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Estimated Rice Sales at Perum Bulog Sub Divre Medan using the *Double Exponential Smoothing Method*

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Abstract.*The estimated rice sales at Perum Bulog Sub Divre Medan is crucial information in planning and managing rice supplies. In this study, we apply the Double Exponential Smoothing forecasting method to estimate rice sales at Perum Bulog Sub Divre Medan. This approach allows us to identify complex sales patterns and generate accurate forecasts to aid in informed decision making. We use historical rice sales data to train a forecasting model and evaluate its performance. Experimental results show that the Double Exponential Smoothing method can provide reliable estimates of rice sales, with a satisfactory level of accuracy. The implications of these findings are discussed in the context of inventory management and operational planning of Perum Bulog Sub Divre Medan.*

Keywords: *Perum Bulog, Medan Sub Divre, rice sales, forecasting, Double Exponential Smoothing*

BACKGROUND

Rice is the main staple food of Indonesia. Disruptions to food (rice) security such as shortages of rice availability and increases in rice prices can trigger social insecurity, economic and political instability and can overall disrupt national stability. Considering the importance of rice, the government always strives to maintain the availability of rice throughout the year, distribute rice evenly, stabilize rice prices and increase food security from domestic production (rice self-sufficiency).

The problem that occurs at Perum Bulog *Sub Divre* Medan is that the supply of rice at Bulog does not take into account demand in the market. Basically every company has something called inventory, okay raw material inventory and finished material inventory. One of them is Perum Bulog, Bulog has a supply of several tons of rice every month. However, rice supplies are limited done Logistics Bureau it turns out become impact Which not enough so Good for Bulog itself is because the rice supply in Bulog does not take into account demand in the market. In 2018, Bulog had rice supplies of 728,292 tons, while market demand was only 538,883 tons. Why could something like this happen, because Bulog has three tasks, namely: the first is stability price market, Which second availability food, Which third affordability.

Because Bulog has not been able to determine the exact amount of rice sales Every year, Bulog often experiences leftover rice in the warehouse and the rice will experience a decline in quality such as smelly and rotten rice due to the incorrect amount of rice supplies. So that Bulog has difficulties in several ways, including anticipating changes in production quantities, providing raw materials, achieving targets and determining maximum profits . So a method is needed to predict the amount of rice that will be produced for sale For every the year And can made as guidelines by Perum Bulog in making sales rice.

THEORETICAL STUDY

Understanding Forecasting

Meanwhile, forecasting is an activity. These predictions can be based on various methods, namely the *single exponential smoothing method* , *the double exponential smoothing method* , and the *triple exponential smoothing method* . All of this is known as the forecasting method. Forecasting is estimating conditions in the future Which will come through testing circumstances in Century Then. In Everything in social life is uncertain and difficult to predict precisely, so forecasting is needed. Efforts are always made to make forecasts in order to minimize the influence of this uncertainty on a problem. In other words, forecasting aims to get a forecast that is possible minimize *forecast errors* which are usually measured by *mean square error* , *mean absolute error* , and so on (Purwanto 2017).

Good forecasting is forecasting that pays attention to the data patterns used so that the approach will be better and can minimize the resulting error rate. This forecasting can be done using an exponential smoothing approach, this method basically uses past data which is smoothed by exponentially decreasing weighting of older observation values or newer values. The use of forecasting techniques begins with data patterns in the past. For develop model Which in accordance with use the assumption that data patterns in the past will repeat themselves in the future .

Based on their nature, forecasting techniques can be divided into two main categories, namely:

1. Forecasting Qualitative
   Qualitative forecasting is forecasting based on qualitative data. The data used is qualitative data from the past. The results of the forecasts made depend greatly on the person who wrote them. This is important because the results of the forecast are determined based on the thoughts and knowledge of the compiler.
2. Forecasting Quantitative
   Quantitative forecasting is forecasting that is based on quantitative data in the past. Good forecasting is forecasting that is carried out by following forecasting procedures, so the deviation between the forecasting results and the reality that occurs is smaller.

Time Series

Time series analysis is a series of observational data happen based on index time in a way sequentially with intervals time still. Time series analysis is a statistical procedure applied to predict the probabilistic structure of conditions that will occur in the future in the context of decision making. Data patterns for *time series* are divided into horizontal patterns (H), seasonal patterns, cyclical patterns, and *trend patterns* .

Exponential Smoothing Method

exponential smoothing method is a development of the *moving average method* . In this method, forecasting is done by repeating calculations continuously using new data. The general form of *exponential smoothing* is:

$$F_{t+1} = \alpha X_t + (1 - \alpha) F_t \quad (1)$$

Information:

F_{t+1} = Forecast for a future period

X_t = Actual data in the t-th period

F_t = Forecast in the t-th period

α = *Smoothing parameter*

Types of *Exponential Smoothing*

1. *Single Exponential Smoothing* Method

   Also known as *simple exponential smoothing* which is used in short term forecasting, usually only 1 month into the future. The model assumes that the data fluctuates around a fixed *mean value, with no trend* or consistent growth pattern.

$$S_t' = \alpha X_t (1 - \alpha) S_{t-1}' \quad (2)$$

2. *Double Exponential Smoothing* Method

   Method This used when data show exists *trend* . *Exponential Smoothing* with a *trend* is like simple smoothing except that two components must be updated every period-the level and the *trend* . Level is a smoothed estimate of the data value at the end of each period. *Trend* is a smoothed estimate of the average growth at the end of each period.

$$S_t'' = \alpha S_t'' (1 - \alpha) S_{t-1}'' \quad (3)$$

The formula used to implement *Brown* 's *Exponential Smoothing* is as follows:

$$S_t' = \alpha X_t (1 - \alpha) S_{t-1}' \quad (4)$$

$$S_t'' = \alpha S_t'' (1 - \alpha) S_{t-1}'' \quad (5)$$

$$a_t = 2S_t' - S_t'' \quad (6)$$

$$b_t = \frac{\alpha}{1-\alpha} (S_t' - S_t'') \quad (7)$$

$$F_{t+m} = a_t + b_t m \quad (8)$$

$$e_t = X_t - F_t \quad (9)$$

Information:

S_t'= *Single exponential smoothing value*

S_t''= *Double exponential smoothing value*

α= The magnitude of the $0 < \alpha < 1$*exponential smoothing parameter*

a_t, = b_t*Smoothing* constant

F_{t+m}= Forecasting results for *m* future periods to be forecast

e_t= Error in the t- *th period*

RESEARCH METHODS

Study Which will done can categorized as study field *(field research)* or case study, namely research that goes directly into the research object using direct interview methods with practitioners as well as documents directly from Perum Bulog *Sub* Medan *Division* . The steps taken to conduct this research are as follows:

1. Collect rice sales data by month

2. Plotting data to find out data patterns
3. Calculating *the Single Exponential Smoothing value*
4. Calculating the *Double Exponential Smoothing value*
5. Calculate the values of the constants $a_t$andb_t
6. Calculating values (*forecasting*) based on the model
7. Calculating the *error value* .

RESULTS AND DISCUSSION

Data obtained from Perum Bulog *Sub Divre* Medan is as follows

Table 1 . Rice Sales Data

Year	Q	Sales Amount (Tons)
Jan-16	1	16,947.76
Feb-16	2	15,520.44
Mar-16	3	13,473.21
Apr-16	4	14,275.62
May-16	5	16,414.47
Jun-16	6	14,206.17
Jul-16	7	13,395.27
August-1	8	11,207.88
Sep-16	9	10,770.06
Oct-16	10	12,258.43
Nov-16	11	13,184.62
Dec-16	12	10,364.58
Jan-17	13	13,428.77
Feb-17	14	13,750.64
Mar-17	15	14,463.21
Apr-17	16	14,726.72
May-17	17	12,174.77
Jun-17	18	11,371.97
Jul-17	19	13,093.21
August-1	20	12,608.78
Sep-17	21	10,410.36
Oct-17	22	14,748.33
Nov-17	23	11,174.32
Dec-17	24	10,902.98
Jan-18	25	15,967.77
Feb-18	26	10,720.46
Mar-18	27	13,353.22
Apr-18	28	15,185.67
May-18	29	11,474.47
Jun-18	30	11,906.19
Jul-18	31	17,345.27
August-1	32	11,007.87
Sep-18	33	10,970.03
Oct-18	34	15,758.43
Nov-18	35	12,034.63
Dec-18	36	10,094.59
Jan-19	37	9,439.94
Feb-19	38	10,561.73
Mar-19	39	9,682.44

Apr-19	40	9,701.09
May-19	41	11,895.69
Jun-19	42	10,217.97
Jul-19	43	9,226.06
August-1	44	9,375.85
Sep-19	45	10,152.01
Oct-19	46	9,578.29
Nov-19	47	9,683.04
Dec-19	48	10,341.70
Jan-2	49	11,134.91
Feb-2	50	8,371.82
Mar-20	51	9,458.43
Apr-20	52	8,687.45
May-20	53	7,854.73
Jun-20	54	8,994.04
Jul-20	55	9,394.85
Aug-20	56	8,435.67
Sep-20	57	9,677.54
Oct-20	58	9,846.37
Nov-20	59	9,975.80
Dec-20	60	8,248.16

The rice sales data is then plotted to determine the data pattern .

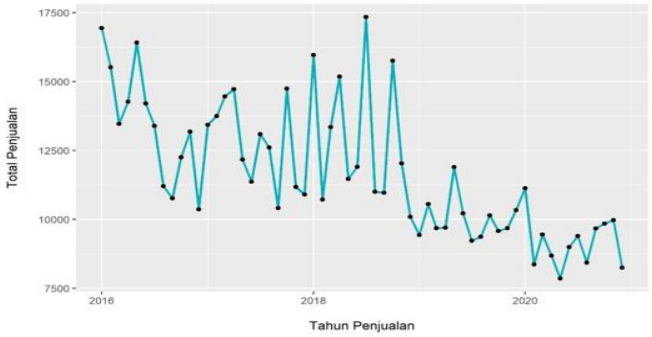

Figure 1 . Rice Sales Graph 2016-2020

From Figure 1 . It is known that the data obtained fluctuates. This shows that the data is not constant. Apart from that, in the data graph that has been presented, the data tends to decrease, so the data contains elements *trend* .

Analysis uses the *Double Exponential Smoothing* (DES) method Brown

The solution uses the *Double Exponential Smoothing* Method Brown has predetermined steps or formulas. From the data in Table 1 . and Figure 1 . Rice Sales forecasting will be carried out for the next year. After analyzing the alpha values from 0.1 to 0.9, the calculation steps or procedures carried out are the same for all alpha values so that in this research the data analysis will show only the best alpha value, namely alpha 0.2.

Tab el 2 . Alpha value 0.2

Year	t	X_t	S'_t	S''_t	a_t	b_t	F_{t+m}	e_t
Jan-16	1	16947,76	16947,76	16.947,76	0,00	0,00	0,00	0,00
Feb-16	2	15520,44	15520,44	16.890,67	16.433,92	-57,09	0,00	0,00
Mar-16	3	13473,21	13473,21	16.717,43	15.331,53	-173,24	15.158,29	-1.685,08
Apr-16	4	14275,62	14275,62	16.508,89	14.840,53	-208,54	14.631,98	-356,36
Mei-16	5	16414,47	16414,47	16.371,64	15.273,68	-137,25	15.136,43	1.278,04
Jun-16	6	14206,17	14206,17	16.197,18	14.801,54	-174,46	14.627,08	-420,91

Jul-16	7	13395,27	13395,27	15.973,46	14.183,63	-223,73	13.959,90	-564,63
Aug-16	8	11207,88	11207,88	15.639,65	12.969,17	-333,81	12.635,37	-1.427,49
Sep-16	9	10770,06	10770,06	15.231,23	11.963,86	-408,42	11.555,43	-785.37
Oct-16	10	12258.43	12258.43	14,850.92	11,808.51	-380.30	11,428.21	830.22
Nov-16	11	13184.62	13184.62	14,540.88	12,060.52	-310.05	11,750.47	1,434.15
Dec-16	12	10364.58	10364.58	14,175.40	11,251.55	-365.48	10,886.07	-521.49
Jan-17	13	13428,77	13428,77	13.911,63	11.801,44	-263,77	11.537,67	1.891,10
Feb-17	14	13750,64	13750,64	13.736,37	12.334,34	-175,25	12.159,08	1.591,56
Mar-17	15	14463,21	14463,21	13.653,28	12.988,57	-83,09	12.905,48	1.557,73
Apr-17	16	14726,72	14726,72	13,643.04	13,561.13	-10.24	13,550.89	1,175.83
May-17	17	12174.77	12174.77	13,577.76	13,055.49	-65.28	12,990.20	-815.43
Jun-17	18	11371.97	11371.97	13,447.75	12,407.64	-130.01	12,277.62	-905.65
Jul-17	19	13093.21	13093.21	13,350.36	12,571.24	-97.39	12,473.85	619.36
Aug-17	20	12608.78	12608.78	13,258.36	12,522.42	-91.99	12,430.43	178.35
Sep-17	21	10410.36	10410.36	13,085.57	11,703.20	-172.80	11,530.41	-1,120.05
Oct-17	22	14748.33	14748.33	13,041.49	12,688.86	-44.08	12,644.78	2,103.55
Nov-17	23	11174.32	11174.32	12,938.59	12,115.42	-102.90	12,012.52	-838.20
Des-17	24	10902.98	10902.98	12,791.31	11,613.08	-147.28	11,465.81	-562.83
Jan-18	25	15967.77	12,955.31	12,824.11	13,086.51	32.80	13,119.31	2,848.46
Feb-18	26	10720.46	12,508.34	12,760.96	12,255.73	-63.15	12,192.57	-1,472.11
Mar-18	27	13353.22	12,677.32	12,744.23	12,610.41	-16.73	12,593.68	759.54
Apr-18	28	15185.67	13,178.99	12,831.18	13,526.79	86.95	13,613.75	1,571.92
May-18	29	11474.47	12,838.08	12,832.56	12,843.61	1.38	12.844,99	-1.370,52
Jun-18	30	11906,19	12.651,71	12.796,39	12.507,02	-36,17	12.470,85	-564,66
Jul-18	31	17345,27	13.590,42	12.955,20	14.225,64	158,81	14.384,45	2.960,82
Aug-18	32	11007,87	13.073,91	12.978,94	13.168,88	23,74	13.192,62	-2.184,75
Sep-18	33	10970.03	12,653.13	12,913.78	12,392.49	-65.16	12,327.33	-1,357.30
Oct-18	34	15758.43	13,274.19	12,985.86	13,562.52	72.08	13,634.61	2,123.82
Nov-18	35	12034.63	13,026.28	12,993.94	13,058.62	8.08	13,066.70	-1,032.07
Dec-18	36	10094.59	12,439.94	12,883.14	11,996.74	-110.80	11,885.94	-1,791.35
Jan-19	37	9,439.94	11,839.94	12,674.50	11,005.38	-208.64	10,796.74	-1,356.80
Feb-19	38	10,561.73	11,584.30	12,456.46	10,712.14	-218.04	10,494.09	67.64
Mar-19	39	9,682.44	11,203.93	12,205.96	10.201,90	-250,51	9.951,39	-268,95
Apr-19	40	9.701,09	10.903,36	11.945,44	9.861,28	-260,52	9.600,76	100,33
Mei-19	41	11.895,69	11.101,83	11.776,71	10.426,94	-168,72	10.258,22	1.637,47
Jun-19	42	10.217,97	10.925,05	11.606,38	10.243,73	-170,33	10,073.40	144.57
Jul-19	43	9,226.06	10,585.26	11,402.16	9,768.35	-204.23	9,564.13	-338.07
Aug-19	44	9,375.85	10,343.37	11,190.40	9,496.35	-211.76	9,284.59	91.26
Sep-19	45	10,152.01	10,305.10	11,013.34	9,596.86	-177.06	9,419.80	732.21
Oct-19	46	9,578.29	10,159.74	10,842.62	9,476.86	-170.72	9,306.14	272.15
Nov-19	47	9,683.04	10,064.40	10,686.98	9,441.82	-155.64	9,286.18	396.86
Dec-19	48	10,341.70	10,119.86	10,573.55	9,666.17	-113.42	9,552.74	788.96
Jan-20	49	11,134.91	10,322.87	10.523,42	10.122,32	-50,14	10.072,19	1.062,72
Feb-20	50	8.371,82	9.932,66	10.405,27	9.460,05	-118,15	9.341,90	-970,08
Mar-20	51	9.458,43	9.837,81	10.291,77	9.383,85	-113,49	9.270,36	188,07
Apr-20	52	8.687,45	9.607,74	10.154,97	9.060,51	-136,81	8.923,71	-236,26
Mei-20	53	7.854,73	9.257,14	9.975,40	8.538,88	-179,57	8.359,31	-504,58
Jun-20	54	8.994,06	9.204,52	9.821,23	8.587,82	-154,18	8.433,64	560,42
Jul-20	55	9.394,85	9.242,59	9.705,50	8.779,68	-115,73	8.663,95	730,90
Agu-20	56	8,435.67	9,081.20	9,580.64	8,581.77	-124.86	8,456.91	-21.24
Sep-20	57	9,677.54	9,200.47	9,504.61	8,896.34	-76.03	8,820.30	857.24
Oct-20	58	9,846.37	9,329.65	9,469.62	9,189.69	-34.99	9,154.70	691.67
Nov-20	59	9,975.80	9,458.88	9,467.47	9,450.29	-2.15	9,448.15	527.65
Dec-20	60	8,248.16	9,216.74	9,417.32	9,016.15	-50.15	8,966.01	-717.85

Selection of Best Alpha Parameters

The choice of parameter α in this study was chosen based on *the Mean Absolute Percentage Error* which has the smallest value. The α value that has been determined is between

$0 < \alpha < 1$, namely 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, and 0.9. MAPE calculation results for parameters $\alpha = 0$, 1 to $\alpha = 0$, 9 can be seen in the table at lower.

Table 3 . MAPE value for parameter α = 0.1 to *α = 0.9*

Parameter α	MAPE
0.1	1.08%
0.2	**0.27** %
0.3	0.57%
0.4	0.79%
0.5	1.03%
0.6	1.32%
0.7	1.64%
0.8	1.99%
0.9	2.34%

Based on Table 3 . it was concluded that the smallest MAPE value was at $\alpha = 0$, 2 , namely with MAPE = 0.27%

Rice Sales Forecasting

After conducting an analysis using past data on rice sales from Perum Bulog Sub-Division of Medan, a forecast of rice sales at Perum Bulog Sub-Division of Medan can be calculated for the following years, namely for 2022 . The calculations done use formula (2.8) that is by using mark *at* And *bt* on data Which to 60 whereas mark *m* indicates the period to be forecast. The forecasting results are as follows following:

Table 4 . Results of Rice Sales Forecast Value

Year	t	Forecasting the Number of Rice Sales (Tons)
January 2022	61	8,966.01
February 2022	62	8,915.86
March 2022	63	8,865.71
April 2022	64	8,815.57
May 2022	65	8,765.42
June 2022	66	8,715.27
July 2022	67	8,665.13
August 2022	68	8,614.98
September 2022	69	8,564.83
October 2022	70	8,514.69
November 2022	71	8,464.54
December 2022	72	8,414.40

CONCLUSIONS AND RECOMMENDATIONS

1. Conclusion

Based on the results of data processing from January 2016 to December 2020 it was concluded that the *α parameter* was the best for forecasting Quantity Rice sales at Perum Bulog Sub Divre Medan are $\alpha = 0.2$ *with* an *error* percentage of 0.27% and sales of rice at Perum Bulog Sub Divre Medan in 2022 will experience a decrease every month. The following is the total rice sales for 2022 , January 2022 amounting to 8,966.01 tons, February 2022 amount 8,915.86 Tons, March 2022 amounted to 8,865.71 Tons, April 2022 amounted 8,815.57 Ton, May 2022 amount 8,765.42 Ton, June 2022 amount 8,715.27 Ton, July 2022 amounted to 8,665.13 tons, August 2022 amounted to 8,614.98 tons, September 2022 amounted to 8,564.83 tons, October 2022 amounted to 8,514.69 Ton,

November 2022 amounted to 8,464.54 tonnes, December 2022 amounted to 8,414.40 tonnes.

2. Suggestion

Suggestions Which can given For company or researcher is as follows:

1. With exists analysis data on thesis This, expected Corporation Logistics Bureau Medan Sub Divre can apply it in estimating the amount of sales in the coming period.
2. On study furthermore can use *time* method *another series* for forecasting.

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