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Food Stock Analysis with the Utilization of the Single Moving Average Method

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ABSTRACT
A grocery store is a store that sells daily necessities. Nine basic ingredients or better known as basic necessities are the type of business that anyone needs. The community needs a grocery store that sells daily necessities at affordable prices and close to the neighborhood. Sahriul Grosir is a business engaged in the sale of rice where uncertain demand makes this business to determine the stock for the following month. This research aims to implement the single moving average method for rice stock forecasting to support proper decision making. By using historical sales data from January 2024 to January 2025 to forecast the next 6 months. Forecasting results for the next 6 months, from February 2025 to July 2025. With a forecasting value obtained of 223, MAD value of 23.32, MSE value of 1203.20 and MAPE value of 9.43.

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1. INTRODUCTION

Stock management is an important aspect of the wholesale business, especially in the high-demand and volatile grocery sector [1] . Poorly managed stock availability can cause problems such as overstocks that lead to losses due to expired goods or stock shortages that hinder the sales process and customer satisfaction. [2]. A grocery store is a store that sells daily necessities. Nine basic commodities or better known as groceries are the type of business that anyone needs [3]. Community needs for grocery stores that sell daily necessities at affordable prices and close to the neighborhood [4]. Sembako consists of various food and beverage ingredients that are generally needed by the Indonesian people, namely basic daily necessities such as rice, sugar, cooking oil and so on. The transformation of the retail industry has significantly impacted its operations, where more efficient operational actions are required [5].

Wholesale Sahriul as a grocery trading business still uses manual methods in determining the amount of stock which is often less accurate in predicting future needs. Therefore, the application of forecasting methods such as Single Moving Average (SMA) can help identify demand patterns and provide more accurate predictions regarding stock procurement [6]. By applying the Single Moving Average method, it is hoped that a more effective stock management system can be obtained, reducing the risk of excess and shortage of stock and increasing operational efficiency [7].

Wholesale Sahriul is a business engaged in the sale of basic necessities which is located at Jalan Dusun III, West Sei Silau Village, Setia Janji District, Asahan Regency, North Sumatra [8].In the last two years, Sahriul Wholesale has experienced difficulties in estimating the level of basic food stock needs for the community because it still relies on temporary guesses regarding the management of basic food stocks at Sahriul Wholesale. Predicting stock manually only uses a stock book and this method is less accurate in predicting future stock. There is no forecasting system that can facilitate the Sahriul Wholesale in determining the amount of rice stock.

This research is important to do because with the forecasting process carried out, Sahriul Wholesale can improve the efficiency of rice inventory so that rice does not accumulate in the warehouse. Forecasting is an important tool in effective and efficient planning. An important step after forecasting is carried out is to verify the forecast in such a way that it reflects past data and the causal system underlying the growth [9]. As long as the forecasting representation is reliable, the forecasting results can continue to be used. The SMA method is the most widely used method for determining the trend equation of data because it yields mathematically.

The Single Moving Average method or also abbreviated as SMA is one of the most efficient moving average methods in the calculation process [10], Single Moving Average is a forecasting method that is carried out by taking a group of observation values, then finding the average as a forecast for the upcoming period [11]. This method to estimate the future by taking the observation value of past data and the data from the past will be calculated to find an average to be able to do a calculation called Single Moving Average or can also be called a single moving average method, data from the past is utilized by the Single Moving Average method to be able to know the future [12]. The Single Moving Average (SMA) method is more suitable if the data being analyzed has small fluctuations or is not too complex. SMA is simple, easy to understand, and quick to apply without requiring a lot of data or complicated calculations. If the purpose of forecasting is to capture short-term trends in stable or seasonal data, SMA can provide fairly accurate results. Compared to other more complex methods, SMA is more efficient and suitable for situations with limited resources or when simplicity and speed are preferred. The following is previous research on forecasting using the single moving average method:

1. Research conducted by Ilfan and Nurliana in 2022 [13] The conclussion that with the system created, it can help the IM Parfum Pekanbaru store to recap sales data every month where the data is stored in the database. And the application of the Single Moving Average method made to forecast the inventory of IM Parfum Pekanbaru in December 2021 is 1,542 bottles with an average MAD value of 242, an MSE value of 127073.4 and a MAPE value or forecasting error value of 17.3%, which means that the possibility of forecasting differences with reality in the field is not too much.
2. Research conducted by Nia Kurnia in 2022 [8] Based on the results of the research, the authors conclude that using the SMA (Single Moving Average) method at the dedeh retail grocery store has a high level of accuracy, namely movement 8 in rice with an accuracy rate of 83.91%, MAD of 33.33, MAPE of 16.09%, and MSE of 1666.67 with forecasting results of 475 (Kg) for prediction accuracy in July 2022. So that the SMA method can provide a solution to predict the stock of basic food sales items in the prediction data of the dedeh retail grocery store so that the stocking of these items can be adjusted.
3. Research conducted by Eko Siswanto et al in 2021 [14] with the inventory forecasting system using the moving average method can be used as a decision-making system for managers in determining the amount of inventory of goods for the future period.
4. The next research researched by Kukuh et al in 2022 [9] From the results of forecasting using Single Moving Average and using actual data from December 2021 to June 2022, the forecasting results obtained in July / next month are 2,901 kg. From the MSE (Mean Squared Error) calculation, the error value obtained is 331.14. From this calculation, the error value is much smaller than the calculated value using actual data so that the value of this figure is still acceptable.
5. The next research by Saraswati et al in 2023 [15] The single moving average method is used to predict field demand in the next period, where the data processed is the data from a priori calculations, on the AA Alkaline Battery item the number of predicted items requested in the 3-month period and the 3-month support period is 6.33 pcs and the AAA Alkaline Battery item the number of predicted items requested in the 3-month support period is 4 pcs.

The Single Moving Average (SMA) method is a simple and effective forecasting technique for analyzing time series data. Its advantages include ease of understanding and application, ability to smooth out data fluctuations, and effectiveness in capturing short-term trends [16]. SMA is also easily adaptable to different time periods, does not require a lot of data, and provides clear visualization. This method is particularly suitable for stable or seasonal data, although it is less effective for highly volatile data. As such, SMA is ideal for forecasting that requires simplicity and accuracy in the short term [17].

2. RESEARCH METHOD

There are several stages to this research: (1) Problem identification: is the first step where at this stage looking for problems that occur in the field through direct observation to the Sahriul Wholesale. (2) Problem Statement: formulate problems obtained in the field based on the results of observations and interviews. (3) Collecting Data: collect necessary data such as wholesale sales data and other data that is

considered important. (4) Analysis Data: namely analyzing the data that has been obtained using the SMA method. (5) Design System: is a pattern or description of the user interface of the application to be made using Microsoft Visio and using a use case diagram as a system user design. (6) Build System: Convert the design to an application using the sublime text editor and mysql database. This type of research is quantitative with the research stages as shown in Figure 1.

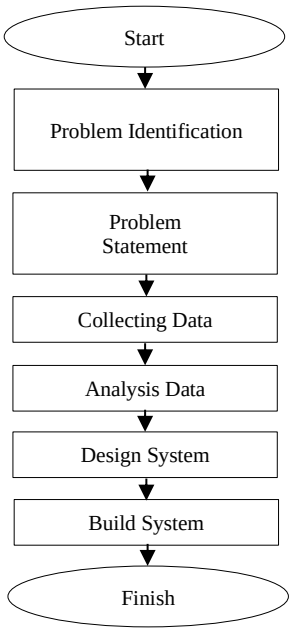

Figure 1. Stage of Research

2.1 Forecasting

The Single Moving Average method is a forecasting method that is done by taking a group of observation values, looking for the average value as a forecast for the coming period. Single moving average can be calculated using the formula (1) [18].

$$F_{t+1} = \frac{X_1 + \cdots X_T}{T} \quad (1)$$

Where to calculate forecasting is obtained from value of Ft+1 is period forecasting value t+1, value X is observation data of period t and T is Time.

1. Mean Absolute Error (MAD)
   MAD is a statistical metric that measures the average of the absolute difference between each data value and the average value of the data. To measure the error value using MAD can be calculated using the formula (2).

$$MAD = \frac{\sum |Yt - Ft|}{n} \quad (2)$$

   Where to calculate MAD is obtained from value Yt is Actual Data, value Ft is observation data of period and value n isTotal Period.

2. Mean Sequence Error (MSE)
   MSE is another method to evaluate forecasting methods. Each error or residual is squared. It is then summed and divided by the number of observations. This approach manages large forecasting errors because the errors are squared. can be calculated using the formula (3).

$$MSE = \frac{\sum |Yt - Ft|^2}{n} \quad (3)$$

   Where to calculate MSE is obtained from value Yt is Actual Data, value Ft is observation data of period and value of n is Total Period.

3. Mean Absolute Error (MAPE)
   MAPE is calculated by using the absolute error in each period divided by the real observed value for that period. Then, averaging the absolute percentage errors. MAPE is an error measurement that calculates the size of the percentage deviation between actual data and forecasting data. MAPE can be calculated using the formula (4).

$$MAPE = \frac{\sum|Yt-Ft|(100)}{|Yt|} \quad (4)$$

   Where to calculate MAPE is obtained from value Yt is Actual Data and value of Ft is observation data of period.

2.2 System Design

The results of the use case diagram design aim to help identify and document the main functionality of the system. In addition, it provides an overview of how users or actors will interact with the system [19]. This use case has two actor, namely the admin to manage the system and owner to check the forecast result. The system design can be seen in Figure 2.

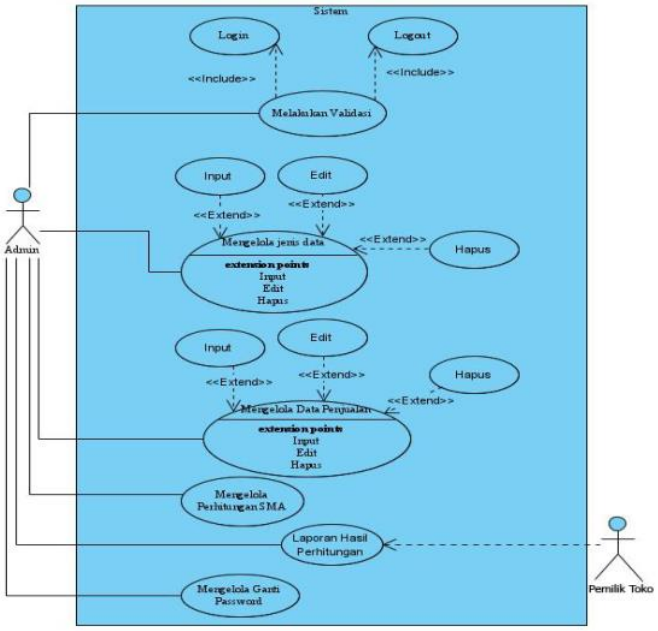

Figure 2. Use Case Diagram

This system was built using the php programming language and uses mysql as a database for data storage. In this system there are 2 people who can use the system, namely the admin and the shop owner. The admin is in charge of inputting sales data and carrying out the forecasting process, while the shop owner can only see the forecasting results that have been processed by the system and these results can be printed to be kept as an archive by the shop owner. With this forecasting system, it can help Sahriul Wholesale to forecast rice stocks in the following month quickly so as to maximize sales [20].

3. RESULTS AND ANALYSIS

This is the previous year's rice sales data from January 2024 to January 2025. Figure 3 shows that sales have increased and decreased. So Sahriul Wholesale has only estimated how much rice stock must be provided in the following month. If the estimate is wrong, a problem occurs, namely stock vacancies and excess stock.

3.1 Forecasting Single Moving Average

The results of the needs analysis obtained are the input data needed in predicting the amount of clothing inventory from January 2024 to Januari 2025. The input data will be processed using the SMA method to calculate data using manual methods and system calculations. Meanwhile, the analysis of output needs in the form of a web-based program display that can be used when you have activated the local server,

namely XAMPP. The interface design of this application program uses Microsoft Visio 2010 supporting software.

Table 1 is the initial sales data, namely data for the previous 1 year from Januari 2024 to Januari 2025 where from this data we will forecast the stock for February 2025 until July 2025. After obtaining sales data for one year earlier, it can be calculated forecasting using the formula (1).

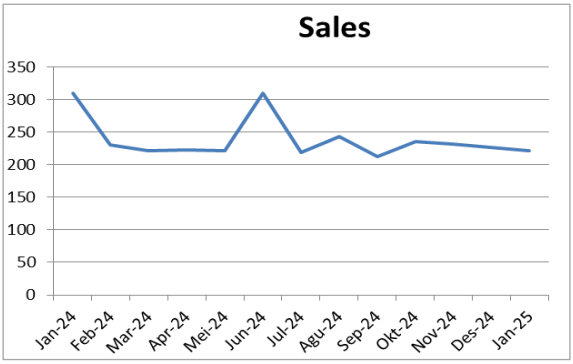

Figure 3. Sales Data One Year Before

Table 1. Forecasting 6 Month Result

No	Period	Actual (Yt)	Ft
1	Jan-24	310	0,00
2	Feb-24	230	0,00
3	Mar-24	222	270,00
4	Apr-24	223	226,00
5	Mei-24	221	222,50
6	Jun-24	310	222,00
7	Jul-24	219	265,50
8	Agu-24	243	264,50
9	Sep-24	213	231,00
10	Okt-24	235	228,00
11	Nov-24	232	224,00
12	Des-24	227	233,50
13	Jan-25	221	229,50
14	Feb-25	224	224,00
15	Mar-25	223	222,50
16	Apr-25	224	224,00
17	May-25	223	222,50
18	Jun-25	223	223,25
19	Jul-25	223	222,88

3.2 MAD, MSE and MAPE

For the calculation of MAD, MSE and MAPE can be calculated using formulas (2), (3) and (4) so that the results are obtained in the following Table 2.

Table 2. MAD, MSE and MAPE Result for Six Months Later

No	Period	Actual (Yt)	Ft	Error	Abs Error	Error^2	e/Yt	APE
1	Jan-24	310	0,00					
2	Feb-24	230	0,00					
3	Mar-24	222	270,00	48,00	48,00	2304,00	0,216	21,62
4	Apr-24	223	226,00	3,00	3,00	9,00	0,01	1,35
5	Mei-24	221	222,50	1,50	1,50	2,25	0,01	0,68
6	Jun-24	310	222,00	-88,00	88,00	7744,00	0,28	28,39
7	Jul-24	219	265,50	46,50	46,50	2162,25	0,21	21,23
8	Agu-24	243	264,50	21,50	21,50	462,25	0,09	8,85
9	Sep-24	213	231,00	18,00	18,00	324,00	0,08	8,45
10	Okt-24	235	228,00	-7,00	7,00	49,00	0,03	2,98
11	Nov-24	232	224,00	-8,00	8,00	64,00	0,03	3,45
12	Des-24	227	233,50	6,50	6,50	42,25	0,03	2,86
13	Jan-25	221	229,50	8,50	8,50	72,25	0,04	3,85
14	Feb-25	224	224,00					
15	Mar-25	223	222,50					
16	Apr-25	223	223,25					
17	May-25	223	222,88					
18	Jun-25	223	223,06					

No	Period	Actual (Yt)	Ft	Error	Abs Error	Error^2	e/Yt	APE
19	Jul-25	223	222,97					
			Total		256,50	13235,25	1,04	103,70
			MAD		23,32			
			MSE			1203,20		
			MAPE					9,43

After calculating the forecasts for the next 6 months, namely until July 2025, the comparison results for all forecasts for each month are shown in Table 3.

Table 3. Error Comparison for Each Period

No	Period	Forecast	MAD	MSE	MAPE
1	Feb-25	224	23,32	1203,20	9,43
2	Mar-25	223	23,32	1203,20	9,43
3	Apr-25	223	23,32	1203,20	9,43
4	May-25	223	23,32	1203,20	9,43
5	Jun-25	223	23,32	1203,20	9,43
6	Jul-25	223	23,32	1203,20	9,43

3.3 Implementation

The result of the implemented forecasting system is a web-based platform that enables users to perform forecasting efficiently, access results in real-time, and interact with the system through an intuitive and user-friendly interface. In addition, the system is designed to be accessible across various devices, supports informative data visualizations, and is equipped with features for storing and managing forecasting history to facilitate future analysis and decision-making..

3.3.1 Graphic Forecasting

In the graph Figure 4, there are two lines, namely blue is the actual sales data or data and the black line is the forecasting generated by the system calculation using the single moving average method for six months later.

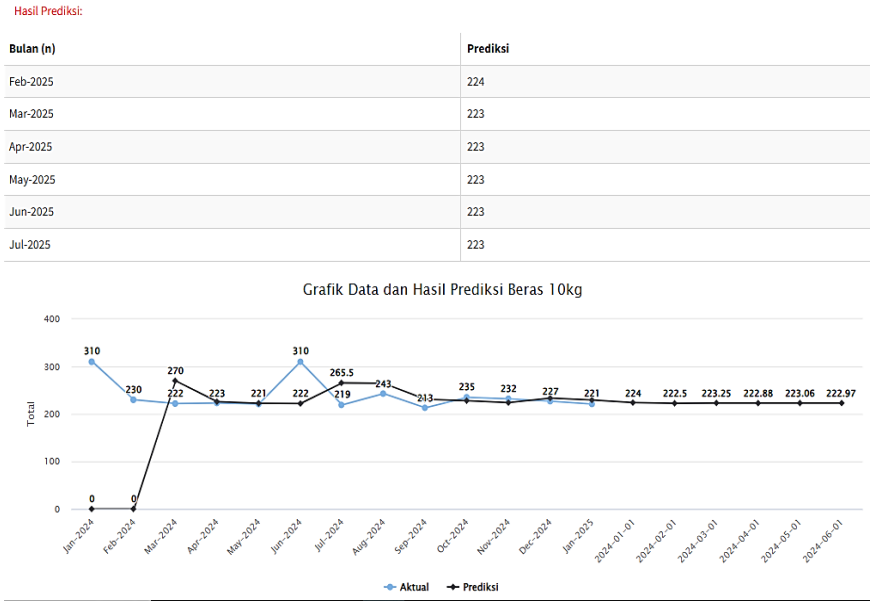

Figure 4. Graphic Forecasting

The forecasting page is a menu used by the admin to perform the groceries forecasting process based on the sales data that has been previously entered. the results can be printed to archive. The system calculation results are the same as the manual calculation results as shown in Figure 3 below with forecast February 2025 is 224, forecast March 2025 is 223, MAD value is 11,45, MSE value is 199,86 and MAPE value is 4,61%.

3.3.2 Discussion

The single moving average forecasting method has shown its effectiveness in forecasting rice stocks for the next 6 months, from February 2025 to July 2025. This forecasting is suitable for short-term

forecasting with data that is quite simple, easy to understand, and fast to apply. The difference between this research and other research is in the amount of forecasting. The research that has been referred to in the previous reference only forecasts the next 1-2 months while this research forecasts up to the next 6 months. This research is important to do as one of the methods that has the potential to reduce losses due to uncertain market demand. However, to optimize this method, a considerable amount of data is required. It is recommended that future studies test this method using more data such as the previous three to five years of data.

This study contributes to the body of knowledge by demonstrating that extending the forecasting horizon from two months to six months can provide businesses with greater flexibility and preparedness in managing inventory. In the context of rice stock management, this extended horizon allows wholesalers to anticipate seasonal fluctuations, adjust procurement strategies, and maintain an optimal balance between supply and demand. Although the single moving average method is relatively simple compared to more complex forecasting models, its practicality and low computational requirements make it highly applicable for small to medium-sized enterprises. By incorporating more comprehensive historical data in future research, the accuracy and robustness of this method can be further enhanced, potentially making it a reliable tool for decision-making in a broader range of market conditions.

4. CONCLUSION

The results of manual calculations and computer calculations have the same results for forecasting the next 6 months, from February 2025 to July 2025. With a forecasting value obtained of 223, MAD value of 23.32, MSE value of 1203.20 and MAPE value of 9.43 from sales data 1 year earlier. This research reveals that the forecasting method used provides Sahriul Wholesale to assist in making the right and fast decisions. By using this method, the wholesaler can increase sales without stock shortages in the following month. Researchers realize that there are limitations in this research, such as the lack of data used for forecasting. Therefore, the development of this research should test with more data.

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