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Drug Sales Forecasting at XYZ Pharmacy using Single Moving Average and Single Exponential Smoothing Methods Based on a Web-Based System

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Abstract

This study aims to develop a web-based drug sales prediction system at XYZ Pharmacy by implementing two forecasting methods: Single Moving Average (SMA) and Single Exponential Smoothing (SES). The system is designed to help address fluctuations in drug demand that may lead to overstocking or stockouts, which can ultimately impact pharmacy operations and service quality. The system was built using PHP as the programming language and MySQL as the database, with a primary focus on the sales forecasting feature. The dataset used includes the sales of 5 types of drugs from July 2024 to May 2025, which were analyzed to predict sales for the following month. Evaluation results show that the SES method with a smoothing constant α = 0.2 achieved a Mean Absolute Percentage Error (MAPE) of 9.38%, while the SMA method with a 5-month period resulted in a MAPE of 9.43%. Among all the data, Mefenamic Acid yielded the most accurate prediction for June 2025. Both methods were successfully implemented in the system, with SES showing slightly better performance, especially in handling gradual trend changes. Additionally, the system allows users to compare forecasting results across methods and supports better decision-making in inventory management, helping to maintain optimal drug availability at the pharmacy.

Keywords: *Sales Forecasting, Single Moving Average, Single Exponential Smoothing, MAPE, Web-Based System.*

1. Introduction

As time progresses, modern humans have discovered more rational forecasting methods, utilizing historical data. Advances in statistics have also driven the development of these methods. In this era, quantitative thinking is increasingly dominant, leading many decisions to be made based on analytical results. This situation makes the role of statistics increasingly crucial in the decision-making process, as predicting what might happen in the future allows for easier and more focused decision-making[1].

Pharmacies are businesses engaged in the sale of medicines and health products, as well as providing healthcare services. In addition to selling prescription drugs, pharmacies also provide generic drugs available without a prescription[2]. As public demand for medicines increases, XYZ Pharmacy, located in Babat District, is required to manage inventory and sales more efficiently. One of the main challenges faced is predicting drug sales to meet demand without experiencing overstocking or understocking. Overstocking can lead to losses due to expired drugs, while understocking can result in lost customers and revenue[3].

Furthermore, in the business world, forecasting plays a crucial role in supporting decision-making. With forecasting, a business can anticipate future prospects and achieve optimal profits. Specifically, in demand forecasting, the goal is to minimize the risk of sales forecast errors that could lead to losses. For example, if sales forecasts are too high, this can lead to overproduction and burden operational costs[4].

Statistical methods such as the Single Moving Average (SMA) and Single Exponential Smoothing (SES) have proven effective in sales forecasting. The SMA method calculates the average sales over a specific period[5]. The SES method, on the other hand, places more weight on recent data, allowing the pharmacy to be more responsive to changes in demand. A good forecasting method can help pharmacies better plan drug inventory and optimize revenue[6].

Besides SMA and SES, other forecasting methods exist, such as SAW (Simple Additive Weighting), ARIMA (Autoregressive Integrated Moving Average), and TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution). Each method has its own advantages, but often requires more complex data, additional parameter settings, or more intensive computation. In this study, SMA and SES were chosen due to their simplicity, time efficiency, and relevance to the characteristics of pharmacy sales data. However, if future sales data patterns become more complex or require multi-criteria analysis, methods such as SAW, ARIMA, or TOPSIS can be considered to support more accurate and strategic decision-making[7].

This study will focus on XYZ Pharmacy, a growing pharmacy. By implementing a web-based sales forecasting system using SMA and SES methods, the pharmacy is expected to improve inventory management efficiency and maximize profits. The use of a web-based system in pharmacy management can improve data access and accelerate decision-making, allowing for quick adjustments[8].

This study aims to compare the effectiveness of the Single Moving Average (SMA) and Single Exponential Smoothing (SES) methods in predicting drug sales at XYZ Pharmacy. Through analysis of historical sales data and the application of both methods, this study is expected to provide an overview of the most appropriate forecasting method to use. The results of this study are expected to provide practical benefits for pharmacies in improving the accuracy of sales predictions, thereby supporting more effective strategic decision-making[9].

2. Methodology

The research procedure is a series of systematic steps designed to achieve the research objectives by collecting relevant and reliable data and information. This study employed a descriptive and quantitative approach to data collection and analysis[10]. Data were collected through interviews, observations, and analysis of various factors influencing sales estimates, including historical sales data. The results of this data collection were processed to develop a website-based drug sales forecasting system at XYZ Pharmacy using the Single Moving Average (SMA) and Single Exponential Smoothing (SES) methods. Furthermore, this study also aimed to evaluate and compare the performance of the two methods.

3. Result and Discussion

In this research, system requirements analysis encompasses various elements required in the system development process. These requirements include data collection through observation at XYZ Pharmacy, the application of calculation formulas, system design, and the system implementation stage. All these stages are carried out to ensure the system built meets the research objectives and can operate optimally.

3.1. Observation Data

The data in this study were obtained through three main methods: observation, interviews, and literature review. Direct observations were conducted at XYZ Pharmacy to obtain a realistic picture of sales activities and drug inventory management. Furthermore, interviews were conducted with relevant parties, such as pharmacists and employees, to obtain in-depth information regarding sales patterns and challenges faced in inventory management. Literature review was also used to strengthen the theoretical foundation and understand forecasting methods relevant to this study. The drug sales data for the study are shown in the following table, where the researcher used 11 months of purchase data as analysis material in developing the forecasting system.

Table 1: XYZ Pharmacy Sales Data for July 2024 - May 2025

No	Month	Product Data				
		Antasida Doen	Ibuprofen	Mefenamic Acid	Molacort	Paracetamol
1	July 2024	73	100	146	58	142
2	August 2024	67	87	157	71	128
3	September 2024	89	70	143	82	115
4	October 2024	94	105	178	44	92
5	November 2024	81	98	180	97	118
6	December 2024	102	112	142	134	134
7	January 2025	107	81	158	109	102
8	February 2025	95	94	190	87	114
9	March 2025	88	60	162	73	98
10	April 2025	100	96	140	65	152
11	May 2025	86	89	163	54	131

3.2. Application of Forecasting

In this study, sales predictions for June 2025 were generated using sales data from July 2024 to May 2025 as the basis for the calculations. This data was used because it covers the last 11 months and is considered to be representative of sales patterns. Forecasting was conducted using two methods: Single Moving Average (SMA) and Single Exponential Smoothing (SES). These two methods were chosen to allow for comparison of the prediction results. The calculation results were then evaluated using the Mean Absolute Percentage Error (MAPE) value for each product. The calculation steps are explained as follows:

a. Calculating Single Moving Average

For the June 2025 period, the Single Moving Average (SMA) method with a 5-month moving average was used as the basis for the prediction calculations. This method was chosen because it can reduce sales data fluctuations, resulting in more stable forecast values. For example, researchers used monthly sales data from the previous five periods and then calculated the predicted values using the SMA formula, as shown in the following equation[11]:

$$S_{t+1} = \frac{x_1 + x_{t-1} + \cdots . + x_{t-n+1}}{n}$$

Description:

St + 1 = Forecast for period t+1

Xt = Data period t

n = Moving average Timeframe

Table 2: Manual Single Moving Average Calculation of Antasida Doen

No	Month	Antasida Doen	Single Moving Average Prediction	APE
1	July 2024	73	-	-
2	August 2024	67	-	-
3	September 2024	89	-	-
4	October 2024	94	-	-
5	November 2024	81	-	-
6	December 2024	102	80,80	20,78
7	January 2025	107	86,60	19,07
8	February 2025	95	94,60	0,42
9	March 2025	88	95,80	8,86
10	April 2025	100	94,60	5,40
11	May 2025	86	98,40	14,42
12	June	-	95,20	-

The prediction results obtained using the Single Moving Average (SMA) method with a period of 5 show that in June 2025 the forecast value of Antasida Doen drug sales is 95.20.

Table 3: Manual Single Moving Average Calculation of Ibuprofen

No	Month	Ibuprofen	Single Moving Average Prediction	APE
1	July 2024	100	-	-
2	August 2024	87	-	-
3	September 2024	70	-	-
4	October 2024	105	-	-
5	November 2024	98	-	-
6	December 2024	112	92,00	17,86
7	January 2025	81	94,40	16,54
8	February 2025	94	93,20	0,85
9	March 2025	60	98,00	63,33
10	April 2025	96	89,00	7,29
11	May 2025	89	88,60	0,45
12	June	-	84,00	-

The prediction results obtained using the Single Moving Average (SMA) method with a period of 5 show that in June 2025 the forecast value of Ibuprofen drug sales is 84.00.

Table 4: Manual Single Moving Average Calculation of Mefenamic Acid

No	Month	Mefenamic Acid	Single Moving Average Prediction	APE
1	July 2024	146	-	-
2	August 2024	157	-	-
3	September 2024	143	-	-
4	October 2024	178	-	-
5	November 2024	180	-	-
6	December 2024	142	160,80	13,24
7	January 2025	158	160,00	1,27
8	February 2025	190	160,20	15,68
9	March 2025	162	169,60	4,69
10	April 2025	140	166,40	18,86
11	May 2025	163	158,40	2,82
12	June	-	162,60	-

The prediction results obtained using the Single Moving Average (SMA) method with a period of 5 show that in June 2025 the forecast value of Mefenamic Acid drug sales is 162.60.

Table 5: Manual Single Moving Average Calculation of Molacort

No	Month	Molacort	Single Moving Average Prediction	APE
1	July 2024	58	-	-
2	August 2024	71	-	-
3	September 2024	82	-	-
4	October 2024	44	-	-
5	November 2024	97	-	-
6	December 2024	134	70,40	47,46
7	January 2025	109	85,60	21,47
8	February 2025	87	93,20	7,13
9	March 2025	73	94,20	29,04
10	April 2025	65	100,00	53,85
11	May 2025	54	93,60	73,33
12	June	-	77,60	-

The prediction results obtained using the Single Moving Average (SMA) method with a period of 5 show that in June 2025 the forecast value of Molacort drug sales is 77.60.

Table 6: Manual Single Moving Average Calculation of Paracetamol

No	Month	Paracetamol	Single Moving Average Prediction	APE
1	July 2024	142	-	-
2	August 2024	128	-	-
3	September 2024	115	-	-
4	October 2024	92	-	-
5	November 2024	118	-	-

6	December 2024	134	119,00	11,19
7	January 2025	102	117,40	15,10
8	February 2025	114	112,20	1,58
9	March 2025	98	112,00	14,29
10	April 2025	152	113,20	25,53
11	May 2025	131	120,00	8,40
12	June	-	119,40	-

The prediction results obtained using the Single Moving Average (SMA) method with a period of 5 show that in June 2025 the forecast value of Paracetamol drug sales is 119.40.

b. Calculating Single Exponential Smoothing

The Single Exponential Smoothing (SES) method with a smoothing parameter (α = 0.5) is used in the prediction calculation process. This method was chosen because it can give greater weight to the most recent sales data, so that the forecast results are more responsive to changes in data patterns. For example, researchers use monthly product sales data from the previous period, then calculate the predicted value using the SES formula as shown in the following equation[12]:

$$F_{t+1} = a \,.\, X_t + (1 - a) \,.\, F_t$$

Description:

Ft+1 = Prediction for period t+1

Xt = Actual value for period t

Ft = Forecasted value for period t

a = Smoothing weight factor ($0 < a < 1$)

Table 7: Manual Single Exponential Smoothing Calculation of Antasida Doen

No	Month	Antasida Doen	Single Exponential Smoothing	APE
1	July 2024	73	-	-
2	August 2024	67	73	8,96
3	September 2024	89	71,80	19,33
4	October 2024	94	75,24	19,96
5	November 2024	81	78,99	2,48
6	December 2024	102	79,39	22,16
7	January 2025	107	83,91	21,57
8	February 2025	95	88,53	6,81
9	March 2025	88	89,83	2,07
10	April 2025	100	89,46	10,54
11	May 2025	86	91,57	6,47
12	June	-	90,45	-

The prediction results obtained using the Single Exponential Smoothing (SES) method with an alpha of 0.2 show that in June 2025 the forecast value of Antasida Doen drug sales is 90.45.

Table 8: Manual Single Exponential Smoothing Calculation of Ibuprofen

No	Month	Ibuprofen	Single Exponential Smoothing	APE
1	July 2024	100	-	-
2	August 2024	87	100	14,94
3	September 2024	70	97,40	39,14
4	October 2024	105	91,92	12,46
5	November 2024	98	94,54	3,53
6	December 2024	112	95,23	14,97
7	January 2025	81	98,58	21,71
8	February 2025	94	95,07	1,13
9	March 2025	60	94,85	58,09
10	April 2025	96	87,88	8,46
11	May 2025	89	89,51	0,57
12	June	-	89,40	-

The prediction results obtained using the Single Exponential Smoothing (SES) method with an alpha of 0.2 show that in June 2025 the forecast value of Ibuprofen drug sales is 89.40.

Table 9: Manual Single Exponential Smoothing Calculation of Mefenamic Acid

No	Month	Mefenamic Acid	Single Exponential Smoothing	APE
1	July 2024	146	-	-
2	August 2024	157	146	7,01
3	September 2024	143	148,20	3,64
4	October 2024	178	147,16	17,33
5	November 2024	180	153,33	14,82
6	December 2024	142	158,66	11,73
7	January 2025	158	155,33	1,69
8	February 2025	190	155,86	17,97
9	March 2025	162	162,69	0,43
10	April 2025	140	162,55	16,11
11	May 2025	163	158,04	3,04
12	June	-	159,03	-

The prediction results obtained using the Single Exponential Smoothing (SES) method with an alpha of 0.2 show that in June 2025 the forecast value of Mefenamic Acid drug sales is 159.03.

Table 10: Manual Single Exponential Smoothing Calculation of Molacort

No	Month	Molacort	Single Exponential Smoothing	APE
1	July 2024	58	-	-
2	August 2024	71	58	18,31
3	September 2024	82	60,60	26,10
4	October 2024	44	64,88	47,45
5	November 2024	97	60,70	37,42
6	December 2024	134	67,96	49,28
7	January 2025	109	81,17	25,53
8	February 2025	87	86,74	0,30
9	March 2025	73	86,79	18,89
10	April 2025	65	84,03	29,28
11	May 2025	54	80,23	48,56
12	June	-	74,98	-

The prediction results obtained using the Single Exponential Smoothing (SES) method with an alpha of 0.2 show that in June 2025 the forecast value of Molacort drug sales is 74.98.

Table 11: Manual Single Exponential Smoothing Calculation of Paracetamol

No	Month	Paracetamol	Single Exponential Smoothing	APE
1	July 2024	142	-	-
2	August 2024	128	142	10,94
3	September 2024	115	139,20	21,04
4	October 2024	92	134,36	46,04
5	November 2024	118	125,89	6,68
6	December 2024	134	124,31	7,23
7	January 2025	102	126,25	23,77
8	February 2025	114	121,40	6,49
9	March 2025	98	119,92	22,37
10	April 2025	152	115,54	23,99
11	May 2025	131	122,83	6,24
12	June	-	124,46	-

The prediction results obtained using the Single Exponential Smoothing (SES) method with an alpha of 0.2 show that in June 2025 the forecast value of Paracetamol drug sales is 124.46.

c. Calculating Mean Absolute Percentage Error

Testing the accuracy and error rate of each product prediction result is carried out using MAPE (Mean Absolute Percentage Error) which is calculated based on the following equation[13]:

$$APE = \left|\frac{X_t - Y_t}{X_t}\right| .100 \quad MAPE = \left|\frac{\sum APE}{n}\right|$$

Description:

Xt = Real data for period t

Yt = Forecast data for the current period

n = Number of periods

Table 12: MAPE Calculation Results

No	Product	Single Moving Average		Single Exponential Smoothing	
		Forecast Results	MAPE (%)	Forecast Results	MAPE (%)
1	Antasida Doen	95,20	11,49	90,45	12,04
2	Ibuprofen	84,00	17,72	89,40	17,50
3	Mefenamic Acid	162,60	9,43	159,03	9,38
4	Molacort	77,60	38,71	74,98	30,11
5	Paracetamol	119,40	12,68	124,46	17,48

Based on the MAPE calculation results, the best average prediction error for the Mefenamic Acid product was obtained using the Single Moving Average (SMA) method of 9.43% and the Single Exponential Smoothing (SES) method of 9.38%. These values indicate that the level of prediction accuracy is included in the very good category, considering that MAPE below 10% is generally classified as very accurate, MAPE between 10–20% is considered good, 20–50% is sufficient, and above 50% is poor. Thus, these results confirm that the forecasting model used in the study is able to produce fairly accurate and reliable predictions.

3.3. System Design

The process design in this study uses a process-based approach by utilizing Data Flow Diagrams (DFD) as the main tool to describe data flow and inter-process relationships in the system. DFD was chosen because it is able to present workflows clearly and structured. The design stages include the creation of flow diagrams, DFD level 0 (context diagram) for interactions with external entities, DFD level 1 for more detailed process details, as well as the design of Conceptual Data Models (CDM) and Physical Data Models (PDM) that represent data requirements both conceptually and physically.

a. Flowchart system

The system flowchart in this study is divided into three main sections. The first section explains the forecasting process using the Single Moving Average (SMA) method. The second section explains the application of the Single Exponential Smoothing

(SES) method. The third section shows the comparison stage of the prediction results from the two methods. Through this flow, the system can display forecasting results to determine the more accurate method to use in predicting drug sales.

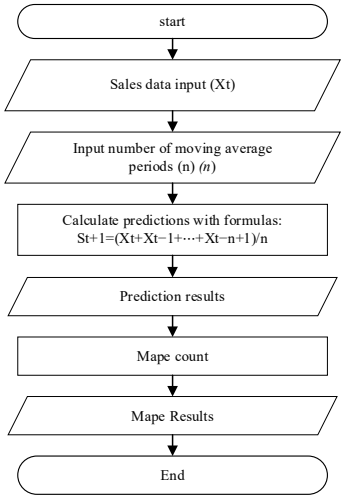

Fig. 1: Flowchart Single Moving Average

The Single Moving Average (SMA) method is used to forecast sales by calculating the average of sales data from the last few months. The process begins by entering historical sales data (Xt), then entering the number of forecasting periods (n). The predicted value for the next period is calculated using the formula $S_{t+1}=(X_t+X_{t-1}+\cdots+X_{t-n+1})/n$. Once the predicted value is obtained, the next step is to calculate its accuracy using MAPE (Mean Absolute Percentage Error), which is the percentage difference between the actual value and the forecasted result. The MAPE result is displayed as an indicator of how good the resulting prediction quality is. The SMA method is relatively simple because it does not require special parameters such as the α value in the SES method, and only depends on the number of averaging periods used in the calculation.

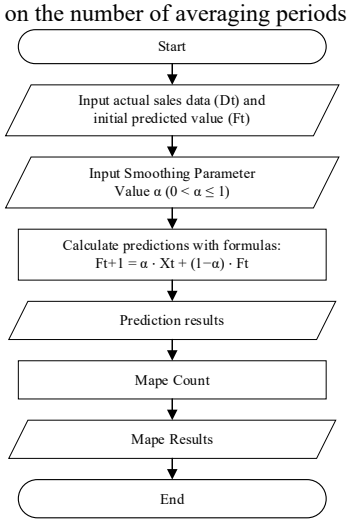

Fig. 2: Flowchart Single Exponential Smoothing

The Single Exponential Smoothing (SES) method is used to forecast sales based on actual sales data (Xt) and the initial predicted value (Ft). The first step is to determine the smoothing constant (α) with a range between 0 and 1. Next, the forecast is performed using the formula $F_{t+1} = \alpha \cdot X_t + (1-\alpha) \cdot F_t$. The α value can be adjusted to obtain more accurate prediction results. After the prediction is calculated for the specified period, the system then evaluates its accuracy using the MAPE (Mean Absolute Percentage Error) method. This MAPE value is an indicator of the level of prediction error and is used to assess the quality of the resulting forecast results.

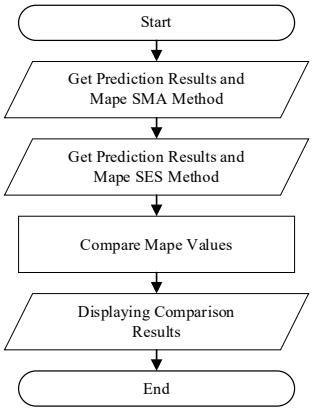

Fig. 3: Flowchart comparison of SMA and SES

This process begins with obtaining sales prediction results and their accuracy using the Single Moving Average (SMA) method, measured by the Mean Absolute Percentage Error (MAPE) value. This value is used to determine the level of error between the predicted results and the actual data. Next, the system also takes the predicted results and MAPE value from the Single Exponential Smoothing (SES) method. After both methods obtain their respective prediction results and MAPE values, the system compares their MAPE values. The method with the lower MAPE value is considered more accurate because it has a lower prediction error. The results of this comparison are then used as the basis for determining which method is more appropriate for use in forecasting drug sales in the system that has been created.

b. Data Flow Diagram (DFD)

A Level 0 DFD, often called a Context Diagram, is useful for explaining the general scope of a system. A context diagram depicts the relationships or interactions between the system and its entities[14]. The purpose of this DFD is to help understand the interactions between the system, users, and other external components within the context of a web-based drug sales prediction system in a pharmacy.

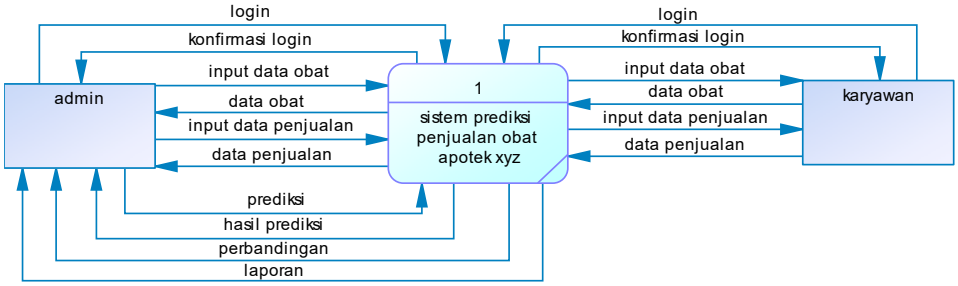

Fig. 4: Data Flow Diagram Level 0

This diagram illustrates the data flow between the system and actors, namely admins and employees. Both can log in through authentication and then input drug and sales data managed by the system as the basis for forecasting. The prediction process uses the Single Moving Average (SMA) and Single Exponential Smoothing (SES) methods, then the results are compared based on the Mean Absolute Percentage Error (MAPE) value to determine the more accurate method. These predictions and comparison results are only accessible to admins for consideration in managing drug stock. The diagram is structured to clarify the overall system's operation.

A Level 1 Data Flow Diagram (DFD) provides a more detailed explanation than a Level 0 DFD because it depicts the system's main processes in depth[15]. At this level, data flows between subprocesses, external entities, and data stores are clearly visible, making the relationships between system components easier to understand. Thus, a Level 1 DFD helps explain how a web-based drug sales forecasting system in a pharmacy works in a more structured and clear manner. Furthermore, a Level 1 DFD also serves as a guideline during the system development phase to ensure it meets user needs.

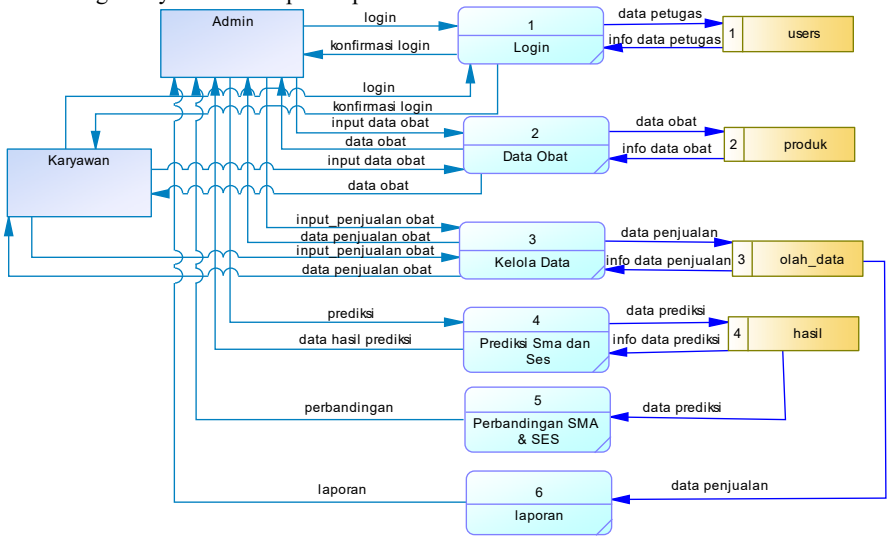

Fig. 5: Data Flow Diagram Level 1

In this system, there are two main actors: the admin and the employee, who have different roles and access rights. The admin has full authority over all system features, from logging in, managing drug data, inputting and processing sales data, processing forecasts, comparing methods, and generating reports. In contrast, employees can only log in, input drug data, and process sales data, without access to the prediction, comparison, or reporting processes. Both login processes are verified through the users entity to ensure data validity. After successful login, drug data is stored in the product entity, and sales are recorded in the data processing entity. The system then runs sales forecasting using the Single Moving Average (SMA) and Single Exponential Smoothing (SES) methods, with the prediction results stored in the results entity. The results of both methods are then compared based on the Mean Absolute Percentage Error (MAPE) value to determine the accuracy of each method.

c. Conceptual Data Model (CDM)

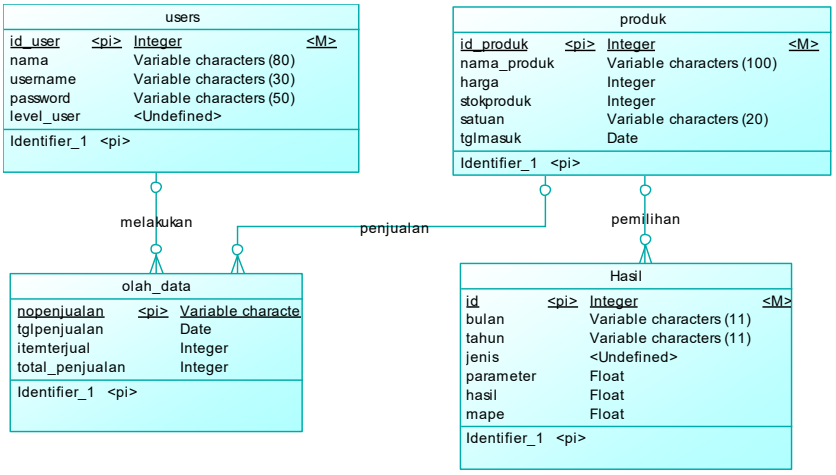

Fig. 6: Conceptual Data Model

The Conceptual Data Model (CDM) presented represents a conceptual database design for a drug sales prediction system at XYZ Pharmacy using the Single Moving Average (SMA) and Single Exponential Smoothing (SES) methods. This model consists of four main entities: users, products, data processing, and results, each of which plays a crucial role in supporting the system's operation. The relationships between these entities are shown through the "do" relationships between users and data processing, "sales" relationships between products and data processing, and "selection" relationships between products and result.

d. Physical Data Model (PDM)

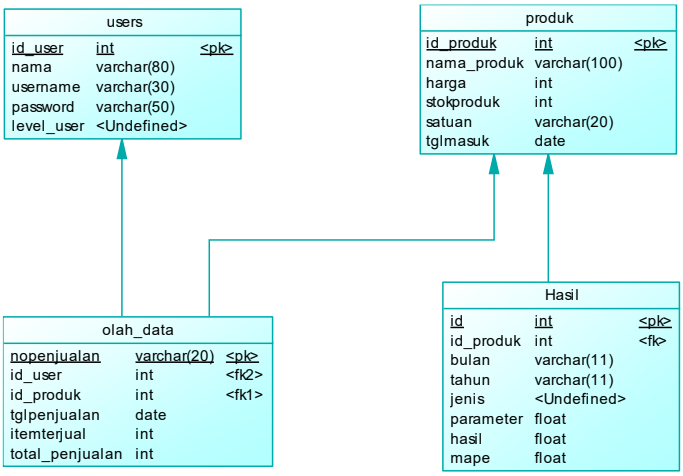

Fig. 7: Physical Data Model

The Physical Data Model (PDM) presented consists of four main tables: users, products, data processing, and results, each of which has been assigned data types according to the system's implementation requirements, such as INT, VARCHAR, DATE, and FLOAT. The users table stores user information, while the products table contains drug data. The data processing table records sales transactions and has relationships with the users and products tables. The results table is used to store the output of the prediction process and is directly connected to the products table. Relationships between tables are built using primary keys and foreign keys, depicted by connecting lines, thus ensuring data integrity while supporting smooth processing and efficient forecasting of drug sales in the pharmacy prediction system.

3.4. System Implementation

The discussion of the system implementation in this application results outlines each page that has been designed and successfully implemented into the system. Each page is explained based on its function and role in supporting the drug sales prediction process, including how the available features work according to the initial design objectives. This explanation aims to provide a comprehensive overview of the system's performance and assess the application's effectiveness when used by both administrators and employees in XYZ Pharmacy operations.

a. Login Page Menu

The login page is the system's initial interface, serving as the primary gateway to access all application features. This page consists of several key components: a username field, a password field, and a Login button. The username field is used to enter the user's identity registered in the database, while the password field serves as an additional layer of security for the authentication process.

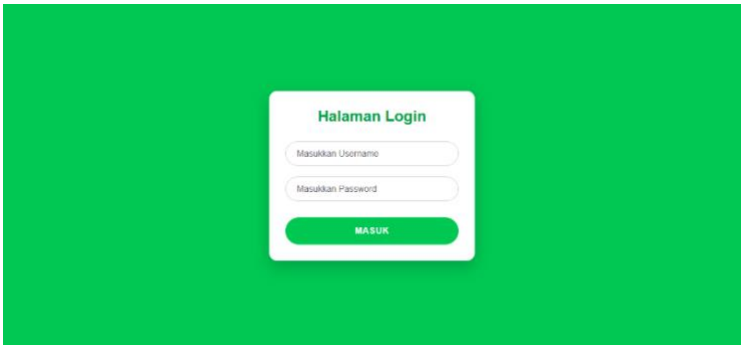

Fig. 8: Login Page Menu

b. Dashboard Page Menu

The Dashboard page displays the admin's control center for using the system. The main page displays brief information about the active admin account, including the username, current time, last login time, and account status. This allows the admin to immediately determine their identity and most recent login activity.

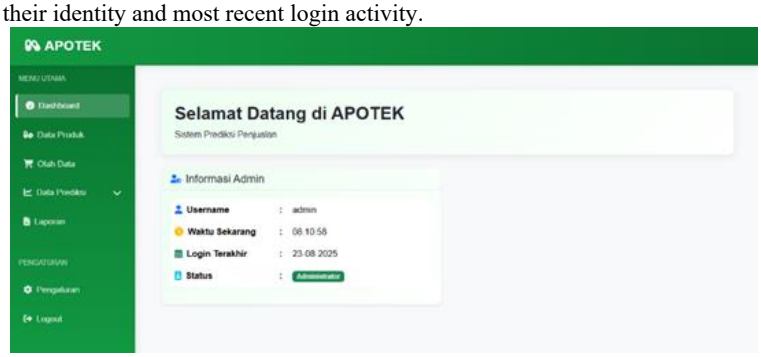

Fig. 9: Dashboard Page Menu

c. Product Page Menu

The Product Data page serves as the central point for managing drug information in pharmacies and is designed to facilitate efficient data management. At the top of the page, there's an Add Data button for adding new products to the system. All product information is displayed in a table containing the product name, price, stock quantity, unit price, and date of entry. Each row of data has an Edit button for updating information and a Delete button for removing unnecessary products.

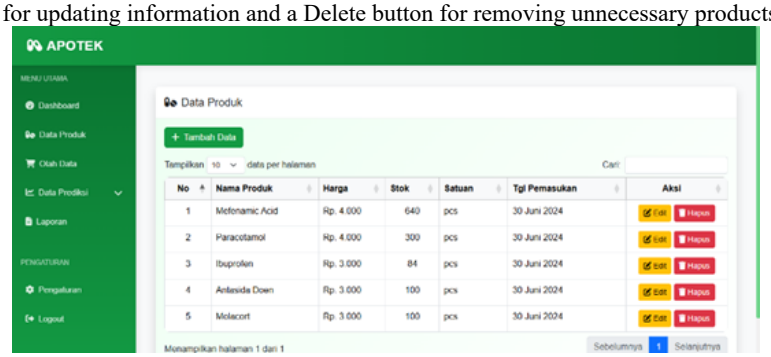

Fig. 10: Product Page Menu

d. Data Processing Page Menu

The Data Processing page is used to record and manage drug sales data based on a specific period. An Add Data button is available to add new sales each month. Data is displayed in a table containing the sales number, date, product name, stock, price, purchase quantity, and total sales. Each row also has a Delete button to remove unnecessary data.

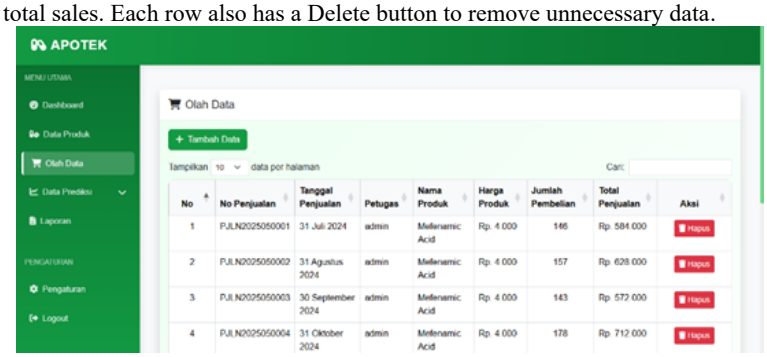

Fig. 11: Data Processing Page Menu

e. SMA Prediction Data Page Menu

The Single Moving Average (SMA) Prediction Data page is used to forecast drug sales using the SMA method. Users are prompted to enter input, such as the name of the product they wish to predict, then click the Forecast Process button to begin the calculation. This feature helps estimate sales volume for the next period based on historical data patterns.

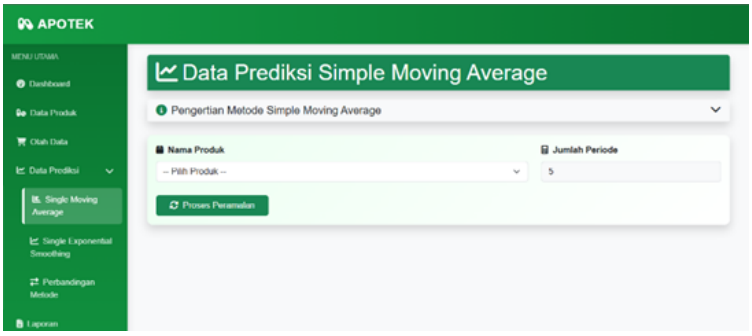

Fig. 12: SMA Prediction Data Page Menu

f. SES Prediction Data Page Menu

The Single Exponential Smoothing (SES) Prediction Data page is used to forecast drug sales using the SES method. Users need to input the product name and alpha value as calculation parameters. Afterward, the Forecast Process button can be pressed to begin the calculation. This feature helps users estimate next month's sales based on previous sales data.

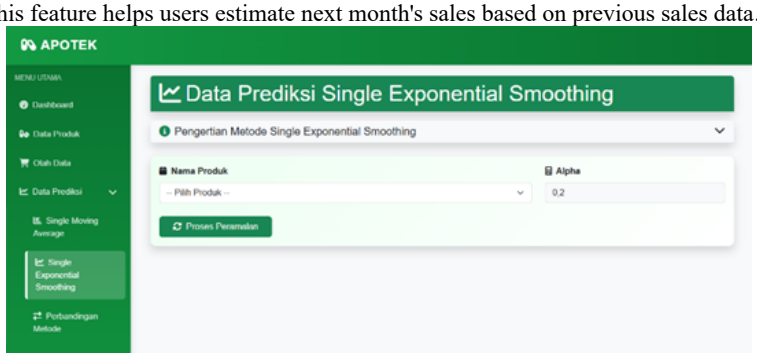

Fig. 13: SES Prediction Data Page Menu

g. Comparison Page Menu

The Forecasting Method Comparison page compares drug sales predictions using the SMA and SES methods. Users can select a product from the input field and then click the Process Forecast button to view the prediction results from both methods, along with the MAPE value as an accuracy indicator.

Fig. 14: Comparison Page Menu

h. Prediction History Page Menu

The Prediction History page displays complete drug sales forecasting data. The table displays information such as product name, month and year of prediction, the method used (SMA or SES), forecast parameters, prediction results, current stock, and the MAPE value as a measure of accuracy. In the Recommendations column, the system provides suggestions based on a comparison between the prediction results and available stock. There's also a Delete button on each row of data to manage unused prediction history.

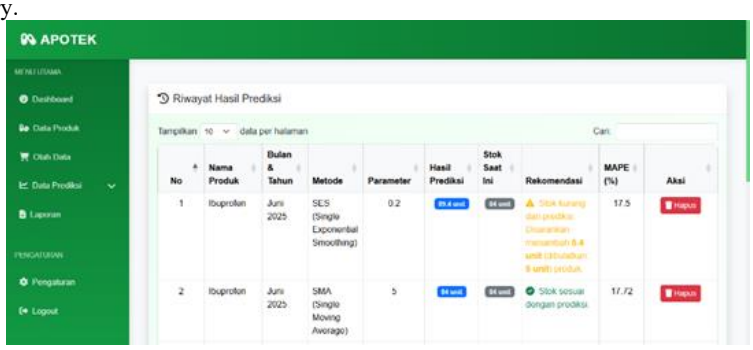

Fig. 15: Prediction History Page Menu

i. Sales Report Page Menu

The sales report page displays data based on the month selected by the user by entering the date. After selecting a month and pressing the Search button, the system displays sales data for that period. This report can also be exported to an Excel file, making it easy for users to save, print, or analyze the data further.

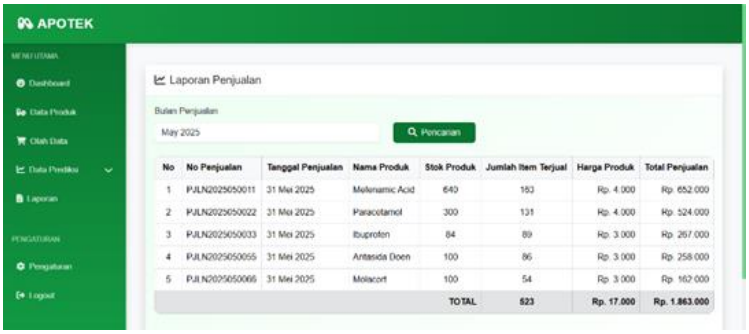

Fig. 16: Sales Report Page Menu

j. User data page menu

The User Data page is used to manage account information that can access the system. On this page, there is an Add Data button that allows you to add a new user by filling in details such as name, username, and access level. User data is displayed in a table containing a sequence number, name, username, and user level (Admin or Employee). Additionally, each row contains an Edit button to update user information and a Delete button to remove user data from the system.

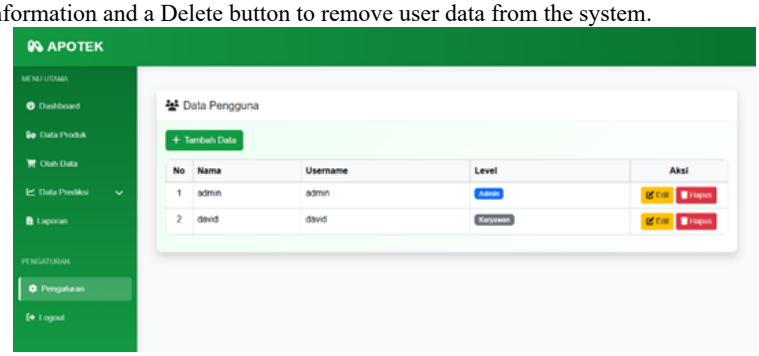

Fig. 16: User Data Page Menu

4. Conclusion

The Single Moving Average (SMA) method was successfully implemented with a 5-month period on a web-based system and proved suitable for stable sales data, as it was able to produce fairly accurate predictions. Of the five products tested (Antacid Doen, Ibuprofen, Mefenamic Acid, Molacort, and Paracetamol) Mefenamic Acid achieved the best results with a MAPE value of 9.43%. Furthermore, the Single Exponential Smoothing (SES) method with an alpha parameter of 0.2 was also successfully implemented and demonstrated good ability to respond to gradual changes in sales trends, with the best MAPE value of 9.38% for the same product. The results of the accuracy comparison between the two methods showed that SES had a slightly better accuracy level than SMA, so this system is considered effective in evaluating forecasting methods and can support more precise decision-making in drug stock management in pharmacies.

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