ACCURACY OF OPERATING PATTERNS IN LANAL TAREMPA IN THE FACE OF REGIONAL VIOLATION RATES WITH DOUBLE HOLT WINTERS EXPONENTIAL SMOTHING AND BAYESIAN NETWORK COMBINATION MODELS

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ABSTRACT

The dynamics in the development of the security situation are so rapid that there are many political policies that change the security situation of a Country. So that everyone competes to create a technique so that the designed method can be applied especially in the field of security. Indonesia is one of the island states that has an area of sea 2/3 of the land so the source of natural wealth is very abundant, this causes many conflicts of interest with neighboring countries. The number of violations of the Lanal Tarempa region in the Natuna Sea as an example. In the calculation between the degree of violation over time and the application of proper operating patterns it takes a method with a forecasting calculation system (Forcasting) in this case using the Time Series Double Holt Winters Exponential Smothing by combining Holt's (Double Exponential Smoothing) model as a closed system model with the Bayesian Network model as an open system model. This proposed model has the ability to follow a significant pattern of actual data movement. The number of illegal fishing violations based on the data of the last 4 (four) years. The accuracy of an analysis if in the processing of forecasting data results in a small α (Alpha) and β (Beta) value as well as mape, MSE and MAE correction values.

KEYWORDS: *Security Situation, Breach, Tarempa Naval Base, Operation Pattern, Forecasting and Bayesian Network Model.*

1. INTRODUCTIONS

Indonesia as the world's largest maritime country and archipelago has a specific character that is not owned by other countries where 2/3 of Indonesia is an ocean territory. With the greatest water conditions, the threat of maritime and sovereignty is greater. The implications of indonesia's geographical location and constellation, the border area becomes a potential conflict, including the sea border between Indonesia and other countries making cooperation sometimes disrupted. The Natuna Sea is a big concern right now. Conflicts of interest often occur there, especially when it comes to taking natural resources in secret by neighboring countries. This led the Indonesian government to make strict policies such as the capture of foreign fishing vessels, the sinking of foreign fishing vessels, the return of spoils and fines to the State for illegal fishing in the Natuna Sea. Illegal fishing is a violation of the territory which includes a violation of the sovereignty of the Republic of Indonesia so that it becomes the main duty of the TNI, especially the TNI AL in order to support the National Assembly. In accordance with Law No.3 of 2002 article 10 states that the TNI as a defense tool of the Unitary State of the Republic of Indonesia (NKRI) is tasked with carrying out the defense policy of the country at sea implied in the sentence of carrying out operations other than war, so that the duty of the Navy in law enforcement at sea has three roles known as "Trinity Role of the Navy". The task is carried out to ensure the integrity and sovereignty of the Indonesian state over all waters of national jurisdiction while ensuring Indonesia's national interests in and or by sea but will not run if it is not supported by an adequate base.

Sea defense control is tasked to KRI as the leading sector but still requires the concept of supporting facilities and meeting kri needs as based on The Decree of Kasal Number Skep/372/III/2007 on Standardization of Naval Base. Base as one of the components of the Integrated Fleet Weapons System (SSAT). Based on the facilities and capabilities of a base, the base consists of the Main Base of the Navy (LANTAMAL) and the Naval Base (LANAL) consisting of type B and C. One of the bases located in the Natuna Sea is Lanal Ranai and Lanal Tarempa where the second position of Lanal is very strategic and directly facing the border of another Country. Lanal Tarempa's own position is in the Southwest of Lanal Ranai. With this strategic position makes Lanal Tarempa often violations of territory such as illegal fishing by other countries, this becomes an issue where the limitations of patrol elements from Lanal Tarempa such as KAL – 28 and Patkamla who are only able to carry out patrols near the nearest islands have not been able to cover the entire area of Lanal Tarempa so it is necessary to implement a proper operating pattern system with limited operations in the face of any violations in its territory. Violations often committed by other Countries are very uncertain, this causes the current pattern of limited patrol operations to be less maximal so there needs to be an allegation or forecast of violations occurring based on previous years. To be able to predict the need for accurate data is also the right forecasting method. Among the existing forecasting methods holt winters method is that the accuracy is better than other methods. The Holt Winters Method uses comparison of actual data with prediction data in time series so that the results are more accurate. Holt Winters Exponential Smoothing model is also still relatively close system because this method is based only on historical data. In fact, there are several external factors that affect the pattern of operation, such as existing alut sista factors, limited personnel capabilities, and others that should be solved by open system methods. To supplement the forecasting of illegal fishing violations in the Lanal Tarempa region on an open system basis, the Bayesian Network method was used.

The Bayesian Network method can perform probabilistic decision-making (inference) by using other known variable values. Neapolitan also states that the Bayesian Network method can represent a causal relationship between variables found in the Bayesian Network structure. Therefore, Bayesian Network is an appropriate method to develop the idea of an element of uncertainty with a limited amount of data as well. Based on that background, the problem that will be discussed in this study is how to build an open system model combined with a close system method that can be used to determine the exact pattern of operation by predicting data violations of the territory in this case illegal fishing by foreign fishermen taking into account not only historical data but also some factors that allegedly affect the pattern of operations in the Lanal Tarempa region. The results of this study are expected to obtain a model for accuracy in determining the pattern of operation in each level of violation by predicting the number of future violations by applying the Bayesian Network (open system) method approach combined with the time series (close system) forecasting method.

2. MATERIALS / METHODOLOGY

2.1. Research Approach

2.1.1. Operations Research

The approach or method used in this study is to use the rules of surgical research. Operation Research (OR) is a method of problem solving that prioritizes the thinking of the friend to know the various degrees of development of the factors that influence the problem (et.al, 1999). The main purpose of this study is to develop a model that can be used to obtain the right pattern of operation by

predicting illegal fishing violations in the Lanal Tarempa Natuna region. Therefore, the object used in this study is data on the number of illegal fishing violations over the past four years. Statistical Software used to perform data auto correlation calculation and data pattern determination. Minitab 16 software is used to help process data that is also thought to contain missing value. For GeNie 2.0 software is used to develop Bayesian network models based on the initial data that has been obtained and also test the model that has been developed. At the data processing stage, all data obtained is processed using software, such as Minitab 16, and GeNie 2.0. To build the model, 75 percent of the overall data was used and the remaining 25 percent was used to test the model, so out of a total of 48 existing data as much as 36 data was used to build the model and the remaining 12 data was used to test the model.

2.1.2. Qualitative

In addition to using the Rules of Operation Research (OR) also use a qualitative approach where the data obtained is primary and secondary data as well as from the existing literature. In addition to using the Rules of Operation Research (OR) also use a qualitative approach where the data obtained is primary and secondary data as well as from the existing literature.

2.2 Use of Methods

2.2.1. Holt Winters Exponential Smoothing

This method uses time-run data forecasting that follows a linear trend where the first step to perform is to determine or initialize the values of alpha and beta parameters. Common forms used to calculate forecasts are:

a. Exponential Smoothing Equation: $Ft = \alpha Yt + (1 - \alpha)(Ft-1+ T)\ t-1$

b. Trend Estimation Equation: $Tt = \beta\ (Ft- Ft-1) + (1 - \beta)\ Tt-1$

c. Equations Used to make forecasting in the coming p period are

$$: Yt+p = Ft + Tpt$$

Where:

= exponential smoothing value

a = smoothing constant for data (0 < a < 1)

b = smoothing constant for trend estimation (0 < b < 1)

Y = actual value in period t

T = estimated trend p = number of forward periods to be foreseen

2.2.2. Bayesian Networks

Graphically, the construction of the Bayesian Network structure consists of nodes and arrows. The variable will later be represented by a node and have a probability value. The arrow shows the relationship between the variables that affect or are affected. For example, we will observe the level of wetness in the grass. The variables used in the model are grass wetness level (A), rainfall level (B), sprinkler water splash (C). If rainfall levels and splashes of water from sprinklers are high, then the grass will get wetter. In accordance with the rules of the probability chain, the equation is obtained:

$$(x)= \prod_{i=1}^{n} (xi|x1, \dots , xi\text{-}1)$$

where for each Xi, there will be Πi {X1, ..., Xi-1}, which indicates that Xi and {X1, ..., Xi-1} with information are conditionally independent. For the case of the level of grass wetness, it can be written in the equation:

$p(A|B, C)= p(A)$

which means that the event of grass getting wet occurs after rain or sprinklers that water the grass. Therefore, the construction of structures for the level of wetness of grass such as:

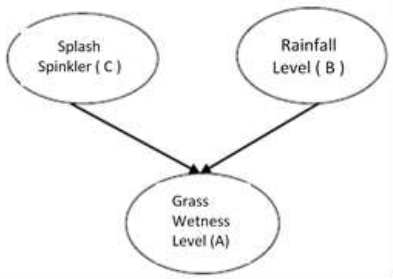

Figure 2.1 Relationship Causal.

In addition, the Bayesian Network is built with a statistical approach called the bayes theorem. In this theorem is used conditional probability which is the chance of an event A if it is known event B has occurred before. Conditional probability is notified with P (A| B). The calculation for conditional probability is contained in the equation below:

$$P(A|B) = \frac{P(A \cap B)}{P(B)} \quad \text{dan} \quad P(A|B) = \frac{P(A \cap B)}{P(B)} . \text{P(A)}$$

In addition, there is also a joint probability which is the chance of occurrence of events A and B that are notified with (P AnB). Calculation for joint probability is found in the equation:

$P(A \cap B) = P\ (A|B)\ xP\ (B\ )\ atau\ P(A \cap B) = P\ (B|A)\ xP(A)$

In determining the parameter value can use the frequency of events and the probability of events. So that later can be known the probability value of each parameter.

3. RESULT AND DISCUSSION

3.1. Conceptual Model

It is a conceptual model of research or an overview of the research to be done. The conceptual model consists of four parts: pre-processing, input, method, and output. The pre-processing section describes information about data without missing value and data that allegedly contains missing value and tools used in the processing of missing value data. The input section describes the information about where the data used in this study was obtained. In the method section describes the information about what methods are used in data processing. Then, the final part is the output section that describes the information about the results of the data processing that has been done.

Figure 3.1 Model Concept

3.2 Development of Model Close System

In this study, the closed system model was built by applying the idea of Holt's method. To build the model, the data used was 75 percent of the overall data and the remaining 25 percent was used to test the model. As for the total data overall is 48 data, so 36 data will be used to build the model and the remaining 12 data will be used to test the model. Thus, the data used to build the model is data from January 2016 to December 2018, while data from January 2019 to December 2019 is used to test the model.

3.3 Causal Relationships

Bayesian Network's method is to describe the la causal relationship between the operating model and the factors that affect it.

Figure 3.2 Causal Relationships

3.4 Calculation of Probability of Each – Individual Factors

The next step in creating the Bayesian Network model is to determine the probability of

events for each node (factor) and the relationship between those nodes. In this study, the probability of an event was calculated based on the frequency at which the state or combination of states of each node was selected.

3.5 Testing Model Open System

Once all the probabilities of events on each node have been calculated, the Bayesian Network model can be said to be complete and can be tested against that model. This test serves to measure the accuracy or level of conformity of movement patterns of the built models. The data used for model testing is 15 data or 25% of the overall data. Bayesian Network model testing is performed by setting evidence on each of the outermost nodes (factor nodes that affect 1, node factors affecting 2, and so on), based on the state in each month.

3.6 Development of Model Combines between Open and Closed System

The combination model was built by combining holt's model with the Bayesian Network model. Basically, the level of conformity of Holt's model is higher than the level of conformity of the Bayesian Network model, so the combination of these two methods is expected to improve the accuracy of forecasting the right operating patterns. The development of this combination model follows equations in Holt's model that begin by looking for an estimate of the level value and trend value until it is later obtained from the forecasting results. From the test results of the model, a significant degree of pattern conformity is obtained. Where the pattern's conformity level is essentially the same as the conformity level of Holt's own model, but from MAPE, MAD, and MSD error calculations, holt's and Bayesian Network's combination models have a smaller error value compared to Holt's models. Thus, the use of this combination model can apparently improve the accuracy of forecasting.

3.7 Model Close System Testing

In this study, the closed system model was built by applying the idea of Holt's method. To build the model, the data used was 75 percent of the overall data and the remaining 25 percent was used to test the model. Thus, the data used to build the model is illegal fishing data from January 2016 to December 2018, while the prediction data from January 2020 to December 2020 is used to test the model.

Table 3.1 Holt's Model Test results

NO	Months	Holt's Winters Predictions		Result
		Forcast Violations	Forecasting	
1.	Jan '20	27.5361	Decreased	Appropriate
2.	Feb '20	27.2798	Decreased	Appropriate
3.	Mar '20	27.0234	Decreased	Not Appropriate
4.	Apr '20	26.7671	Decreased	Appropriate
5.	Mei '20	26.5107	Decreased	Appropriate
6.	Jun '20	26.2544	Decreased	Appropriate
7.	Jul '20	25.9980	Decreased	Not Appropriate
8.	Aug '20	25.7417	Decreased	Appropriate
9.	Sep '20	25.4853	Decreased	Appropriate
10.	Oct. '20	25.2289	Decreased	Appropriate
11.	Nov. '20	24.9726	Decreased	Appropriate
12.	Des '20	24.7162	Decreased	Appropriate
MAPE				9.36572
MAD				2.36804
MSD				8.76783
Pattern Level				83.34 %

3.8 Model Open System Testing

Once all the probabilities of events on each node have been calculated, the Bayesian Network model can be said to be complete and can be tested against that model. This test serves to measure the accuracy or level of conformity of movement patterns of the built models. The data used for model testing is data from January 2019 to December 2019. The factors or nodes on the Bayesian Network model are built with Use Software GeNie 2.0.

Figure 3.3 Bayesian Network Model Testing.

Table 3.2 Bayesian Test Results

Months	Bayesian Network Predictions			Result
	High	Low	Predictions	
Jan '20	0.7	0.3	Increased	Appropriate
Feb '20	0.7	0.3	Increased	Appropriate
Mar '20	0.43	0.57	Decreased	Appropriate
Apr '20	0.43	0.57	Decreased	Not Appropriate
Mei '20	0.43	0.57	Decreased	Appropriate
Jun '20	0.43	0.57	Decreased	Appropriate
Jul '20	0.43	0.57	Decreased	Appropriate
Aug '20	0.68	0.32	Increased	Not Appropriate
Sep '20	0.68	0.32	Increased	Appropriate
Oct. '20	0.68	0.32	Increased	Not Appropriate
Nov '20	0.68	0.32	Increased	Appropriate
Des '20	0.7	0.3	Increased	Appropriate
Pattern Level				75%

From the test results of the model in Table 3.2, it can be seen that the Bayesian Network model that has been built has a pattern conformity level with the actual data movement pattern of 75%. This figure is still smaller than the degree of pattern conformity produced by Holt's method, so with the combination between these two methods it is expected to improve the accuracy of forecasting the appropriate operating patterns. In this combination model, the α(Alpha) value is 0.383731 and the trend beta value is 0.109555. While the MAPE value becomes 8.57443, the MAD value becomes 2.19136, and the MSD value becomes 9.3245. With the conformity rate being 79.2%. These values are obtained using the help of software minitab 16. In the builder data and test data, the forecasting results are obtained from the addition or reduction between the estimated level value and the multiplication of probability and the estimated trend value. The process of addition or subtraction as well as probability depends on the forecasting results of the Bayesian Network model.

4. CONCLUTIONS

In the development of the proposed model in establishing the right pattern of operation by forecasting the amount of data violation (Illegal Fishing) not only considering historical data but also some factors that influence the pattern of such operations is carried out by combining holt's model with the Bayesian Network model. This proposed model has better accuracy compared to the original model (closed system). This proposed model also has the ability to follow the conformity of actual data movement patterns significantly. The value is calculated based on the total frequency of conformity between the proposed model movement pattern and the actual data movement pattern of the number of violations (Illegal Fishing).

By combining Holt's model with the Bayesian Network model. This proposed model has a MAPE value of 8.57%, a MAD value of 2.19%, and an MSD value of 9.32. This proposed model also has the ability to follow the conformity of the actual data movement pattern by 79.2%. The value is calculated based on the total frequency of conformity between the proposed model movement pattern and the actual data movement pattern of the number of violations (Illegal Fishing).

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