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Forecasting Analysis of Fishermen's Productivity Data Using Single Exponential Smoothing

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Abstract

One of the reasons why it is vital to forecast fisher production data in coastal regions is to increase fish resource management efficiency. By calculating the number of fishing boats, the amount of fish that must be caught, and the amount of raw materials required for fish processing based on the anticipated amount of fishermen's production in the following period, decision-makers can determine the amount of fish that must be caught and the amount of raw materials required for fish processing. So that the objective of the research is to forecast fishermen's production data using the Single Exponential Smoothing method, this method is effectively used to perform forecasting of time series data with short period data intervals to produce forecasts for the next period, and it can measure the rate of change of fishermen's production data each period. The results of forecasting data on fishermen's production utilizing time series data intervals from October 2022 to January 2023 to make forecasts for February 2023, namely a MAPE error rate of 2.85%, indicate that the forecasting results are within the "good" category.

Keywords: forecasting, fishermen's productivity data, single exponential smoothing, controlling production and fulfill market demand.

1. Introduction

Indonesia is a maritime country that has a large ocean area, so that the majority of the population are fishermen. According to data from the Ministry of Marine Affairs and Fisheries, the number of fishermen in Indonesia is around 4.5 million people. They live around coastal areas and small islands in Indonesia (Rochwulaningsih et al., 2019). Fishermen in Indonesia usually catch fish using traditional equipment such as nets, shells and traditional fishing boats. However, fishermen's catch data is very dependent on the weather and the availability of facilities, it is important to make efforts to improve the economic and social conditions of fishermen, for example in groups of fishermen in Ketewel village, Bali. The local government is currently still focusing on development in the Indonesian maritime sector (Muliawati et al., 2021). Due to developments in the Indonesian fishing industry, the Ketewel Village Office wants to use information technology (Riyadi & Cahyono, 2021; Sukmawati et al., 2022) in processing fishermen data there. All fish catch data can be computerized to make it easier to control monthly production and market demand.

In controlling the supply of fish catch stocks, of course, when it fluctuates because the fishermen's production results vary every day, but by applying information technology with forecasting techniques to find out future supplies it can be done (Raju & Laxmi, 2020). Forecasting fisherman production data in coastal areas is an important thing because it can be used to determine the expected amount of fisherman production in the future. By knowing the expected amount of fishermen's production in the future, decision makers can make the right policies and strategies (Hadikurniawati et al., 2021) to increase the production of fishermen in coastal areas.

One of the reasons for the importance of predicting fisherman production data in coastal areas is to increase efficiency in the management of fish resources. By knowing the amount of fishermen's production expected in the future, decision makers can determine the number of fishing vessels needed, the amount of fish to be caught, and the amount of raw material needed for fish processing. In addition, forecasting production data for fishermen in coastal areas can

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also be used to determine expected fish prices in the future. By knowing the expected amount of fisherman production in the future (Anwar et al., 2021; Wahyudin & Purwanto, 2021), decision makers can determine the price of fish in accordance with market conditions. Forecasting fisherman production data in coastal areas can also be used to improve fishermen's welfare. By knowing the expected amount of fishermen's production in the future, decision makers can determine the number of fishing boats needed and improve the welfare of fishermen by providing the necessary financial support and facilities.

Research on forecasting fisherman production data is a study conducted to find out the most effective method for predicting fisherman production in the future (Finnis et al., 2019). One method that is often used in forecasting fisherman production data is the single exponential smoothing method. Research conducted by (Lisnawati et al., 2022) analyze the effectiveness of the single exponential smoothing method in forecasting fisherman production data. This study uses fisherman production data. Other research (Supriatin et al., 2020)shows that the single exponential smoothing method is quite effective in predicting the amount of fishermen's production in the future. Other research (Sinaga & Irawati, 2020) found that the value of the smoothing parameter (α) used in forecasting greatly influences the forecasting results (Dantas & Oliveira, 2018). Therefore, it is important to determine the correct α value in forecasting fisherman production data. In addition, researchers also found that forecasting fisherman production data using the single exponential smoothing method is better than other methods such as moving averages and weighted moving averages (Pamungkas et al., 2021). This is because the single exponential smoothing method is more effective in measuring the level of change in fisherman production data.

Based on several studies related to fishermen's data forecasting, the research objective is to apply the single exponential smoothing method in the problem of forecasting fishermen's production data in Ketewel village because this method can forecast with time series data with a limited time limit with fairly accurate forecasting results. (Selvaraj et al., 2020), so that it can assist village officials in recording data as well as when storing fisherman data processing and assisting the central government in predicting the number of fish catches, local governments can estimate the amount of funds to be allocated to fishermen groups and can fulfill market demand and can increase production fish caught by fishermen.

2. Research Method

This research uses quantitative methods. The interview process was conducted to find out the respondents' perceptions, views, and experiences in detail and depth regarding information on fisherman catch data. The interview process was conducted with 5 groups of fishermen, namely Wira Baruna, Sari Baruna, Segara Windu, Segara Madu, and Putra Wahana. Based on interviews, obtained data on fisherman catches for a 5 month period during the period October 2022 to January 2023, the research objective is to be able to apply forecasting using the single exponential smoothing method for forecasting the following month, namely in February 2023.

2.1. Single Exponential Smoothing

This technique is an evolution of the moving averages technique (Dantas & Oliveira, 2018). In this strategy, forecasting is accomplished by continuously repeating calculations with the most recent data (Hayadi et al., 2021). Each piece of data is assigned a weight, with fresher data receiving a bigger weight. The following equation is utilized in the method's calculation.

$$F_t = \alpha \cdot X_{t-1} + (1-\alpha)(F_{t-1}) \tag{1}$$

where:

F_t : forecast for the next period,

F_{t-1} : forecast value of period to F_{t-1},

α : the weight indicating the smoothing constant ($0 < \alpha < 1$),

X_{t-1} : actual value in the previous period.

To circumvent this, the method of single exponential smoothing is utilized. The weight given to existing data in the single exponential smoothing approach is for the most recent data, (1-) for older data, (1-)2 for older data, and so on. The amount of α is between 0 and 1. The closer to 1 the value is, the more weight is placed on the most recent data. Thus, we may say that the forecast for the next period is the previous forecast + (α) multiplied by the forecast error from the previous period. In forecasting using the single exponential smoothing (SES) approach, the amount of (α) is calculated by trial and error until the amount of (α) that yields the smallest forecast error is identified. This approach is better suited for anticipating random fluctuations in data (Gustriansyah et al., 2019).

2.2. Calculation of Forecasting Accuracy

In calculating the value of forecasting accuracy there are many methods that can be used, but not all methods can be in accordance with the existing cases. In general there are three types of calculations to see how big the error rate is in forecasting, viz(Syafwan et al., 2021):

a) MAD (Mean Absolute Deviation) Is a calculation used to calculate the average absolute error, the calculation uses the equation:

$$\text{MAD} = \frac{\sum \left|\text{Actual - Forecast}\right|}{n} \quad (2)$$

From Eq. 2, it can be interpreted that $\sum \left|\text{Actual - Forecast}\right|$ is the result of the reduction between the actual and forecast values for each period which is then absoluteized, and then the results of the reductions are added up. And n is the number of periods used for calculations.

b) MSE (Mean Square Error) Is a calculation used to calculate the average rank error, the calculation uses the equation(Nirmala et al., 2021):

$$\text{MSE} = \frac{\sum \left(\text{Actual - Forecast}\right)^2}{n-1} \quad (3)$$

From Eq. 3, it can be interpreted that $\sum \left(\text{Actual - Forecast}\right)$ is the result of subtraction between the actual and forecast values that have been squared, then the results are summed. And n is the number of periods used for calculations.

c) MAPE (Mean Absolute Percentage Error) Is a calculation used to calculate the average absolute percentage error, with the equation:

$$\text{MAPE} = \frac{1}{n} \sum \left|\frac{\text{Actual - Forecast}}{\text{Actual}}\right| \times 100 \quad (4)$$

From Eq. 4, it can be interpreted that $\sum \left|\frac{\text{Actual - Forecast}}{\text{Actual}}\right|$ is the result of subtraction between the actual and forecast values that have been absolute, then divided by the actual value per each period, then the results are summed -the result. And n is the number of periods used for calculations. The lower the MAPE number, the better the forecasting model, and a range of MAPE values can be used as a measurement tool for a forecasting model's accuracy (Kolade, 2019). The range of these values can be seen in Table 1 (Chicco et al., 2021).

Table 1. MAPE Value Range

No	MAPE ranges	Description
1.	< 10 %	Very Good Forecasting Model Ability
2.	10 - 20 %	Good Forecasting Model Ability
3.	20 - 50 %	Feasibility Forecasting Model Ability
4.	> 50 %	Poor Forecasting Model Ability

3. Results and Discussion

This calculation analysis will calculate the actual value to produce forecasting results every month using the predetermined single exponential smoothing method. Which is the results of these calculations, and will be calculated again from the accuracy value of each method by looking at the smallest error obtained. The actual time series data for fisherman production can be seen in Table 2.

Table 2. Actual data on fishermen's catch production

No.	Period	Actual Value (in Kg units)
1.	October 2022	980
2.	November 2022	810
3.	December 2022	889
4.	January 2023	953
5.	February 2023	892

3.1. Single Exponential Smoothing Calculation Analysis

In forecasting fishermen's production data in this Ketewel village, negligence (a) will be tried (trial) as a weight value with a calculation (a = 0.5) and the initial forecasting data uses initial estimate data, namely 900.

F1 = 900 + 0.5 (980 – 900) = 940
F2 =940 + 0.5 (810 – 940) = 875
F3 = 875 + 0.5 (889 – 875 = 882
F4 = 882 + 0.5 (953 – 882) = 917.2

From the calculation results it can be explained the comparison between the forecasting results and the actual results which can be seen in the form of a comparison in Table 3.

Table 3. Forecasting results of fishing catch production data

No.	Period	Actual Value (in Kg units)	Forecasting Value (in Kg unit)
1.	October 2022	980	900
2.	November 2022	810	940
3.	December 2022	889	875
4.	January 2023	953	882
5.	February 2023	892	917,2

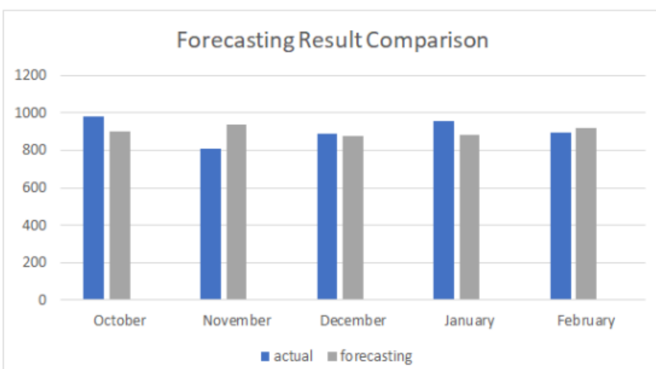

Fig. 1. Comparison of actual and forecast values

3.2. Calculation of forecasting accuracy values

Calculation of the value of forecasting accuracy, from the 3 existing calculations MAD, MSE, and MAPE, in this case calculations are used with these three methods. The calculation is done by calculating each data every month using these 3 methods.

a) Mean Absolute Deviation (MAD) Results

The result of the reduction between the actual and forecast values for each period which is then absoluteized, and then the results of the reductions are added up. And n is the number of periods used for calculations.

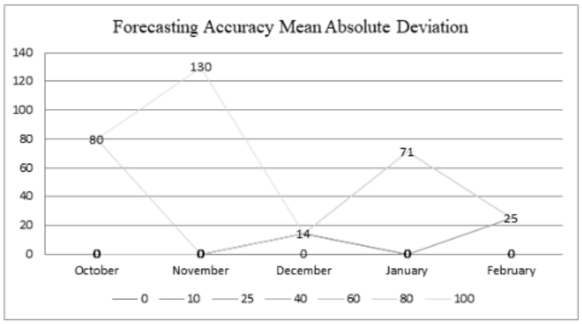

Fig. 2. MAD Accuracy Forecasting

The results in Figure 2 are obtained from calculating MAD accuracy using equation (2), as follows.

Oct: 980-900 = 80
Nov: 810-940 = 130
Dec: 889-874 = 14
Jan: 953-882 = 71
Feb: 892-917.2 = 25

b) Mean Square Error Results

The result of subtraction between the actual and forecast values that have been squared, then the sum of these results is carried out. And n is the number of periods used for calculations.

Oct: 802 = 6400

Nov: 130^2= 16,900

Dec: 14^2= 196

Jan: 71^2= 5,041

Feb: 25.52 = 635.5

The graph of the results of calculating the accuracy of the MSE method can be seen in Figure 3.

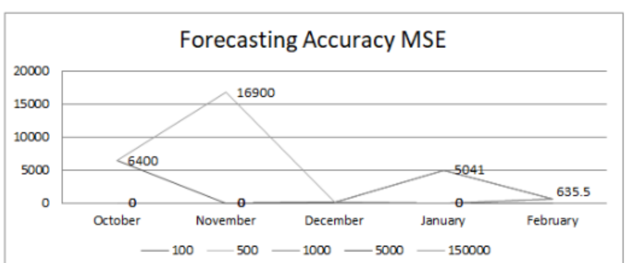

Fig. 3. MSE Accuracy Forecasting

c) Mean Absolute Percentage Error (MAPE) Results

Is the result of subtraction between the actual and forecast values that have been absolute, then divided by the actual value per each period, then the results are summed up. And *n* is the number of periods used for calculations.

Oct: 980-900/1*100%
= 8.2%
Nov: 810-940/1*100%
= 16%
Dec: 889-874/1*100%
= 1.15%
Jan: 953-882/1*100%
= 7.45%
Feb: 892-917,2/1*100%
= 2.85%

The graph of the results of calculating the accuracy of the AMPE method can be seen in Figure 4.

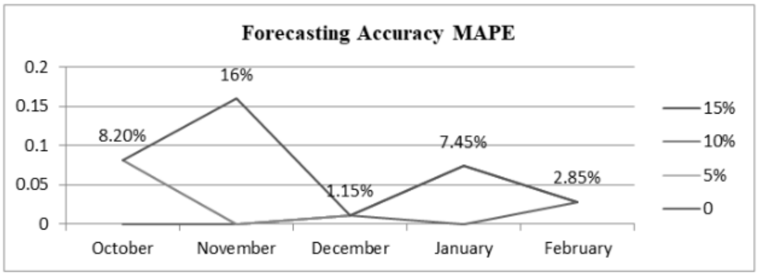

Fig. 4. MAPE Accuracy Forecasting

From the results of calculating the level of forecasting accuracy in the last 5 months, it shows that the greatest value is at 16% in February. Thus this figure shows that it is still below 20% so that the ability of the single exponential smoothing forecasting model on fishermen's production income is in the good category range.

4. Conclusion

The conclusion of the study shows that the Single Exponential Smoothing method is able to produce forecasting of fisherman catch production data with a MAPE error value of 2.85% which indicates the forecasting results are in the very good category. The Single Exponential Smoothing method is very effective for forecasting from time series data with short period data intervals to produce forecasts for the following period and this method is able to measure the level of change in fisherman production data for each period. So that the results of forecasting can be a reference in controlling fish catch production and meeting market demand every month.

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