

Analysis of demand forecasting for Madura herbal medicine Rapet Wangi (Case study: PT. Firdaus Kurnia Indah)

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Abstract. PT. Firdaus Kurnia Indah's Madurese herbal products include various types, one of which is rapet wangi's herbal medicine. This herbal medicine is specifically designed for women and is in high demand among consumers. The large demand means that the supply of rapet wangi's herbal medicine sometimes requires pre-order. The purpose of this study is to accurately forecast the demand for rapet wangi's herbal medicine, it is necessary to forecast demand correctly using several forecasting methods. The demand data pattern for herbal medicine products is fluctuating, so the method that can be used is the time series method, namely moving average, weight moving average, exponential smoothing and exponential smoothing with trend. The results of the forecasting analysis that will be selected are the forecasting results with the smallest MAD (Mean Absolute Deviation), MSE (Mean Square Error) and MAPE (Mean Absolute Percentage Error). The smallest MAPE value indicates that the forecasting error is small. The results of this research, it can be concluded that considering the data on the quantity of raw materials at PT Firdaus Kurnia Indah, the exponential smoothing method is suitable for predicting rapet wangi's product. This is evident from the MAPE values in all models used, which produce the smallest error at 23,19% with next period forecast is 935 product.

1 Introduction

Jamu is a herbal drink derived from natural ingredients that is in great demand by the public. The use of herbal medicine by Indonesian people is more than 50% [1]. Madurese herbal medicine is the work of the Madurese ancestral heritage in maintaining their health. Drinking herbal medicine in the tradition of the Bangkalan Madurese community is a form of culture in responding to and resolving health problems experienced every day [2]. One of the Madurese herbal medicine industries in Bangkalan is PT Firdaus Kurnia Indah with the products produced namely Rapet wangi, Empot wangi, Galian montok, sirih wangi and many more. The herbal product with the most demand is rapet wangi herbal medicine. Rapet wangi herbal medicine is specifically for adult women. The properties of this herbal medicine can overcome feminine problems such as vaginal discharge, unpleasant odor and prevent body odor.

The demand for rapet wangi herbal products is uncertain every month. The company has stock that is ready to be sold in quantities that are not too large. If there is demand in large quantities, the company will order. Jamu returns and makes products according to the number of requests. This causes the company to be unable to meet customer demand. The inventory system used is make to order. The average number of requests for fragrant rapet herbal medicine each month is ± 1000 products. However, there is demand that exceeds the

average that occurs in October 2022 and December 2022 by 1800 products. Herbal medicine inventory control at PT Firdaus Kurnia Indah is still carried out based on previous customer experience or purchasing history, so that along with high demand for products, there will be a shortage of herbal medicine product inventory and can lead to the loss of customers.

The production planning hitherto conducted has been based solely on estimates and a relatively straightforward process, thereby allowing for significant disparities between the established plans and the actual demand. This situation can lead to consequential impacts on the company, such as overstock or stockout issues [3]. Consequently, inventory control must be meticulously planned and grounded in a strong foundation of planning. To address the challenges of fluctuating demand and improve inventory management, accurate forecasting methods are essential. These methods will help the company better align its production and stock levels with actual market demand. Therefore, the company needs to forecast the quantity of product inventory using forecasting methods to avoid excess inventory and potential financial losses.

Forecasting involves predicting future demand based on historical data. The use of products can be established in fixed quantities [4]. A good forecast is undoubtedly not based on groundless speculation but rather on predictions grounded in observed behaviors repeatedly. Forecasting activities necessitate the

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application of methods with the aim of minimizing forecasting errors. Software such as POM-QM can be employed for forecasting [5]. POM-QM includes various methods for forecasting. Forecasting is a crucial aspect of business operations, as it allows organizations to anticipate future demand and make informed decisions. There are various forecasting methods available, and the choice of method depends on the characteristics of the data and the specific requirements of the business. One of the commonly used forecasting methods is moving average, which provides a smoothed representation of the data by calculating the average of a certain number of previous data points.

Another method is weighted moving average, which assigns different weights to the previous data points, with more recent data points receiving higher weights. Exponential smoothing, on the other hand, is a forecasting technique that assigns exponentially decreasing weights to past observations, giving more weight to recent data.

The choice of the appropriate forecasting method for product demand depends on various factors, such as the nature of the product, the availability of historical data, and the desired level of accuracy.

Moving average and weighted moving average are commonly used in forecasting due to their simplicity and ability to capture trends in the data. Exponential smoothing, on the other hand, is often preferred for its ability to adapt to changing patterns in the data, making it suitable for forecasting products with irregular or volatile demand.

Furthermore, exponential smoothing with trend can be used to account for underlying trends in the data, which can be particularly useful for forecasting products with long-term growth or decline patterns.[6], [7], [8], [9]

The selection of the appropriate forecasting method for product demand is a crucial decision that can have significant implications for the success of a business. The demand data pattern for herbal medicine products is fluctuating, so the method that can be used is the time series method, namely Moving Average, Weighted Moving Average, Exponential Smoothing, Trend Analysis (regress over time), Linear Regression/Least Square, Multiplicative Decomposition (seasonal), and Additive Decomposition (seasonal) [10]. The purpose of this study is to accurately forecast the demand for rapet wangi's herbal medicine. The contribution of this research is to provide information to companies in determining the amount of demand for fragrant herbal medicine in the coming year so that the company does not have a shortage or excess of herbal medicine products.

2 Methods

The research on forecasting Madura herbal medicine product commenced with data collection spanning from September 2022 to October 2023. This study was conducted at PT Firdaus Kurnia Indah, located at Jl Ki Lemah Duwur Gang IX No 16 Pejagan, Bangkalan,

Madura, East Java Province. The data processing for this research utilized POM-QM software. The actual data pattern of demand for this herbal medicine fluctuates (trend). This study employs various forecasting methods to predict the demand for Madura herbal medicine. These methods include Moving Average, Weighted Moving Average, Exponential Smoothing, and Exponential Smoothing with Trend. Subsequently, an analysis of errors was performed using the Mean Absolute Deviation (MAD), Mean Square Error (MSE), and Mean Absolute Percentage Error (MAPE) formulas to determine the most appropriate forecasting method [11].

2.1 Moving average and weight moving average

The moving average model uses a number of actual demand data new to generate forecast values for future demand come. The moving average method will be effectively applied if we can assumes that market demand for the product will remain stable throughout time. The n-period moving average method uses the following formula [12] :

$$MA\ n - periode = \frac{\sum \text{demand } n \text{ previous period}}{n} \quad (1)$$

Weighted moving averages is a method forecasting that is more responsive to change. This is because the data from the new period is given greater weight. Weighted moving averages can expressed by the following formula [13] :

$$WMA = \frac{\sum (\text{weight } n \text{ period}) \times (\text{demand } n \text{ period})}{\sum \text{weight}} \quad (2)$$

2.2 Exponential smoothing

Forecasting methods with exponential smoothing are usually used for patterns unstable data or large and turbulent changes. This forecasting method works almost the same as a thermostat. If there is a forecast error is positive, which means the actual value of demand is higher than the forecast value ($A - F > 0$), then the exponential smoothing model will automatically increase the value the prediction. Conversely, if the forecast error is negative, that is means that the actual value of demand is lower than the forecast value ($A - F < 0$), then the exponential smoothing method will automatically reduce the forecast value.

This adjustment process takes place continuously, except for forecast errors has reached zero. Forecasting using the exponential smoothing method is carried out based on the formula as below [13].

$$F_t = F_{t-1} + \alpha (A_{t-1} - F_{t-1}) \quad (3)$$

Information

F_t : forecast value for the t-th time period

F_{t-1} : forecast value for the past time period, t-1

At-1: actual value for one time period ago, t-1
A : smoothing constant

2.3 Exponential smoothing with trend

Trend line analysis model used as a forecasting model if the pattern historical data from actual demand shows there is an upward trend in time to time [13]. Exponential method smoothing with trend is usually more appropriate for predict data that experiences an upward trend. The exponential smoothing with trend formula is as follows following:

Base Level

$$E_t = \alpha \times Y_{t-1} + (1 - \alpha) (E_{t-1} - T_{t-1}) \quad (4)$$

$t=1,2,\dots,n$

Expectation Trend Value

$$T_t = (1 - \beta) T_{t-1} + \beta (E_t - E_{t-1}) \quad (5)$$

Forecast with Trend

$$Ft = Et + Tt \quad (6)$$

3 Result and discussion

The data utilized in this study consists of historical data on rapet wangi product used from September 2022 to August 2023. The one-year historical data for rapet wangi herbal medicine demand at PT Firdaus Kurnia Indah is presented in Table 1 below.

Table 1. Historical data for herbal medicine raw materials.

Month	Rapet wangi (product)
September 2022	1018
October 2022	1854
November 2022	1416
December 2022	1852
January 2023	1222
February 2023	1159
March 2023	1055
April 2023	886
May 2023	895
June 2023	1243
July 2023	1280
August 2023	916

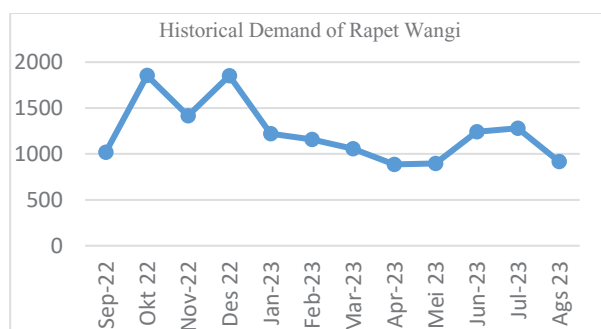


Fig. 1. Graphical plot of demand Rapet Wangi's product data from September 2022 to August 2023.

Figure 1 above depicts the historical data for rapet wangi herbal medicine from September 2022 to August 2023 in graphical form. The graph illustrates the fluctuating trend in the availability of product.

3.1 Moving average

The moving average method employs a set of recent actual data to generate forecasted values for future demand [14]. Forecast error is used to gauge the level of error in forecasting [15]. The smaller the value in the error, the more suitable it is for use. The forecast calculation for Manjakani raw material at PT Firdaus Kurnia Indah can be seen as follows:

Table 2. Forecasting using the moving average method for 3 months from September 2022 to August 2023.

Month	Rapet wangi (product)	Forecast
September 2022	1018	
October 2022	1854	
November 2022	1416	
December 2022	1852	1429,33
January 2023	1222	1707,33
February 2023	1159	1496,67
March 2023	1055	1411
April 2023	886	1145,33
May 2023	895	1033,33
June 2023	1243	945,33
July 2023	1280	1008
August 2023	916	1139,33
Next Period		1146,33

In table 2 the calculation of forecast errors for the quantity of rapet wangi from September 2022 to August 2023 was obtained from the Moving Average forecasting method using the POM-QM software for a three-month period. The forecasted quantity for the next batch of rapet wangi is 1146,33 product, with a Mean Absolute Deviation (MAD) of 310.25, Mean Squared Error (MSE) of 105.978,6, and Mean Absolute Percentage Error (MAPE) of 26,64%. Comparison of forecasting results and actual data can be seen in Figure 2 below:

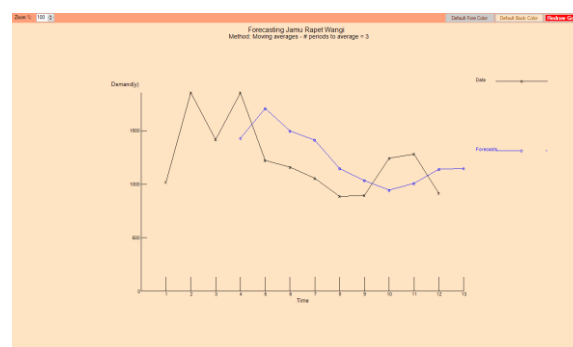


Fig. 2. Graphical plot with moving average.

In Figure 2, the pattern of forecasting data obtained is not visible fluctuates according to actual data on demand for fragrant rapet herbal medicine. That way,

results forecasting between actual data and forecast data is not suitable forecasting is carried out.

3.2 Weight moving average

The Weighted Moving Average method is more responsive to changes as it assigns greater weight to data from recent periods [16] In table 3, the calculation of forecast errors for the quantity of raw materials from September 2022 to August 2023 was obtained from the Weighted Moving Average forecasting method using the POM-QM software with weights of 2, 3, and 2.

Table 3. Forecasting using the WMA (n=3, weights: 2, 3, 2) for Months from September 2022 to August 2023.

Month	Rapet wangi (product)	Forecast
September 2022	1018	
October 2022	1854	
November 2022	1416	
December 2022	1852	1490
January 2023	1222	1665,71
February 2023	1159	1547,42
March 2023	1055	1384
April 2023	886	1147,28
May 2023	895	1036,43
June 2023	1243	936,85
July 2023	1280	991,85
August 2023	916	1154,14
Next Period		1165,43

The forecasted quantity for the next batch of raw materials is 1165,43 product of rapet wangi, with a MAD of 306,47; MSE of 100.975,3 and MAPE of 26,55%. Comparison of forecasting results and actual data can be seen in Figure 3 below:

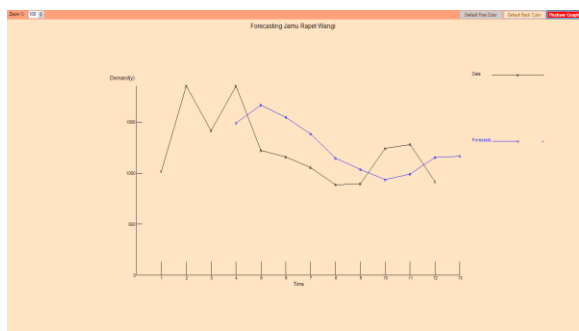


Fig. 3. Graphical plot with weight moving average.

In Figure 3, the pattern of forecasting data obtained is not visible fluctuates according to actual data on demand for fragrant rapet herbal medicine. That way, results forecasting between actual data and forecast data is not suitable forecasting is carried out.

3.3 Exponential smoothing

The Exponential Smoothing method operates by approaching the value of actual forecasts, wherein positive error values, signifying that the actual demand is higher than the forecasted value, will automatically

increase the forecasted value and vice versa [17]. In table 4, the calculation of forecast errors for the quantity of raw materials from September 2022 to August 2023 was obtained from the Exponential Smoothing forecasting method using the POM-QM software with $\alpha = 0.795$.

The forecasted quantity for the next batch of rapet wangi is 934,06, with a MAD of 308,92; MSE of 155.069,6; and MAPE of 23,19%. Comparison of forecasting results and actual data can be seen in Figure 4.

Table 4. Forecasting using exponential smoothing ($\alpha = 0,95$) for Month from September 2022 to August 2023.

Month	Rapet wangi (product)	Forecast
September 2022	1018	
October 2022	1854	1018
November 2022	1416	1812,2
December 2022	1852	1435,81
January 2023	1222	1831,19
February 2023	1159	1252,46
March 2023	1055	1163,67
April 2023	886	1060,43
May 2023	895	894,7
June 2023	1243	894,9
July 2023	1280	1225,6
August 2023	916	1277,28
Next Period		934,06

In the graph above, the pattern of forecasting data obtained looks fluctuating as is the actual data on demand for fragrant rapet herbal medicine. That way, the forecasting results between actual data and forecasting data is still possible forecasting is carried out.

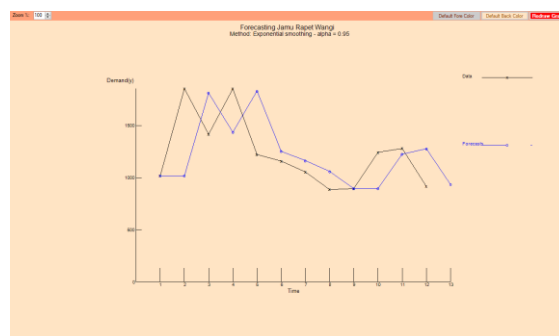


Fig. 4. Graphical plot with exponential smoothing.

3.4 Exponential smoothing with trend

The Exponential Smoothing with Trend method, an analysis model of trend lines, is employed as a forecasting model when the historical pattern of actual demand data indicates an upward trend over time. This method is suitable for forecasting data exhibiting an increasing trend [4]. In table 5, the calculation of forecast errors for the quantity of raw materials from September 2022 to August 2023 was obtained from the

Exponential Smoothing with Trend forecasting method using the POM-QM software with $\alpha = 0.3$ and $\beta = 0.5$.

The forecasted quantity for the next batch of rapet wangi is 1063,17 product, with a Mean Absolute Deviation (MAD) of 305,95; Mean Squared Error (MSE) of 133.237,2 and Mean Absolute Percentage Error (MAPE) of 24,02%.

In the graph above, the pattern of forecasting data obtained looks fluctuating as is the actual data on demand for fragrant rapet herbal medicine. That way, the forecasting results between actual data and forecasting data is still possible forecasting is carried out.

Table 5. Forecasting using exponential smoothing with trend ($\alpha = 0,3$ and $\beta = 0,5$) for Month from September 2022 to August 2023.

Month	Rapet wangi (product)	Forecast
September 2022	1018	
October 2022	1854	1018
November 2022	1416	1394,2
December 2022	1852	1397,74
January 2023	1222	1597,92
February 2023	1159	1422,59
March 2023	1055	1302,8
April 2023	886	1192,5
May 2023	895	1057,21
June 2023	1243	988,23
July 2023	1280	1106,7
August 2023	916	1185,26
Next Period		1063,17

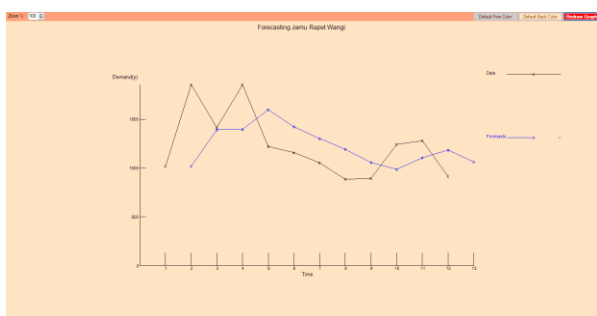


Fig. 5. Graphical plot with exponential smoothing with trend.

3.5 Comparative analysis of forecasting results

After processing the data from the 4 methods above, this is done comparison of MAPE values produced by the four methods for get the smallest error value. Comparative analysis of forecasting results can find out the effectiveness and accuracy of a method in forecasting a time series data [18]. The smaller the MAPE value, the the more accurate a forecasting model is. The following are the forecasting results of the four method by comparing MAPE values.

Table 6. Error comparison between moving average, weight moving average, exponential smoothing and exponential smoothing with trend.

Methods	MAD	MSE	MAPE
Moving Average	310,25	105.978,6	26,64%
Weight Moving Average	306,47	100.975,3	26,55%
Exsponensial Smooting	308,92	155.069,6	23,19%
Exsponensial Smooting with Trend	305,95	133.237,2	24,02%

From Table 6, it can be observed that the exponential smoothing yields a smaller error of 23,19 % compared to the Moving Average of 26,6%, Weighted Moving Average of 26,55%, and Exponential Smoothing with Trend of 24,02%. Therefore, the exponential smoothing method is suitable for forecasting at PT Firdaus Kurnia Indah due to its accurate calculations, resulting in smaller forecast. next period forecast is 935 product. Exponential smoothing is a widely recognized technique for time series forecasting due to its efficiency and accuracy. Exponential smoothing methods are known for their simplicity, computational efficiency, and ability to produce forecasts comparable to more complex statistical models[19]. Existing studies have shown that exponential smoothing techniques can generate accurate forecasts without necessitating excessive resources.

A low MAPE value is an important metric for evaluating the performance of a forecasting model. Specifically, a MAPE between 0-10% is considered excellent, 11-20% is good, 21-50% is acceptable, and values above 50% are deemed poor [20].

4 Conclusion

Based on the results of this research, it can be concluded that considering the data on the quantity of raw materials at PT Firdaus Kurnia Indah, the exponential smoothing method is suitable for predicting rapet wangi's product. This is evident from the MAPE values in all models used, which produce the smallest error at 23,19% with next period forecast is 935 product.

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References

1. Andriati And R. T. Wahjudi, *Society's acceptance level of herb as alternative to modern medicine for lower, middle, and upper class group*, Masyarakat, Kebudayaan Dan Politik, **29**, 3, 133–145 (2016)
2. Ekna Satriyati, *Menjaga tradisi minum jamu madura dengan penyampaian pesan interpersonal kesehatan antara peramu dan pengguna*, DIMENSI, **10**, 2, 24–35 (2017)

3. A. Saputro And B. Purwanggono, *Peramalan perencanaan produksi semen dengan metode exponential smoothing pada PT. Semen Indonesia*, Industrial Engineering Online Jurnal, **5**, 4, 1–7 (2016)
4. A. D. Mahardika And N. Susanto, *Peramalan perencanaan produksi terak dengan metode exponential smoothing with trend pada PT. Semen Indonesia (Persero) Tbk*, Industrial Engineering Online Journal, **6**, 1, 1–10 (2017)
5. Ilyas A. Prakoso, Kusnadi, And B. Nugraha, *Peramalan penjualan produk dengan metode regresi linear dan aplikasi POM-QM Di PT XYZ*, Scientific Journal Widya Teknik, **21**, 1, 14–20 (2022)
6. P. R. Winters, *Forecasting sales by exponentially weighted moving averages*, Manage Sci, **6**, 324–342, (1960), <https://api.semanticscholar.org/Corpusid:154867353>
7. M. Atwani, M. Hlyal, And J. Elalami, *A Review Of Artificial Intelligence Applications In Supply Chain*, in ITM Web Of Conferences (2022), <https://api.semanticscholar.org/Corpusid:249445047>
8. F. Layla Sari, *Demand Forecasting Of Trading Companies Based On Time Sequence* (2021)
9. S. Mukhopadhyay, A. O. Solis, And R. S. Gutierrez, *The accuracy of non-traditional versus traditional methods of forecasting lumpy demand*, J Forecast, **31**, 8, 721–735 (2012), doi: 10.1002/For.1242.
10. Nisa Ayunda, Faizah, And Sujarwo, *Analisa Peramalan Data Time-Series Dengan Aplikasi Windows POM-QM*, Buana Matematika: Jurnal Ilmiah Matematika Dan Pendidikan Matematika, **11**, 2, 167–180 (2021), doi: 10.36456/Buanamatematika.V11i2.5913.
11. S. Hartini, Teknik mencapai produksi optimal (Lubuk Agung, Bandung, 2011)
12. J. Heizer and B. Render, Manajemen operasi: manajemen keberlangsungan dan rantai pasokan edisi ke-11 (Salemba Empat, 2015)
13. V. Gaspersz, Production planning and inventory control (Gramedia Pustaka Utama, 1998)
14. E. Heriansyah and S. Hasibuan, *Implementasi Metode Peramalan Pada Permintaan Bracket Side Stand K59A*, Jurnal PASTI, **12**, 2, 209–223 (2018)
15. D. Ratna Kania, S. Putri Lestari, B. Barlian, P. Studi Manajemen, F. Ekonomi and Bisnis, And U. Perjuangan Tasikmalaya, *Penerapan Metode Peramalan Moving Average Dan Exponential Smoothing Untuk Menyusun Perencanaan Produksi (Survei Pada UMKM Pembuatan Bordir Dan Pakaian, Nining Collection Di Ciamis)*, Jurnal Ilmiah Multidisiplin, **1**, 10, 3609–3622 (2022)
16. I. Setiawan, Rancang bangun aplikasi peramalan persediaan stok barang menggunakan metode Weighted Moving Average (WMA) pada toko barang XYZ (2021)
17. N. P. L. Santiari And I. G. S. Rahayuda, *Penerapan Metode Exponential Smoothing Untuk Peramalan Penjualan Pada Toko Gitar*, JOINTECS (Journal Of Information Technology And Computer Science), **5**, 3, P. 203 (2020) doi: 10.31328/Joointecs.V5i3.1520.
18. N. Ayunda, Faizah, And Sujarwa, *Analisa peramalan data time-series dengan aplikasi windows POM-QM*, Jurnal Ilmiah Matematika dan Pendidikan Matematika, **11**, 2 (2021)
19. A. Abrami, A. Y. Aravkin, And Y. Kim, *Time series using exponential smoothing cells*, Jun (2017), <http://Arxiv.Org/Abs/1706.02829>
20. C. C. Holt, *Forecasting seasonals and trends by exponentially weighted moving averages*, Int J Forecast, **20**, 1, 5–10 (2004), doi: <https://doi.org/10.1016/J.Ijforecast.2003.09.015>.