IMPLEMENTATION OF THE TRIPLE EXPONENTIAL SMOOTHING METHOD IN FORECASTING SYSTEMS FOR THE TOTAL PRODUCTION AND SALES OF TIMBA COR TC PLANNING

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Abstract

Production planning is a problem at CV. Pandu Kencana Jombang, where the production quantity of Timba Cor TC is not planned ahead of the production process but is instead determined statically or based on warehouse stock without considering sales dynamics. The author proposes a solution by implementing the Triple Exponential Smoothing forecasting method. This well-known adaptive method is used for time series modeling and involves three levels of smoothing: overall, trend, and seasonal smoothing. Before forecasting the production and sales of TC Cor Lead for Week 1 of April 2022, an alpha value with the smallest error percentage is required. To find this, data from August 2021 to March 2022 is used for forecasting, applying alpha values from 0.1 to 0.9, and calculating the MAPE (mean absolute percentage error) for each. Once the alpha with the smallest MAPE is found, it is used to predict Week 1 of April 2022. The study results show that the Triple Exponential Smoothing method successfully predicted the production and sales with 97.7% accuracy and a 6.3% MAPE for production, and 93.7% accuracy with a 6.3% MAPE for sales.

INTRODUCTION

Production planning is very important so that companies, especially in the operational section, can determine the best way to meet predicted demand by adjusting production values, labor levels, inventory levels, overtime work, subcontracting rates, and other variables that can be controlled. The company's income may decrease or even disappear just because it is unable to meet consumer demand, which will result in a loss of consumer interest. To plan the amount of production, the company needs to take into account market demand, which in this case can be seen from the company's sales reports or by predicting future sales[1].

CV. Pandu Kencana is a company engaged in the production of used plastic waste processing products located in Godong village, Gudo sub-district, Jombang district, East Java. One of the products produced by CV. Pandu Kencana, namely Timba Cor TC with doff and valve types. By using used plastic waste as the main ingredient for making TC Lead Lead products, it will really help the company in terms of cost and quantity of raw materials, along with the amount of plastic waste generated at this time, so that the company is able to produce on a large scale[2].

CV. Pandu Kencana is a company engaged in the production of used plastic waste processing products located in Godong village, Gudo sub-district, Jombang district, East Java. One of the products produced by CV. Pandu Kencana, namely Timba Cor TC with doff and valve types. By using used plastic waste as the main ingredient for making TC Lead Lead products, it will really help the company in terms of cost and quantity of raw materials, along with the amount of plastic waste generated at this time, so that the company is able to produce on a large scale[3], [4].

In connection with the above problems, to optimize the planning of production quantities, especially for TC Lead Cast products, a system can be applied that is able to predict the amount of production and sales in the coming period. The Triple Exponential Smoothing method is one of the forecasting methods that will be used to calculate the estimated amount of production and sales based on past historical data[5]. The Triple Exponential Smoothing method uses the average of the last few data points as future forecast data[6]. This method tries to smooth out very high or very low data changes[7]. This method is dynamic because it can adjust the ebb and flow of data in the latest period, making it possible to use it on an ongoing basis.

Research Method

1.   Production planning

Planning is one of the management functions; in planning, it is determined the efforts that will or need to be taken by company leaders to achieve company goals by considering problems that may arise in the future. The result of planning is a work plan, which is the best alternative to achieving the goals set[3].

Production planning is planning regarding the production factors needed to produce products at a certain point in the future as expected. Planning and control are two management functions that cannot be separated in every field of activity, including production activities. Planning is the first step in the management process, which includes setting goals and objectives to be achieved and making decisions about how to achieve these goals and objectives[1].

2.   Metode Triple Exponential Smoothing

According to Szmit et al., the Holt-Winters Model, also called the Triple Exponential Smoothing Model, is a well-known adaptive model used for modeling time series characterized by trend and seasonality[8]. In the additive version, the Triple Exponential Smoothing method presents the smoothing variant of the time series as the sum of three elements[9]. Meanwhile, according to Santoso (the Holt-Winters Model, also called the Triple Exponential Smoothing Model, is a well-known adaptive model used for modeling time series characterized by trend and seasonality[10]. In the additive version, the Triple Exponential Smoothing method presents the smoothing variant of the time series as the sum of three elements. This model is no different from the previous model (Double Exponential Smoothing), which only provides additional seasonal factors[11]. Seeing from the two opinions above, it can be concluded that this method is a development of the Double Exponential Smoothing method by adding a seasonal factor, so that this method is able to predict seasonal data[12]. This method has the basic equation for calculating forecasting, which is as follows[13]:

Overall Smoothing:

$S_t = S_t = \alpha \, X\_t/(I\_{(t - L)}) + (1 - \alpha)(S_t - 1 + b_t - 1)$

Trend Smoothing:

$b_t = \gamma(S_t - S_t - 1) + (1 - \gamma) b_t - 1$

Seasonal Smoothing:

$I_t = \beta \, X\_t/S\_t + (1 - \beta) I_t - L$

Future Period Forecasting:

$F_t + m = (S_t + b_t \, m) I_t - L + m$

explanation:

St   = single or overall smoothing value

Xt   = Actual data at time-t

bt   = Trend smoothing

It   = Seasonal Smoothing

Ft − m = Forecast value

L   = Length of season (e.g., number of months or quarter of a year)

m = future period

α, γ, β = A constant with a value between 0 and 1

The following are the steps for calculating the triple exponential smoothing method[14] :

Define S't Value

S't = S't = aXt + (1 - a)S't-1

Define S''t Value

S''t = aS't + (1 - a)S''t-1

Define S'''t Value

S'''t = aS''t + (1 - a)S'''t-1

Define Konstanta

at = 3S't - 3S''t + S'''t

Define Slope

bt = a/(2(1-a)^2) [(6-5a)S't - (10-8a)S''t + (4-3a)S'''t]

Define Ct

ct = a/(2(1-a)^2) (S't - 2S''t + S'''t)

Define Forecast

Ft+m = at + btm + ctm2

The following is a flowchart of the Triple Exponential Smoothing and MAPE algorithms used in the process of forecasting the amount of production and sales of timba cor TC in this system :
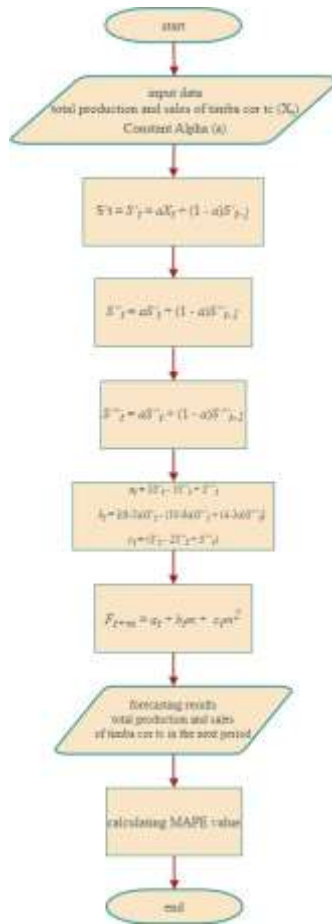
Figure 1 Flowchart Metode Triple Exponential Smoothing

System design is described in the form of a chart with certain symbols that describe the sequence of processes in detail and the relationship between one process and another and include all actors in a system. Forecasting System Design Planning Amount of Production and Sales of tima cor TC is as follows:
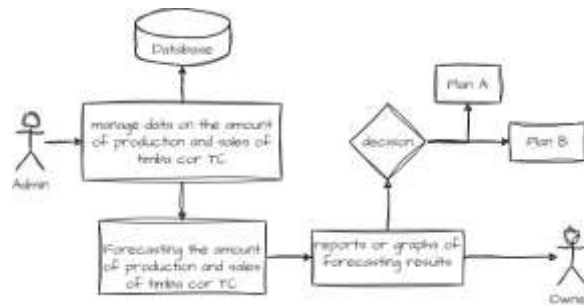
Figure 2 Desain Sistem Peramalan Perencanaan Jumlah Produksi dan Penjualan Timba Cor TC

In this study, the data used for forecasting was obtained directly from CV. Pandu Kencana Jombang. The data used is data on total production and sales for the period August 2021ndMarch 2022. Data on the total production of timba cor TC are 32 in a weekly period. While the data on the number of sales of timba cor TC is 32 data points in a weekly period, From the production and sales data, it can be concluded that the

data is unstable and has experienced a decline to a fairly low level; therefore, the Triple Exponential Smoothing method was applied to perform smoothing to calculate the estimated production and sales of timba cor TC in the following week.

RESULT AND DISCUSSION

Based on the observations on the website conditions, the results can be drawn as follows:

1.   Calculations with the Triple Exponential Smoothing Method

The calculations that will be discussed are only forecasting the amount of timba cor TC Doff production with an alpha value of 0.1 because calculations on forecasting the amount of production and other sales and alpha are then calculated in the same way, and the results will be presented in tabular form. The calculation steps are as follows:

Define S't Value

$S't = aXt + (1 - a)S't-1$

$S't = (0,1)32000 + (1 - 0,1)31000 = 31100$

$S't = (0,1)31000 + (1 - 0,1)31100 = 31090$

$S't = (0,1)38000 + (1 - 0,1)31090 = 31781$

$S't = (0,1)19500 + (1 - 0,1)31781 = 30552,9$

$S't = (0,1)30500 + (1 - 0,1)30552,9 = 30547,61$

$S't = (0,1)25000 + (1 - 0,1)30547,61 = 29992,849$

$S't = (0,1)50000 + (1 - 0,1)29992,849 = 31993,5641$

$S't = (0,1)33000 + (1 - 0,1)31993,5641 = 32094,20769$

$S't = (0,1)27000 + (1 - 0,1)32094,20769 = 31584,78692$

$S't = (0,1)32000 + (1 - 0,1)31584,78692 = 31626,30822$

$S't = (0,1)30000 + (1 - 0,1)31626,30822 = 31463,67740$

$S't = (0,1)30000 + (1 - 0,1)31463,67740 = 31317,30966$

$S't = (0,1)38000 + (1 - 0,1)31317,30966 = 31985,57869$

$S't = (0,1)31000 + (1 - 0,1)31985,57869 = 31887,02082$

$S't = (0,1)41500 + (1 - 0,1)31887,02082 = 32848,31874$

$S't = (0,1)49000 + (1 - 0,1)32848,31874 = 34463,48687$

$S't = (0,1)35000 + (1 - 0,1)34463,48687 = 34517,13818$

$S't = (0,1)30000 + (1 - 0,1)34517,13818 = 34065,42436$

$S't = (0,1)22000 + (1 - 0,1)34065,42436 = 32858,88192$

$S't = (0,1)35000 + (1 - 0,1)32858,88192 = 33072,99373$

$S't = (0,1)30000 + (1 - 0,1)33072,99373 = 32765,69436$

S't = (0,1)28000 + (1 - 0,1)32765,69436 = 32289,12492

S't = (0,1)34000 + (1 - 0,1)32289,12492 = 32460,21243

S't = (0,1)22000 + (1 - 0,1)32460,21243 = 31414,19119

S't = (0,1)33000 + (1 - 0,1)31414,19119 = 31572,77207

S't = (0,1)35000 + (1 - 0,1)31572,77207 = 31915,49486

S't = (0,1)35000 + (1 - 0,1)31915,49486 = 32223,94537

S't = (0,1)25000 + (1 - 0,1)32223,94537 = 31501,55084

S't = (0,1)40000 + (1 - 0,1)31501,55084 = 32351,39575

S't = (0,1)35000 + (1 - 0,1)32351,39575 = 32616,25618

S't = (0,1)50000 + (1 - 0,1)32616,25618 = 34354,63056

Define S''t Value

S''t = aS't + (1 - a)S''t-1

S''t = (0,1)31100 + (1 - 0,1)31000 = 31010

S''t = (0,1)31090 + (1 - 0,1)31010 = 31018

S''t = (0,1)31781 + (1 - 0,1)31018 = 31094,3

S''t = (0,1)30552,9 + (1 - 0,1)31094,3 = 31040,16

S''t = (0,1)30547,61 + (1 - 0,1)31040,16 = 30990,905

S''t = (0,1)29992,849 + (1 - 0,1)30990,905 = 30891,0994

S''t = (0,1)31993,5641 + (1 - 0,1)30891,0994 = 31001,34587

S''t = (0,1)32094,20769 + (1 - 0,1)31001,34587 = 31110,63205

S''t = (0,1)31584,78692 + (1 - 0,1)31110,63205 = 31158,04753

S''t = (0,1)31626,30822 + (1 - 0,1)31158,04753 = 31204,87360

S''t = (0,1)31463,67740 + (1 - 0,1)31204,87360 = 31230,75398

S''t = (0,1)31317,30966 + (1 - 0,1)31230,75398 = 31239,40955

S''t = (0,1)31985,57869 + (1 - 0,1)31239,40955 = 31314,02646

S''t = (0,1)31887,02082 + (1 - 0,1)31314,02646 = 31371,32590

S''t = (0,1)32848,31874 + (1 - 0,1)31371,32590 = 31519,02518

S''t = (0,1)34463,48687 + (1 - 0,1)31519,02518 = 31813,47135

S''t = (0,1)34517,13818 + (1 - 0,1)31813,47135 = 32083,83804

S''t = (0,1)34065,42436 + (1 - 0,1)32083,83804 = 32281,99667

S''t = (0,1)32858,88192 + (1 - 0,1)32281,99667 = 32339,68519

S''t = (0,1)33072,99373 + (1 - 0,1)32339,68519 = 32413,01605

S''t = (0,1)32765,69436 + (1 - 0,1)32413,01605 = 32448,28388

S''t = (0,1)32289,12492 + (1 - 0,1)32448,28388 = 32432,36798

S''t = (0,1)32460,21243 + (1 - 0,1)32432,36798 = 32435,15243

S''t = (0,1)31414,19119 + (1 - 0,1)32435,15243 = 32333,05630

S''t = (0,1)31572,77207 + (1 - 0,1)32333,05630 = 32257,02788

S''t = (0,1)31915,49486 + (1 - 0,1)32257,02788 = 32222,87458

S''t = (0,1)32223,94537 + (1 - 0,1)32222,87458 = 32222,98166

S''t = (0,1)31501,55084 + (1 - 0,1)32222,98166 = 32150,83857

S''t = (0,1)32351,39575 + (1 - 0,1)32150,83857 = 32170,89429

S''t = (0,1)32616,25618 + (1 - 0,1)32170,89429 = 32215,43048

S''t = (0,1)34354,63056 + (1 - 0,1)32215,43048 = 32429,35049

Define S'''t Value

S'''t = aS''t + (1 - a)S'''t-1

S'''t = (0,1)31010 + (1 - 0,1)31000 = 31001

S'''t = (0,1)31018 + (1 - 0,1)31001 = 31002,7

S'''t = (0,1)31094,3 + (1 - 0,1)31002,7 = 31011,86

S'''t = (0,1)31040,16 + (1 - 0,1)31011,86 = 31014,69

S'''t = (0,1)30990,905 + (1 - 0,1)31014,69 = 31012,3115

S'''t = (0,1)30891,0994 + (1 - 0,1)31012,3115 = 31000,19029

S'''t = (0,1)31001,34587 + (1 - 0,1)31000,19029 = 31000,30584

S'''t = (0,1)31110,63205 + (1 - 0,1)31000,30584 = 31011,33846

S'''t = (0,1)31158,04753 + (1 - 0,1)31011,33846 = 31026,00937

S'''t = (0,1)31204,87360 + (1 - 0,1)31026,00937 = 31043,89579

S'''t = (0,1)31230,75398 + (1 - 0,1)31043,89579 = 31062,58161

S'''t = (0,1)31239,40955 + (1 - 0,1)31062,58161 = 31080,26441

S'''t = (0,1)31314,02646 + (1 - 0,1)31080,26441 = 31103,64061

S'''t = (0,1)31371,32590 + (1 - 0,1)31103,64061 = 31130,40914

S'''t = (0,1)31519,02518 + (1 - 0,1)31130,40914 = 31169,27075

S'''t = (0,1)31813,47135 + (1 - 0,1)31169,27075 = 31233,69081

S'''t = (0,1)32083,83804 + (1 - 0,1)31233,69081 = 31318,70553

S'''t = (0,1)32281,99667 + (1 - 0,1)31318,70553 = 31415,03464

S'''t = (0,1)32339,68519 + (1 - 0,1)31415,03464 = 31507,49970

S'''t = (0,1)32413,01605 + (1 - 0,1)31507,49970 = 31598,05133

S'''t = (0,1)32448,28388 + (1 - 0,1)31598,05133 = 31683,07459

S'''t = (0,1)32432,36798 + (1 - 0,1)31683,07459 = 31758,00393

S'''t = (0,1)32435,15243 + (1 - 0,1)31758,00393 = 31825,71878

S'''t = (0,1)32333,05630 + (1 - 0,1)31825,71878 = 31876,45253

S'''t = (0,1)32257,02788 + (1 - 0,1)31876,45253 = 31914,51006

S'''t = (0,1)32222,87458 + (1 - 0,1)31914,51006 = 31945,34652

S'''t = (0,1)32222,98166 + (1 - 0,1)31945,34652 = 31973,11003

S'''t = (0,1)32150,83857 + (1 - 0,1)31973,11003 = 31990,88288

S'''t = (0,1)32170,89429 + (1 - 0,1)31990,88288 = 32008,88403

S'''t = (0,1)32215,43048 + (1 - 0,1)32008,88403 = 32029,53867

S'''t = (0,1)32429,35049 + (1 - 0,1)32029,53867 = 32069,51985

Define Constant

at = 3S't - 3S''t + S'''t

at = 3(31100) - 3(31010) + 31001 = 31271

at = 3(31090) - 3(31018) + 31002,7 = 31218,7

at = 3(31781) - 3(31094,3) + 31011,86 = 33071,96

at = 3(30552,9) - 3(31040,16) + 31014,69 = 29552,91

at = 3(30547,61) - 3(30990,905) + 31012,3115 = 29682,4265

at = 3(29992,849) - 3(30891,0994) + 31000,19029 = 28305,43909

at = 3(31993,5641) - 3(31001,34587) + 31000,30584 = 33976,96053

at = 3(32094,20769) - 3(31110,63205) + 31011,33846 = 33962,06538

at = 3(31584,78692) - 3(31158,04753) + 31026,00937 = 32306,22752

at = 3(31626,30822) - 3(31204,87360) + 31043,89579 = 32308,19966

at = 3(31463,67740) - 3(31230,75398) + 31062,58161 = 31761,35187

at = 3(31317,30966) - 3(31239,40955) + 31080,26441 = 31313,96474

at = 3(31985,57869) - 3(31314,02646) + 31103,64061 = 33118,29730

at = 3(31887,02082) - 3(31371,32590) + 31130,40914 = 32677,49391

at = 3(32848,31874) - 3(31519,02518) + 31169,27075 = 35157,15141

at = 3(34463,48687) - 3(31813,47135) + 31233,69081 = 39183,73735

at = 3(34517,13818) - 3(32083,83804) + 31318,70553 = 38618,60596

at = 3(34065,42436) - 3(32281,99667) + 31415,03464 = 36765,31772

at = 3(32858,88192) - 3(32339,68519) + 31507,49970 = 33065,08989

at = 3(33072,99373) - 3(32413,01605) + 31598,05133 = 33577,98438

at = 3(32765,69436) - 3(32448,28388) + 31683,07459 = 32635,30603

at = 3(32289,12492) - 3(32432,36798) + 31758,00393 = 31328,27474

at = 3(32460,21243) - 3(32435,15243) + 31825,71878 = 31900,89878

at = 3(31414,19119) - 3(32333,05630) + 31876,45253 = 29119,85718

at = 3(31572,77207) - 3(32257,02788) + 31914,51006 = 29861,74263

at = 3(31915,49486) - 3(32222,87458) + 31945,34652 = 31023,20736

at = 3(32223,94537) - 3(32222,98166) + 31973,11003 = 31976,00118

at = 3(31501,55084) - 3(32150,83857) + 31990,88288 = 30043,01967

at = 3(32351,39575) - 3(32170,89429) + 32008,88403 = 32550,38840

at = 3(32616,25618) - 3(32215,43048) + 32029,53867 = 33232,01575

at = 3(34354,63056) - 3(32429,35049) + 32069,51985 = 37845,36006

Define Slope

bt = a/(2(1-a)^2) [(6-5a)S't - (10-8a)S''t + (4-3a)S'''t]

bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))31100 - (10-8(0,1))31010 + (4-3(0,1))31001] = 28,5

bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))31090 - (10-8(0,1))31018 + (4-3(0,1))31002,7] = 20,95

bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))31781 - (10-8(0,1))31094,3 + (4-3(0,1))31011,86] = 214,31

bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))30552,9 - (10-8(0,1))31040,16 + (4-3(0,1))31014,69] = -171,245

bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))30547,61 - (10-8(0,1))30990,905 + (4-3(0,1))31012,3115] = -145,61225

bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))29992,849 - (10-8(0,1))30891,0994 + (4-3(0,1))31000,19029] = -280,04574

bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))31993,5641 - (10-8(0,1))31001,34587 + (4-3(0,1))31000,30585] = 336,62668

bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))32094,20769 - (10-8(0,1))31110,63205 + (4-3(0,1))31011,33847] = 311,25184

bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))31584,78692 - (10-8(0,1))31158,04754 + (4-3(0,1))31026,00938] = 114,72379

bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))31626,30823 - (10-8(0,1))31204,87361 + (4-3(0,1))31043,8958] = 106,31312

bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))31463,67741 - (10-8(0,1))31230,75399 + (4-3(0,1))31062,58162] = 40,6692

bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))31317,30967 - (10-8(0,1))31239,40956 + (4-3(0,1))31080,26441] = -9,9004

bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))31985,5787 - (10-8(0,1))31314,02647 + (4-3(0,1))31103,64062] = 179,94504

bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))31887,02083 - (10-8(0,1))31371,32591 + (4-3(0,1))31130,40915] = 120,05741

bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))32848,31875 - (10-8(0,1))31519,02519 + (4-3(0,1))31169,27075] = 371,42118

$bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))34463,48687 - (10-8(0,1))31813,47136 + (4-3(0,1))31233,69081] = 767,27761$

$bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))34517,13818 - (10-8(0,1))32083,83804 + (4-3(0,1))31318,70553] = 651,36793$

$bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))34065,42437 - (10-8(0,1))32281,99667 + (4-3(0,1))31415,03465] = 407,47487$

$bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))32858,88193 - (10-8(0,1))32339,6852 + (4-3(0,1))31507,4997] = -13,79656$

$bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))33072,99374 - (10-8(0,1))32413,01605 + (4-3(0,1))31598,05134] = 37,93258$

$bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))32765,69436 - (10-8(0,1))32448,28388 + (4-3(0,1))31683,07459] = -67,00721$

$bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))32289,12493 - (10-8(0,1))32432,36799 + (4-3(0,1))31758,00393] = -202,65332$

$bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))32460,21243 - (10-8(0,1))32435,15243 + (4-3(0,1))31825,71878] = -130,68361$

$bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))31414,19119 - (10-8(0,1))32333,05631 + (4-3(0,1))31876,45253] = -416,24643$

$bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))31572,77207 - (10-8(0,1))32257,02788 + (4-3(0,1))31914,51007] = -310,53845$

$bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))31915,49486 - (10-8(0,1))32222,87458 + (4-3(0,1))31945,34652] = -167,74335$

$bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))32223,94538 - (10-8(0,1))32222,98166 + (4-3(0,1))31973,11004] = -56,74226$

$bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))31501,55084 - (10-8(0,1))32150,83858 + (4-3(0,1))31990,88289] = -256,97029$

$bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))32351,39576 - (10-8(0,1))32170,8943 + (4-3(0,1))32008,88403] = 24,27901$

$bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))32616,25618 - (10-8(0,1))32215,43049 + (4-3(0,1))32029,53868] = 93,62603$

$bt = 0,1/(2(1-0,1)^2) [(6-5(0,1))34354,63056 - (10-8(0,1))32429,35049 + (4-3(0,1))32069,51986] = 571,46093$

Define Ct

$ct = a/(1-a)^2 (S't - 2S''t + S'''t)$

ct = 0,1/(1-0,1)^2 (31100 - 2(31010) + 31001) = 1

ct = 0,1/(1-0,1)^2 (31090 - 2(31018) + 31002,7) = 0,7

ct = 0,1/(1-0,1)^2 (31781 - 2(31094,3) + 31011,86) = 7,46

ct = 0,1/(1-0,1)^2 (30552,9 - 2(31040,16) + 31014,69) = -6,33

ct = 0,1/(1-0,1)^2 (30547,61 - 2(30990,905) + 31012,3115) = -5,2085

ct = 0,1/(1-0,1)^2 (29992,849 - 2(30891,0994) + 31000,19029) = -9,74271

ct = 0,1/(1-0,1)^2 (31993,5641 - 2(31001,34587) + 31000,30585) = 12,23677

ct = 0,1/(1-0,1)^2 (32094,20769 - 2(31110,63205) + 31011,33847) = 10,91706

ct = 0,1/(1-0,1)^2 (31584,78692 - 2(31158,04754) + 31026,00938) = 3,63829

ct = 0,1/(1-0,1)^2 (31626,30823 - 2(31204,87361) + 31043,8958) = 3,21552

ct = 0,1/(1-0,1)^2 (31463,67741 - 2(31230,75399) + 31062,58162) = 0,7994

ct = 0,1/(1-0,1)^2 (31317,30967 - 2(31239,40956) + 31080,26441) = -1,00303

ct = 0,1/(1-0,1)^2 (31985,5787 - 2(31314,02647) + 31103,64062) = 5,69341

ct = 0,1/(1-0,1)^2 (31887,02083 - 2(31371,32591) + 31130,40915) = 3,39232

ct = 0,1/(1-0,1)^2 (32848,31875 - 2(31519,02519) + 31169,27075) = 12,09308

ct = 0,1/(1-0,1)^2 (34463,48687 - 2(31813,47136) + 31233,69081) = 25,55846

ct = 0,1/(1-0,1)^2 (34517,13818 - 2(32083,83804) + 31318,70553) = 20,59466

ct = 0,1/(1-0,1)^2 (34065,42437 - 2(32281,99667) + 31415,03465) = 11,31439

ct = 0,1/(1-0,1)^2 (32858,88193 - 2(32339,6852) + 31507,4997) = -3,86406

ct = 0,1/(1-0,1)^2 (33072,99374 - 2(32413,01605) + 31598,05134) = -1,91342

ct = 0,1/(1-0,1)^2 (32765,69436 - 2(32448,28388) + 31683,07459) = -5,52838

ct = 0,1/(1-0,1)^2 (32289,12493 - 2(32432,36799) + 31758,00393) = -10,09392

ct = 0,1/(1-0,1)^2 (32460,21243 - 2(32435,15243) + 31825,71878) = -7,21449

ct = 0,1/(1-0,1)^2 (31414,19119 - 2(32333,05631) + 31876,45253) = -16,9811

ct = 0,1/(1-0,1)^2 (31572,77207 - 2(32257,02788) + 31914,51007) = -12,67622

ct = 0,1/(1-0,1)^2 (31915,49486 - 2(32222,87458) + 31945,34652) = -7,22108

ct = 0,1/(1-0,1)^2 (32223,94538 - 2(32222,98166) + 31973,11004) = -3,07294

ct = 0,1/(1-0,1)^2 (31501,55084 - 2(32150,83858) + 31990,88289) = -9,99066

ct = 0,1/(1-0,1)^2 (32351,39576 - 2(32170,8943) + 32008,88403) = 0,22829

ct = 0,1/(1-0,1)^2 (32616,25618 - 2(32215,43049) + 32029,53868) = 2,6535

ct = 0,1/(1-0,1)^2 (34354,63056 - 2(32429,35049) + 32069,51986) = 19,32654

Define Forecast

Ft+m = at + btm + 1/2ctm2

Ft+m = 31271 + 28,5(1) + 0,5((1)(1)2) = 31300

Ft+m = 31218,7 + 20,95(1) + 0,5((0,7)(1)2) = 31240

Ft+m = 33071,96 + 214,31(1) + 0,5((7,46)(1)2) = 33290

Ft+m = 29552,91 + -171,245(1) + 0,5((-6,33)(1)2) = 29378,5

Ft+m = 29682,4265 + -145,61225(1) + 0,5((-5,2085)(1)2) = 29534,21

Ft+m = 28305,4390899999 + -280,04574(1) + 0,5((-9,74271)(1)2) = 28020,522

Ft+m = 33976,96054 + 336,62668(1) + 0,5((12,23677)(1)2) = 34319,7056

Ft+m = 33962,06538 + 311,25184(1) + 0,5((10,91706)(1)2) = 34278,77575

Ft+m = 32306,22752 + 114,72379(1) + 0,5((3,63829)(1)2) = 32422,77046

Ft+m = 32308,19966 + 106,31312(1) + 0,5((3,21552)(1)2) = 32416,12054

Ft+m = 31761,35187 + 40,6692(1) + 0,5((0,7994)(1)2) = 31802,42077

Ft+m = 31313,96474 + -9,9004(1) + 0,5((-1,00303)(1)2) = 31303,56283

Ft+m = 33118,2973 + 179,94504(1) + 0,5((5,69341)(1)2) = 33301,08905

Ft+m = 32677,49392 + 120,05741(1) + 0,5((3,39232)(1)2) = 32799,24749

Ft+m = 35157,15142 + 371,42118(1) + 0,5((12,09308)(1)2) = 35534,61914

Ft+m = 39183,73735 + 767,27761(1) + 0,5((25,55846)(1)2) = 39963,79419

Ft+m = 38618,60597 + 651,36793(1) + 0,5((20,59466)(1)2) = 39280,27123

Ft+m = 36765,31773 + 407,47487(1) + 0,5((11,31439)(1)2) = 37178,44979

Ft+m = 33065,08989 + -13,79656(1) + 0,5((-3,86406)(1)2) = 33049,3613

Ft+m = 33577,98439 + 37,93258(1) + 0,5((-1,91342)(1)2) = 33614,96026

Ft+m = 32635,30603 + -67,00721(1) + 0,5((-5,52838)(1)2) = 32565,53463

Ft+m = 31328,27475 + -202,65332(1) + 0,5((-10,09392)(1)2) = 31120,57447

Ft+m = 31900,89879 + -130,68361(1) + 0,5((-7,21449)(1)2) = 31766,60793

Ft+m = 29119,85718 + -416,24643(1) + 0,5((-16,9811)(1)2) = 28695,12021

Ft+m = 29861,74263 + -310,53845(1) + 0,5((-12,67622)(1)2) = 29544,86607

Ft+m = 31023,20737 + -167,74335(1) + 0,5((-7,22108)(1)2) = 30851,85347

Ft+m = 31976,00118 + -56,74226(1) + 0,5((-3,07294)(1)2) = 31917,72246

Ft+m = 30043,01967 + -256,97029(1) + 0,5((-9,99066)(1)2) = 29781,05406

Ft+m = 32550,38841 + 24,27901(1) + 0,5((0,22829)(1)2) = 32574,78156

Ft+m = 33232,01576 + 93,62603(1) + 0,5((2,6535)(1)2) = 33326,96854

Ft+m = 37845,36006 + 571,46093(1) + 0,5((19,32654)(1)2) = 38426,48426

The calculation process continues using different alpha values, namely (0.2), (0.3), (0.4), (0.5), (0.6), (0.7), (0,8), and (0.9). The calculation results are shown in the following table:

Table 1 : The Calculation Results of Triple Exponential Smoothing for Forecasting the Production Quantity of Timba Cor TC Doff

AKTUAL	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9
31000	31300	31600	31900	32200	32500	32800	33100	33400	33700
38000	31240	31360	31360	31240	31000	30640	30160	29560	28840
19500	33290	35400	37390	39320	41250	43240	45350	47640	50170
30500	29378,5	26716	23138,5	18736	13562,5	7636	938,5	-6584	-15021,5
25000	29534,21	27990,72	26965,03	26959,04	28406,25	31696,96	37203,47	45305,28	56414,29
50000	28020,52	25583,80	24084,23	23512,51	23531,25	23530,43	22662,67	19858,36	13820,60
33000	34319,70	39221,54	45663,31	53165,73	61125	69058,68	76803,31	84681,71	93658,23
27000	34278,77	37342,05	39363,12	39327,96	36464,843	30404,41	21133,55	8788,467	-6685,734
32000	32422,77	32374,46	30458,39	26690,04	21794,921	17083,07	14155,19	14630,14	20038,35
30000	32416,12	32227,40	30932,34	29483,67	29109,375	30773,33	34706,30	40176,92	45482,73
30000	31802,42	30921,93	29464,64	28468,20	28500,976	29306,00	29895,37	29044,84	25969,98
38000	31303,56	30127,74	28976,42	28653,45	29143,798	29841,32	30153,32	30066,71	30314,55
31000	33301,08	34476,91	36157,26	38719,02	41728,637	44592,19	47093,31	49436,06	51830,74
41500	32799,24	32931,34	32911,28	32657,65	31547,729	29182,38	25599,75	21005,99	15475,75
49000	35534,61	38228,96	40787,43	43228,37	45418,090	47672,45	50632,72	54927,80	61060,11
35000	39963,79	45881,50	50647,96	54328,11	56932,418	58689,29	59697,03	59663,45	57919,59
30000	39280,27	41908,85	41487,26	38614,01	33841,026	27776,05	20857,19	13422,78	5988,050
22000	37178,44	36173,99	32303,83	27384,19	22864,486	19875,43	19147,35	21141,47	26120,88
35000	33049,36	27723,91	21119,03	15563,28	12157,512	11034,13	11567,99	12671,46	12979,54
30000	33614,96	30420,65	28643,46	30059,61	34568,032	41118,41	48434,55	55573,28	62246,22
28000	32565,53	29236,74	28090,50	29261,93	31091,974	31709,74	29840,72	25016,52	17338,60
34000	31120,57	27435,16	26423,00	27008,77	27356,626	26581,03	25046,65	23962,49	24812,17
22000	31766,60	30085,23	31489,96	34065,78	36286,963	38028,14	39942,72	42540,09	45595,74
33000	28695,12	24642,25	23098,16	21541,50	18799,471	15032,30	10615,55	5504,692	-656,3045
35000	29544,86	28056,56	29656,98	31833,56	34153,563	37270,43	41767,72	47957,70	56186,04
35000	30851,85	31522,26	34590,41	37281,79	39166,611	40374,82	40619,20	39238,37	35389,09
25000	31917,72	33705,66	36597,78	38051,95	38109,679	37210,043	35625,61	33768,14	32447,49
40000	29781,05	29015,81	28124,77	25345,22	21433,755	17217,445	13228,60	9855,940	7243,760
35000	32574,78	35142,47	37872,80	40018,15	42839,199	47144,102	53188,54	60895,29	69950,09
50000	33326,96	35888,87	37467,50	37679,06	37322,193	36289,991	33884,85	29224,60	21475,16
	38426,48	45235,84	50385,53	54237,27	57783,109	61260,737	64862,63	69186,17	75361,28

2.   MAPE Calculation

To find the highest alpha value, search for the MAPE value. MAPE: the smaller the error value, the more accurate the forecasting results will be[15]. As with the calculation of the Triple Exponential Smoothing method above, the MAPE calculation will only calculate at an alpha of 0.1 because for alpha other than 0.1 it has the same way of calculating.

MAPE = (((31000 - 31300) / 31000) + ((38000 - 31240) / 38000) + ((19500 - 33290) / 19500) + ((30500 - 29378,5) / 30500) + ((25000 - 29534,21) / 25000) + ((50000 - 28020,522) / 50000) + ((33000 - 34319,7056)

/ 33000) + ((27000 - 34278,77575) / 27000) + ((32000 - 32422,77046) / 32000) + ((30000 - 32416,12054) / 30000) + ((30000 - 31802,42077) / 30000) + ((38000 - 31303,56283) / 38000) + ((31000 - 33301,08905) / 31000) + ((41500 - 32799,24749) / 41500) + ((49000 - 35534,61914) / 49000) + ((35000 - 39963,79419) / 35000) + ((30000 - 39280,27123) / 30000) + ((22000 - 37178,44979) / 22000) + ((35000 - 33049,3613) / 35000) + ((30000 - 33614,96026) / 30000) + ((28000 - 32565,53463) / 28000) + ((34000 - 31120,57447) / 34000) + ((22000 - 31766,60793) / 22000) + ((33000 - 28695,12021) / 33000) + ((35000 - 29544,86607) / 35000) + ((35000 - 30851,85347) / 35000) + ((25000 - 31917,72246) / 25000) + ((40000 - 29781,05406) / 40000) + ((35000 - 32574,78156) / 35000) + ((50000 - 33326,96854) / 50000)) / 30) * (-100%) = 3,54245%

After calculating MAPE for each alpha value, the MAPE results can be displayed in tabular form as follows:

Table 2 : Hasil Perhitungan MAPE Peramalan Jumlah Produksi Timba Cor TC Doff

Alpha	MAPE
0,1	3,542458
0,2	3,185062
0,3	3,513354
0,4	3,815294
0,5	3,962374
0,6	4,08735
0,7	4,302635
0,8	4,667376
0,9	5,197279

From the table above, it can be seen that the alpha value has the smallest MAPE, namely 0.2 with a MAPE value of 3.19%. With this, it can also be seen that the forecasting accuracy value of the amount of timba cor TC Doff production is 100% minus 3.19% = 96.81%.

Conclusion

Data processing in the system is by calculating the data for August 2021 - March 2022. The system will calculate the actual data for August 2021 - March 2022 with Triple Exponential Smoothing and proceed with calculating the MAPE value to find the alpha with the smallest MAPE value. The most accurate forecast is the one using alpha with the smallest MAPE value.

The lowest MAPE value or error was found for the production of timba cor TC Doff, namely with an alpha of 0.2 and 3.19% MAPE, then for the production of Pentil TC Cor Lead, namely with an alpha of 0.8 and 1.43% MAPE, then for the sale of timba cor TC Doff, namely with an alpha of 0.5 and MAPE of 9.6%, then for sales of timba cor TC Pentil, namely with an alpha of 0.9 and MAPE of 2.94%. This at the same time confirms the accuracy of forecasting with actual data for August 2021–March 2022, which is 97.7% for production and 93.7% for sales. With these results, forecasting using the Triple Exponential Smoothing method and the MAPE forecasting error testing method can be said to be successful.

Conflicts of Interest

The authors have disclosed no conflicts of interest.

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