3. Similarity The Aplications of Model Bayesian Networks For Analysis and Preventive Actions on Maritime Security Operations

By Okol Sri Suharyo

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The Applications Of Model Bayesian Networks For Analysis And Preventive Actions On Maritime Security Operations

Sukmo Hadi Nugroho , Benny Sukandari , Adi Bandono , Okol Sri Suharyo

Abstract: The implementation of Maritime Security Operations of Navy needed support for both major supporters down. In an operating system, necessary information, coordination, and readiness elements for the operation are achieved. In maritime security especially in the Natuna Sea needed an operation pattern that effectively and efficiently as carrying out an act in which such actions can be repressive action or preventive action so that the response elements operating there can be maximum in deterring acts of territorial violations and theft of fish illegally by foreign fishermen. Need factors - factors (variables) that can be optimized to maritime security in the Natuna Sea can be maximized especially with the operational situation of uncertainty. To the reduction of various errors that may arise, then be made a Bayesian network model to measuring of the performance responsiveness of maritime security operations with a causal mapping approach. Causal mapping is used to form a network structure on a Bayesian network. The purpose of this research is to create a model system to determine the variables that build the model maritime security. This model was made using expert opinion and literature studies as the basis for preparing the variable and interdependence. The prior probability conditionals and conditionals probability tables using a questionnaire that was given to the expert. From the data obtained were then computed using software Netica with the results of the Navy capability that exists today when measured responsibility in implementing maritime security against acts of poaching in Natuna Sea by foreign fishermen only have a percentage of 74.7% of the 17 independent variables that are subsequently carried out a sensitivity analysis which produces 2 pieces of variables that affect the capability of the warship and capability of the aircraft as well as the first variable of the dependent variables, in this case, is better than the repressive measures of preventive measures.

Keywords: Bayesian Network, Maritime Security Operation, Causal Mapping

1. INTRODUCTION

Indonesia is an archipelagic state, the largest in the world that has 17,508 islands with a sea area of 5.8 million km2 and a coastline of ± 81,000 km. Where the territory lies in the cross position of the world between two continents and two oceans, this geographical position causes the sea between the islands to become a sea channel that is very important for both national and international shipping traffic. The security issue in the Natuna Sea, which was previously called the South China Sea, is a serious concern lately, especially the Southeast Asia region and even America has intervened in this issue, all because the Natuna Sea is one of the regions that have good economic value, politics, and security, so that the State of China claims history based on the past that the Natuna Sea / South China Sea is the territory of China, so there is a need for security operations in dealing with these problems in addition to maritime security operations where threats can suddenly occur changing maritime security elements into security elements by order so that the response speed in threats is quickly overcome [15]. Also, the Natuna Sea is a very crowded and crowded international trade route, where commercial vessels from the Singapore Strait pass the Natuna Sea to the European Continent. The geographical location of the Natuna Sea bordering Malaysia, Brunei Darussalam, Thailand, and Vietnam makes it vulnerable to crime, such as illegal fishing and human trafficking.

- *Sukmo Hadi Nugroho , Benny Sukandari , Adi Bandono , Okol S Suharyo*
- *Esa Unggul University, Jakarta Indonesia*
- *Indonesia Naval Command and Staff College, SESKOAL Jakar Indonesia*
- *Sekolah Tinggi Teknologi Angkatan Laut, STTAL Surabay Indonesia*

These two things make the Natuna Sea an ideal place for fish pirates to do their work [3]. The Indonesian Navy, in this case, must respond to any threat reports in the Natuna Sea and to make various efforts to maintain security in the region so that it is free from criminal acts at sea. In carrying out security operations in the Natuna Sea, especially in handling illegal fishing actions, a fast response is needed to foreign fishing vessels by sea patrols [5]. Handling can be in the form of preventive measures, namely prevention of fishing action by foreign fishing vessels through routine patrol activities throughout the year whereas if there are already foreign fishing boats taking fish, of course, the need for repressive action is necessary. Crimes or violations in the Indonesian sea are broadly defined into 3 (three) sections such as the following [2]:

a) Violation of the Indonesia sea territory by foreign vessels.
b) A direct and indirect crime that threatens to harm the interests of the people and state of Indonesia, includes/, piracy, and theft of state assets in the sea (mines, fish and other marine resources).
c) Any crime carried out through marine media / Indonesian waters such as fuel smuggling, timber, illegal immigrants (illegal entry) and other items.

Then it is necessary to have an appropriate policy effort so that maritime security has a high response rate to the emergence of every effort that leads to illegal fishing by foreign fishermen. To overcome the various problems that arise as mentioned above, the author seeks to apply a method that can assist in Maritime Security's responsive operation process in responding to criminal acts at sea, especially fishing by foreign fishermen so that they can run effectively and efficiently [4]. The interrelated relationship between variables will be solved by the Causal Mapping approach as the basis for compiling the Bayesian Network

model that accommodates existing Uncertainty elements. From the background of the problem as described above, it is known that the absence of standardization of a policy that regulates in a preventive and repressive action from the Sea Security Operation in the Natuna Sea against criminal acts that is accurate and comprehensive so that it needs some formulation of the problem as follows [6]:

a) What is the comparison of preventive and repressive actions in influencing the responsibility of Operation Sea Security in criminal acts of fishing theft in the Natuna Sea using the Bayesian Network model?

b) How do you approach the Causal Map in reality in the field in the Natuna Sea Marine Security Operation accurately and what factors (variables) contribute strongly to the response speed of Maritime Security?

The research purposes, referring to the formulation of the problem, the objectives to be achieved from this final assignment are:

a) Get results from Maritime Security Operation Responsibility in the Natuna Sea by using Netica Software.

b) Obtaining factors that influence the ability of the Navy in the Responsibility for Operation of Marine Security in the Natuna Sea from determinant variables both *independent* and *dependent variables.*

2.MATERIAL AND METHODS

2.1.The Research Location and Situation

The Navy has a perception that the sea must be safe from three aspects of threats which include both dimensions of sovereignty and law, while the three aspects of the threat are threats of violence, navigation hazards and threats of violation of law based on mandate of Republic of Indonesia Law number 34 of 2004 about the Indonesia Military. The position of Natuna is located in the northernmost part of Indonesia. To the north, Natuna borders Vietnam and Cambodia, in the south borders South Sumatra and Jambi, in the west with Singapore, Malaysia, Riau and Bintan District, while in the east it borders East Malaysia (Sarawak) and West Kalimantan. Natuna is in Hong Kong, Japan, Korea, and Taiwan international shipping lines. Geographically Natuna Regency is located in the northern hemisphere of Indonesia precisely between 2° North Latitude - 5° North Latitude and 104° East Longitude - 110° East Longitude. The position of Natuna is located in the northernmost of Indonesia [7]. To the north, Natuna borders Vietnam and Cambodia, in the south borders South Sumatra and Jambi, in the west with Singapore, Malaysia, Riau and Bintan District, while in the east it borders East Malaysia (Sarawak) and West Kalimantan. Natuna is in Hong Kong, Japan, Korea, and Taiwan international shipping lines. Geographically Natuna Regency is located in the northern hemisphere of Indonesia precisely between 2° North Latitude - 5° North Latitude and 104° East Longitude - 110° East Longitude. The conflict that broke out in the South China Sea, due to the interpretation of what is referred to as the 9 line on the Chinese map, gave claim rights to 90% of the 3.5 million square kilometer waters in the sea. By looking at the economic and strategic meaning of the sea, this is an urgent international problem that has also involved the US. China's expansion in the South China Sea also affected National interests Indonesian. China has unilaterally included parts of the Natuna Islands in line 9 of the line, and therefore claims a segment of the Riau Islands Province in Indonesia as their territory [8].

2.2. Sea Security Operations

Regarding the enforcement of sovereignty and law in the sea in accordance with the United Nations Convention on the Law of the Sea (UNCLOS, 1982) which was ratified in Law Number 17 of 1985 and 1994 stated that a country's warship has the right to pursue pursuits, examination, and prosecution of violations committed by foreign vessels including piracy in the sea, piracy, fishing without permission, violation of territorial boundaries, and others. Republic of Indonesia Warship is a Navy warship that has special signs, under the command of a Navy Officer who is manned by warships personnel who are subject to army discipline laws that have integrated technical requirements and requirements. The Warships grouping in 3 forces, namely Striking Forces, Patrol Ships and Supporting Forces, is intended to focus on the priority scale in preparing ships according to the reality of combat functions in the field with support according to their respective functions, especially prioritized on weapons systems, driving systems, navigation equipment and sea presence operations for marine security measures [9]. Maritime Patrol of Aircraft (MPA), in this case, belongs to the Navy is a Navy Aircraft capable of carrying out maritime air patrols with specifications of the Naval Version (Naval Version) or aircraft used for surveillance activities continuous all the time to a certain area related to marine factors.

2.3. Enforcement of Sovereignty and Law at Sea

Enforcement of sovereignty in the sea has two dimensions of understanding, namely sovereignty and sovereign rights in the sea of a country that has been universally regulated in UNCLOS 1982. Indonesia has ratified the convention into Law No. 17 of 1985. In each Indonesian waters regime, sovereignty and sovereignty are stipulated as follows [10]:

a. On the Sea the area as wide as 12 nautical miles from the base of Indonesia has full sovereignty, meaning that the state has the right to regulate all provisions of national law.

b. In the Additional Zone as wide as 24 nautical miles from the baseline, Indonesia has sovereign rights in the fields of customs, sanitation, immigration and fiscal.

c. ZEEI (Indonesian Exclusive Economic Zone) as wide as 200 nautical miles from the baseline, has sovereign rights in the exploration and exploitation of marine resources.

d. The Indonesian Continental Shelf covers the seabed and subsoil from below sea level located outside its territorial sea along with the natural continuation of its land area to the outer periphery of the continent or up to a distance of 200 nautical miles from the baseline where the Territorial Sea is measured. The outer limit of the Continental Shelf must not exceed 350 nautical miles from the baseline or up to a distance of 200 miles in terms of the edge of the continental shelf less than 200 miles wide [1].

2.4. The Concept of Causality

Causality is to find out the relationship of one variable to another variable. The Theory of Causality (Causality) has emerged as long as human civilization, even the same age as this nature and the reality of existence itself.
With knowledge of causality, it is possible to predict future events or new studies and to train several actions to control events (BradfordHill, 1980)

There are 3 elements in the Causality relationship (Neuman, 2000), namely [11]:

a. Temporal Order Because there must be a prior effect, this assumption results in a causal direction, that is, from cause to effect. And also is one of the conditions needed for causality.

b. Researchers also need "associations" Two variables associated when both occur together in a patterned way or appear together to be a cause.

c. Eliminating "Alternative" As a result caused by variable Cause and not because of anything else. And done by controlling other variables (researchers usually use statistical techniques).

Causality Representation

Causality is used to form hypotheses, theories, and laws that have also been considered as a composition of independent and dependent variables. According to [13], several definitions need to be determined before making a causal map, namely:

a. Variable, is a concept that has several values.

b. Independent variables, also called independent variables, influences, stimuli, predictors, causes (antecedents), are variables that affect the dependent variable.

c. The dependent variable also called the dependent variable, output, criteria, consequent. It is a variable whose changes depend/are determined by changes in the independent variable.

d. Intervening variables are variables that theoretically affect the relationship between independent and dependent variables into indirect relationships and cannot be observed and measured.

e. A condition variable is a framing variable of the previous condition which helps in making the causes of conjunctive plurality.

Causal Maps

Causal Maps are cognitive maps that represent basic causal knowledge on a specific domain [14]. Causal maps are decision-making tools that are used for decision-makers to represent prominent points, knowledge, and conditions that influence decision making (Nadkarni & Shenoy, A Bayesian Network Approach to Making Inferences in Causal Maps). A causal map is formed from 3 important components (Nadkarni & Shenoy, A Bayesian Network Approach to Making Inferences in Causal Maps), namely:

a. Node, in a causal map the node represents the causal concept.

b. Links (represented by a directional arrow) represent a causal relationship between causal concepts where links can have a positive or negative influence on the effect of concepts.

c. Concept Strength is the strength of a concept that represents the causal value of a causal relationship.

Causal Probability

Causal probability is expressed using calculus probability because it can be used to handle information about a dependent situation and encompasses many aspects of acceptable human reasoning. Through the use of conditional probabilities, where for example the probability of occurrence of A determined by event B is represented by P (A | B), for people who understand the concept of conditional probability that A increases the probability of B, in probability theory this will be represented as P (B | A) greater than P (B | not-A) [14].

2.5. The Concept of Bayes Theory

Before further getting to know Bayesian you must first know more deeply about the Bayes Theorem, which is the main foundation in the Bayesian approach. Bayes introduces a version of the equation of several probabilities now known as the Bayes Theorem. The application of the Bayes Theorem is essentially a subjective approach, where such an approach is carried out through observations based on samples, tests, hypotheses, regression analysis, and others. The essence of the Bayes Theorem is a careful study of what actions or alternative actions are available, after which they are followed by considering the risks (profits/losses) for each situation that will occur in the future [12].

Bayesian Networks

Bayesian Networks (BN) Bayesian Belief Network is a probabilistic model in the form of Directed Acyclic Graph / DAG which is used to describe the relationship of probabilities and Probabilistic Inference between Variables (Neapolitan, 2004). BN is defined by 2 components, namely Directed Acyclic Graph / DAG and Conditional Probability

Table / CPT. The first component is DAG in the form of nodes and arrows. The second component is the Conditional Probability Table (CPT) for each variable found on the network. CPT for variable B specifies the conditional distribution P (B I Parent (B)), where the parent (B) is the parent node of B. The BN combines two aspects of decision-makers, namely qualitative aspects and quantitative aspects [12]. The qualitative aspect is represented by the causal relationship of the problem through a directed acyclic graph, while the quantitative aspect is represented by the level of trust from the decision-maker where the interdependence relationship is expressed in the form of a conditional probability distribution for each variable in the network.

Bayesian Network Structure

Graphically, Bayesian Network is a model where each variable is represented by a node and a causal relationship denoted by an arrow called Edge. Following are some of the components used to build the Bayesian Network structure, namely [11]:

a. Nodes. A node represents a variable in the modeled situation.
b. Edges. An edge represents a causal relationship between two Nodes. In the graph, edges are drawn in the form of arrows between two Nodes. The direction of the arrow indicates the direction of causality.
c. States. States represent values that exist in each node.
d. Beliefs Evidence. Beliefs are probabilities where a variable will be in a certain state based on evidence in a particular situation. The evidence is information about a particular situation [1].

There are two types of evidence, namely [13]:

a. Hard evidence, namely evidence in a node that is 100% worth in one state and 0% in another state
b. Soft evidence that is evidence in a node that is worth less than 100% in one of its states and/or greater than 0% in another state.

2.6. Research Methodology

To facilitate the research process, a research design was drawn up in a research flowchart. In the flow chart, this research will be outlined about the points to be worked following the scientific research method. The design of this study is divided into three stages, namely the preparation stage, the implementation phase, and the termination stage. The preparation phase includes identifying problems and objectives of research, literature study, preliminary study, and identification of methods. The implementation phase includes data collection, modeling, discussion, and sensitivity analysis. While at the end stage, conclusions and suggestions will be determined from the results of the research.

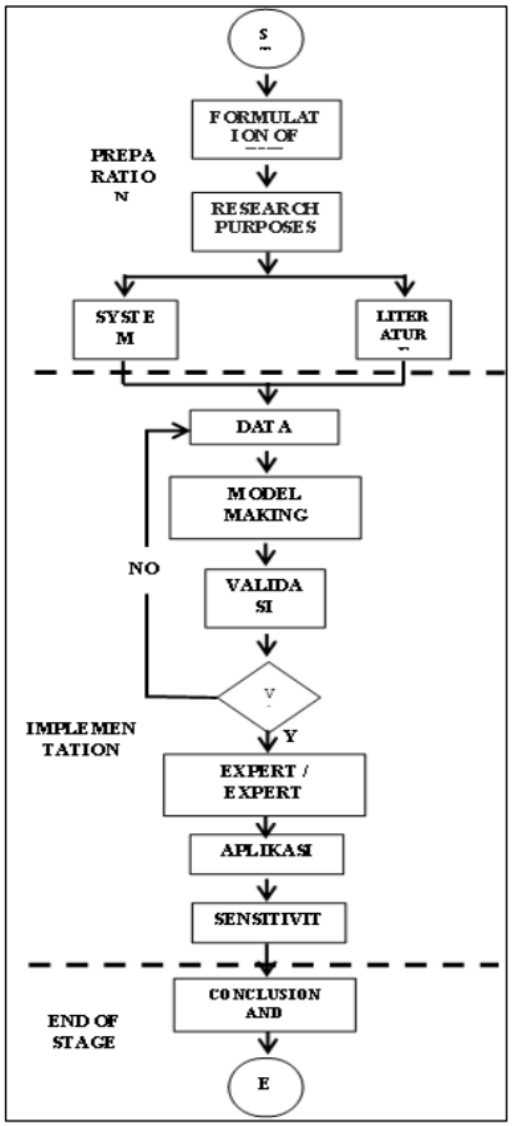

Figure 1. *Flowchart of Research*

Model Making

The second step of the implementation phase is to make a Bayesian network model. In the process of making this model, the Causal Mapping approach is used [5], Nadkarni & Shenoy, A Causal Approaching To Constructing Bayesian Networks. The causal mapping approach is divided into 4 stages, namely: Data Elicitation, Derivation of Causal Maps, Constructing Bayesian Networks and Derivation of the Parameters of Bayesian Networks.

Interpolation calculation uses the following equations:

IF3 = (P2X – P8x)/(P1X – P8x)
IF2 = (P3X – P8x)/(P1X – P8x)

After the interpolation factor is known, the estimated values for non-filled states can be searched using the following equation:

$P_{4x}=[(P_{3x} - P_{8x}) \times IF_3] + P_{8x}$
$P_{6x}=[(P_{5x} - P_{8x}) \times IF_3] + P_{8x}$
$P_{7x}=[(P_{5x} - P_{8x}) \times IF_2] + P_{8x}$

Software Application

Existing models and data are then processed using Netica Software. All data obtained is then entered into each state space for subsequent running programs.

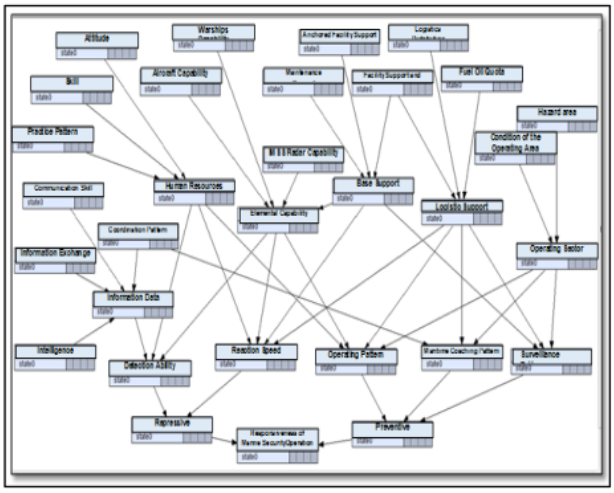

Figure 2. *The Model Compilation Results with Causal Mapping*

3. RESULT AND DISCUSSION

The data used in the form of 2016 secondary data obtained from the Main Naval Base IV and Guspurlabar as well as the results of questionnaires from experts, in this case, the Warships commanders and staff who have experience serving in the Natuna Sea. To obtain questionnaire data, the author makes a choice concept that is inseparable from Bayesian Network terminology which contains the identification of causal statements and gets the percentage of prior probability. The experts in this questionnaire were Warships commanders and officers who had served in the Natuna Sea. Data from questionnaires from experts consists of elicitation data, Identification of Causal Statement in the Text and prior probability data in the form of a percentage. The process of collecting data with a questionnaire was carried out using two ways, namely direct interviews and written questionnaires with nine people whom we considered as experts/experts in Kamla operations against acts of fishing theft and regional violations. In the process of making this model, the data that has been obtained from both the maritime security literature study, the Indonesian Navy White Paper and interviews with nine experts on marine security operations will be used as a basis for making the Bayesian Network Model.

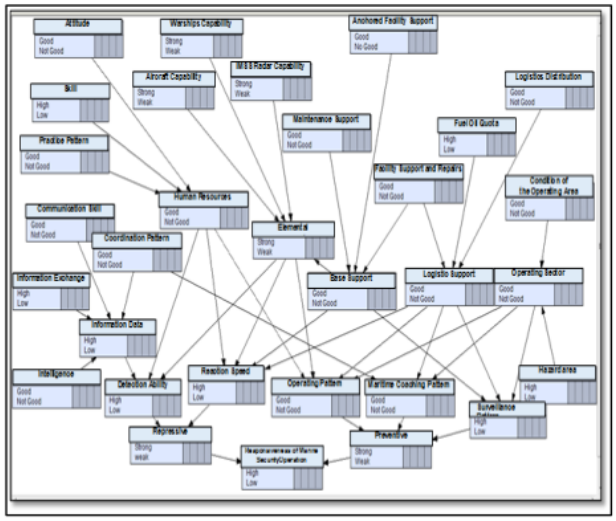

Figure 3. *Causal Map circuit in Netica Software*

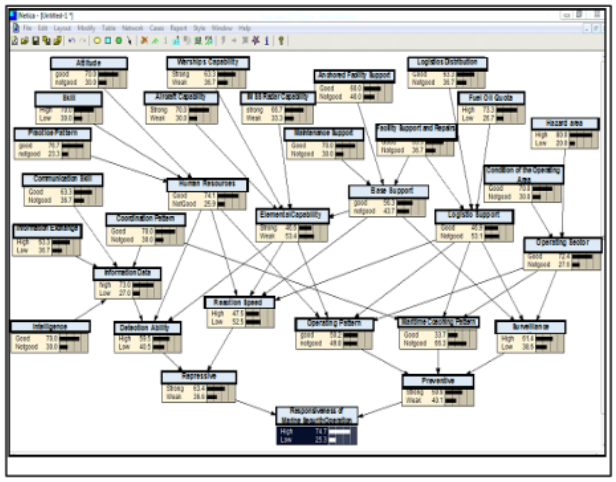

Figure 4. *Results of the Maritime Security Operations Response in the Natuna Sea*

After analyzing the supporting variables and also as a determining factor in the security responsibility. It is known that the independent variable is a free factor without being bound and can relate to various dependent variables, while the dependent variable requires at least two independent variables to improve performance. In maritime security on the Natuna Sea, the dependent variable is considered to be more able to improve the Warships response than the independent variable because the operating structure pattern system tends to be triangular where the variable closest to the goal will greatly affect the percentage increase. However, the bottom supporting factors greatly influence the performance of the advanced supporters, in this case, are the independent variables.The independent variable that influences the dependent variable is the attitude of the Indonesian Navy soldiers from the standpoint of HR variance of beliefs 0.0193203, Capability of warships from the point of view of elemental capabilities with

variance of beliefs 0.0429330, support from physical faculties from the standpoint of support with variance of beliefs 0.0234881, logistics facility support from the viewpoint of logistical support with variance beliefs 0.0879003, operating area conditions from the point of view of the operating sector with its variance of beliefs 0.0432081 and exchange of information from the viewpoint of information data with 0.0103020 variance of beliefs and coordination patterns from angles view of the maritime coaching pattern with its variance of beliefs 0.0396743. On the basis of these findings, it can be concluded that the independent variable of warship capability and aircraft capability (Pesud) must be the most important point of concern for policymakers in the Navy in order to increase defense equipment capital so that maritime security responsibility in the Natuna Sea against regional violations and illegal fishing by foreign fishermen. While the variable capabilities of the IMSS radar were not dominant, only 0.0000998 had a variance of beliefs because the radars in some AL bases in the Natuna Sea could not work properly and even some parts were damaged. The Bayesian Network method shows that the importance of lower supporting factors in increasing maritime security responsibility where we can map the strength of elements ranging from defense equipment capabilities to base readiness and supporting facilities such as fuel, improvements to the professionalism of soldiers. From the results above, it can be seen that the repressive variables are better than the preventive variables because the effectiveness of repressive actions is better than preventive measures seen from all aspects such as operating cost factors, the level of warrior stresses in operations and the level of defense equipment is better maintained. Also, the need for variable balance in increasing maritime security responsibility in the Natuna Sea to achieve maximum results, so that not only one or two variables can be maximized because the results are not necessarily optimal. The more supporting variables are maximal, the objectives will be achieved following expectations, but it needs fairly careful analysis in the process of increasing the supporting variables because it involves the Navy's policies and capabilities.

4.CONCLUSIONS

From the results of the collection, data processing, analysis and discussion and interpretation of the results of data processing that has been done, the conclusions that can be taken in this final project are:

a. The Navy's ability to respond to any threat of regional violations and illegal fishing by foreign fishermen in the Natuna Sea only has a responsibility of 74.7%.
b. In the Maritime Security system model in the Natuna Sea consists of 17 independent variables and 13 dependent variables that support maritime security responsibility.

Through sensitivity analysis, it is known that there are independent variables that influence the maritime security responsiveness model fundamentally, namely warship capability and aircraft capability with a variance of beliefs 0.0009471 and 0.0008886 and dependent variables are repressive actions with a variance of beliefs 0.0554271.

5.FUTURE WORK

In the preparation of this Final Project, the respondents who were asked for assistance by nine experts / maritime security experts and got the security response results were almost the same or there were no significant differences. This is because the experts were taken from Warships commanders and staff officers who had experience working in the Natuna Sea so that they had the same homogeneity of perceptions. During the preparation and writing of this Final Project, several things are needed to improve the methodology/method of further research when using the Bayesian Network model. These things are as follows:

a. There is a need to limit the selection of experts in terms of qualifications, competencies, and certifications following the topics discussed in this study.
b. Sharpness is needed for the problems to be raised, especially in terms of uncertainty and interdependence relations. Both of these are fundamental in implementing the Bayesian Network approach.
c. This study uses more data in the form of perceptions from experts (qualitative data) in data collection and processing. For this study to be more perfect, it is necessary to add data objectivity from each independent variable (quantitative data) such as the number, conditions and technical capabilities to complete the existing data so that it is more able to represent the reality of the system in the field.

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