FORECASTING NUMBER OF LEGAL VIOLATIONS IN INDONESIAN SEA USING THE FUZZY DOUBLE EXPONENTIAL SMOOTHING METHOD

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ABSTRACT

Maritime security in Indonesia is an indicator of the success of the Government in managing the sovereignty of the State because two-thirds of Indonesia is sea, so Indonesia is called a maritime country. This study aims to predict the number of law violations in Indonesian seas. Predicting events is a strategic step to set the next security operation strategy. The method used to predict violations of law at sea in Indonesia is Fuzzy Double Exponential Smoothing, the Fuzzy method is used to normalize violation data and the Double Exponential Smoothing method is used to predict future events, a combination of fuzzy and double exponential smoothing methods was developed to improve some previous research which only use exponential smoothing only in making predictions. The data processed is data on violations of law at sea in Indonesia from 1996 to 2019 from the Indonesian Maritime Security Agency. The results obtained from this study are the data smoothing constant value (α = 0.81), the trend smoothing value (γ = 0.08), the mean absolute percentage error value (MAPE = 21.78%) and the root mean value average error (RMSE = 60.72). The results of this study predict that the number of violations of law at sea in Indonesia in 2020 will decrease to 98 cases, this is due to several factors, including the focus of the Government on carrying out security operations in Indonesian seas in an integrated manner involving many institutions. The research contribution can be considered by Indonesian Maritime Security Agency to improve Indonesia's maritime security by involving institutions that have legal authority in Indonesian seas.

Keywords: *Forecasting, Fuzzy Double Exponential Smoothing, lawlessness at sea*

1. INTRODUCTION

Forecasting is an activity to predict what will happen in the future. Forecasting techniques are divided into two, namely forecasting models based on statistical mathematical models such as moving average, exponential smoothing, ARIMA, SARIMA and regression [1]. The second model is a forecasting model based on artificial intelligence such as neural networks, genetic algorithms, and classification [2], [3].

Forecasting plays an important role in everyday life. With a forecasting method that has a high level of accuracy, one is expected to design the appropriate action early to achieve more efficient and optimal results. Several studies using the Exponential Smoothing model have been widely used by researchers, among others [4], [5] using DES to predict violations of law at sea in Indonesia. There are also several researchers using the Fuzzy Time Series method, the advantages of the Fuzzy Time Series (FST) include that the calculation process does not require a complicated system such as genetic algorithms and neural networks, making it easier to develop.

Fuzzy theory was first published by Zadeh and Goguen [6], [7], [8] which aims to generalize the classical notion of sets (Zimmerman, 2001). Fuzzy time series calculations to determine the length of the interval have been

determined at the beginning of the calculation process. The determination of the length of the interval is very influential in the formation of fuzzy relationships which of course will have an impact on differences in the results of forecasting calculations.

One of the important problems to be studied using forecasting methods is the violation of laws in Indonesian seas. The problems in Indonesian waters are still quite complex. The extent of Indonesian waters is not balanced with efforts to protect the sea area from violations of the law [9], [10]. Various violations occurred, ranging from illegal fishing, immigrants, sea pirates, to terrorism. The commitment of the Government to reduce the number of law violations in Indonesian seas continues to be improved through the formation of an embryo for the Indonesian Coast Guard which has the authority to deal with problems in Indonesian waters [11].

Violation of the law at sea is one indicator to measure the level of security of a nation. Various violations of law at sea have increased significantly with various types of violations resulting in losses to the State. Globally, the increase in violations of law at sea in Indonesia has an impact on State revenues, the survival of the sea and the sovereignty of the Indonesian sea. The government can anticipate to control the number of violations of law in the Indonesian sea by implementing a forecasting system.

This study aims to predict the number of law violations in Indonesian seas by implementing the Fuzzy Double Exponential Smoothing (FDES) method. The fuzzy method is used to process real data on legal violations in the Indonesian sea area into fuzzy data with a fuzzy logic approach [12]. The DES method is used to predict the data generated by fuzzy processing, Holt's double exponential smoothing is obtained using two parameters α and γ (with values between 0 and 1), the final result of this study is based on the value of the smallest percentage error of the forecast data [13], [14], [15].

This research will provide information to the Government to set a joint operation strategy in order to reduce the number of violations of law at sea in Indonesia in the future. In addition, the results of forecasting can be used to take policies to anticipate the number of violations at sea, besides that, the benefits of forecasting can regulate the distribution of supervisory vessels in several areas.

2. MATERIAL AND METHODS

2.1 Forecasting

Forecasting is the art and science of predicting events in the future. Forecasting always involves historical data to project future events with mathematical models. Based on some of the definitions above, in essence, forecasting is a decision about the possibility of the future based on previous facts.

Before forecasting, it is necessary to know the problems in decision making. There are two approaches to solve the problem of decision modeling, namely: a qualitative approach and a quantitative approach. The qualitative approach does not use calculations with definite formulas and methods but through the opinions of various parties, such as the opinion of the executive board, market survey, opinion of an expert, etc. The quantitative approach is a forecasting method that relies on historical data by relying on statistics and mathematics in order to obtain scientifically justifiable results.

The type of forecasting can be grouped into three parts, namely: (a) short term forecasting, this forecast includes a period of up to one year but generally less than 3 months, (b) medium term or intermediate forecast, generally includes a monthly calculation of up to 3 years, and (c) long-term forecasting, generally for planning 3 years or more. The benefits of forecasting are as follows: (a) as a tool to plan effectively and efficiently, (b) to determine resource requirements in the future, and (c) to make decisions quickly, precisely and efficiently. Forecasting Purpose (a) as a reviewer of current and past government policies also see the extent of influence in the future and (b) forecasting is the basis for formulating policies to improve Indonesia's maritime security.

2.2 Fuzzy Time Series

Time series data is data that is collected from time to time to describe the progress of events. Periodic data analysis makes it easy for us to know the progress of events and their effects on other events. Data movement patterns and variable values can be followed or known by the presence of periodic data, so that periodic data can be used as a basis for future decision making.

Fuzzy logic is a logic that has a value of fuzziness between true or false. Fuzzy logic allows membership values between 0 and 1. Fuzzy logic is an appropriate way to map an input space into an output space, has a continuous value and fuzzy logic is expressed in degrees of membership and degrees of truth.

According to Chen et al. (1996), the main difference between fuzzy time series and conventional time series is the value used in forecasting, which is the fuzzy set of real numbers over the set universe. Fuzzy set can be defined as a class of numbers with vague limitations.

If U is the set of universes, U = {u_1, u_2, ..., u_n}, then a fuzzy set A of U is defined as A = f_1 (u_1) / u_1 + f_2 (u_2) / u_2 + ... + fA (un) / un where fA is the membership function of A, fA: U → [0,1].

The fuzzy time series method uses second-order fuzzy logical relationships in the process so that it cannot predict data for the first two years (Hsu et al. 2010). This is because the process of making second order fuzzy logical relationships which will later be formed into forecast rules requires actual data from the previous two years to be used as a fuzzy set.

2.3 Double Exponential Smoothing (DES)

Exponential Smoothing is a category of time series methods that use weighting of past data to make forecasts. The amount of weight changes exponentially decreases depending on historical data. The forecast of Holt's double exponential smoothing is obtained using two parameters α and γ (with values between 0 and 1) which need to be optimized in order to obtain the best combination of these two parameters. The best combination between the two parameters is measured by looking at the resulting Mean Square Error (MSE) value. The smaller the resulting MSE value the better the combination of the two parameter values.

The initialization process for the Holt double exponential smoothing requires two estimated values, one taking the first smoothing value for S_0 and the other taking trends b_0. For the terms initial values S_0 and b_0 can be obtained by adjusting a linear regression model, then the intersection and slope points are used as initial values for S_0 and b_0. Holt's Double Exponential Smoothing formula uses three equations, with the following formula:

$$S_t = \alpha X_t + (1-\alpha)(S_{t-1} + b_{t-1}) \quad (1)$$

$$b_t = \gamma(S_t - S_{t-1}) + (1-\gamma)b_{t-1} \quad (2)$$

$$F_{t+m} = S_t + b_t m \quad (3)$$

Where:

S_t	=	the exponential smoothing value in period t
S_{t-1}	=	exponential smoothing value in period t-1
X_t	=	actual value in period t
b_t	=	trend value in period t
b_{t-1}	=	trend value in period t-1
α, γ	=	smoothing parameter with a value between 0 and 1
m	=	the period to be predicted
F_{t+m}	=	forecast m the future period

The forecast above adjusts S_t directly for the trend of the previous period, namely b_{t-1} by adding the last smoothing value, namely S_{t-1}, this helps to remove slowness.

2.4 Fuzzy Double Exponential Smoothing (FDES)

Several previous studies have compared the Fuzzy Time Series method with the Double Exponential Smoothing method, but in this study changes have been made by combining these methods to obtain forecast results that have a low error value.

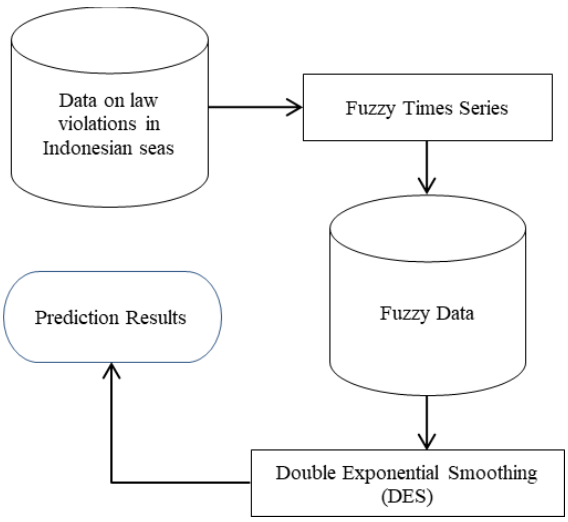

Figure 1. Block diagram of Fuzzy Double Exponential Smoothing

This research applies the fuzzy time series cheng model and the Holt double exponential smoothing method to predict the number of law violations in the Indonesian sea area. Based on Figure 1, the workings of Fuzzy Double Exponential Smoothing are firstly the actual data on violations of law in the Indonesian sea is resolved by using the Fuzzy Time Series model of Cheng to get Fuzzy data output, then the fuzzy data is processed using the Double Exponential Smoothing method of the Holts model, then the final result For the DES forecasting, the error value analysis will be carried out by looking at the MAD, MSE, RMSE, MAPE and MPE values. The results that have the smallest error value will be used as recommendations for the results of forecasting violations of law in Indonesian seas for the next three years.

2.5 Measuring Forecasting Errors

The measure used in calculating the overall in forecast error. These measures can be used to compare different forecasting models, to monitor whether the forecast is functioning properly or not. Three sizes of the most famous is the Mean Absolute Deviation (MAD), Mean Square Error (MSE), Root Mean Square Error (RMSE), Mean Absolute Percent Error (MAPE) and Mean Percent Error (MPE).

a. ME (*Mean Error*)

$$ME = \frac{\sum A_t - F_t}{n} \quad (4)$$

b. MAD *(Mean Absolute Deviation)*

$$MAD = \frac{\sum[A_t - F_t]}{n} \quad (5)$$

c. MSE *(Mean Square Eror)*

$$MSE = \frac{\sum[A_t - F_t]^2}{n} \quad (6)$$

d. MAPE *(Mean Absolute Percent Eror)*

$$MAPE = \frac{\sum_i^n \left[\frac{A_t - F_t}{A_t}\right] x\ 100\%}{n} \quad (7)$$

3. RESULTS AND DISCUSSION

Data on the number of law violations in Indonesia's maritime territory from 1996 to 2019 can be seen in Table 1.The data on the number of violations shows a decreasing trend throughout the year as shown in Figure 2.

Figure 2. Data trend of violations of law in Indonesian seas 1996-2019

3.1 Fuzzy times series results

The stages of the fuzzy times series process are: (a) Determining the set universe (U) of actual data, (b) Determining the width of the interval using a frequency distribution, (c) Determining the width of the interval, (d)

finding the middle value. Based on Table 1, we can determine the set of universe U = [90, 450] and divide it into 12 sub intervals with equal interval lengths.

$\mu_1 = (90 - 120)$ $\mu_2 = (120 - 150)$
$\mu_3 = (150 - 180)$ $\mu_4 = (180 - 210)$
$\mu_5 = (210 - 240)$ $\mu_6 = (240 - 270)$
$\mu_7 = (270 - 300)$ $\mu_8 = (300 - 330)$
$\mu_9 = (330 - 360)$ $\mu_{10} = (360 - 390)$
$\mu_{11} = (390 - 420)$ $\mu_{12} = (420 - 450)$

Fuzzy sets A_1, A_2, ...,.A_k, can be determined based on the sub interval that has been formed in the previous step by adjusting the model below.

$$A_k = \begin{cases} \frac{1}{u_1} + \frac{0.5}{u_2} & k = 1 \\ \frac{0.5}{u_{k-1}} + \frac{1}{u_k} + \frac{0.5}{u_{k+1}} & 2 \leq k \leq n\text{-}1 \\ \frac{0.5}{u_{n-1}} + \frac{1}{u_n} & k = n \end{cases} \quad (8)$$

Obtained from:

$A_1 = 1/u_1 + 0.5/u_2$
$A_2 = 0.5/u_1 + 1/u_2 + 0.5/u_3$
$A_3 = 0.5/u_2 + 1/u_3 + 0.5/u_4$
$A_4 = 0.5/u_3 + 1/u_4 + 0.5/u_5$
$A_5 = 0.5/u_4 + 1/u_5 + 0.5/u_5$
$A_6 = 0.5/u_5 + 1/u_6 + 0.5/u_6$
$A_7 = 0.5/u_6 + 1/u_7 + 0.5/u_7$
$A_8 = 0.5/u_7 + 1/u_8 + 0.5/u_8$
$A_9 = 0.5/u_8 + 1/u_9 + 0.5/u_9$
$A_{10} = 0.5/u_9 + 1/u_{10} + 0.5/u_{10}$
$A_{11} = 0.5/u_{10} + 1/u_{11} + 0.5/u_{11}$
$A_{12} = 0.5/u_{11} + 1/u_{12} + 0.5/u_{12}$
$A_{13} = 0.5/u_{12} + 1/u_{13}$

Table 1. Fuzzification Data Of Number Of Legal Violations In Indonesian Sea

Year	Number of Violations	Fuzzification
1996	228	A_5
1997	267	A_6
1998	287	A_7
1999	421	A_{12}
2000	352	A_9
2001	310	A_8
2002	229	A_7
2003	246	A_6
2004	263	A_7
2005	160	A_3
2006	187	A_4
2007	201	A_5
2008	295	A_7
2009	246	A_6
2010	217	A_7
2011	160	A_3
2012	172	A_3
2013	179	A_3
2014	123	A_2
2015	102	A_1
2016	163	A_3
2017	132	A_2
2018	109	A_1
2019	97	A_1

Table2. Second Order Fuzzy Logical Relationship Group

$A_5, A_6 \rightarrow A_7$	$A_6, A_7 \rightarrow A_{12}$	$A_7, A_{12} \rightarrow A_9$	$A_{12}, A_9 \rightarrow A_8$
$A_9, A_8 \rightarrow A_7$	$A_8, A_7 \rightarrow A_6$	$A_7, A_6 \rightarrow A_7$	$A_6, A_7 \rightarrow A_3$
$A_7, A_3 \rightarrow A_4$	$A_3, A_4 \rightarrow A_5$	$A_4, A_5 \rightarrow A_7$	$A_5, A_7 \rightarrow A_6$
$A_7, A_6 \rightarrow A_7$	$A_6, A_7 \rightarrow A_3$	$A_7, A_3 \rightarrow A_3$	$A_3, A_3 \rightarrow A_3$

$A_3, A_3 \rightarrow A_2$	$A_3, A_2 \rightarrow A_1$	$A_2, A_1 \rightarrow A_3$	$A_1, A_3 \rightarrow A_2$
$A_3, A_2 \rightarrow A_1$	$A_2, A_1 \rightarrow A_1$	$A_1, A_1 \rightarrow \#$	

Table 3. Output Fuzzy Violation Of The Law In Indonesian Sea

Year	Number of Violations	Fuzzy Logical Relationship Group	Math rule	Output Fuzzy
1996	228	-	-	-
1997	267	-	-	-
1998	287	$A_5, A_6 \rightarrow A_7$	1	285
1999	421	$A_6, A_7 \rightarrow A_{12}$	2	435
2000	352	$A_7, A_{12} \rightarrow A_9$	3	345
2001	310	$A_{12}, A_9 \rightarrow A_8$	4	315
2002	229	$A_9, A_8 \rightarrow A_7$	5	285
2003	246	$A_8, A_7 \rightarrow A_6$	6	255
2004	263	$A_7, A_6 \rightarrow A_7$	7	285
2005	160	$A_6, A_7 \rightarrow A_3$	8	165
2006	187	$A_7, A_3 \rightarrow A_4$	9	195
2007	201	$A_3, A_4 \rightarrow A_5$	10	225
2008	295	$A_4, A_5 \rightarrow A_7$	11	285
2009	246	$A_5, A_7 \rightarrow A_6$	12	255
2010	217	$A_7, A_6 \rightarrow A_7$	13	285
2011	160	$A_6, A_7 \rightarrow A_3$	14	165
2012	172	$A_7, A_3 \rightarrow A_3$	15	165
2013	179	$A_3, A_3 \rightarrow A_3$	16	165
2014	123	$A_3, A_3 \rightarrow A_2$	17	135
2015	102	$A_3, A_2 \rightarrow A_1$	18	105
2016	163	$A_2, A_1 \rightarrow A_3$	19	165
2017	132	$A_1, A_3 \rightarrow A_2$	20	135
2018	109	$A_3, A_2 \rightarrow A_1$	21	105
2019	97	$A_2, A_1 \rightarrow A_1$	22	105

Based on the results of the fuzzy calculation process as shown in Table 3, it can be explained as follows:

a. For group 1, from table 3 it can be seen that there is a fuzzy logical relationship group as follows: A_5, $A_6 \rightarrow A_7$. Where the maximum membership value for the fuzzy A_7 set falls on the interval μ_7 = [270-300], and the mean value of the interval μ_7 is 285, then the forecasting value for group 1 is 285.
b. For group 14, it can be seen that there is a fuzzy logical relationship group as follows: A_6, $A_7 \rightarrow$A3. Where the maximum membership value for the fuzzy A_3 set falls on the μ_3 = [150-180] interval, and the mean value of the μ_3 interval is 165, then the forecasting value for group 14 is 165.
c. For group 22, it can be seen that there is a fuzzy logical relationship group as follows: $A_2, A_1 \rightarrow A_1$. Where the maximum membership value for the fuzzy A_1 set falls on the interval μ_1 = [90-120], and the mean value for the interval μ_1 is 105, then the forecasting value for group 22 is 105.

Figure 3. Fuzzy time series results

The output data from the fuzzy time series forecasting will be used as forecasting data using the Double Exponential Smoothing method with the Holts model.

3.2 Double Exponential Smoothing Forecasting Results

Holt's double exponential smoothing method can be used to predict the number of lawlessness in Indonesian seas for the future. Holt smoothest the trend value separately by using two parameters, namely α and γ (with values 0 and 1) which need to be optimized so that the best combination of these two parameters is obtained. By means of consecutive trials obtained were 0.81 and 0.08 which resulted in an MSE of 3687.486 and a MAPE of 0.21772.

Company:	BAKAMLA		
Double Exponential Smoothing: Holt's Method			
Level Alpha:	0,81	MAD:	46,98833
		MSE:	3687,486
Trend Beta:	0,08	RMSE:	60,72467
		MAPE:	0,21772
Number of Observations (100 maximum):	22	MPE:	-0,09886
Seed Value: =average of first 4 observations	345,00		

Figure 4. The optimal values for the parameters α and γ

Mean Absolute Percentage Error (MAPE) is a measure of relative error, in addition to Mean Absolute Deviation (MAD) and Root Mean Squared Error (RMSE). MAPE is usually more meaningful than MAD because MAPE states the percentage error in the prediction or forecasting of actual results during a certain period which will provide information that the percentage error is too high or too low, in other words MAPE is the absolute average error during a certain period which is then multiplied by 100 % in order to get a percentage result. MAPE is a measure of relative precision used to determine the percentage of deviation from the estimation results. This approach is useful when the size or size of the forecast variable is important in evaluating the accuracy of the forecast. MAPE indicates how much error in estimating is compared to real values. Based on Lewis (1982), the MAPE value can be interpreted or interpreted into four categories, namely:

a. <10% = very accurate
b. 10-20% = good
c. 20-50% = fair
d. > 50% = inaccurate

The smaller the MAPE value, the smaller the error of the estimation results, on the contrary the greater the MAPE value, the greater the error of the estimation results. The results of a prediction method have very good predictive ability if the MAPE value is <10% and have good predictive ability if the MAPE value is between 10% and 20%.

The history data used in the Double Exponential Smoothing Holt calculation process is shown in the Table. 4 is the historical data from the calculation of fuzzy times series. Next, the initialization process for Holt's double exponential smoothing requires two estimated values, namely, taking the first smoothing value with S_0 and taking the trend b_0. For the terms initial values S0 and b0 can be obtained by adjusting the linear regression model $S_0 = 285$ and $b_0 = (315 - 185) / 3 = 10$. The next stage is the process of calculating the smoothing value and trend value in each period.

- For *t=0,*
  $S_0 = 285$
  $b_0 = (315\text{-}285)/3 = 10$
- For *t=1,*
  $S_1 = \alpha X_1 + (1\text{-}\alpha)(S_0 + b_0)$
  $= 0.81(435) + (1- 0.81)(104{,}69 + -6.725)$
  $= 408.40$
  $b_1 = \gamma(S_1 - S_0) + (1 - \gamma)b_0$
  $= 0.08(435\text{-}285)+(1\text{-}0.08)*\text{-}6.725$
  $= 19.07$
  $F_{1+1} = S_1 + b_1(1)$
  $= 408.40 + 19.07$
  $= 427.47$

The model for predicting the number of law violations in the Indonesian sea for future periods is obtained as follows:

F23 = 98; F24 = 91; F25 = 84; F26 = 78

In detail, the graph of the results of forecasting Fuzzy Double Exponential Smoothing can be seen in Figure 5.

Table 4. Results of Fuzzy Double Exponential Smoothing

Observation		Forecast		Correlogram of Errors		
Number	Actual Value	Forecast Value	Error	Autocorrel Values (AC)	Upper 95% Value	Lower 95% Value
1	285,00	345,00	-60,00	-0,2510745	0,44338	-0,44338
2	435,00	295,00	140,00	-0,0065734	0,44338	-0,44338
3	345,00	427,47	-82,47	-0,121971	0,44338	-0,44338
4	315,00	374,40	-59,40	-0,049897	0,44338	-0,44338
5	285,00	336,16	-51,16	-0,0858998	0,44338	-0,44338
6	255,00	301,28	-46,28	-0,1186279	0,44338	-0,44338
7	285,00	267,36	17,64	-0,0340813	0,44338	-0,44338
8	165,00	286,36	-121,36	0,0589154	0,44338	-0,44338
9	195,00	184,90	10,10	0,2472737	0,44338	-0,44338
10	225,00	190,58	34,42	-0,0134866	0,44338	-0,44338
11	285,00	218,19	66,81	0,068536	0,44338	-0,44338
12	255,00	276,36	-21,36	-0,1914209	0,44338	-0,44338
13	285,00	261,73	23,27	0,0437373	0,44338	-0,44338
14	165,00	284,76	-119,76	-0,0132638	0,44338	-0,44338
15	165,00	184,18	-19,18	-0,051698	0,44338	-0,44338
16	165,00	163,82	1,18	-0,0911777	0,44338	-0,44338
17	135,00	160,03	-25,03	0,1638125	0,44338	-0,44338
18	105,00	133,39	-28,39	-0,0426496	0,44338	-0,44338
19	165,00	102,19	62,81	-0,0411111	0,44338	-0,44338
20	135,00	148,93	-13,93	0,0402048	0,44338	-0,44338
21	105,00	132,61	-27,61	-0,009547	0,44338	-0,44338
22	105,00	103,42	1,58	0	0,44338	-0,44338
23		97,97				
24		91,25				
25		84,52				
26		77,80				

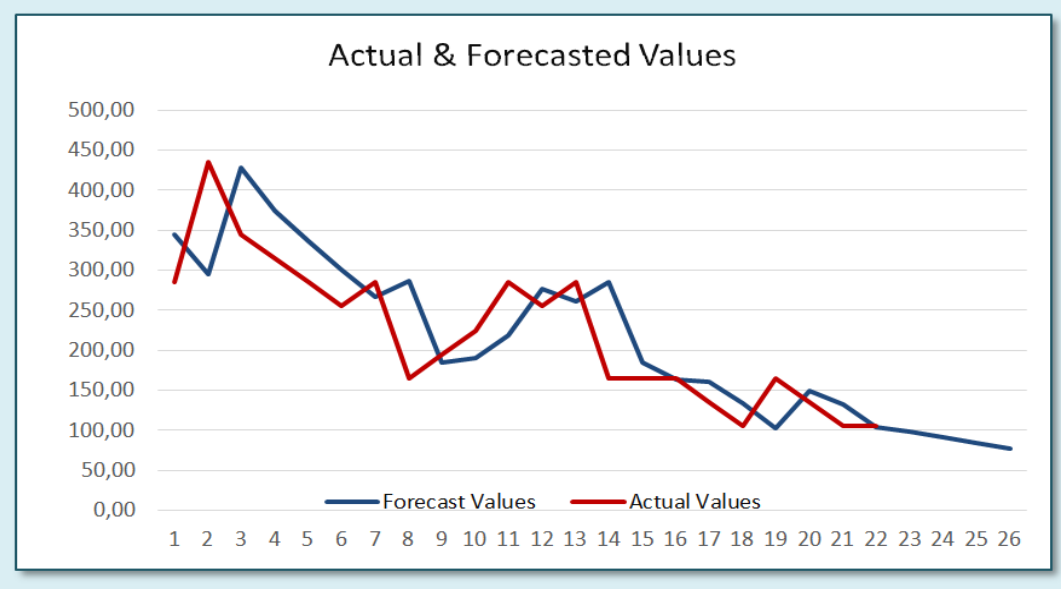

Figure 5.Fuzzy Double Exponential Smoothing Forecasting Results

3.3 Analysis of Forecasting Results

The results of forecasting using the Fuzzy Double Exponential Smoothing method as shown in Figure 5 show that the trend of violation of Indonesian maritime law has decreased and the error value of forecasting results is below 10%, meaning this research is very accurate. The results of research (Heru, 2020, Marcus, 2020) using the Double Exponential Smoothing and Triple Exponential Smooting methods also show a decline in the next three years. This is because the Indonesian government continues to innovate so that it can continue to improve Indonesia's maritime security, even though the current condition is a health emergency due to the spread of COVID-19 which has not ended in Indonesia.

The use of technology is carried out more intensively to carry out surveillance of marine areas that are prone to illegal fishing activities by foreign fishing vessels (KIA). The area is mainly the North Natuna Sea in the Riau Islands Province. Indonesia's maritime security conditions are getting better due to the Government's focus on maritime security through the Indonesian Maritime Security Agency (BAKAMLA), which is pushed by the president as the embryo of the Indonesian Coast Guard. It is due to the reconciliation of the interests of the nation and the State that cooperation between government agencies that have legal authority coordinates to work together and jointly patrol.

The contribution of this research can be used as a reference by the Government to take strategic steps to improve Indonesia's maritime security and collaborating joint patrols with Indonesian maritime security agencies is the best solution to see criminals increasingly smarter in using technology and their tricks.

4. CONCLUSION

This research has shown that the prediction of the number of law violations in Indonesian seas using the Fuzzy Double Exponential Smoothing method is predicted to decrease in the next three years, this is because the Government focuses on strengthening synergy of Indonesia's maritime security by forming an embryo of the Indonesia Coast Guard, namely the Indonesian Maritime Security Agency. The most optimal data smoothing parameter values ($\alpha = 0.81$), trend smoothing values ($\gamma = 0.08$), the mean absolute percentage error value (MAPE = 21.78%) and the root mean error value (RMSE) = 60.72), meaning that the results of this forecast have good quality because the MAPE value is 21%.

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