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THE APPLICATION OF THE ANALYTICAL NETWORK PROCESS (ANP) METHOD TO DETERMINE THE DOMINANT FACTOR CAUSING THE ACCIDENT IN THE WEST SURABAYA SAILWAY

Yoyok Nurkarya Santosa[1], Taufik Pamungkas[2], Rofi Hidayatur Rakhman[3]

[1,2,3]*Naval Technology College, Bumimoro-Morokrembangan, Surabaya 60187, Indonesia*
ynksantosa@gmail.com

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ABSTRACT

The Surabaya West Shipping Route is the second busiest shipping channel in Indonesia after the entry channel Tanjung Priok. Due to the long and narrow shipping lanes and the large flow of ships going in and out of ports, it is very vulnerable to maritime accidents, be it grounding, ship collisions, or other types of accidents, which of course will have a negative impact on Intersolar shipping. By looking at the facts mentioned above, it is deemed necessary to carry out scientific research so that we can determine the dominant factors that cause shipping accidents in the West Surabaya Shipping Channel so that later it is hoped that the main criteria that cause accidents will also be known. In making decisions about the causes of accidents in the Surabaya West Shipping Channel, existing problems cannot be arranged in a hierarchical form because they involve interactions and dependencies of higher-level elements on lower-level elements. Therefore, in this research, the Analytic Network Process (ANP) method is used which has the ability to accommodate the relationship between criteria or alternatives.

Keywords: *Analytic Network Process (ANP), Alternatives, West Surabaya Shipping Route, Main Criteria*

1. INTRODUCTION

The West Surabaya shipping channel is the second busiest shipping channel in Indonesia after the Tanjung Priok entry channel (Department of Transportation, 2006). Because of its strategic location and supported by the potential hinterland area of East Java, the port of Tanjung Perak is also the center for intersolar shipping in the Eastern Region of Indonesia. Every day the average number of ships entering and exiting the channel to Tanjung Perak Port reaches 34 ships. It is estimated that by implementing the ASEAN-China free market agreement, the number of ships calling at Tanjung Perak Port will also increase.

Geographically, the West Surabaya Shipping Channel is located in the Madura Strait at position: 07º11'54''S - 112º43'22''E with the coastal conditions around the port being low and swampy. To enter the Port of Tanjung Perak there are two shipping lanes that are commonly used and are called the East Surabaya Shipping Lane and the Surabaya West Shipping Lane. The East Surabaya Shipping Channel is used for ships that have a small draft (draft 1-2 meters), so that the intensity of ships entering or leaving the Surabaya West Shipping Channel heading to islands other than East Java is small. One of the factors is that the East Surabaya Shipping Route is very risky because the Kalimas River empties into the port which results in silting up for shipping lanes to use so that it will have an impact on the shipping of ships with large drafts. Based on these facts, most ships with a large draft (2-9 meters) will prefer to pass through the West Surabaya Shipping Channel, which is the main channel to enter the Port of Tanjung Perak which is 25 nautical miles long, 100 meters wide with a depth varying between 9.7 to 12 meters. Due to the long and narrow shipping lanes and the large flow of ships going in and out of ports, it is very vulnerable to maritime accidents, be it grounding, ship collisions, or other types of accidents such as fires,

But lacking in other criteria (e.g. machine condition), or when alternatives are found that have better scores in other criteria (e.g. geographical conditions), but are deficient in other criteria (e.g. organizational policy). So this condition can be resolved using the Multi-Criteria Decision Making (MCDM) approach. One method that is quite widely known and compatible with this kind of conflict is the

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*Analytic Network Process*or ANP is a decision-making method for problems of a technical-social nature (socio-technical) based on a number of criteria (multi-criteria). ANP is a new approach to qualitative methods, which by its creator, Professor Thomas Saaty, a research expert from Pittsburgh University, is intended to 'replace' the Analytic Hierarchy Process (AHP) method. The advantage of ANP over other methodologies is its ability to help us measure and synthesize a number of factors in a hierarchy or network. No other methodology has synthesis facilities like the ANP methodology.

2. LITERATURE REVIEW

2.1 Multi-Criteria Decision Making (MCDM)

Multi-criteria decision-making (MCDM) is an approach to the decision-making process that has a decision problem situation with criteria, objectives, and multiple attributes (Pohekar and Ramachandran, 2004). MCDM is divided into two, namely Multi-Attribute Decision Making (MADM) and Multi-Objective Decision Making (MODM). The following are the characteristics of MCDM:

a. There are more than 2 (two) conflicting attributes and criteria: fulfilling the satisfaction of one causes a reduction in other decisions (trade-off).

b. There are more than 2 (two) alternative decision solutions

3. Conflict: Intrapersonal and Interpersonal.

2.2. Analytic Network Process (ANP)

The Analytic Network Process(ANP) is a method that produces a framework for overcoming decision-making problems without involving assumptions related to the independence between higher and weaker-level elements and the independence of elements within one level.

Like the Analytic Hierarchy Process (AHP), ANP involves hierarchical relationships but this hierarchical control does not require a standard structure like AHP so it is able to handle complex relationships between decision levels and attributes. This ANP models a system with feedback and a system where one level may dominate or be dominated, either directly or indirectly by another level. In ANP, the pairwise comparison method is also used as in AHP. This pairwise comparison process uses numbers/scales that reflect the level of importance/preference of a decision element with other decision elements at the same hierarchical level. This helps decision-makers compare each decision element.

The advantage of ANP compared to AHP is that this method eliminates the need to arrange components in a straight chain like a hierarchy. This method allows the structure to develop more naturally so it is a better way to describe what happens in the real world. And by including dependencies, feedback, and influence cycles in the supermatrix, ANP is more objective and more likely to capture what happens in the real world.

Overall, ANP is a better decision-making tool than AHP, but its implementation requires more work to capture facts and interactions. So for decisions that are simple and must be made quickly, the extra work to capture the facts and interactions complicates their use.

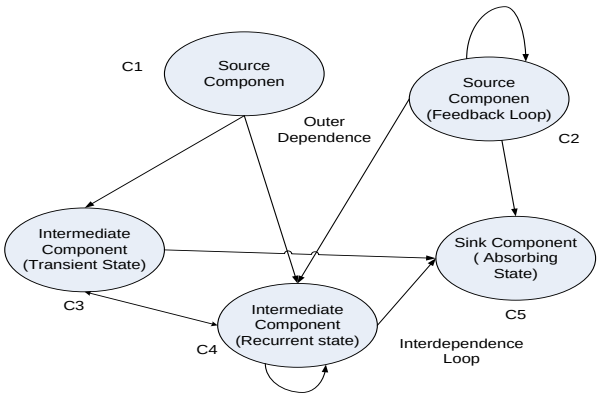

Figure 1. Feedback Network Structure

3. RESEARCH METHODS

This research is a descriptive study using qualitative methods, where data and information related to research problems obtained through literature studies and field interviews are analyzed quantitatively, and then interpreted according to the meaning contained in the data and information. Data collection techniques are carried out through library research and in-depth interviews with parties who are considered competent and have information and data related to research problems.

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4. DISCUSSION AND RESULTS

4.1. Data Collection Using Questionnaires

Creating a questionnaire uses a network model that has been formed as a reference. The questionnaire was created based on the relationship between criteria elements, both interdependence, and interdependence, and the preference relationship between criteria and goals (goals) by means of pairwise comparisons between clusters and between cluster elements.

This questionnaire aims to find out how big the relationship is based on the respondents' assessments. The respondents were experts, who were Navy officials, Commander 3 KM. Tanto Harmoni and Decision Maker at the Tanjung Perak Surabaya Harbormaster Service, while the experts have served for more than 10 years on KRI or civil vessels directly related to/users of the Surabaya West Shipping Channel.

The reason why different respondents were chosen to fill out this questionnaire was in the hope that there would be stakeholder representation in providing assessments from different points of view so that they could approach the actual conditions.

This questionnaire aims at 2 (two) assessment objectives, namely to weigh in determining alternative priorities for the dominant factors causing accidents in the Surabaya West Shipping Channel and determining the main/critical criteria for several factors that have been explained previously. In answering the questions in this questionnaire, respondents do not need to carry out discrete weighting with numbers but only intuitively through linguistic variables. A linguistic variable is a variable whose value is in the form of words or sentences. Here we will use statements to compare two criteria with five basic linguistic criteria, including equally important, slightly more important, more important, very important, and most important.

4.2 Data processing

The next stage after obtaining the data is data processing activities. Regarding the method used in this research, uses the ANP method, and the data processing is carried out with the help of Super Decisions software. The data processed is questionnaire data which represents the respondents' perceptions regarding the factors that cause accidents.

The geometric mean that has been calculated is then entered into a pairwise comparison matrix in the super decisions software.

Figure 2. Pairwise Comparison Matrix of Internal Requirements Criteria

Figure 3. Pairwise Comparison Matrix of External Requirements Criteria

After obtaining one pairwise comparison value for each relationship, local priority weights are calculated. Every time local priority weighting is carried out, the consistency value that must be taken into account must not exceed 0.1. For example, it can be seen in the picture which shows the inconsistency values of pairwise comparisons between sub-criteria in the Operational Requirement criteria.

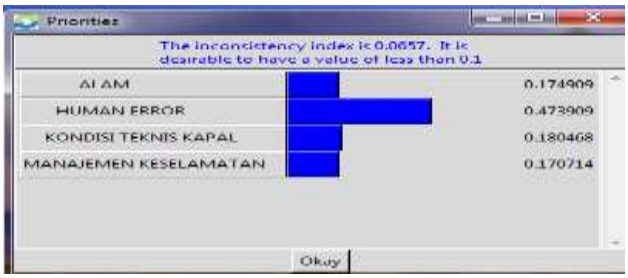

Figure 4. Inconsistency Index Between Subcriteria

4.3 Processing with Super Decisions Software

After entering all the geometric means into matrix format in the Super Decisions software, the software carries out all stages of the ANP method by running Priorities, which contains, among other

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things, alternative weight values and all sub-criteria weights as in Figure 5.

Figure 5. Alternative Weight Values and All Sub-Criteria Weights

Furthermore, the final result in the form of a ranking of the sub-criteria in the alternative group can be seen by Synthesizing in the super decisions software as in Figure 6.

Figure 6. Synthesizing in the super decisions software

4.4 Sensitivity Analysis

Sensitivity analysis was carried out using Super Decisions software by changing the criteria weight values for the alternatives being tested. In this test, it will be known that by changing the criteria weight values for the alternatives being tested, it will affect the original ranking results or not. If there is a point where there is a change in ranking/priority then that point is called the critical point of an alternative.

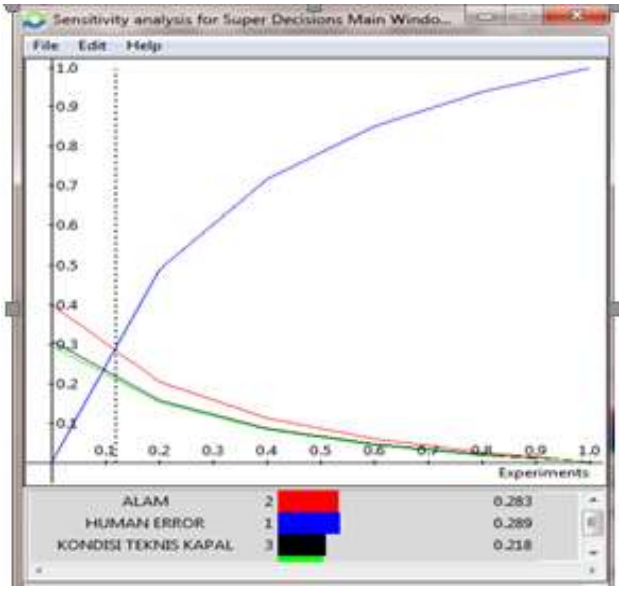

Figure 7. Sensitivity Analysis of Human Error Alternatives

5. CONCLUSION AND SUGGESTIONS

5.1 Conclusions

From the results of data collection and processing, as well as analysis and interpretation of the results of data processing that has been carried out, the conclusions that can be drawn in this final assignment are:

a. The types of accidents that occur in the West Surabaya Shipping Channel are collisions, grounding/stranding, fire/explosion, people falling into the sea, and drowning.
b. The dominant factor that causes shipping accidents in the selected APBS is the one that gets the largest priority weight value, namely Human Error with a priority weight value of 0.42986, then Nature with a priority weight value of 0.22708, and then Ship Technical Condition with a priority weight value of 0 .17510 and as the final priority of the four existing alternatives is Safety Management with a priority weight value of 0.16796. The main/critical criteria that receive the greatest priority weight in selecting alternative dominant factors causing shipping accidents in the APBS are the Organizational Policy criteria with a priority weight value of 0.51594. Sequentially, the criteria in determining the dominant factors causing shipping accidents in APBS are Management System, Workload, Crew Skills,
c. Criteria, both internal and internal, causing accidents in the West Surabaya Shipping Channel were obtained from interviews, brainstorming from experts, and existing literature.

The steps needed to inventory the causes of shipping accidents are of course preceded by observing the number and types of accidents that

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occur in the West Surabaya Shipping Channel, coming up with criteria and sub-criteria for causal factors, and ending with weighting. The way to formulate recommendations and guidelines is by formulating and simplifying the problem in the right form based on the causes and factors that contribute to shipping accidents.

5.2 Suggestions

Suggestions that can be put forward in writing this final assignment are:

a. There is a need to improve the competency and discipline of scout officers and supporting operators, as well as perfect the administrative system of piloting operations which includes the availability of guides (the current number of guides can be said to be less than sufficient), guide waiting rooms, guide equipment, guide boats, and tugboats).
b. It is necessary to create a system for regulating and monitoring ship traffic, crossing locations, and anchoring areas considering that the condition of the body often shifts and is accompanied by a lot of shallowness.
c. There is a need to improve the implementation of the ISM Code on ships, regarding resources and personnel, as well as providing knowledge and increasing understanding to ship crews regarding navigation management (Bridge Team Management), especially regarding regulations for preventing collisions at sea in narrow channels.
Future researchers who are interested in similar research should develop it by combining it with other methods to analyze more complex problems, one of which is the Dematel method.

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