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Decision support for predicting revenue target determination with comparison of double moving average and double exponential smoothing

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ABSTRACT

The success of the company requires careful planning. Perusahaan Daerah Air Minum (PDAM) is a drinking water facility management company that plays an important role in supporting the smooth development of the region with the influence of revenue targets. Prediction of revenue targets is deemed necessary for accurate and effective decision making. Predictions are made by comparing the double moving average (DMA) and double exponential smoothing (DES) methods which refer to the actual data from the previous five (5) years. Measuring forecasting accuracy using mean absolute percentage error (MAPE) and assessing accuracy analysis results using tracking signal. Prediction test uses five (5) order values on DMA and five (5) alpha values on DES. Based on the test, it shows that the DMA has the advantage of a smaller MAPE value <10 with very good criteria and the results of the analysis of the pattern graph on the tracking signal that do not exceed the upper control limit (UCL) and the lower control limit (LCL). It is concluded that the DMA method is more recommended as a reference approach to support decisions to determine PDAM revenue targets and as a basis for planning and policy making to predict future revenue targets.

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1. INTRODUCTION

Forecasting is important. The forecasting process can be applied to various fields, such as business, industry, government, economics, medicine, social, political, environmental, accounting, and others [1]. Forecasting is an activity to predict future conditions using past data [2]. The forecasting consists of taking historical data as inputs then using them to predict future observations, thus determining future trends [3].

A forecast has two main techniques, namely statistics and assessment [4]. Statistical techniques are mostly used for business applications when data is available [5]. Valuation techniques are used for a variety of applications where data are not available for statistical forecasts [6].

Methods in forecasting are classified into two methods, qualitative and quantitative methods. Qualitative forecasting has properties that do not use past data and uses certain opinions so that it cannot be solved in a mathematical way. Quantitative methods are used more often than qualitative methods. One of them that is widely used is the time series analysis in which the data is accumulated over a certain period of time. Time series tend to be used to predict the future and are created using detailed data sets generated in the past [7], [8].

Accurately and effectively evaluating future epidemic trends requires short-term forecasts [9]. Time series analysis is widely used as a quantitative forecasting method, such as forecasting the number of new hospitalized patients [10], the cost of treatment [11] and water consumption expenditure [12]. Moving average model analysis has also been widely used in various research fields, such as to analyze surveillance data for predicting the number of disease patients [13], predicting the amount of water production [14] and so on.

Perusahaan Daerah Air Minum (PDAM) is a state-owned enterprise in the field of drinking water and clean water management to improve the welfare of the community in terms of social, health and public services and PDAM Samarinda city is a regional government business entity that is also engaged in this field. In order to support the smooth development of the region, the important role and success of PDAMs must always be pursued by achieving the revenue target obtained through clean water levies. The achievement of this revenue target will affect the company's optimal planning in supporting the smooth development of the region.

The research objective is to find out the best method in predicting future PDAM revenue targets as a decision support model for decision makers in PDAM. The comparison method is double moving average (DMA) and double exponential smoothing (DES) method. Accuracy test of the prediction results is carried out by applying the mean absolute percentage error (MAPE) method and analyzing the prediction results using the tracking signal. The results of the comparison method are used as a reference in decision making and the best method can be applied in predicting PDAM revenue targets. The data used is income data for the last five (5) years from January 2015 to December 2019. The output results are used in decision making to plan revenue targets or potential income in the next 1 (one) year. Through this research, planners and decision makers can consider broader strategic alternatives, strategic plans and actions to deal with future possibilities.

Studies related to forecasting using the DMA and DES methods include prediction to determine bitcoin price trading using bitcoin price dataset 2 (two) years prior. Prediction is done by applying the DES method based on the percentage of absolute MAPE. From the results of the application using the DES method and testing using MAPE, the smallest MAPE value is 2.89%, with the best alpha being at an alpha value of 0.9 [15] and forecasting the number of foreign tourists using data from the previous 8 (eight) years and comparing the DMA and DES time series forecasting methods. The results showed that the DMA method on the 12th order obtained the smallest MAPE value of 14.12%. While the DES Brown and Holt DES methods produce MAPE values of 12.71% and 12.21%, respectively. So it is concluded that the DES method is more suitable for the trend of time series calculations in the case of predicting the number of foreign tourists [16]. Jitter efficiency research using DES by comparing the DES method based on kalman filter (KF) and extended kalman filter (EKF). The results showed that the DES method was superior with 20% better results than the KF-based method and 18% better than the EKF-based method [17]. Forecasting trends in the incidence of acute hemorrhagic conjunctivitis (AHC) using seasonal autoregressive integrated moving average (SARIMA) and exponential smoothing models using data from 2011-2016 with the conclusion that the SARIMA method has a minimum error percentage so that it becomes the recommended model in sample simulation [18]. Forecasting Brazil's death rate due to work accidents by comparing three moving average models, the results of which the autoregressive moving average (ARIMA) and beta autoregressive moving average (ARMA) models perform better than the kumaraswamy autoregressive moving average (KARMA) model [19]. Research on forecasting income targets that compares DES and triple exponential smoothing methods. The results show that the DES method is more recommended than triple exponential smoothing based on a lower error value [20]. So, in this study, we continue with previous research by comparing the DES method that has been recommended in previous studies with the DMA method based on MAPE accuracy testing and pattern chart analysis with tracking signals.

2. RESEARCH METHOD

2.1. Double moving average (DMA)

The process of generating future forecasts on the moving average model requires some new data based on actual demand data. The stability over time of demand for the product will make the moving average method effective. To get forecast results in the future period, historical data is needed for a certain period. For example, using a 3-month movement, predictions in the 4th month can be calculated after the 3rd month ends and so on [21]. The basis of the multiple moving average method is to calculate a second moving average. The steps in applying the multiple moving average method are:

$$S'_t = \frac{X_t + X_{t-1} + \cdots X_{t+1-n}}{n} \quad (1)$$

$$S''_t = \frac{S'_t + S'_{t-1} + \cdots S'_{t+1-n}}{n} \quad (2)$$

$$a_t = 2S'_t - S''_t \quad (3)$$

$$b_t = \frac{2}{n-1}\,(S'_t - S''_t) \quad (4)$$

$$F_{t+m} = a_t + b_t m \quad (5)$$

X_t shows the data in period *t*, *n* as an order, S'_t is the first average value of period *t* and S''_t is the second average value of period *t*. The a_t indicates interception in the period *t*, b_t shows the trend value of the period *t* and F_{t+m} is a forecast in the period *t*+*m*.

2.2. Double exponential smoothing (DES)

The DES method was proposed by Brown to overcome the differences that arise between the actual data and the forecast value if there is a trend in the plot [22]. When the data shows a trend, the DES method can be used to estimate the growth of the average value at the end of each period [18]. Forecasting algorithms using the DES method are:

$$S'_t = \alpha X_t + (1 - \alpha)S'_{t-1} \quad (6)$$

$$S''_t = \alpha S'_t + (1 - \alpha)S''_{t-1} \quad (7)$$

$$a_t = 2S'_t - S''_t \quad (8)$$

$$b_t = \frac{\alpha}{1-\alpha}\, S'_t - S''_t \quad (9)$$

$$F_{t+m} = a_t + b_t m \quad (10)$$

S'_t is a single smoothing value and S''_t is a double smoothing value, X_t is the actual data value, α is a smoothing constant between 0 and 1, F_{t+m} is the result of forecasting the next period and *m* is a number of predicted advance periods [23].

2.3. Mean absolute percentage error (MAPE)

MAPE is the middle or average value of the total percentage error for a given data set. Forecasts contain a level of uncertainty so that there will be an error value between the predicted value and the actual value. MAPE is used to determine the magnitude of the error in the time series data model. If it has forecast and actual values for n periods, then MAPE can be calculated by (11). The MAPE value has criteria that explain that the smaller the MAPE value, the better the accuracy value. MAPE score criteria are shown in Table 1 [24].

$$MAPE = \sum_{x=1}^{n} \left|\frac{a_x - \bar{r}_x}{a_x}\right| x \frac{100}{n} \quad (11)$$

Table 1. MAPE criteria value

MAPE value	Criteria
< 10	Very good
10-20	Good
20-50	Enough
> 50	Bad
< 10	Very bad

2.4. Tracking signal

Tracking signal is a measure of how well a forecast estimates the actual values of a forecast updated every week, month or quarter, so that new demand data is compared to forecast values. The calculation of the tracking signal is shown in (12) [25]. Where the running sum of the forecast errors (RSFE) is divided by the mean absolute deviation (MAD). The RSFE value is the cumulative sum of the differences between the actual data and the forecast results in each period, while the MAD is the ratio between the absolute cumulative errors for each period.

$$Tracking\ Signal = \frac{RFSE}{MAD} \quad (12)$$

The actual value is greater than the estimated value indicated by a positive tracking signal value and the actual value is smaller than the estimated value indicated by a negative tracking signal value. The tracking signal is said to be good if it has a low RSFE value and has a positive error equal to or equal to a negative error, so that the center of the tracking signal is close to zero. After the tracking signals are calculated, a control tracking signal map can be constructed as well as a control map in statistical process control having an upper control limit (UCL) and a lower control limit (LCL). Production planning and inventory control (PPIC) experts, George Plossl and Oliver Wight suggest the tracking signal control limit to use a maximum value of 4 [26], so that if the tracking signal is outside the control limit, the forecasting accuracy cannot be accepted and the forecasting model needs to be reviewed, and if the tracking signal is within the control limits then the calculation can be continued [25].

3. RESULTS AND DISCUSSION

3.1. Data collection

Decision making model to predict future PDAM revenue targets is carried out by applying two methods and comparisons are made to find out the best method to be recommended in terms of predicting revenue targets. The comparison method is the DMA and DES method. Then tested with two techniques, namely testing accuracy of the prediction results using MAPE method and testing based on the analysis of the prediction results using tracking signal method in the form of a pattern graph. The resulting output is used as a reference in making decisions and knowing the advantages of the best method in predicting revenue targets for the coming years. The data used is PDAM Tirta Kencana Samarinda revenue data for the last five (5) years, from January 2015 to December 2019. This data then becomes the basis for forecasting the next 1 (one) year.

3.2. Prediction using double moving average (DMA) method

Calculations using DMA method are carried out using 5 time-order values, namely 2, 4, 6, 8 and 10. The forecasting data used is income data from 2015 to 2019 to forecast income in 2020. Because at t=1 year the forecast value of S_1 is not available, the value of S_1 is determined to be the same as the value of X_1 in all calculations. Forecasting monthly income is done by performing calculations in (1) to (5). The stages of applying the DMA method are:

- Determination of the number of periods or months (m).
- First average value is single moving average (S't) withn (1).
- The second average value is DMA (S"t) with (2).
- The constant value for m periods (next month) with (3).
- The value of the trend coefficient with (4).
- The final result of the prediction uses (5).

Calculations using the DMA method for the 2020 revenue target are carried out on every 5 time order values, namely 2, 4, 6, 8 and 10.

3.3. Prediction using double exponential smoothing (DES) method

Different alpha values are used to predict income using DES method, as many as 5 alphas, namely alpha 0.1, 0.3, 0.5, 0.7, and 0.9. Forecasting data used is income data from 2015-2019 for 2020 predictions. At t=1 year the forecast value of S_1 is not available, the value of S_1 is determined to be the same as the value of X_1 in the calculation. Forecasting monthly income is done by performing calculations in (6) to (10). The stages of applying the DES method are:

- Value of single exponential smoothing (S't) with (6).
- DES (S"t) value with (7).
- The constant value for m periods (next month) with (8).
- The value of the trend coefficient with (9).
- The final result of the prediction using (10).

Calculations using the DES method for the 2020 revenue target are carried out on each of the five (5) alpha values, namely alpha 0.1, 0.3, 0.5, 0.7 and 0.9.

3.4. Prediction result accuracy using mean absolute percentage error (MAPE)

The accuracy value test was carried out based on the prediction results of each method. Test the accuracy of the prediction results using the MAPE method to see errors in forecasting. MAPE value from the prediction results using DMA for each order value is shown in Table 2 and MAPE value from DES method prediction for each alpha value is shown in Table 3.

Table 2. MAPE value of the predicted results of the DMA method for each orde value

Orde value	MAPE value
n=2	8.27
n=4	9.53
n=6	11.27
n=8	11.23
n=10	9.36

Table 3. MAPE value of predicted results of DES method on each alpha value

Alpha value	MAPE value
α=0.1	20.99
α=0.3	13.01
α=0.5	11.40
α=0.7	11.52
α=0.9	11.60

In the MAPE test results from the prediction results of the DMA method, the best MAPE value is obtained at the value of order n=2 with the smallest MAPE value of 8.27. The MAPE test results from the predictions of the DES method, the best MAPE value is found at α (alpha)=0.5 with the smallest MAPE value of 11.4. The two results are a comparison between the two methods to find out which method is more recommended based on the smallest MAPE value.

3.5. Verification and graph analysis of predicted result patterns using tracking signals

After obtaining the best forecasting method based on the smallest MAPE value of the two methods used, then verification of the prediction results using the tracking signal method is presented in the form of a pattern graph to measure accuracy of the prediction results of income targets from two methods so that they can be used as considerations in making decisions. The graph of the tracking signal pattern provides information on whether or not there is a value that comes out of UCL of 4 and LCL of -4. Tracking signal calculation to get the value of the accuracy verification of the prediction results used (12). The results of the tracking signal from the prediction results of the two methods are presented in Table 4.

Table 4. Tracking signal accuracy value predicted revenue target results from both methods for 2019

Month Period	Tracking Signal	
	DMA	DES
January	-1	-1
February	-2	0,25
March	-3	1,38
April	-3,64	2,4
May	-2,78	3,33
June	-1,48	4,27
July	-2,1	5,17
August	-2,49	6,14
September	-1,98	7,2
October	-2,08	8,24
November	-3,97	9,12
December	-3,58	9,99

Based on Table 4, value of the tracking signal from the prediction results of the two methods is then presented in the form of a pattern graph that shows the verification of the prediction results of the income target from the DMA and DES methods. The graph of tracking signal pattern from the prediction results of the DMA method is presented in Figure 1 and the graph of the tracking signal pattern from the predicted result of the DES method is presented in Figure 2.

Figure 1 shows that the tracking signal value from the DMA method does not exceed the UCL and LCL values so that the prediction results using the DMA method can be used as a reference to predict future income targets. Figure 2 shows the tracking signal value in the DES method that exceeds the UCL and LCL control limits so that the prediction results using the DES method are considered inappropriate for predicting future revenue targets. Then the value of the tracking signal in the DMA method that meets the UCL and LCL.

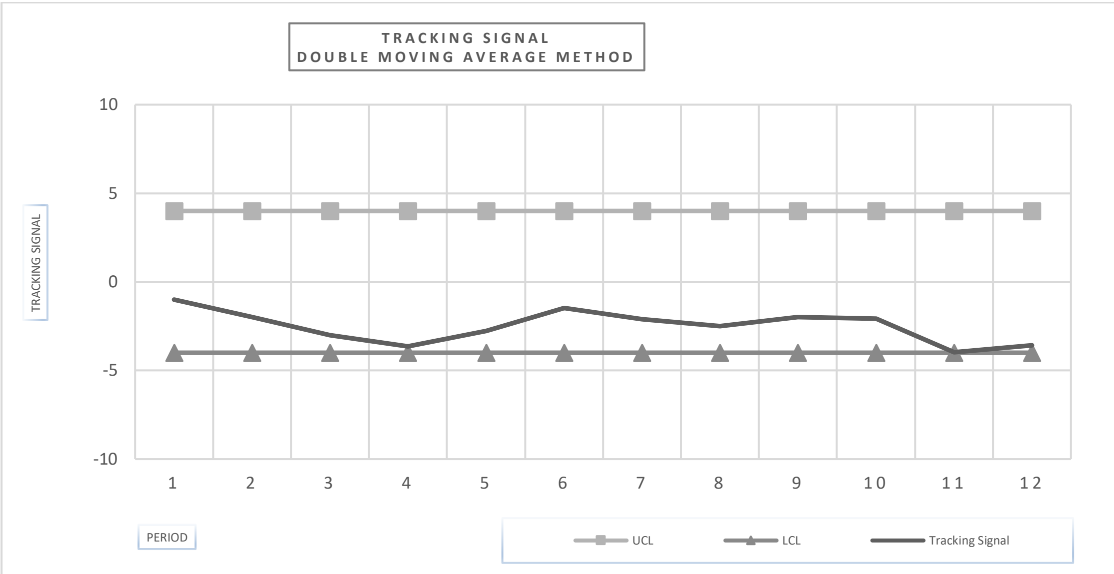

Figure 1. Chart of tracking signal patterns from predicted results of DMA method

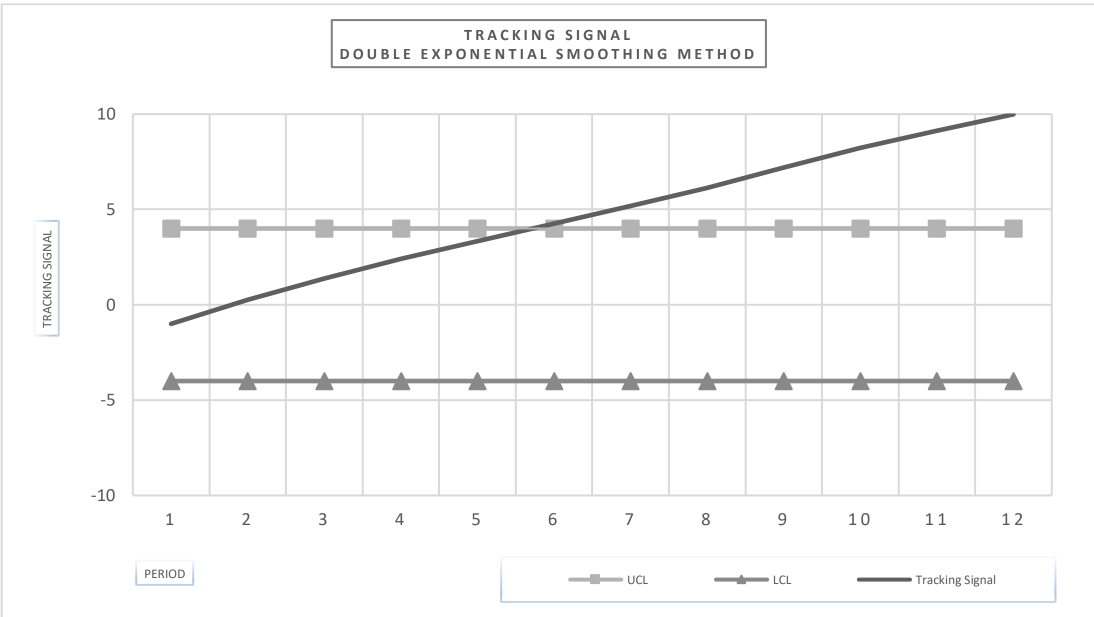

Figure 2. Chart of tracking signal patterns from predicted results of DES method

4. CONCLUSION

Decision support model to predict PDAM's revenue target in the coming year is done by comparing the DMA and DES methods to find the most suitable and best method. Prediction of income targets using the DMA method is carried out on 5 time-order values, namely 2, 4, 6, 8, and 10 and predictions of income targets using the DES method are carried out on 5 alpha values, namely alpha 0.1, 0.3, 0.5, 0.7, and 0.9. The test is carried out using two techniques, namely testing the accuracy of the prediction results using MAPE and analyzing the prediction results using Tracking Signal in the form of a pattern graph. Based on the results of testing the MAPE value, the DMA method obtained the best MAPE value at order n=2 with the smallest MAPE value of 8.27 while the DES method obtained the best MAPE value at α=0.5 with the smallest MAPE value of 11.4. Based on the verification and analysis of the tracking signal pattern graph, the tracking signal value in DMA does not exceed the UCL and LCL values, while the tracking signal pattern graph in DES shows the tracking signal value exceeds the UCL and LCL control limits. From the tests that have been carried out, it is concluded that the DMA method is more suitable as a reference for predicting future revenue targets because the MAPE value is < 10 (very good) and the tracking signal value does not exceed UCL and LCL. It is suggested that the DMA method can be used as an approach to support the prediction of PDAM revenue targets as a follow-up to the planning policy decision makers in predicting future revenue targets.

REFERENCES

[1] G. N. Boshnakov, “Introduction to time series analysis and forecasting,” *Journal of Time Series Analysis*, vol. 37, no. 6, pp. 864–864, Nov. 2016, doi: 10.1111/jtsa.12203.
[2] R. B. Chase, N. J. Aquilano, and F. R. Jacobs, *Operations management for competitive advantage*, vol. 9. New York: Mc Graw Hill, 2004.
[3] H. Bousqaoui, I. Slimani, and S. Achchab, “Comparative analysis of short-term demand predicting models using ARIMA and deep learning,” *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 11, no. 4, pp. 3319–3328, Aug. 2021, doi: 10.11591/ijece.v11i4.pp3319-3328.
[4] J. S. Armstrong, Ed., *Principles of forecasting*, vol. 30. Boston, MA: Springer US, 2001.
[5] J. Wang, G. Athanasopoulos, R. J. Hyndman, and S. Wang, “Crude oil price forecasting based on internet concern using an extreme learning machine,” *International Journal of Forecasting*, vol. 34, no. 4, pp. 665–677, Oct. 2018, doi: 10.1016/j.ijforecast.2018.03.009.
[6] D. Buncic, “Superforecasting: the art and science of prediction. By Philip Tetlock and Dan Gardner,” *Risks*, vol. 4, no. 3, Jul. 2016, doi: 10.3390/risks4030024.
[7] L.-Y. Wei, “A hybrid ANFIS model based on empirical mode decomposition for stock time series forecasting,” *Applied Soft Computing*, vol. 42, pp. 368–376, May 2016, doi: 10.1016/j.asoc.2016.01.027.
[8] S. Ismail and A. Shabri, “Time series forecasting using least square support vector machine for Canadian lynx data,” *Jurnal Teknologi*, vol. 70, no. 5, Sep. 2014, doi: 10.11113/jt.v70.3510.
[9] P. Guan, W. Wu, and D. Huang, “Trends of reported human brucellosis cases in mainland China from 2007 to 2017: an exponential smoothing time series analysis,” *Environmental Health and Preventive Medicine*, vol. 23, no. 1, Dec. 2018, doi: 10.1186/s12199-018-0712-5.
[10] L. Zhou, P. Zhao, D. Wu, C. Cheng, and H. Huang, “Time series model for forecasting the number of new admission inpatients,” *BMC Medical Informatics and Decision Making*, vol. 18, no. 1, Dec. 2018, doi: 10.1186/s12911-018-0616-8.
[11] S. Wang, M. Petzold, J. Cao, Y. Zhang, and W. Wang, “Direct medical costs of hospitalizations for cardiovascular diseases in Shanghai, China,” *Medicine*, vol. 94, no. 20, p. e837, May 2015, doi: 10.1097/MD.0000000000000837.
[12] S. N. A. M. Razali, M. S. Rusiman, N. I. Zawawi, and N. Arbin, “Forecasting of water consumptions expenditure using holt-winter’s and ARIMA,” *Journal of Physics: Conference Series*, vol. 995, Apr. 2018, doi: 10.1088/1742-6596/995/1/012041.
[13] D. M. Khairina, R. Khairunnisa, H. R. Hatta, and S. Maharani, “Comparison of the trend moment and double moving average methods for forecasting the number of dengue hemorrhagic fever patients,” *Bulletin of Electrical Engineering and Informatics (BEEI)*, vol. 10, no. 2, pp. 978–987, Apr. 2021, doi: 10.11591/eei.v10i2.2711.
[14] D. M. Khairina, S. Maharani, P. P. Widagdo, Ramlawati, and H. R. Hatta, “Forecasting model of amount of water production using double moving average method,” in *2020 3rd International Conference on Computer and Informatics Engineering (IC2IE)*, Sep. 2020, pp. 167–170, doi: 10.1109/IC2IE50715.2020.9274603.
[15] F. Liantoni and A. Agusti, “Forecasting bitcoin using double exponential smoothing method based on mean absolute percentage error,” *JOIV : International Journal on Informatics Visualization*, vol. 4, no. 2, pp. 91–95, May 2020, doi: 10.30630/joiv.4.2.335.
[16] D. Febrian, S. I. Al Idrus, and D. A. J. Nainggolan, “The comparison of double moving average and double exponential smoothing methods in forecasting the number of foreign tourists coming to North Sumatera,” *Journal of Physics: Conference Series*, vol. 1462, no. 1, Feb. 2020, doi: 10.1088/1742-6596/1462/1/012046.
[17] M. G. Chung and S.-K. Kim, “Efficient jitter compensation using double exponential smoothing,” *Information Sciences*, vol. 227, pp. 83–89, Apr. 2013, doi: 10.1016/j.ins.2012.12.008.
[18] H. Liu *et al.*, “Forecast of the trend in incidence of acute hemorrhagic conjunctivitis in China from 2011-2019 using the seasonal autoregressive integrated moving average (SARIMA) and exponential smoothing (ETS) models,” *Journal of Infection and Public Health*, vol. 13, no. 2, pp. 287–294, Feb. 2020, doi: 10.1016/j.jiph.2019.12.008.
[19] C. Melchior, R. R. Zanini, R. R. Guerra, and D. A. Rockenbach, “Forecasting Brazilian mortality rates due to occupational accidents using autoregressive moving average approaches,” *International Journal of Forecasting*, vol. 37, no. 2, pp. 825–837, Apr. 2021, doi: 10.1016/j.ijforecast.2020.09.010.
[20] D. M. Khairina, Y. Daniel, and P. P. Widagdo, “Comparison of double exponential smoothing and triple exponential smoothing methods in predicting income of local water company,” *Journal of Physics: Conference Series*, vol. 1943, no. 1, Jul. 2021, doi: 10.1088/1742-6596/1943/1/012102.
[21] R. Nau, “Forecasting with moving averages,” Fuhua School of Business, Duke University. Tech. Rep., 2014.
[22] X. Li, “Comparison and analysis between holt exponential smoothing and brown exponential smoothing used for freight turnover forecasts,” in *2013 Third International Conference on Intelligent System Design and Engineering Applications*, Jan. 2013, pp. 453–456, doi: 10.1109/ISDEA.2012.112.
[23] S. Baharaeen and A. S. Masud, “A computer program for time series forecasting using single and double exponential smoothing techniques,” *Computers and Industrial Engineering*, vol. 11, no. 1–4, pp. 151–155, Jan. 1986, doi: 10.1016/0360-8352(86)90068-9.
[24] P.-C. Chang, Y.-W. Wang, and C.-H. Liu, “The development of a weighted evolving fuzzy neural network for PCB sales forecasting,” *Expert Systems with Applications*, vol. 32, no. 1, pp. 86–96, Jan. 2007, doi: 10.1016/j.eswa.2005.11.021.

[25] V. Gaspersz, *Production planning and inventory control*. Jakarta: Vincent Foundation and PT Gramedia Pustaka Umum, 2004.
[26] G. W. Plossl, *Production and and inventory control, principles and techniques*, 2nd ed. Pearson, 1985.

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