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Prediction of Sparepart Sales Level using Exponential Smoothing Method

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ABSTRACT

Prediction of spare parts is very important to do, in order to ensure the availability of stock when there is a lot of demand. In predicting spare parts, accurate calculations are needed, for that we need the Exponential Smoothing method, where the process of this method is carried out in several stages of testing the previous data to get the right value. The results obtained will be a recommendation for the following year how much inventory of spare parts is needed.

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1. INTRODUCTION

Difficulty in meeting marketing targets is one of the main obstacles that is often faced by a business, especially UD. This Rismauli is due to an mismatch or imbalance between the number of sales of goods supplied and the number of goods sold out, and has not been able to predict the value of sales of goods in the coming year because the system they are using is not yet optimal, causing a loss in business income. Therefore we need a tool that can help and maximize company performance in forecasting the optimal number of orders with minimal costs in the future so that it can help business owners make the right decisions.

By paying attention to the problems that exist in the sale of motorcycle spare parts, by utilizing the exponential smoothing method, a sales and stock forecasting system will be built[1]. Because the exponential smoothing method is a procedure of continuous improvement in forecasting the latest observed objects. This forecasting method focuses on decreasing priority exponentially on older objects of observation[2]. Smoothing can be done for two purposes, namely for forecasting and for eliminating short-term fluctuations in time series data. This model gives different weights to each observation. The oldest observation has the lowest weight and the newest observation has the highest weight[3].

Previous research entitled Application of the Exponential Smoothing Method in the Raw Material Inventory Control Information System stated that the manual system that has been used so

far has been unable to keep up with the current development of the business world[4]. This problem causes an increase in the cost of providing a wider warehouse for storing goods and an increase in the cost of maintaining goods so they are not damaged. The facts that occur in the field show that the purchase of goods from customers has seasonal and trend patterns. Based on the facts in the field, we need an inventory control information system using the exponential smoothing method. This inventory control information system aims to help calculate the number of items to be provided in the coming period, determine the time for reordering and determine the amount of safety stock that must be provided, thereby increasing profits through selling goods on demand from customers and increasing efficiency because there is no accumulation of goods in the warehouse. in a long time.

2. RESEARCH METHOD

In carrying out this research, clear and structured stages are needed, in order to facilitate the process, it is necessary to make a diagram design such as the diagram below:

Figure 1. Diagram of Methods and Research Stages

Method is the unity of methods, procedures, work concepts, rules and postulates that are used by a science, art or other discipline. Systems development methodology means methods, procedures, work concepts, rules, postulates that will be used to develop an information system.

2.1. Material

A. Forecasting

Forecast is a situation or condition that is predicted to occur in the future. Forecasting is an important tool in planning effectively and efficiently. Forecasting is needed to determine when an event will occur or arise, so that the appropriate action can be taken[5].

Forecasting makes the management of a variable in the future visible, making it easier for plans for future periods. Every company policy is inseparable from efforts to improve people's welfare or increase the company's success in achieving its goals in the future, where the policy is implemented. Therefore, it is necessary to see and study the situation and conditions at the time the policy was implemented. Attempts to see and study these situations and conditions cannot be separated from forecasting activities. In an effort to know or see developments in the future, forecasting is needed to determine when an event will occur or a need will arise, so that policies can be prepared. In addition, forecasting is needed to provide information to leaders as a basis for making a decision[6].

B. Exponential Smoothing Methods

The exponential smoothing method is a fairly good forecasting method for long-term and medium-term forecasting, especially at the operational level of a company, in the development of the basic mathematical smoothing method it can be seen that the exponential concept has developed and became a practical method with quite wide use, especially in forecasting for inventories. The main advantages of using the exponential smoothing method are low cost, easy application, and speed to accept[7].

Forecasting is a group of methods that show the weighting decreases continuously (exponentially) to the value of the older observations (observations). Therefore this method is called the exponential smoothing procedure. As with moving averages, the exponential smoothing method consists of single, multiple, and more complex methods. All of them have the same characteristics, namely the new value is given a relatively larger weight than the older observed value. In the case of moving averages, the weight applied to the observed values is a byproduct of the particular MA system being taken. But in exponential smoothing, one or more

smoothing parameters are specified explicitly, and the result of this choice determines the weight to be applied to the observed value.

There are four models of the exponential smoothing method that accommodate assumptions about trends and seasonality:

1. Simple (singular), this model assumes that the observation series does not have seasonal trends and variations.
2. Holt, this model assumes that the observation series has a linear trend but does not have seasonal variations.
3. Winters, this model assumes that the observation series has a linear trend and seasonal variations.
4. Custom, this model allows the determination of trend components and seasonal variations.

There are three parameters that need to be defined, depending on the components of the trend and seasonal variations[4]:

A. Alpha (α) is a parameter that controls the relative weighting of the recently carried out observations. If alpha is 1 then only the most recent observations are used exclusively. Conversely, if alpha is 0 then the past observations are calculated with a weight equivalent to the latest. The alpha parameter is used in all models.
B. Beta (β) is a parameter that controls the relative weighting of recent observations to estimate the appearance of a trend series. Beta values range from 0 to 1. The greater the value, the greater the weight given to the most recent observations. Beta parameter is used in models that have a linear or exponential trend component with no seasonal variation.
C. Gamma (γ) is a parameter that controls the relative weighting of recent observations to estimate the appearance of seasonal variations. Gamma values range from 0 to 1. The larger the value indicates the greater weight given to the most recent observations. Gamma parameters are used in models that have seasonal variations.

A single exponential refinement will always follow every trend in the actual data, because all it can do is do nothing more than adjust future forecasts by a percentage of the last error. Past forecast errors are used to correct future forecasts in the opposite direction to these errors. The adjustment continues until the error is corrected. This principle, apparently simple, plays a very important role in forecasting. If used properly this principle can be used to develop a self-adjusting process that corrects forecast errors automatically. This method is very well applied to serial data that has a stationary pattern and may not be effective in handling forecasts with the trend of data belonging to the trend component and the seasonal pattern. This is because if it is set on a data series that has a trend and is constant, the forecast will always be behind the trend. In addition, this exponential method also gives a relatively higher weight to the value of the latest observations compared to the previous period. The formula for the Single Exponential Smoothing model is as follows[8]:

$$F_{t+1} = F_t + \alpha\,(A_t - F_t)$$

Dimana:

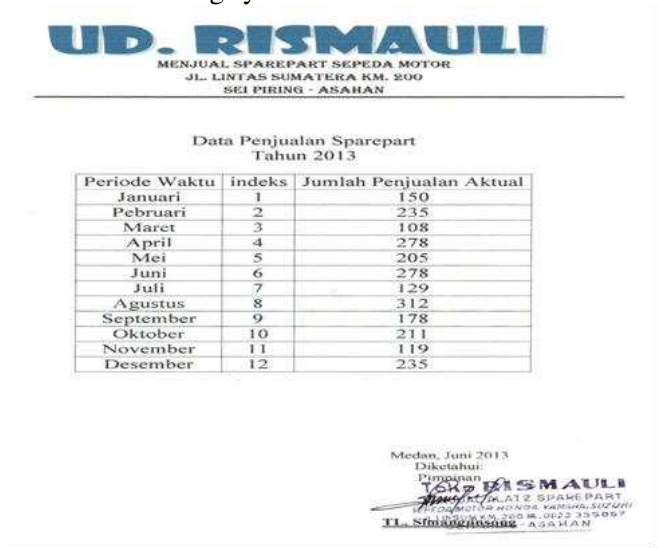
Ft : Forecasting Value for period t
At-1 : Actual value in the previous period (t-1)
Ft+1 : Forecast value in the previous period (t-1)
α : Data smoothing constant with a value between 0 and 1
et : Forecast error (actual value minus forecast) for period t

This method uses α as the smoothing coefficient. Low α values will lead to a wider distance with the trend, because they give less weight to current demand. A low α value is suitable when the data is stable. Higher α values are useful where actual changes tend to occur because they are more responsive to fluctuations in demand. Finding the right α value can generally be determined by testing the error (trial and error) of different α to determine the α value which will produce the smallest error value[9].

2.2. Data

Based on the results of direct observations at UD. Rismauli, data processing carried out at UD. Rismauli is a manual data processing system for motorcycle spare parts sales where every sale

of motorbike spare parts sold will be recorded in a sales invoice receipt and recorded into a ledger. In order to achieve such a well-coordinated performance, consumer data, sales data are needed to overcome the weaknesses of the existing system at UD. Rismauli.



UD. RISMAULI
MENJUAL SPAREPART SEPEDA MOTOR
JL. LINTAS SUMATERA KM. 200
SEI PIRING - ASAHAN

Data Penjualan Sparepart
Tahun 2013

Periode Waktu	indeks	Jumlah Penjualan Aktual
Januari	1	150
Pebruari	2	235
Maret	3	108
April	4	278
Mei	5	205
Juni	6	278
Juli	7	129
Agustus	8	312
September	9	178
Oktober	10	211
November	11	119
Desember	12	235

Medan, Juni 2013
Diketahui:
Pimpinan

TOKO RISMAULI
TL. Simangunsong

Figure 2. Spare Parts Sales Data

UD. RISMAULI
MENJUAL SPAREPART SEPEDA MOTOR
JL. LINTAS SUMATERA KM. 200
SEI PIRING - ASAHAN

Data Peramalan Penjualan Sparepart
Tahun 2014

Periode Waktu	indeks	Jumlah Peramalan
Januari	1	**170**
Pebruari	2	189
Maret	3	165
April	4	315
Mei	5	245
Juni	6	258
Juli	7	115
Agustus	8	325
September	9	180
Oktober	10	215
November	11	115
Desember	12	245

Sei Piring, Juni 2014
Diketahui:
Pimpinan

TL. Simangunsong

Figure 3. Spare Parts Sales Data

3. RESULTS AND DISCUSSION

A. Sales Analysis Using the Exponential Smoothing Method

The sales data that the author obtained are the results of sales of fantasy type motorcycle spare parts for Honda brand lamps in 2013, with details as shown in Table 1 below:

Table 1. 2013 Sales Season Index

Time period	index	Actual sales amount (A_t)
Januari	1	150
Pebruari	2	235
Maret	3	108
April	4	278
Mei	5	205
Juni	6	278
Juli	7	129
Agustus	8	312
September	9	178
Oktober	10	211
November	11	119

Desember	12	235

Based on the seasonal index of motorcycle spare parts sales shown in Table 1 above, to calculate the forecasting value for a certain month the exponential smoothing formula can be used as follows:

Ft = Ft-1 + α (At-1 - Ft-1)

While the α value used in this forecasting is α = 0.1, α = 0.5, and α = 0.9.

B. Forecasting using α = 0.1

Exponential Smoothing with α = 0.1 means giving less weight than the previous forecast compared to the previous data. So forecasting the sales of motorcycle spare parts at UD. Rismauli in February 2014 are as follows:

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

$F_{Pebruari} = F_{Januari} + 0{,}1 * (A_{Januari} - F_{Januari})$

$= 170 + 0{,}1\ (150\text{-}170)$

$= 170 - 2$

$= \underline{168}$

Information :

Because the data is in the form of spare parts sales data, it is impossible for the result to be a fraction, so the fraction results are rounded off with the following conditions:

0 - 0.499 round to 0

0.5 - 0.999 round to 1.

Based on the results of the above calculations, forecasting the sales of motorcycle spare parts for the next period can be seen in Table 2. below.

Table 2. Forecasting Sales Using the Exponential Method α = 0.1

Time period	Index	Actual sales (A_t)	Forecasting (F_t)
Januari	1	150	**170**
Pebruari	2	235	168
Maret	3	108	175
April	4	278	168
Mei	5	205	179
Juni	6	278	182
Juli	7	115	192
Agustus	8	325	186
September	9	178	199
Oktober	10	211	197
November	11	119	198
Desember	12	235	190

Then the minimum stock that the company must have is the forecasting value at α = 0.1 plus the minimum stock per month (15) which can be seen in Table 3. Below :

Table 3. Minimum stock data per month at α = 0.1 Year 2014

Time period	Forecasting amount	Minimal stock
Januari	**170**	**185**
Pebruari	160	183
Maret	198	190
April	153	183
Mei	216	194
Juni	211	197
Juli	245	207
Agustus	180	201
September	253	214
Oktober	216	212
November	214	213
Desember	167	205

C. Forecasting using α = 0.5

Exponential Smoothing with α = 0.5 means giving the same weight from the previous forecast compared to the previous data. So forecasting the sales of motorcycle spare parts at UD. Rismauli in January 2014 are as follows:

Ft = Ft-1 + α (At-1 - Ft-1)

F February = 170 + 0.5 (150-170)
= 170 – 10
= 160

Information :

Because the data is in the form of spare parts sales data, it is impossible for the result to be a fraction, so the fraction results are rounded off with the following conditions:

0 - 0.499 round to 0

0.5 - 0.999 round to 1.

Based on the results of the above calculations, forecasting sales of motorcycle spare parts for the next period can be seen in Table 4. below.

Table 4. Forecasting Sales Using the Exponential Method α = 0.5

Time period	Index	Actual sales (A_t)	Forecasting (F_t)
Januari	1	150	**170**
Pebruari	2	235	160
Maret	3	108	198
April	4	278	153
Mei	5	205	216
Juni	6	278	211
Juli	7	115	245
Agustus	8	325	187
September	9	178	250
Oktober	10	211	214
November	11	119	213
Desember	12	235	166

Then the minimum stock that the company must have is the forecasting value at α = 0.5 plus the minimum stock per month (15) which can be seen in Table 5. below:

Table 5. Minimum stock data per month at α = 0.5 Year 2014

Time period	Forecasting amount	Minimum stock
Januari	**170**	**185**
Pebruari	160	175
Maret	198	213
April	153	168
Mei	216	231
Juni	211	226
Juli	245	260
Agustus	180	202
September	253	265
Oktober	216	229
November	214	228
Desember	167	181

D. Forecasting using α = 0.9

Exponential Smoothing with α = 0.9 means that it gives greater weight than the previous forecast compared to the previous data. So forecasting the sales of motorcycle spare parts at UD. Rismauli in January 2014 are as follows:

Ft = Ft-1 + α (At-1 - Ft-1)

February F = 170 + 0.9 (150-170)
= 170 - 18
= 152

Information :

Because the data is in the form of spare parts sales data, it is impossible for the result to be a fraction, so the fraction results are rounded off with the following conditions:

0 - 0.499 round to 0
0.5 - 0.999 round to 1.

Based on the results of the above calculations, forecasting the sales of motorcycle spare parts for the next period can be seen in Table 6. below:

Table 6. Forecasting Sales Using the Exponential Method α = 0.9

Time period	Index	Actual sales (A_t)	Forecasting (F_t)
Januari	1	150	**170**
Pebruari	2	235	152
Maret	3	108	227
April	4	278	120
Mei	5	205	262
Juni	6	278	211
Juli	7	115	271
Agustus	8	325	131
September	9	178	306
Oktober	10	211	191
November	11	119	209
Desember	12	235	128

Then the minimum stock that the company must have is the forecasting value at α = 0.9 plus the minimum stock per month (15) which can be seen in Table 7. below:

Table 7. Minimum stock data per month at α = 0.9 Year 2014

Time period	Forecasting amount	Minimum stock
Januari	**170**	**185**
Pebruari	152	167
Maret	227	242
April	120	135
Mei	262	277
Juni	211	226
Juli	271	286
Agustus	143	158
September	295	310
Oktober	190	205
November	209	224
Desember	128	143

E. Error Calculation Using MAD (Mean Absolute Deviation)

Before calculating the MAD value can be done, the difference between actual sales and forecasting (At-Ft) is calculated first as can be seen in Table 8. below:

Table 8. The difference between Actual and Forecasted Sales at α = 0.1

Time period	Actual sales (A_t)	Forecasting (F_t)	Difference $\|A_t-F_t\|$
Januari	150	**170**	20
Pebruari	235	168	67
Maret	108	175	67
April	278	168	110
Mei	205	179	26
Juni	278	182	96
Juli	129	192	63
Agustus	312	186	126
September	178	199	21
Oktober	211	197	14
November	119	198	79
Desember	235	190	45
Total			734

Based on the results of the above calculations, it can be seen that the number of forecasting periods (n) = 12, then the MAD value can be calculated as follows:

MAD $= \sum | \text{At-Ft} / n |$
$= 734/12$

= 61.17

Before calculating the MAD value can be done, the difference between actual sales and forecasting (At-Ft) is first calculated as can be seen in Table 9.

Table 9. The difference between Actual and Forecasted Sales at α = 0.9

Time period	Actual sales (A_t)	Forecasting (F_t)	Difference (A_t-F_t)
Januari	150	**170**	**20**
Pebruari	235	152	83
Maret	108	227	119
April	278	120	158
Mei	205	262	57
Juni	278	211	67
Juli	129	271	142
Agustus	312	143	169
September	178	295	117
Oktober	211	190	21
November	119	209	90
Desember	235	128	107
Total			1150

Based on the results of the above calculations, it can be seen that the number of forecasting periods (n) = 12, then the MAD value can be calculated as follows:

MAD = ∑ | At-Ft / n |

= 1150/12

= 95.83

Based on the results of the MAD (Mean Absolute Deviation) calculation above, it can be seen that the smallest MAD value can be obtained at a value of α = 0.1, namely 61.17. This shows that forecasting motorcycle spare parts sales using the Exponential Smoothing method is most suitable for UD. Rismauli is at a value of α = 0.1. This shows that the historical pattern of the actual data does not fluctuate or is relatively stable over time.

4. CONCLUSION

Companies in determining the sales forecasting method are most suitable to be applied in the next period by comparing forecasting for several alpha (α) values so that the smallest error value can be obtained at what α value, in this case using the Mean Absolute Deviation (MAD). The actual sales report in one period is needed to forecast sales in the next period. This sales report data will be analyzed using the Exponential Smoothing Method to generate sales forecasts for the next period.

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