



FORECASTING CARDIOVASCULAR DRUG DEMAND USING TRIPLE EXPONENTIAL SMOOTHING ADDITIVE

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ABSTRACT

Drug management and pharmaceutical services in hospitals often face two main problems: stockouts and overstocking. This research aims to apply the Triple Exponential Smoothing (TES) additive method to forecast cardiovascular drug needs for the period of January–March 2024 at RSUD Dr. Kanujoso Djatiwibowo. This research employs a retrospective method using cardiovascular drugs data collected between January 2021 and December 2023. The forecasting results were interpreted using Mean Absolute Percentage Error (MAPE). The forecasting conducted in the range of January - March 2024, there four drug items distribute in highly accurate forecasts (MAPE<10%), while four drugs exhibited good forecasting performance (MAPE 10%-20%). Additionally, two drug items showed fair forecast results (MAPE 20%-50). This study concluded that RSUD Dr. Kanujoso Djatiwibowo could use TES Additive forecasting method.

Keywords: additive; cardiovascular drugs; forecasting; triple exponential smoothing

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INTRODUCTION

Pharmaceutical services play a crucial role in ensuring the availability of high-quality medicines for patients. However, hospital medication management often faces several challenges, one of which is suboptimal drug planning, which frequently results in medication shortages (Hanjaya et al., 2021). Such conditions not only disrupt the continuity of patient treatment but also lead to increased costs for replenishing supplies, often at higher prices (Friska et al., 2019). On the other hand, overstocking of medicines can also pose a problem, as it may lead to expired or damaged drugs. Therefore, it is essential for hospitals to implement better and more effective drug planning to ensure adequate medication availability without incurring unnecessary waste (Rosmania & Supriyanto, 2015).

The main issue of medication inventory in hospitals can result in substantial financial losses, particularly for high-cost drugs (Toyo et al., 2021). Cardiovascular diseases are the leading cause of death worldwide, with at least 15 out of 1,000 people suffering from such conditions (Riskseddas, 2018; Setiadi & Halim, 2018). Furthermore, cardiovascular diseases are among the top conditions with the highest healthcare claim costs (BPJS Kesehatan, 2021). Medication inventory issues for these drugs can cause significant losses, thus requiring greater attention to planning in order to minimize and control these problems (Hariyono et al., 2017). Forecasting drug needs can serve as a tool to address this issue (Saepulloh & Putra, 2018).

Forecasting is an activity conducted to estimate future events (Saepulloh & Putra, 2018). A commonly used method is the Triple Exponential Smoothing (TES) method, which predicts future drug needs (Burinskiene, 2022). TES has been proven effective in predicting medication needs in studies such as at RS Paru Dr. H. A. Rotinsulu Bandung and RS GMIM

Siloam Sonder, where it analyzed drug usage patterns over time (Lawalata et al., 2021; Saepulloh & Putra, 2018).

Forecasting using TES can be performed using two approaches: TES additive and TES multiplicative. The additive model is superior when used for data with consistent time series variations (Yusuf et al., 2022). This approach is effective when fluctuations remain relatively constant between periods, allowing for a clear separation of seasonal effects and other influencing factors (Tirkeş et al., 2017). Forecast accuracy is crucial to calculate the reliability of predictions, as it is impossible to achieve perfect forecasting due to numerous factors influencing future errors. One value used to assess prediction accuracy is the Mean Absolute Percentage Error (MAPE) (Sabarina et al., 2021; Satibi, 2015). The objective of this study is to forecast drug needs using the TES Additive method at RSUD Dr. Kanujoso Djatiwibowo Balikpapan for the period of January–March 2024. The use of this method is expected to make a significant contribution to the development of more effective and efficient medication management strategies, particularly in ensuring stable drug availability in accordance with demand patterns at RSUD Dr. Kanujoso Djatiwibowo Balikpapan.

METHOD

This study utilizes retrospective data for analysis. The data includes the 10 cardiovascular drugs with the highest usage at RSUD Dr. Kanujoso Djatiwibowo Balikpapan during the period of January 2021 to December 2024. 10 cardiovascular drugs with the highest usage at RSUD Dr. Kanujoso Djatiwibowo Balikpapan during the period of January 2021-December 2024. Forecasting was conducted using EViews 12 software and the Triple Exponential Smoothing (TES) Additive method. The input data consisted of monthly drug usage records over a period of 36 months. The resulting output included the smoothing constant values α , β , and γ . Forecasting was then performed for the subsequent three months, specifically January to March 2024, using the previously obtained smoothing constant values. To evaluate the accuracy of the forecast, the Mean Absolute Percentage Error (MAPE) was calculated (Sumitra & Basri, 2020). The MAPE value was derived by inputting the actual drug usage data and the forecasted values into Microsoft Excel. The MAPE value was calculated using the following equation:

$$MAPE = \frac{\sum[actual - forecasting]}{actual} \times 100\% \quad (\text{Heizer et al., 2020})$$

The MAPE value will then be interpreted as shown in Table 1.

Table 1.

MAPE Interpretation

MAPE (%)	Interpretation
<10	Highly accurate forecasting
10 - 20	Good forecasting
20 - 50	Reasonable forecasting
>50	Inaccurate forecasting

(Montaño Moreno et al., 2013)

RESULT

Based on cardiovascular drug usage data at RSUD Dr. Kanujoso Djatiwibowo Balikpapan for the period January 2021 to December 2023, there are 10 cardiovascular drugs with the highest usage, Amlodipine 10 mg tablets, Atorvastatin 20 mg tablets, Clopidogrel 75 mg tablets, Amlodipine 5 mg tablets, Candesartan 16 mg, Furosemide 40 mg, Candesartan 8 mg, Acetosal 100 mg, Bisoprolol 2.5 mg, and Rosuvastatin 10 mg. Each drug with the same active ingredient, dosage form, and strength was grouped together. This grouping includes both generic and non-generic drugs used in the hospital. The purpose of grouping identical drug

items is to determine the actual quantity of each drug item with the same active ingredient, dosage form, and strength.

Forecasting using the TES Additive method involves three levels of smoothing: level smoothing (α), trend smoothing (β), and seasonal smoothing (γ). The optimal constant values depend on the characteristics of the data being analyzed (Nangi et al., 2021). The optimal values for each smoothing constant are automatically obtained using EViews 12 software. The smoothing constant values range between 0 and 1. A value close to 0 indicates that the analyzed data is relatively stable and does not change significantly over time. Conversely, a value close to 1 suggests that the data fluctuates over time, making the forecast more sensitive to new observations (Hyndman & Athanasopoulos, 2018).

Table 2. Smoothing Constants Results and MAPE Interpretation

No.	Drug Item	Smoothing Constants (0-1)			Average MAPE	MAPE Interpretation
		α	β	γ		
1.	Amlodipine 10 mg	0,710	0,000	0,000	14%	Good forecasting
2.	Atorvastatin 20 mg	0,460	0,000	0,000	18%	Good forecasting
3.	Clopidogrel 75 mg	0,950	0,000	0,000	10%	Good forecasting
4.	Amlodipine 5mg	0,000	0,000	0,000	16%	Good forecasting
5.	Candesartan 16 mg	0,990	0,000	0,000	14%	Good forecasting
6.	Furosemide 40 mg	0,340	0,000	0,000	10%	Good forecasting
7.	Candesartan 8 mg	0,940	0,000	0,000	18%	Good forecasting
8.	Asetosal 80 mg	0,870	0,000	0,000	13%	Good forecasting
9.	Bisoprolol 2,5 mg	0,820	0,000	0,000	17%	Good forecasting
10.	Rosuvastatin 10 mg	0,500	0,000	0,000	38%	Reasonable forecasting

Table 3.
MAPE Interpretation for January – March 2024

No.	Drug Item	3-Month Usage	3-Month Forecast	Average 3-Month MAPE	MAPE Interpretation
1	Amlodipine 10 mg	66828	38877	17%	Good Forecasting
2	Atorvastatin 20 mg	88186	49447	15%	Good Forecasting
3	Clopidogrel 75 mg	47477	31198	6%	Highly Accurate Forecasting
4	Amlodipine 5mg	36238	28104	13%	Good Forecasting
5	Candesartan 16 mg	44261	27376	8%	Highly Accurate Forecasting
6	Furosemide 40 mg	42330	24233	10%	Good Forecasting
7	Candesartan 8 mg	34132	23127	3%	Highly Accurate Forecasting
8	Acetosal 80 mg	46913	22418	29%	Reasonable forecasting
9	Bisoprolol 2,5 mg	30424	18099	25%	Reasonable forecasting
10	Rosuvastatin 10 mg	28548	20113	9%	Highly Accurate Forecasting

DISCUSSION

This study forecasts the demand for cardiovascular drugs at RSUD Dr. Kanujoso Djatiwibowo using the Triple Exponential Smoothing (TES) Additive method. TES Additive is well-suited for data with relatively stable seasonal patterns (Nawawi et al., 2021) and is recognized for its ability to produce accurate forecasting results (Yusuf et al., 2022). Historical drug usage data spanning 36 months was utilized to calculate the smoothing constants α (alpha), β (beta), and γ (gamma). The optimal values were generated automatically using EViews 12 software and are presented in Table II. The smoothing constants obtained through TES Additive varied, indicating differences in the stability of drug usage patterns across the selected items (Sabarina et al., 2021). The variability in α (alpha) values highlights that the forecasted levels differ among drug types, demonstrating the model's ability to closely follow actual drug usage patterns, as also noted in previous research by (Afrilia, 2021). This variation suggests differing responsiveness to recent data changes.

Meanwhile, the smoothing constants β (beta) and γ (gamma) were consistently 0.000 for all drug items, reflecting the absence of significant fluctuations in trends or seasonal patterns within the analyzed dataset (Hyndman & Athanasopoulos, 2018). Similar findings from other studies confirm that TES Additive can achieve high forecast accuracy even when β and γ values are zero (Nurhamidah et al., 2020).

The application of TES Additive is particularly appropriate for this dataset, as the observed seasonal patterns remain relatively stable over time. This confirms the effectiveness of TES Additive in forecasting drug usage with minimal seasonal and long-term trend variations (Kristianto et al., 2017; Nurhamidah et al., 2020). Table II reveals that nine drugs achieved good forecast accuracy with Mean Absolute Percentage Error (MAPE) values ranging from 10% to 20%. These drugs include Amlodipine 10 mg, Atorvastatin 20 mg, Clopidogrel 75 mg, Amlodipine 5 mg, Candesartan 16 mg, Furosemide 40 mg, Candesartan 8 mg, Acetosal 100 mg, and Bisoprolol 2.5 mg. One drug, Rosuvastatin 10 mg, was categorized as having reasonable forecast accuracy with a MAPE of 38%. Comparative analysis demonstrates that TES Additive produces superior results with lower MAPE values compared to other exponential smoothing methods (Vimala & Nugroho, 2022).

Forecasting was performed for the subsequent three months to estimate drug demand for January to March 2024. The results, presented in Table III, were generated using the historical drug usage data from the prior 36 months and the corresponding smoothing constants obtained earlier (Table II). Effective inventory management is crucial for hospitals to ensure continuity of patient treatment and enhance operational efficiency. Short-term demand forecasting facilitates accurate inventory planning, mitigates critical drug shortages, and optimizes resource allocation (Yuniarti, 2020). Forecasting for a three-month procurement period enables bulk purchasing, which can lead to logistical efficiencies, reduced shipping costs, and improved price negotiations with suppliers. Maintaining adequate drug supplies over this period ensures uninterrupted treatment for patients, minimizes the risk of stockouts, and allows consistent monitoring of treatment effectiveness.

Table III highlights the varying MAPE values for each drug item. Four drugs Clopidogrel 75 mg, Candesartan 16 mg, Candesartan 8 mg, and Rosuvastatin 10 mg achieved highly accurate forecasts with MAPE values below 10%. Additionally, Amlodipine 10 mg, Atorvastatin 20 mg, Amlodipine 5 mg, and Furosemide 40 mg demonstrated good forecast accuracy with MAPE values between 10% and 20%. These findings indicate that TES Additive can produce forecasts closely aligned with actual drug usage data. Two drugs, Acetosal 100 mg and Bisoprolol 2.5 mg, were categorized as having reasonable forecast accuracy with MAPE values ranging from 20% to 50%. The forecasting results should be supplemented with additional relevant information, such as market trends and policy changes, to support more comprehensive decision-making. Moreover, regular monitoring of forecast accuracy is essential to maintain the reliability and effectiveness of the forecasting process.

CONCLUSION

Based on the forecasting analysis of cardiovascular drug usage data at RSUD Dr. Kanujoso Djatiwibowo over a 36-month period January 2021 to December 2023, the smoothing constants obtained varied for each drug item, reflecting differences in their usage patterns. Using the Triple Exponential Smoothing Additive method the forecast for the period **January-March 2024** demonstrated highly accurate results (MAPE < 10%) for **4 drug items**, good accuracy (MAPE between 10%–20%) for **4 drug items**, and reasonable accuracy (MAPE between 20%–50%) for **2 drug items**. These findings highlight the effectiveness of the TES Additive method in providing reliable short-term forecasts, which can support

accurate inventory planning, minimize drug shortages, and optimize resource management within the hospital.

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