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# Forecasting Drug Needs Using the Single Exponential Smoothing Method at Ibnu Sina Regional Hospital, Gresik Regency

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**Abstract:** This study was conducted at Ibnu Sina Regional Hospital in Gresik Regency with the aim of improving the accuracy of drug demand forecasting. The main issue in the hospital's drug inventory management is the inaccuracy in estimating demand, which leads to the risk of stock shortages or surpluses and disrupts healthcare services. The study seeks to compare the effectiveness of the currently used consumption-based method with the Single Exponential Smoothing method as a more adaptive alternative to changes in demand. A descriptive approach was used, utilizing historical order and usage data of ten selected generic drugs from July to December 2023. Forecasting accuracy was evaluated using the Mean Absolute Percentage Error (MAPE) indicator. The results indicate that the Single Exponential Smoothing method provides higher accuracy compared to the consumption method, with MAPE values below 10% for most of the drug data. Therefore, this method is more effective in minimizing forecasting errors and supports more efficient and timely drug procurement decisions. The study concludes that implementing the Single Exponential Smoothing method can enhance drug inventory management and is worth considering as the basis for a hospital drug demand forecasting system.

**Keyword:** Forecasting, Single Exponential Smoothing, Inventory Management

## INTRODUCTION

Improving the quality of healthcare services is one of the key pillars in achieving the well-being of the Indonesian population. Hospitals, as healthcare service institutions, play a strategic role in ensuring access to adequate treatment, including the timely and appropriate availability of medicines. Forecasting is a method for estimating the impact of current situations on future developments (N. D. Rahmawati et al., 2021). Forecasting plays a critical role in managerial decision-making, particularly in operational areas, as it helps organizations plan for capacity, inventory, labor, and other resources more efficiently (Heizer et al., 2020). Optimal drug availability is a critical component in ensuring the success of patient therapy and the smooth operation of hospital services. However, there is no coherent method for measuring the performance of the procurement process, making it difficult for hospital purchasing departments to make well-informed decisions (Hanif Dzulquarnain & Kirono, n.d.). This situation has serious implications, considering that healthcare commodities are essential public needs. By applying accurate forecasting, hospitals can optimize the pharmaceutical supply chain and respond to patient demands more quickly and effectively (Nahmias & Olsen, 2021).

One of the commonly used methods for drug requirement planning in hospitals is the consumption method, which is an approach based on drug usage data from previous periods. A study by (Hernowo et al., 2020) Studies have shown that the consumption method, which relies solely on historical drug usage data, has limitations in accurately predicting demand surges—particularly during emergency situations such as health crises or disease outbreaks. Inaccurate forecasting can lead to disruptions in drug distribution, budget inefficiencies, and even pose risks to patient safety.

This study was conducted at Ibnu Sina Regional Hospital in Gresik Regency, a referral hospital that faces ongoing challenges in maintaining the availability of essential generic drug stock. Based on historical data from July to December 2023, discrepancies were found between the quantity of drugs ordered and the actual usage. Therefore, this research aims to apply the Single Exponential Smoothing method and compare its accuracy with the consumption method as a basis for more efficient drug demand management recommendations.

Theoretically, this study is grounded in forecasting theory within operations management, which emphasizes the importance of utilizing historical data to anticipate future needs (Hyndman & Athanasopoulos, 2021). Accurate forecasting supports strategic decision-making in hospital logistics, helping to reduce costs caused by overstocking or stockouts, and ultimately improving the quality of patient care. The Single Exponential Smoothing method can enhance inventory management efficiency by minimizing the risks of both drug shortages and surpluses (Ardiansyah et al., 2019).

The data used in this study include the quantity of generic drugs ordered and consumed to meet demand over a specific period, as well as the forecasting accuracy, which indicates how closely the estimated values align with the actual figures. The level of accuracy is measured using the Mean Absolute Percentage Error (MAPE), an indicator widely used due to its practical interpretability in percentage form (Makridakis et al., 1998).

The research problem addressed in this study is formulated as follows:

1. How is the consumption method applied as the current drug demand forecasting system at Ibnu Sina Regional Hospital in Gresik Regency?
2. What are the results of drug demand forecasting when the Single Exponential Smoothing method is applied at Ibnu Sina Regional Hospital in Gresik Regency?
3. How accurate is the Single Exponential Smoothing method in forecasting drug demand at Ibnu Sina Regional Hospital in Gresik Regency?

## METHOD

This research is a descriptive study with a quantitative approach, aiming to analyze and compare the forecasting accuracy of drug demand using the Single Exponential Smoothing method and the consumption method currently applied at Ibnu Sina Regional Hospital in Gresik Regency. According to (Sugiyono, 2017) a descriptive qualitative approach is used to examine conditions in a natural setting, with the researcher serving as the key instrument.

The subject of this study consists of historical data on the ordering and usage of generic drugs recorded by the Pharmacy Department of Ibnu Sina Regional Hospital in Gresik Regency during the period from July to December 2023. The objects of analysis include ten types of generic drugs with high usage rates that are listed in the national formulary, thus representing the hospital's primary pharmaceutical needs. These data were selected due to their strong relevance to the research objectives and their reflection of significant drug demand patterns.

The main instruments used in this study are calculation worksheets and numerical data processing software (Microsoft Excel), which were utilized to perform forecasting using the Single Exponential Smoothing formula and to calculate forecasting accuracy using the Mean

Absolute Percentage Error (MAPE). The smoothing constant (α) was determined using a trial-and-error approach to obtain the most accurate forecasting value.

The research procedure was carried out in several stages. First, secondary data were collected in the form of generic drug ordering and usage quantities from the hospital's internal reports. Second, the data were analyzed using the Single Exponential Smoothing method, applying the following formula:

$$\boldsymbol{F_t + 1 = \alpha A_t + (1 - \alpha) F_t}$$

Description:

$F_t + 1$ = forecast value for period t + 1
$A_t$ = actual value in period t
$F_t$ = forecast value for the previous period
α = smoothing constant, with a range of $0 < \alpha < 10$

After the forecasting process is completed, the results are evaluated using three accuracy indicators: Mean Absolute Deviation (MAD), Mean Squared Error (MSE), and Mean Absolute Percentage Error (MAPE). The MAPE value is used as the primary benchmark for assessing the accuracy of the forecasting model. According to (Lewis, 1982), a MAPE value below 10% can be categorized as highly accurate forecasting.

## RESULTS AND DISCUSSION

### Result

The following are research findings taking into account the context and problem formulation:

### Consumption Method

The drug demand planning system currently implemented at the Pharmacy Department of Ibnu Sina Regional Hospital in Gresik Regency remains conventional and is not yet supported by a forecasting approach based on quantitative methods. Estimates of the quantity and types of drugs to be ordered are made subjectively, relying on the staff's experience, intuition, and observations of past patient demand patterns. This approach is manual and lacks a systematic structure, often resulting in suboptimal accuracy in predicting drug availability.

**Table 1. Generic Drug Order and Usage Data for July - December 2023**

| No. | Generic Drugs | Order | Usage |
|---|---|---|---|
| 1 | Adalat oros 30 mg tab. | 108000 | 118169 |
| 2 | Asam folat 1 mg tab. | 121500 | 122524 |
| 3 | Cefixime 100 mg caps. | 89000 | 95142 |
| 4 | Citicoline 250 mg/2 ml inj. | 27850 | 28145 |
| 5 | Eperisone 50 mg tab. | 115300 | 120293 |
| 6 | Glucosamine 500 mg tab. | 82000 | 87291 |
| 7 | Metformin 500 mg tab. | 198000 | 230783 |
| 8 | Omeprazole 40 mg inj. | 100000 | 103464 |
| 9 | Ondansetron 4 mg inj. | 50000 | 57785 |
| 10 | Paracetamol 500 mg tab. | 181000 | 198788 |

Source: Generic Drug Order and Usage Data at Ibnu Sina Regional Hospital, Gresik Regency, July – December 2023

Based on the data collected from July to December 2023, it was observed that the quantity of drug orders did not always align with actual usage patterns in the field. In some months, drug consumption exceeded the ordered quantities, posing a risk of service delays due to stock shortages. Therefore, it is necessary to evaluate the current system and implement a more data-driven and measurable forecasting method.

**Single Exponential Smoothing Method**

Drug usage data serves as the primary variable in the drug demand forecasting process using the Single Exponential Smoothing method. The data analyzed consists of monthly drug usage records from the Pharmacy Department of Ibnu Sina Regional Hospital in Gresik Regency for the period of July to December 2023.

**Table 2. Generic Drug Usage Data for July - December 2023**

| No. | Obat Generik | Years 2023 | | | | | |
|---|---|---|---|---|---|---|---|
| | | July | August | September | October | November | December |
| 1 | Adalat oros 30 mg tab. | 9823 | 9863 | 9798 | 9512 | 10238 | 11335 |
| 2 | Asam folat 1 mg tab. | 7125 | 13192 | 10596 | 12206 | 11662 | 8629 |
| 3 | Cefixime 100 mg caps. | 9460 | 9680 | 8537 | 8072 | 6371 | 4719 |
| 4 | Citicoline 250 mg/2 ml inj. | 3647 | 1794 | 2091 | 2288 | 2538 | 2747 |
| 5 | Eperisone 50 mg tab. | 11953 | 9820 | 9820 | 10888 | 11753 | 10303 |
| 6 | Glucosamine 500 mg tab. | 7830 | 7812 | 7306 | 7897 | 9197 | 10273 |
| 7 | Metformin 500 mg tab. | 20548 | 19492 | 17068 | 18547 | 18958 | 21187 |
| 8 | Omeprazole 40 mg inj. | 8185 | 9179 | 8612 | 9314 | 9374 | 8878 |
| 9 | Ondansetron 4 mg inj. | 4732 | 4741 | 4907 | 5108 | 5701 | 4937 |
| 10 | Paracetamol 500 mg tab. | 17378 | 18721 | 15985 | 18326 | 17851 | 17326 |

Source: Generic Drug Usage Data at Ibnu Sina Regional Hospital, Gresik Regency, July – December 2023

The drug usage data presented in Table 2 shows the consumption volumes of various types of medications at the Pharmacy Department of Ibnu Sina Regional Hospital in Gresik Regency during the period from July to December 2023. This data serves as the primary input in the drug demand forecasting analysis using the Single Exponential Smoothing method, which aims to more accurately estimate future drug requirements.

The following are the forecasting calculations for each generic drug using a smoothing constant of 0,3.

**Table 3. Results of Forecasting Drug Needs for Adalat Oros 30 mg Tablets Using the Single Exponential Smoothing Method**

| Period | Actual $A_t$ | Smoothed Value $S_t$ | Forecast $F_t$ | Absolute Error $A_t - F_t$ | Squared Error $(A_t - F_t)^2$ | Percent Error $\frac{A_t - F_t}{A_t}$ |
|---|---|---|---|---|---|---|
| 2023 | | | | | | |
| July | 9823 | 9823 | – | – | – | – |
| August | 9863 | 9835 | 9823 | 40 | 1,600 | 0.41% |
| September | 9798 | 9823.9 | 9835 | 37 | 1,369 | 0.38% |
| October | 9512 | 9730.3 | 9823.9 | 311.9 | 97,299 | 3.28% |
| November | 10238 | 9882.6 | 9730.3 | 507.7 | 257,766 | 4.96% |
| December | 11335 | 10318.3 | 9882.6 | 1452.4 | 2,109,469 | 12.81% |
| 2024 | | | | | | |
| January | | | 10318.3 | – | – | – |
| | | | | MAD 469.8 | MSE 495,300.6 | MAPE 4.37% |
| Real consumption | | | | | 10812 | |
| Alfa error (%) | | | | | 4.57% | |

Source: Data Processing Results, 2025

**Table 4. Results of Forecasting the Need for 1 mg Asam Folat Tablets Using the Single Exponential Smoothing Method**

| Period | Actual $A_t$ | Smoothed Value $S_t$ | Forecast $F_t$ | Absolute Error $A_t - F_t$ | Squared Error $(A_t - F_t)^2$ | Percent Error $\frac{A_t - F_t}{A_t}$ |
|---|---|---|---|---|---|---|
| 2023 | | | | | | |
| July | 7125 | 7125 | – | – | – | – |
| August | 13192 | 9062.1 | 7125 | 6067.0 | 36,808,689 | 46.0 |
| September | 10596 | 9510.27 | 9062.1 | 1533.9 | 2,352,692 | 14.47 |
| October | 12206 | 10188.39 | 9510.27 | 2695.73 | 7,267,165 | 22.08 |
| November | 11662 | 10572.87 | 10188.39 | 1473.61 | 2,171,742 | 12.63 |
| December | 8629 | 9987.41 | 10572.87 | 1943.87 | 3,778,723 | 22.52 |
| 2024 | | | | | | |
| January | | | 9987.41 | – | – | – |
| | | | | MAD 2,742.02 | MSE 10,443,702.2 | MAPE 23.54% |
| | Real consumption | | | | 10841 | |
| | Alfa error (%) | | | | 7.87% | |

Source: Data Processing Results, 2025

**Table 5. Results of Forecasting the Need for Cefixime 100 mg Capsules Using the Single Exponential Smoothing Method**

| Period | Actual $A_t$ | Smoothed Value $S_t$ | Forecast $F_t$ | Absolute Error $A_t - F_t$ | Squared Error $(A_t - F_t)^2$ | Percent Error $\frac{A_t - F_t}{A_t}$ |
|---|---|---|---|---|---|---|
| 2023 | | | | | | |
| July | 9460 | - | - | - | - | - |
| August | 9680 | 9526,00 | 9460,00 | 220 | 48400 | 2.27% |
| September | 8537 | 9229,30 | 9526,00 | 989 | 978121 | 11.59% |
| October | 8072 | 8882,11 | 9229,30 | 1157.3 | 1338324.29 | 14.34% |
| November | 6371 | 8128,78 | 8882,11 | 2511.11 | 6302054.84 | 39.41% |
| December | 4719 | 7105,84 | 8128,78 | 3409.78 | 11633680.54 | 72.26% |
| 2024 | | | | | | |
| January | | | 7105,84 | – | – | – |
| | | | | MAD 1657,44 | MSE 4.059.623,38 | MAPE 27,97% |
| | Real consumption | | | | 5861 | |
| | Alfa error (%) | | | | 21.24% | |

Source: Data Processing Results, 2025

**Table 6. Results of Forecasting the Need for Citicoline 250 mg/2 ml Injection Using the Single Exponential Smoothing Method**

| Period | Actual $A_t$ | Smoothed Value $S_t$ | Forecast $F_t$ | Absolute Error $A_t - F_t$ | Squared Error $(A_t - F_t)^2$ | Percent Error $\frac{A_t - F_t}{A_{t\,x}}$ |
|---|---|---|---|---|---|---|
| 2023 | | | | | | |
| July | 3647 | – | – | – | – | – |
| August | 1794 | 3033.1 | 3647 | 1853 | 3431825 | 103.31% |
| September | 2091 | 2777.87 | 3033.1 | 942.1 | 887553.61 | 45.06% |
| October | 2288 | 2632.51 | 2777.87 | 489.87 | 240964.27 | 21.41% |
| November | 2538 | 2601.26 | 2632.51 | 94.51 | 8932.40 | 3.72% |
| December | 2747 | 2644.78 | 2601.26 | 145.74 | 21238.95 | 5.30% |
| 2024 | | | | | | |
| January | | | 2644.78 | – | – | – |
| | | | | MAD 705.44 | MSE 925,102.05 | MAPE 35.56% |

| Period | Actual $A_t$ | Smoothed Value $S_t$ | Forecast $F_t$ | Absolute Error $A_t - F_t$ | Squared Error $(A_t - F_t)^2$ | Percent Error $\frac{A_t - F_t}{A_{t\ x}}$ |
|---|---|---|---|---|---|---|
| Real consumtion | | | | | 3368 | |
| Alfa error (%) | | | | | 21.47% | |

Source: Data Processing Results, 2025

**Table 7. Results of Forecasting the Need for Eperisone 50 mg Tablets Using the Single Exponential Smoothing Method**

| Period | Actual $A_t$ | Smoothed Value $S_t$ | Forecast $F_t$ | Absolute Error $A_t - F_t$ | Squared Error $(A_t - F_t)^2$ | Percent Error $\frac{A_t - F_t}{A_t}$ |
|---|---|---|---|---|---|---|
| 2023 | | | | | | |
| July | 11953 | – | – | – | – | – |
| August | 9820 | 11313.1 | 11953 | 2133 | 4550689 | 21.72% |
| September | 9820 | 10865.17 | 11313.1 | 1493.1 | 2229349.6 | 15.21% |
| October | 10888 | 10872.02 | 10865.17 | 22.83 | 521.36 | 0.21% |
| November | 11753 | 11136.31 | 10872.02 | 880.98 | 775125.36 | 7.5% |
| December | 10303 | 10886.32 | 11136.31 | 833.31 | 694412.76 | 8.09% |
| 2024 | | | | | | |
| January | | | 10886.32 | – | – | – |
| | | | | MAD 1072.24 | MSE 1,650,419.61 | MAPE 10.95% |
| Real consumption | | | | | 11425 | |
| Alfa error (%) | | | | | 4.71% | |

Source: Data Processing Results, 2025

**Table 8. Results of Forecasting the Need for Glucosamine 500 mg Tablets Using the Single Exponential Smoothing Method**

| Period | Actual $A_t$ | Smoothed Value $S_t$ | Forecast $F_t$ | Absolute Error $A_t - F_t$ | Squared Error $(A_t - F_t)^2$ | Percent Error $\frac{A_t - F_t}{A_t}$ |
|---|---|---|---|---|---|---|
| 2023 | | | | | | |
| July | 7830 | | - | - | - | - |
| August | 7812 | 7824.6 | 7830 | 18 | 324 | 0.23% |
| September | 7306 | 7660.82 | 7824.6 | 518.6 | 268976.0 | 7.10% |
| October | 7897 | 7724.47 | 7660.82 | 236.18 | 55784.58 | 2.99% |
| November | 9197 | 8160.53 | 7724.47 | 1472.53 | 2168775.8 | 16.01% |
| December | 10273 | 8751.52 | 8160.53 | 2112.47 | 4462596.5 | 20.57% |
| 2024 | | | | | | |
| January | | | 8751.52 | – | – | – |
| | | | | MAD 871.16 | MSE 1,393,691.78 | MAPE 9.78% |
| Real consumption | | | | | 11349 | |
| Alfa error (%) | | | | | 22.90% | |

Source: Data Processing Results, 2025

**Table 9. Results of Forecasting Metformin 500 mg Tablet Drug Needs Using the Single Exponential Smoothing Method**

| Period | Actual $A_t$ | Smoothed Value $S_t$ | Forecast $F_t$ | Absolute Error $A_t - F_t$ | Squared Error $(A_t - F_t)^2$ | Percent Error $\frac{A_t - F_t}{A_t}$ |
|---|---|---|---|---|---|---|
| 2023 | | | | | | |
| July | 20548 | – | – | – | – | – |
| August | 19492 | 20208.4 | 20548 | 1056 | 1115136 | 5.42% |
| September | 17068 | 19274.48 | 20208.4 | 3140.4 | 986849.76 | 18.40% |

| | | | | | | |
|---|---|---|---|---|---|---|
| October | 18547 | 19043.63 | 19274.48 | 727.48 | 529227.38 | 3.92% |
| November | 18958 | 19018.74 | 19043.63 | 85.63 | 7332.30 | 0.45% |
| December | 21187 | 19627.82 | 19018.74 | 2168.26 | 4700705.41 | 10.23% |
| 2024 | | | | | | |
| January | | | 19627.82 | – | – | – |
| | | | | MAD<br>1235.15 | MSE<br>1,466,450.57 | MAPE<br>7.68% |
| Real consumtion | | | | | 23499 | |
| Alfa error (%) | | | | | 16.48% | |

Source: Data Processing Results, 2025

**Table 10. Results of Forecasting the Need for Omeprazole 40 mg Injection Using the Single Exponential Smoothing Method**

| Period | Actual $A_t$ | Smoothed Value $S_t$ | Forecast $F_t$ | Absolute Error $A_t - F_t$ | Squared Error $(A_t - F_t)^2$ | Percent Error $\frac{A_t - F_t}{A_t}$ |
|---|---|---|---|---|---|---|
| 2023 | | | | | | |
| July | 8185 | – | – | – | – | – |
| August | 9179 | 8483.20 | 8185 | 994.00 | 988,036.00 | 10.83% |
| September | 8612 | 8521.84 | 8483.20 | 128.80 | 16,589.44 | 1.50% |
| October | 9314 | 8759.49 | 8521.84 | 792.16 | 627,517.47 | 8.51% |
| November | 9374 | 8943.84 | 8759.49 | 614.51 | 377,622.54 | 6.56% |
| December | 8878 | 8924.09 | 8943.84 | 65.84 | 4,334.91 | 0.74% |
| 2024 | | | | | | |
| January | | | 8924.09 | – | – | – |
| | | | | MAD<br>519.06 | MSE<br>402,820.07 | MAPE<br>5.63% |
| Real consumption | | | | | 9897 | |
| Alfa error (%) | | | | | 9.83% | |

Source: Data Processing Results, 2025

**Table 11. Results of Forecasting the Need for Ondansetron 4 mg Injection Using the Single Exponential Smoothing Method**

| Period | Actual $A_t$ | Smoothed Value $S_t$ | Forecast $F_t$ | Absolute Error $A_t - F_t$ | Squared Error $(A_t - F_t)^2$ | Percent Error $\frac{A_t - F_t}{A_t}$ |
|---|---|---|---|---|---|---|
| 2023 | | | | | | |
| July | 4732 | – | – | – | – | – |
| August | 4741 | 4734,70 | 4732,00 | 9,00 | 81,00 | 0,19% |
| September | 4907 | 4786,39 | 4734,70 | 172,30 | 29.687,29 | 3,51% |
| October | 5108 | 4882,87 | 4786,39 | 321,61 | 103.433,00 | 6,30% |
| November | 5701 | 5128,31 | 4882,87 | 818,13 | 669.331,79 | 14,35% |
| December | 4937 | 5070,92 | 5128,31 | 191,31 | 36.599,94 | 3,88% |
| 2024 | | | | | | |
| January | | | 5070,92 | – | – | – |
| | | | | MAD<br>302.47 | MSE<br>167,826.60 | MAPE<br>5.64% |
| Real consumption | | | | | 5770 | |
| Alfa error (%) | | | | | 12.11% | |

Source: Data Processing Results, 2025

**Table 12. Results of Forecasting the Need for Paracetamol 500 mg Tablets Using the Single Exponential Smoothing Method**

| Period | Actual $A_t$ | Smoothed Value $S_t$ | Forecast $F_t$ | Absolute Error $A_t - F_t$ | Squared Error $(A_t - F_t)^2$ | Percent Error $\frac{A_t - F_t}{A_t}$ |
|---|---|---|---|---|---|---|
| 2023 | | | | | | |
| July | 17378 | – | – | – | – | – |
| August | 18721 | 17725.91 | 17378 | 1343 | 1803649 | 7.17% |
| September | 15985 | 17242.14 | 17725.91 | 1741 | 3030481 | 10.89% |
| October | 18326 | 17545.30 | 17242.14 | 1083 | 1172889 | 5.91% |
| November | 17851 | 17623.41 | 17545.30 | 306 | 93636 | 1.71% |
| December | 17326 | 17515.49 | 17623.41 | 297 | 88209 | 1.71% |
| 2024 | | | | | | |
| January | | | 17515.49 | – | – | – |
| | | | | MAD | MSE | MAPE |
| | | | | 954 | 1.195.373 | 5,88% |
| Real consumption | | | | | 19099 | |
| Alfa error (%) | | | | | 8.29% | |

Source: Data Processing Results, 2025

**Table 13. Results of Forecasting Generic Drug Use Using the Single Exponential Smoothing Method**

| No. | Obat Generik | *Forecast* Results | MAD | MSE | MAPE |
|---|---|---|---|---|---|
| 1 | Adalat oros 30 mg tab. | 10318.3 | 469.8 | 495,300.6 | 4.37% |
| 2 | Asam folat 1 mg tab. | 9987.41 | 2,742.02 | 10,443,702.2 | 23.54% |
| 3 | Cefixime 100 mg caps. | 7105,84 | 1657,44 | 4.059.623,38 | 27,97% |
| 4 | Citicoline 250 mg/2 ml inj. | 2644.78 | 705.44 | 925,102.05 | 35.56% |
| 5 | Eperisone 50 mg tab. | 10886.32 | 1072.24 | 1,650,419.61 | 10.95% |
| 6 | Glucosamine 500 mg tab. | 8751.52 | 871.16 | 1,393,691.78 | 9.78% |
| 7 | Metformin 500 mg tab. | 19627.82 | 1235.15 | 1,466,450.57 | 7.68% |
| 8 | Omeprazole 40 mg inj. | 8924.09 | 519.06 | 402,820.07 | 5.63% |
| 9 | Ondansetron 4 mg inj. | 5070,92 | 302.47 | 167,826.60 | 5.64% |
| 10 | Paracetamol 500 mg tab. | 17515.49 | 954 | 1.195.373 | 5,88% |

Source: Data Processing Results, 2025

Based on the calculation results, the values of MAD (Mean Absolute Deviation), MSE (Mean Squared Error), and MAPE (Mean Absolute Percentage Error) for each drug are presented in Table 13 These metrics were used to measure the deviation between actual values and forecast results. Overall, the analysis shows that the Single Exponential Smoothing method provides varying levels of accuracy across different drugs. Several drugs demonstrated excellent forecasting accuracy, indicated by MAPE values below 10%, such as Adalat Oros 30 mg tablets (MAPE 4.37%), Omeprazole 40 mg injection (5.63%), Ondansetron 4 mg injection (5.64%), Paracetamol 500 mg tablets (5.88%), Metformin 500 mg tablets (7.68%), and Glucosamine 500 mg tablets (9.78%).

According to (Lewis, 1982), a MAPE value below 10% is considered highly accurate. However, several drugs showed relatively high MAPE values, such as Citicoline 250 mg/2 ml injection (35.56%), Cefixime 100 mg capsules (27.97%), and Asam folat 1 mg tablets (23.54%). These high MAPE values indicate low forecasting accuracy, making the results less reliable for procurement decision-making.

Therefore, the Single Exponential Smoothing method can be considered a viable alternative for drug demand planning, particularly for drugs with relatively stable demand patterns over time.

**Accuracy Level of Drug Demand Forecasting Results Using the Single Exponential Smoothing Method**

**Table 14. Comparison of Forecasting Results with Actual Generic Drug Consumption and Alpha Error Values**

| No | Obat Generik | Hasil *Forecast* | Real Consumtion | Alfa error (%) |
|---|---|---|---|---|
| 1 | Adalat oros 30 mg tab. | 10.318,3 | 10812 | 4.57% |
| 2 | Asam folat 1 mg tab. | 9.987,41 | 10841 | 7.97% |
| 3 | Cefixime 100 mg caps. | 7105,84 | 5861 | 21.24% |
| 4 | Citicoline 250 mg/2 ml inj. | 2644.78 | 3368 | 21.47% |
| 5 | Eperisone 50 mg tab. | 10886.32 | 11425 | 4.71% |
| 6 | Glucosamine 500 mg tab. | 8751.52 | 11349 | 22.90% |
| 7 | Metformin 500 mg tab. | 19627.82 | 23499 | 16.48% |
| 8 | Omeprazole 40 mg inj. | 8924.09 | 9897 | 9.83% |
| 9 | Ondansetron 4 mg inj. | 5070,92 | 5770 | 12.11% |
| 10 | Paracetamol 500 mg tab. | 17515.49 | 19099 | 8.29% |

Source: Data Processing Results, 2025

Based on the calculation results, forecasting accuracy varied significantly across drug types. Some drugs showed low error rates, indicating that the method is fairly reliable for predicting their demand. For instance, Adalat Oros 30 mg tablets had a forecasted value of 10,318.3 compared to an actual consumption of 10,812, resulting in an error rate of 4.57%. Similarly, Eperisone 50 mg tablets showed an error of 4.71%. These low error rates suggest that the Single Exponential Smoothing method performs well for drugs with relatively stable demand patterns.

However, certain drugs exhibited high forecasting errors. Glucosamine 500 mg tablets had an error rate of 22.90%, while Citicoline 250 mg/2 ml injection reached 21.47%. These high error values indicate that Single Exponential Smoothing is less effective for capturing fluctuating or inconsistent demand patterns.

Overall, the Single Exponential Smoothing method can be considered effective for forecasting drug needs, particularly for items with stable demand over time. However, its effectiveness decreases when applied to drugs with high demand variability. Therefore, it is essential to consider the consumption characteristics of each drug when selecting an appropriate forecasting method.

## Discussion

**Application of Consumption Method in Drug Demand Forecasting System**

The consumption method is a drug forecasting approach that uses past drug usage data as the basis for calculation, then adjusts for factors such as safety stock, lead time, and remaining inventory. The main steps in applying the consumption method in hospitals, including Ibnu Sina Regional Hospital in Gresik, are: (1) data collection and processing, (2) data analysis, (3) calculation of drug requirements, and (4) adjustment based on budget allocation.

This method tends to be less accurate when there are significant changes in consumption patterns or disease trends, as it relies heavily on historical usage data and does not require morbidity data. Additionally, it does not fully support rational drug use, as it does not account for standardized treatment guidelines (Indras Wari et al., 2022).

**Results of Drug Needs Forecasting Using the Single Exponential Smoothing Method**

Based on the forecasting results presented in Table 13, the smallest MAD value was found in Adalat Oros 30 mg tablets, amounting to 469.8, while the smallest MSE value was also recorded for the same drug, at 495,300.6. This indicates that the Single Exponential Smoothing method produced a very low level of forecasting error deviation for this item. A low MAD value signifies that the average absolute deviation between actual and forecasted values is small, while a low MSE value indicates the absence of large errors or outliers in the forecasting data. As explained by (Makridakis et al., 2008) MAD is effective for measuring accuracy when the data scale is uniform, while MSE offers greater sensitivity to large errors.

Furthermore, in terms of MAPE, which expresses forecasting error as a percentage, the smallest MAPE value was also found in Adalat Oros 30 mg tablets, at 4.37%. According to the accuracy classification proposed by (Lewis, 1982), a MAPE value below 10% is considered highly accurate.

Conversely, the highest MAPE value in the table was observed for Citicoline 250 mg/2 ml injection, at 35.56%, indicating a relatively high forecasting error compared to the actual data. According to (Lewis, 1982), a MAPE value between 20% and 50% is classified as having *reasonable forecast accuracy*, especially when applied to data with high variability or fluctuating patterns—such as seasonal demand data, sales data affected by sudden trends, or irregular medical usage patterns. In this context, although the relative error is not low, the forecasting model is still considered acceptable for providing a general overview of historical trends.

In line with Lewis's perspective, several recent studies also confirm that MAPE values up to 50% can still be considered acceptable under certain conditions. Recent research in the field of drug demand forecasting affirms that MAPE values ranging from 20% to 50% remain relevant and usable, particularly when dealing with fluctuating or seasonal data, and are still applicable in pharmaceutical planning and management (Bagus et al., n.d.).

**Accuracy of Drug Needs Forecasting Using the Single Exponential Smoothing Method**

In this study, the Single Exponential Smoothing method was used to forecast the demand for generic drugs at Ibnu Sina Regional Hospital in Gresik. This method was chosen for its simplicity and its ability to accommodate data with relatively stable patterns over time (Makridakis et al., 1998).

The analysis shows that the forecasting accuracy of the Single Exponential Smoothing method varies depending on the type of drug. For medications with relatively stable consumption patterns, such as Adalat Oros 30 mg tablets, the forecasted value of 10,318.3 compared to the actual consumption of 10,812 resulted in an error rate of only 4.57%. Similar results were observed for Eperisone 50 mg tablets and Paracetamol 500 mg tablets, with error rates of 4.71% and 8.29%, respectively—both considered accurate. These findings suggest that Single Exponential Smoothing is quite effective in projecting the demand for drugs with consistent usage patterns.

The effectiveness of the Single Exponential Smoothing method in this context is consistent with the findings of (Yulianti & Andriani, 2021), who stated that Single Exponential Smoothing performs well for forecasting data that do not exhibit significant trends or seasonal variations. Their study emphasized that Single Exponential Smoothing is capable of maintaining prediction stability for non-fluctuating logistic needs, making it suitable for short-term planning.

However, there are also types of drugs with unstable consumption patterns, resulting in relatively high forecasting errors. For example, Glucosamine 500 mg tablets and Citicoline 250 mg/2 ml injections recorded error rates of 22.90% and 21.47%, respectively. This indicates that the Single Exponential Smoothing method is less suitable for data with high fluctuations or those influenced by trends and seasonality.

Overall, it can be concluded that Single Exponential Smoothing remains accurate for forecasting drug needs with stable demand patterns. This level of accuracy offers benefits in procurement efficiency, budget management, and ensuring continuity in hospital pharmacy services (N. Rahmawati et al., 2020).

For drugs with more complex consumption patterns, it is recommended to apply more adaptive forecasting methods—such as Double Exponential Smoothing, Holt-Winters, or ARIMA—which are capable of capturing trend and seasonal components in the data.

Considering the unique characteristics of each drug, selecting an appropriate forecasting method is crucial. Hospitals need to develop forecasting systems based on historical data that are adaptive to changing demand dynamics, in order to support accurate and strategic decision-making in pharmaceutical logistics management.

## CONCLUSION

Based on the findings of the study on drug demand forecasting at Ibnu Sina Regional General Hospital in Gresik, the following conclusions can be drawn (1) The currently used consumption method remains conventional and simplistic, relying solely on historical usage data from the previous three months. This approach does not account for dynamic factors such as usage trends, patient fluctuations, or extraordinary events, which may lead to inaccuracies in drug planning. (2) The application of the Single Exponential Smoothing method demonstrates more responsive performance in capturing historical data patterns. Calculations of MAD, MSE, and MAPE for various drug types show that The Single Exponential Smoothing produces lower forecasting errors compared to the consumption method. Most drugs yielded MAPE values within the "reasonably acceptable" range (20%–50%), indicating adequate forecasting accuracy in the healthcare context. Therefore, (3) The Single Exponential Smoothing method is considered more accurate in projecting essential drug needs in hospitals and has the potential to serve as an effective tool for pharmacy management in planning drug procurement more efficiently, minimizing stock shortages or surpluses, and supporting improved quality of patient care.

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