

If the sensitivity test is carried out on alternative 1 by increasing the weight value to 0.305, there will be a change in the weight value for the other alternatives. Alternative 2 ranks in priority 5 with a weight value of 0.089, Alternative 3 ranks as priority 3 with a weight value of 0.163, Alternative 4 ranks in priority 4 with a weight value of 0.142, Alternative 5 ranks as priority 2 with a weight value of 0.302

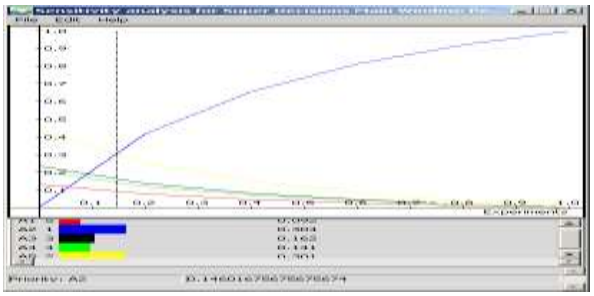


**Figure 8.** Sensitivity Analysis of Alternative 2

If the sensitivity test is carried out on alternative 2 by increasing the weight value to 0.304, there will be a change in the weight value for the other alternatives. Alternative 1 ranks in priority 5 with a weight value of 0.092, Alternative 3 ranks as priority 3 with a weight value of 0.162, Alternative 4 ranks as priority 4 with a weight value of 0.141, Alternative 5 ranks as priority 2 with a weight value of 0.301.

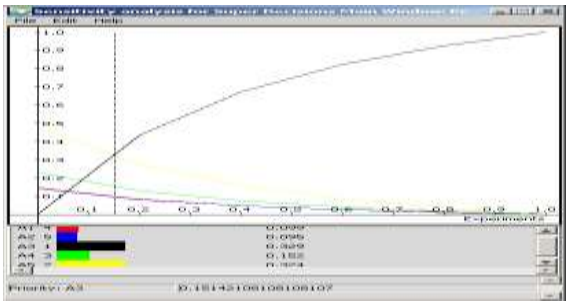


**Figure 9.** Sensitivity Analysis of Alternative 3

If the sensitivity test is carried out on alternative 3 by increasing the weight value to 0.329, there will be a change in the weight value for the other alternatives. Alternative 1 ranks priority 4 with a weight value of 0.099, Alternative 2 ranks priority 5 with a weight value of 0.095, Alternative 4 ranks priority 3 with a weight value of 0.152, Alternative 5 ranks priority 2 with a weight value of 0.324.

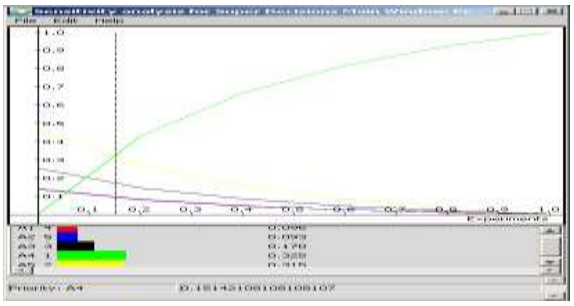


**Figure 10.** Sensitivity Analysis of Alternatives 4

If the sensitivity test is carried out on alternative 4 by increasing the weight value to 0.325, there will be a change in the weight value for the other alternatives. Alternative 1 ranks priority 4 with a weight value of 0.096, Alternative 2 ranks priority 5 with a weight value of 0.093, Alternative 3 ranks priority 3 with a weight value of 0.170, Alternative 5 ranks priority 2 with a weight value of 0.315.

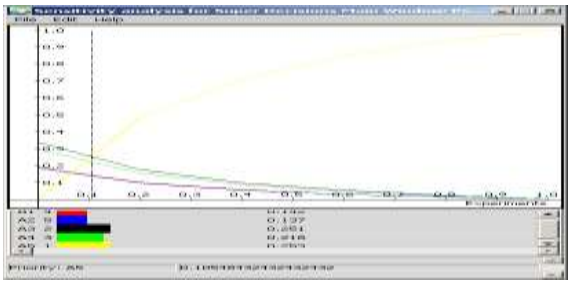


**Figure 11.** Sensitivity Analysis of Alternatives 5

If the sensitivity test is carried out on alternative 5 by increasing the weight value to 0.253, there will be a change in the weight value for the other alternatives. Alternative 1 ranks priority 4 with a weight value of 0.142, Alternative 2 ranks priority 5 with a weight value of 0.137, Alternative 3 ranks as priority 2 with a weight value of 0.251, Alternative 4 ranks priority 3 with a weight value of 0.218.

## 4. CONCLUSIONS

From the processing and data analysis above, conclusions can be drawn as follows:

a. The submarine alternative chosen is the one that gets the highest priority weight value, namely the S-Class submarine made in P-state with a priority weight value of 0.383283. In order of priority alternatives in the selection of submarines are S-Class made in P-state, C-Class made in K-state, R-Class made in T-state, G-Class made in S-state and as the last priority of the five alternatives is the K-Class made in R-state.

b. The criterion that gets the highest priority weight in selecting submarine alternatives is the Sensor criterion with a priority weight value of 0.125127. In order, the criteria for selecting submarines are sensors, threats, neighbour state power, geographic conditions, interoperability, weaponry, navigation, platform and then as a priority, the last criterion of the nine existing criteria is machinery.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