Prediction of Raw Material Purchases using The Weight Moving Average and Double Exponential Smoothing Methods at CV. Sukses Jaya Putra

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Abstract

Technology plays an important role in helping problems that exist in a company. One of them is at CV. Sukses Jaya Putra which often has difficulty knowing how much raw material to buy for the next period. so that there are often errors in purchasing estimates. This study aims to predict the purchase of raw materials in CV.Sukses Jaya Putra by using data records from the previous 14 months as much as 2,181 data to calculate predictions for the next period by comparing two methods, namely weight moving average and double exponential smooth. Researchers compared these two methods in order to find out which method has a smaller error value which means it is better at predicting. The results showed that the weight moving average was more accurate than the double exponential smoothing method with an average result of MAPE of 28.74% and for double exponential smoothing as much as 33.07%. While the results of the next period prediction with the results of 2,251,440.33 for the weight moving average method and 1,672,246.18 for the double exponential smoothing method. For further research, we suggest more variations of weights to be included in calculations using the double exponential smooth or weight moving average approach
.

Keywords
Weighted Moving Average, Prediction, Raw Material Purchases, Double Exponential Smoothing.

1. Introduction
The advancement of information technology (IT) is currently experiencing very rapid development. This Information Technology can be used to support the business world or transactions required for the forecasting process (estimating) or inventory estimation. "Prediction is both an art and a science, predicting future events through engagement Take historical data and predict into the future there is a systematic approach model for the future"(Solikin and Hardini 2019).

CV.Sukses Jaya Putra, which is located at Jalan Citatah Padalarang, West Bandung Regency, activities at CV. Sukses

Jaya Putra include managing feed raw materials, namely grinding limestone, which is processed by a size reduction process, in order to obtain products in the form of flour. The need for equipment and daily needs such as for food, fertilizer and industrial raw materials, stone flour, especially as a source of minerals is very important. Due to the uncertainty of sales, the number of products that must be prepared is uncertain. In carrying out the inventory of goods is important because it can make excess inventory (over-stock) besides that there can be a loss of sales if there is a shortage of inventory or too little inventory. At CV Sukses Jaya Putra itself, there are problems, namely the amount of capital spent on inventorying goods and the limited capacity of the warehouse where the goods are stored. So therefore, to anticipate this problem, forecasting of raw material purchases is needed.

Research related to prediction or forecasting has been carried out using the Double Exponential Smoothing method which has been proven by Darnila et.al argue that it can predict passport applicants for the Immigration Service category II Lhokseumawe city with an accurate value by obtaining the smallest mean absolute percentage error (MAPE) with a parameter value of 0.2 and an SSE value of 2356.83370, as well as an MSE value of 1178.416852 and a MAPE value of 5.585627855(Darnila, Asrianda, and Jannah 2019). Another study based on the results of research using Brown's double exponential smoothing method that predicts the number of new students in the future, after analyzing the data, use the results of Brown's One Parameter with a value of a = 0.2 to predict the number of new students in the following year, namely (F7 + 1) to 63.9928065 rounded up to 64(Supriyanti 2020). However, this approach also has the disadvantage that it must be regularly maintained and checked, rechecking the correctness or errors of the data entered, and updating the application or adding new functionality if there are errors. important.

The research conducted is entitled Prediction of paint sales using weight moving average at Mitra 10 Denpasar. The study explains how the weighted moving average method of forecasting paint sales at Mitra 10 Denpasar calculates the MAPE error value of 8.21%, which means that the value is still within the normal range of errors less than 10%(Made Pirman Duiana et al. n.d.). From the above conclusions, it becomes the basis for the Weighted Moving Average (WMA) weighting system. In the WMA method, the latest data will be included in a greater assessment weight than older data.

Based on the three studies that explain the advantages and disadvantages of each, the researchers conducted a comparison to calculate the forecasting of raw material purchases using two prediction methods to be able to understand that which method is the best in determining the results of the next period's purchases by calculating the error from MAPE to forecast the purchase of raw materials in the next period.

2. Literature Review

According to previous research, a study entitled Information System for Determining Stock Preparation Using Weight Moving Average was conducted by Rasmila, Rahayu Amalia. The research describes the Weight Moving Average method for drug stock preparation at PT. Sinergi Persada Medica (SPM). PT. Sinergi Persada Medica is a company engaged as a distributor of various types of health drugs located in South Sumatra Province. By using 3 weight data and 5-month weight data, the accuracy of the forecasting results is shown in the 5-month weight data type with the smallest error rate of 0.16%. For this reason, to determine the decision, from the 2 calculation samples above, it is better to use weight data of 5 months with the results of predicting the demand for Valesco160 Mg@30Kaplet Medicine by 207 Boxes, because the results of the forecasting accuracy test obtained the smallest value of the 5-month weight data, the smaller the error rate the better the forecasting results (Amalia 2019).

Research entitled Paint Sales Forecasting System Using Weight Moving Average at Mitra 10 Denpasar. The study explains how the Weight Moving Average method for forecasting paint sales at Mitra 10 Denpasar. PT Catur Mitra Sejati Sentosa is a subsidiary of the parent company PT Catur Sentosa Adiprana (CSA) which is engaged as a distributor of building materials under the name Mitra 10, one of its products is paint. The calculation shows that the resulting MAPE error is 8.21%, while this value is still within the prediction error limit of less than 10%. This shows that it can be used to forecast paint sales at Mitra 10 Gatot Subroto Denpasar(Made Pirman Duiana et al. n.d.).

Based on the results of a study entitled prediction of the number of new student candidates using the double exponential smoothing method from Brown, after analyzing the data with the results of One Parameter from Brown with a value of a = 0.2 to predict the number of new students in the following year, namely at AL-Musyarrofah Islamic Elementary School Jakarta in the 2020/2021 school year (F7 + 1) as many as 63.9928065 rounded up to 64 Students have increased(Darnila, Asrianda, and Jannah 2019).

Based on the results of research entitled Prediction System for Total Shirt Production Using Weighted Moving Average, after analyzing the data using the WMA method to calculate production forecasts and using MAPE to calculate the accuracy of the prediction results, it can be concluded that the Ummajee Store prediction system using the WMA method provides an error of 21%. You can use this method to predict the production volume of Ummajee stores(Nurhayati and Syafiq n.d.).

3. Methodology

The researchers conducted the study at CV. Sukses Jaya Putra. A total of 2,181 data were involved in the study and we use prediction. Prediction is an early part of the decision-making process. When deciding before making a prediction, before knowing it is necessary to know what the real problem is. Forecasting is the analysis of quantities, such as demand for one or more products, within a specified period in the future. Any decision regarding the future state must have a prediction on which to base the decision(Imam Shonhaji,2018).Forecasting is an attempt to predict future conditions by examining the past state of the forecast to obtain results that minimize the error of the forecast itself(Supriyanti 2020). In the analysis of time series data, it is known that several predictive models, such as the autoregressive model (AR), Moving Average (MA), Weighted Moving Average (WMA), Autoregressive Moving Average (ARMA) and Autoregressive Integrated Moving Average (ARIMA) models and others can help in this problem(Setiawan 2021) .

In this study, several stages will be carried out to find the desired results, the first stage is to collect the necessary data, the second stage is the preparation of the data, then in the third stage do the modeling that will be used. the fourth stage conducts software development, the fifth stage conducts testing, and evaluation and the last stage is reporting and publication. Data for this research were gathered by primary data collection method through structured Interviews for the required data. The data collection process is carried out in 3 ways, namely observation, literature method and interviews. The results of taking data from sales data using the variable number of items 14 months ago at CV. Sukses Jaya Putra.

3.1 Weight Moving Average (WMA)

Moving Average Method can be used in determining the trend of a time series of data(Suhendra et al. 2021). Weighted Moving Average is a prediction on the formulation using the weighting of each data, a greater weight is given to the last data compared to the previous data(Silvya, Zakir, and Irwan 2020). WMA is a moving average that gives weight. The Weighted Moving method is known as a method that has a technique of giving different weights to the available data so that the most recent data is the most relevant data for prediction so that it is given a greater weight WMA is used for data that does not change quickly. This WMA is used for data that does not change quickly(Setiawan 2021).

$$\mathrm{WMA} = \sum(\mathrm{BN})(\mathrm{PN})/\mathrm{B} \quad (1)$$

Description:

N = Period

B = Weight given for each month

3.2 Double Exponential Smoothing

The principle of single or double exponential smoothing is that if the data contains a trend component, the smoothing value precedes the actual data. Therefore, for a simple smoothing value, you can add a double smoothing value to adjust for the trend(Wijaya and Suroyo n.d.). The double exponential smoothing method can also be used to calculate the linear trend using the double exponential smoothing method. To overcome this, but the trend smoothing process runs with different parameters.

$$\mathrm{Lt} = \alpha \mathrm{Yt}\,/\mathrm{St} + (1-\alpha)\,(\mathrm{Lt}-1 + \mathrm{b\,t}-1) \quad (2)$$

$$\mathrm{Bt} = \alpha\,(\mathrm{Lt}-\mathrm{Lt}-1\,) + (1-\alpha)\,\mathrm{bt}-1 \quad (3)$$

$$\mathrm{St} = \beta\,\mathrm{Yt}\,/\mathrm{St} + (1-\beta)\,(\mathrm{St}-\mathrm{s}) \quad (4)$$

$$\mathrm{Ft}+\mathrm{m} = \mathrm{Lt} + \mathrm{Bt} * \mathrm{m} \quad (5)$$

Description:

Lt = Smoothing value
St = Smoothing value
Bt = Smoothing value
α = Constant (0< α<1)
β = Constant (0< β<1)
Yt = actual
F(t+m) = Prediction

3.3 MAPE (Mean Absolute Percentage)

Mean Absolute Percentage is used to evaluate predictions using the Mean Absolute Percentage Method. The mean absolute percentage error (MAPE) is a calculation used to provide an absolute error value for predicted data compared to actual data(Rizqi, Cahya Prihandoko, and Maidah 2021). The absolute error is calculated by finding the absolute value of the error for a certain period.

$$\text{MAPE} = \sum |\text{Et}|/\text{n}*100\% \qquad (6)$$

Description:

|Et| = eror absolut
N = Number of forecasting periods involved

3.4 Prediction

Prediction is an early part of the decision-making process. When deciding before making a prediction, before knowing it is necessary to know what the real problem is. Forecasting is the analysis of quantities, such as demand for one or more products, within a specified period in the future. Any decision regarding the future state must have a prediction on which to base the decision(Imam Shonhaji 2018).Forecasting is an attempt to predict future conditions by examining the past state of the forecast to obtain results that minimize the error of the forecast itself(Supriyanti 2020). In the analysis of time series data, it is known that several predictive models, such as the autoregressive model (AR), Moving Average (MA), Weighted Moving Average (WMA), Autoregressive Moving Average (ARMA) and Autoregressive Integrated Moving Average (ARIMA) models and others can help in this problem(Setiawan 2021) . A prediction is an estimate of something that has not yet happened. In the social sciences everything all-round uncertain, difficult to estimate exactly(Fawaiq, Jazuli, and Hakim n.d.) .Forecasting) is a calculation analysis technique which is carried out with a qualitative approach as well as quantitative to estimate events in the future(Santoso Pakpahan, Basani, and Rina Hariani n.d.)

3.5 Moving Average (MA)

Moving Average is an average value derived from moving data. In other words, moving averages represent a mathematical function where existing data is averaged. Moving averages are used to smooth data(Silvya, Zakir, and Irwan 2020). The moving average (MA) method is most often applied to time series data to create seasonal variations or irregular fluctuations in the data, allowing analysts to identify existing structural patterns more easily. The definition of Moving Average is a calculation method used to analyze data by creating a series of averages from a data set(Sherlia Yunika, Sugiono 2017). The Moving Average model is also called a moving average calculation. Meanwhile, the choice of time frame can be adjusted according to the needs of the trader. The Moving Average is divided into: Simple Moving Average, Weighted Moving Average, Exponential Moving Average.

4. Result and Discussion

WMA is used to convert actual data into data predictions for the future. Before changing to do the WMA calculation, we will use the weight of 3 periods with data from the previous 14 months at CV. Sukses Jaya Putra. Before doing forecasting calculations, we must first analyze and see the data patterns formed from the previous actual demand, the type of data pattern formed will determine the forecasting method used. From the sales data in the figure above, the data does not show seasonal data patterns (seasonal) or trend data (data that has an upward trend), the demand data looks stable and does not experience a continuous increase or decrease. After all the data is obtained, calculations can be made using the weighted moving average method and double exponential smoothing. In the calculation of the Weighted Moving Average method, giving weight is very important because each data

will be given a different weight with the estimate that the most recent or latest data will have a greater weight than the old data because the most recent data is the most relevant data for forecasting. The determination of the weights is determined in such a way that the total amount is equal to one. For a 3-month moving average for example, weights 1, 2, 3 and double exponential smoothing with α=0.05 β=0.01 are given. (Table 1)

Table 1 Data

No	Period	Actual
1	January	3.194.146
2	February	3.834.043
3	March	3.056.543
4	April	3.978.162
5	May	2.057.366
6	June	2.517.837
7	July	3.628.110
8	August	3.759.468
9	September	3.850.218
10	October	3.702.954
11	November	4.308.872
12	December	3.126.902
13	January	2.267.841
14	February	1.948.686

1.1 Calculation of Weight moving average and Double Exponential Smoothing

Forecasting for weight moving average is done by calculating the predicted value and error starting in April with an average of 3. after calculating using a weight moving average, calculating gems using a weight moving average with a period of three where we are looking for the smallest error starting from January to February March and the results obtained are the forecast values obtained in June which are the smallest even though the actual data smallest in February. (Table 2)

Table 2 Forecasting WMA

No	Period	Actual	FT	Eror
1	January	3.194.146		
2	February	3.834.043		
3	March	3.056.543		
4	April	3.978.162	3.338.644	639.519
5	May	2.057.366	3.646.936	-1.589.570
6	June	2.517.837	2.864.161	-346.324
7	July	3.628.110	2.607.734	1.020.376
8	August	3.759.468	2.996.228	763.240
9	September	3.850.218	3.508.744	341.475
10	October	3.702.954	3.782.950	-79.996
11	November	4.308.872	3.761.461	547.411
12	December	3.126.902	4.030.457	-903.555
13	January	2.267.841	3.616.901	-1.349.060
14	February	1.948.686	2.894.367	-945.681

Forecasting for Double Exponential Smoothing is done by calculating the predicted value and error starting in April with an average of 3. After completing all steps, the results are aggregated to determine the detailed course of action. the result of calculating using a weight moving average is very different from the weight moving average. The calculation is carried out in 3 periods, but it is calculated starting in January and February. with the results of

predictive data that are very close to the actual values in February. (Table 3)

Table 3 Forecasting DES

No	Period	Actual	LT	FT	BT	Ft+m
1.	January	3.194.146		0,95		
2.	February	3.834.043		1,14		
3.	March	3.056.543	3.361.577,33	0,91	-170.151,89	3.032.468,93
4	April	3.978.162	3.241.188,67	0,96	-167.663,73	3.505.505,19
5	May	2.057.366	3.010.040,63	1,13	-170.837,94	2.581.569,38
6	June	2.517.837	2.835.698,05	0,91	-171.013,17	2.546.736,13
7	July	3.628.110	2.721.257,69	0,96	-168.184,53	2.888.567,01
8	August	3.759.468	2.591.560,65	1,14	-166.260,16	2.204.189,59
9	September	3.850.218	2.515.857,89	0,92	-161.732,29	2.267.697,52
10	October	3.702.954	2.428.623,50	0,97	-158.007,39	2.583.490,76
11	November	4.308.872	2.346.437,52	1,15	-154.216,32	2.019.611,20
12	December	3.126.902	2.252.317,57	0,93	-151.211,51	2.047.559,54
13	January	2.267.841	2.112.408,17	0,98	-150.646,40	2.259.486,43
14	February	1.948.686	1.948.269,40	1,15	-151.321,0274	1.672.246,18

1.2 Calculate error of Weight Moving Average and Double Exponential Smoothing error

MAPE for weight moving average is done by calculating the predicted value and error starting in April with an average of 3. this table we use 3 methods to know the eror MAD, MSE and MAPE and we will use MAPE for final error, the smallest result in the weight moving method is in September calculated by MAPE 2.16%. (Table 4)

Table 4 Error WMA

No	Period	Actual	MAD	MSE	MAPE
1	January	3.194.146			
2	February	3.834.043			
3	March	3.056.543			
4	April	3.978.162	639.519	408.983.911.842	16,08 %
5	Mai	2.057.366	1.589.570	2.526.732.255.043	77,26 %
6	June	2.517.837	346.324	119.940.197.535	13,75 %
7	July	3.628.110	1.020.376	1.041.166.841.251	28,12 %
8	August	3.759.468	763.240	582.534.788.773	20,30 %
9	September	3.850.218	341.475	116.604.834.150	8,87 %
10	October	3.702.954	79.996	6.399.360.016	2,16 %
11	November	4.308.872	547.411	299.658.802.921	12,70 %
12	December	3.126.902	903.555	816.411.638.025	28,90 %
13	January	2.267.841	1.349.060	1.819.961.984.227	59,49 %
14	February	1.948.686	945.681	894.311.608.080	48,53 %

MAPE for double exponential smoothing is done by calculating the predicted value and error starting in April with an average of 3. After completing all steps, here is the final error to compare the two existing methods. using data and also the same period of 3 months but has different results due to 2 different methods and the double exponential smoothing method is in May 3.10% (Table 5)

Table 5 Error DES

No	Period	Eror	MAD	MSE	MAPE
1.	January				
2.	February				
3.	March	945.693,07	945.693,07	894.335.383.464,76	30,94 %

4	April	-1.448.139,19	1.448.139,19	2.097.107.128.064,76	36,40 %
5	May	-63.732,38	63.732,38	4.061.815.824,84	3,10%
6	June	1.081.373,87	1.081.373,87	1.169.369.440.471,02	42,95 %
7	July	870.900,99	870.900,99	758.468.541.358,03	24,00%
8	August	1.646.028,41	6,056,892,543.08	2.709.409.523.200,13	43,78%
9	September	1.435.256,48	1.435.256,48	2.059.961.156.443,16	37,28 %
10	October	1.725.381,24	1.725.381,24	2.976.940.407.847,32	46,59 %
11	November	1.107.290,80	1.107.290,80	1.226.092.924.269,27	25,70 %
12	December	220.281,46	220.281,46	48.523.920.436,91	7,04%
13	January	-310.800,43	310.800,43	96.596.904.957,66	13,70 %
14	February	-1.672.246,18	1.672.246,18	2.796.407.274.572,06	85,81 %

4. Conclusion

Based on the results of the final project research that has been carried out, it can be concluded that the computational model mechanism for predicting raw material purchases at CV. Sukses Jaya Putra uses 2,181 data taken from CV.Sukses Jaya Putra and 2 methods, namely weight moving average and double exponential smoothing with a period of 3 months using a weight value of 1,2,3 for weight moving average and a value of $\alpha = 0.05$ and $\beta = 0.01$ for double exponential smoothing. For comparison of the two methods, the results show that the weight moving average method is better because it has an accuracy value calculated by MAPE which has an average of 28.74% compared to double exponential smoothing which is at 33.07%. The prediction results for the next period with the results of 2,251,440.33 for the weight moving average method and 1,672,246.18 for the double exponential smoothing method.

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