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Implementing Moving Average Forecasting System for Apparel Sales: Predicting Inventory Needs with Enhanced Accuracy

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Abstract: Forecasting the supply of goods is one of the company's planning strategies to increase sales. However, there are several obstacles in forecasting the supply of goods in one of the boutiques in Jember Regency such as manual sales data collection, namely by recording clothing sales data in the sales book. So that there can be errors in predicting the supply of goods in the future. The purpose of this study is to apply a clothing sales forecasting system using the moving average method to forecast the supply of goods. This study applies the waterfall model to build a system with stages of analysis, design, implementation and testing. Analysis will be carried out by collecting data related to system requirements through observation, interviews and literature studies. While at the design stage there are usecase diagrams and system flow diagrams. Furthermore, the implementation stage was carried out in boutiques in Jember Regency by piloting the boutique owners. System testing uses black box testing to ensure there are no system functional errors. The findings show that the system in the form of a website can be run properly and can be accessed as long as there is an internet network. In addition, our system is already running well based on the results of black box testing. So that this system can be used by companies as forecasting considerations in providing inventory of goods.

Keywords: Forecasting System, Inventory, Moving Average.

INTRODUCTION

Clothing sales are a very growing business field today. This is evidenced by the increasing number of shops that sell various types of clothing(Sari & Patrikha, 2021). The amount of competition in the business world, especially in the sales industry, requires business people to find a strategy that can increase sales (Arif et al., 2021; Ridwan & Siregar, 2024) In an effort to increase sales, business people must prepare an accurate planning strategy(Satria et al., 2023; Zaki Hasibuan & Suendri, 2023) Planning strategies can help companies in predicting events that will occur in the future so that company goals can be achieved considering the technology that is developing so rapidly (Bilaffayza et al., 2023; Nurhayati & Syafiq, 2022)

Sales forecasting is one of the planning activities that can be done, not only determining long-term planning(Aulia Hanum &; Haryatmi, 2021), forecasting can also be used to estimate inventory so that it does not accumulate in the warehouse. Although forecasts are not always 100% correct because

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the future contains uncertainty, choosing the right method can make forecasting with a small error rate (Hernando & Diana, 2020) Planning using periodic series is using previous data to plan for the future (Idah et al., 2019) Method *Moving Average* is a forecasting method carried out by taking a group of observational values to find the average value as a forecast for the upcoming period (Kumila et al., 2019; Princess & Azizah, 2021; Yuniarti et al., 2022). This method uses a new amount of actual demand data to generate forecast values for future demand (Haba & Najamuddin, 2021). This method is called a moving average because each time new observational data becomes available, a new average number is calculated and used as a forecast value (Nurlifa & Kusumadewi, 2017).

In everyday reality, sales forecasting by utilizing existing technology has not been put to good use (Marzuki et al., 2023). Business people only estimate sales without knowing what will happen in the future (Anita et al., 2023). They provide an item without knowing how the item will sell, so buy without clarity (Asmi & Rasal, 2023). The amount of inventory that is too large or too small will cause various problems. Good decision making about inventory will maintain the continuity of the company's business and encourage people as consumers not to abandon marketed products (Diniaty, 2020). This research is important to support business people forecasting sales inventory using a system.

The results of our initial study show that boutiques in Jember Regency have manual sales data by recording clothing sales data in the sales book. So that there can be errors in making decisions to increase or decrease inventory of goods. Boutique owners know the supply of goods if someone buys. This proves to be detrimental to both owners and buyers. Boutique owners are harmed by losing customers while customers do not get the desired items. There needs to be a system that can forecast the supply of goods in the future using the website-based moving average method. This study aims to apply a website-based clothing sales forecasting system using the moving average method by calculating the level of accuracy of forecasting calculation results using Mean Absolute Percentage Error (MAPE). That is expected to help boutique owners consider providing sales stock. As well as providing ease of use, because it can be accessed anywhere as long as there is an internet network.

LITERATURE REVIEW

In current business practices, sales forecasting remains underutilized despite available technology, leading to uncertainties in future sales projections (Marzuki et al., 2023). Many businesses rely on mere estimations, lacking insight into future market dynamics (Anita et al., 2023), which often results in inventory mismanagement and potential loss of revenue (Asmi & Rasal, 2023). Effective inventory management is crucial for sustaining business operations and ensuring consumer satisfaction (Diniaty, 2020). Addressing this gap, our study focuses on improving sales forecasting for boutiques in Jember Regency, which currently rely on manual sales data recording, leading to suboptimal inventory decisions and customer dissatisfaction. By implementing a website-based moving average method, we aim to provide a more accurate forecast of future supply, building upon previous research that demonstrates the efficacy of moving average methods in sales forecasting (Asynari et al., 2020; Putri & Azizah, 2021). This research extends beyond previous studies by not only incorporating the forecasting process but also assessing its accuracy through comparative analysis across multiple time periods, thus offering insights into optimal forecasting practices.

METHOD

This research carries a qualitative descriptive approach, the type of research being conducted is development research utilizing the waterfall method. The waterfall method is a software development approach characterized by a sequential flow and is among the oldest software development methods. The stages of the waterfall method begin with analysis, design, implementation, and testing.

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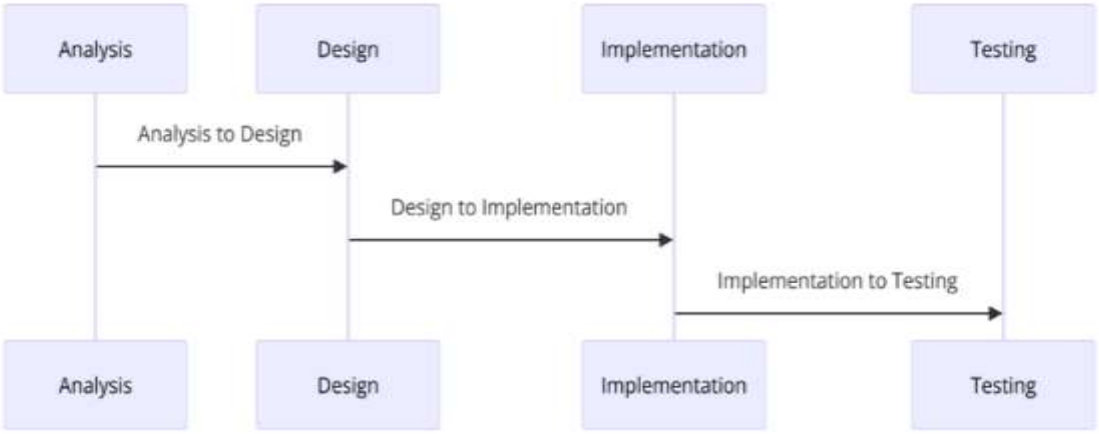

Figure 1. Research Model

The analysis stage is conducted to identify the system requirements by collecting data and information originating from the boutique. This involves understanding the sales flow and inventory recording process. Additionally, interviews with the boutique owner to obtain sales data of Gamis clothing and literature reviews are conducted. Furthermore the results about interviews can be seen in the results section in Table 1. From this analysis, sales data are obtained for calculation purposes. The method employed for forecasting is the moving average method. Subsequently, the sales data obtained are computed using Equation 1.

$$F_{t+1} = \frac{Y_t + Y_{t+1} + Y_{t+2} + \cdots + Y_{t-n+1}}{n} \quad (1)$$

Explanation:
F_{t+1} = Forecast for period
t+1 Y_{t+1} = Data for period t
N = Number of Data

The forecast results are measured using consistency or the accuracy value of the forecast, when the forecast value is either significantly higher or lower than the actual value that occurs. Hence, the forecast results may not be identical to reality, necessitating testing the accuracy level of the forecasted results. The accuracy of a forecast is determined by the magnitude of the error or discrepancy with the actual data. However, the error in forecast values is not solely caused by error values but also by the inability of the forecasting method, which influences the forecast. The measurement of forecast accuracy utilized is the Mean Absolute Deviation (MAD) as shown in Equation 2.

$$MAD = \frac{\sum_{i=1}^{n} |A_t - F_t|}{n} \quad (2)$$

Explanation:
t = Planning period
A = Actual demand during the period
F = Forecasted value during the period
N = Number of forecasting periods

Furthermore, the Mean Absolute Percentage Error (MAPE) value is an evaluation of the forecasting method with the average percentage of absolute errors of the forecasted values against the actual demand. The MAPE value is considered good if it results in less than 10%. The measurement of the MAPE value is in accordance with Equation 3.

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$$MAPE = \frac{\sum_{t=1}^{n|} \left| \frac{X_t - F_t}{n} \times 100\% \right|}{n} \quad (3)$$

Explanation:
PEt = Percentage error value
t = Time period
n = Number of periods
Xt = Actual data value at period t
Ft = Forecasted value during period t

During the design phase, the researcher employs Unified Modeling Language (UML), comprising a use case diagram, Data Flow Diagram (DFD), and user interface. Subsequently, in the implementation phase, the system is developed based on the finalized system design, utilizing PHP and MySQL as the database. During the design phase, we provided an overview of the system process illustrated in Figure 2, which is a use case diagram depicting several activities in the system, and Figure 3, which is a Data Flow Diagram (DFD) illustrating the data flow in the system.

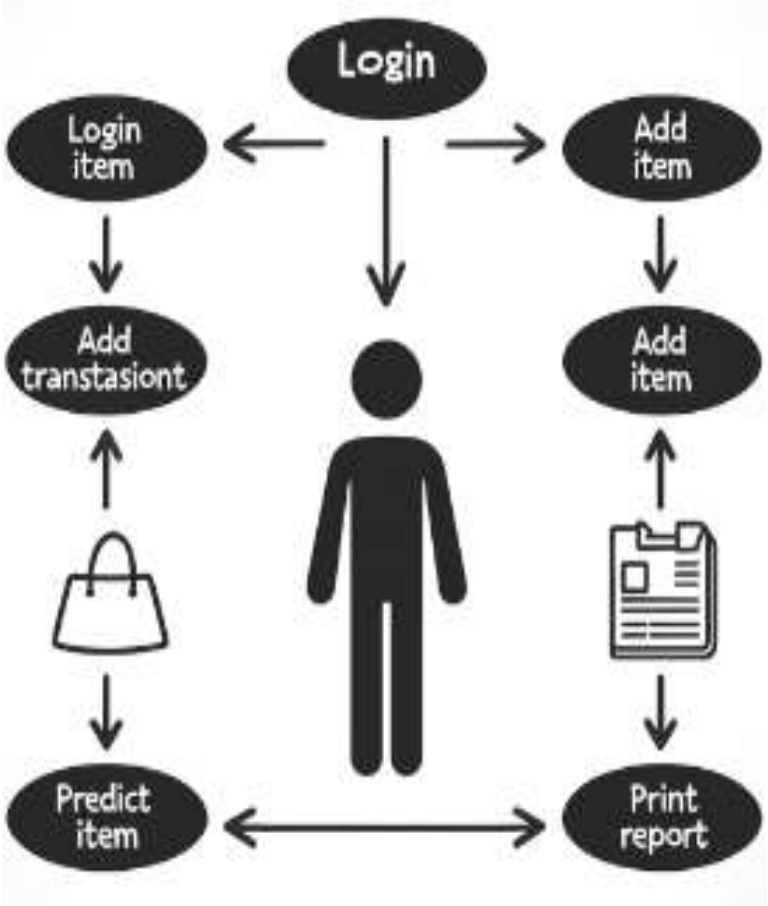

Figure 2. Use Case Diagram

In Figure 2, there is one actor interacting with the system, namely the boutique owner. The boutique owner can perform several activities within the system such as logging in, adding items, adding transactions, predicting inventory, and printing reports.

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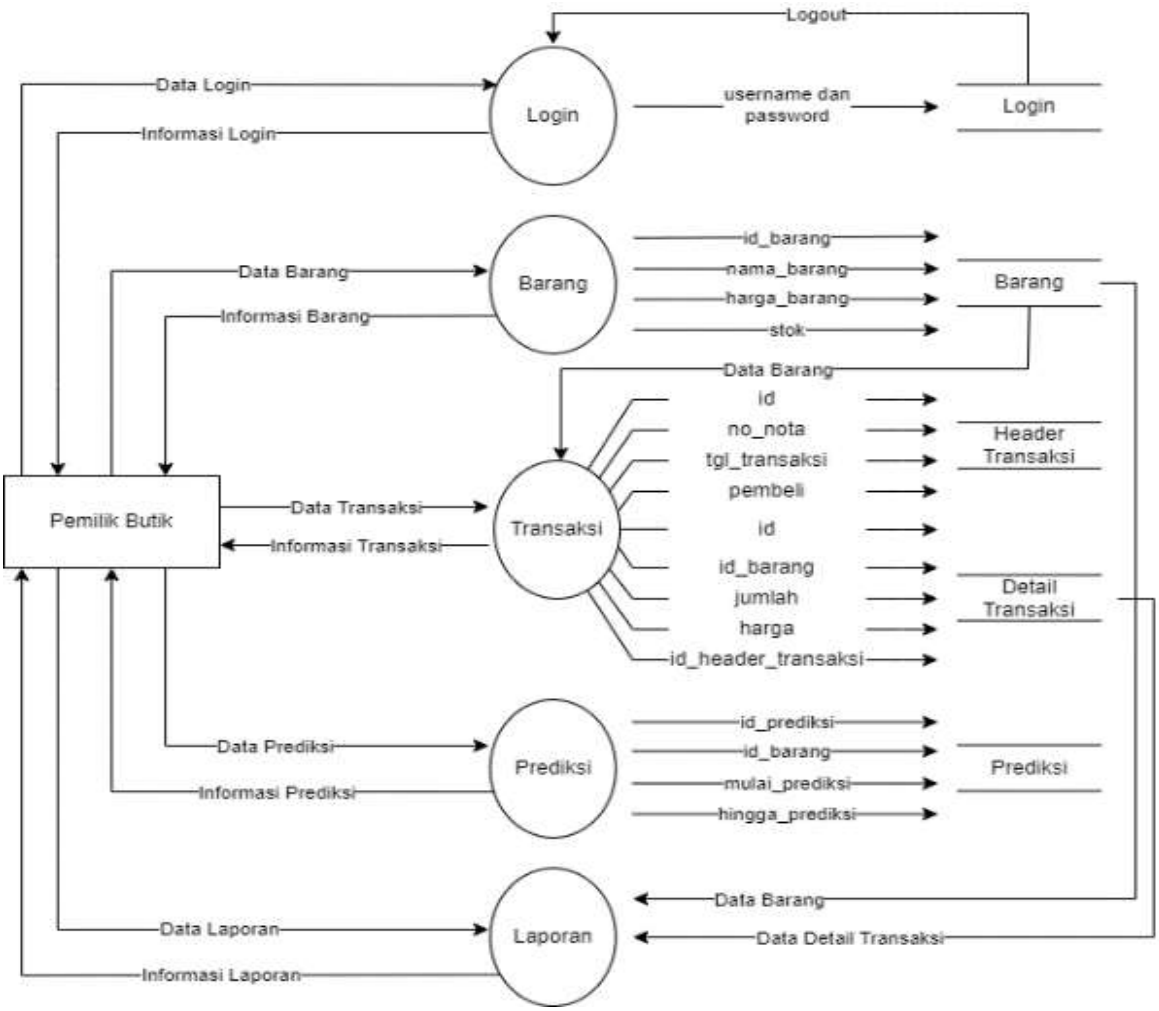

Fig 3. Data Flow Diagram (DFD)

In Figure 3 the visualization will use Bahasa Indonesia. This is because the majority of users will find it easier since it is their native language. The boutique owner logs into the website by entering their username and password. The boutique owner can log out or manage items by entering item data. The entered item data will be stored and used in the transaction menu. The boutique owner can manage transaction data by entering ID, invoice number, transaction date, buyer's name, item ID, quantity, and price. After the transaction is saved, the owner can print the report data. Furthermore, the boutique owner can predict item inventory based on the item ID.

Moving step on to the testing phase, involves assessing the system's feasibility, which has been developed in the previous phases. This phase employs black box testing, aimed at observing the system's results, both inputs and outputs, without knowledge of the system's code structure or software developed using the moving average method.

RESULT

The analysis stage conducted has yielded the boutique owner's requirements for building a forecasting system, which include:

1. Inventory management capability for the boutique owner.
2. Transaction management functionality for the boutique owner.
3. Sales prediction capability for the boutique owner.
4. Ability for the boutique owner to generate transaction reports.

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Furthermore, from the interview results, data such as those presented in Table 1, which depicts sales data for "gamis" clothing from January to December 2023, were obtained.

Table 1. Sales Data of Gamis Clothing

No	Month	Quantity
1	January	30
2	February	35
3	March	40
4	April	30
5	May	23
6	June	22
7	July	31
8	August	37
9	September	33
10	October	29
11	November	30
12	December	33

Based on Table 1, we processed the data using Microsoft Excel. We calculated the forecast for each month using Equation (1). The researcher obtained data calculations from periods of 3, 4, and 5 months. Subsequently, this research was conducted by calculating the Mean Absolute Percentage Error (MAPE) according to Equation (3) to determine the error rate and the Mean Absolute Deviation (MAD) using Equation (2).

Table 2. Accuracy Test Results Using 3 Periods

No	Month	Sales	Prediction	MAD	MAPE
1	January	30			
2	February	35			
3	March	40			
4	April	30	35.00	5	16.67%
5	May	23	35.00	12	52.17%
6	June	22	31.00	9	40.91%
7	July	31	25.00	6	19.35%
8	August	37	25.33	11.67	31.54%
9	September	33	30.00	3	9.09%
10	October	29	33.67	4.67	16.10%
11	November	30	33.00	3	10.00%
12	December	33	30.67	2.33	7.06%
Total					**202.90%**
Average				**6.30**	**22.54%**

Based on Table 2, it is evident that there is a significant difference between the actual and predicted values. The average forecast accuracy, represented by MAD, is 6.30, while the Mean Absolute Percentage Error (MAPE) indicates a prediction error rate of 22.54%.

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Table 3. Accuracy Test Results Using 4 Periods

No	Month	Sales	Prediction	MAD	MAPE
1	January	30			
2	February	35			
3	March	40			
4	April	30			
5	May	23	33.75	10.75	46.74%
6	June	22	32.00	10	45.45%
7	July	31	28.75	2.25	7.26%
8	August	37	26.50	10.5	28.38%
9	September	33	28.25	4.75	14.39%
10	October	29	30.75	1.75	6.03%
11	November	30	32.50	2.50	8.33%
12	December	33	32.25	0.75	2.27%
Total					**158.86%**
Average				**5.41**	**19.86%**

Based on Table 3, it is apparent that there is a notable difference between the actual and predicted values. The average forecast accuracy, represented by MAD, is 5.41, while the Mean Absolute Percentage Error (MAPE) indicates a prediction error rate of 19.86%.

Table 4. Accuracy Test Results Using 5 Periods

No	Month	Sales	Prediction	MAD	MAPE
1	January	30			
2	February	35			
3	March	40			
4	April	30			
5	May	23			
6	June	22	31.6	9.6	43.64%
7	July	31	30.0	1	3.23%
8	August	37	29.2	7.8	21.08%
9	September	33	28.6	4.4	13.33%
10	October	29	29.2	0.2	0.69%
11	November	30	30.4	0.4	1.33%
12	December	33	32.0	1	3.03%
Total					**86.33%**
Average				**3.49**	**12.33%**

Based on Table 4, it is evident that there is no significant difference between the actual and predicted values. The average forecast accuracy, represented by the Mean Absolute Deviation (MAD), is 3.49, and the Mean Absolute Percentage Error (MAPE) indicates a prediction error rate of 12.33%. Therefore, based on the comparison of calculations from the three tables above, the MAD used to calculate the error rate for the 5 period is better than that for the 3 and 4 periods presented in Table 2 and Table 3. This is because it has a smaller MAD value of 3.49 and a MAPE of 12.33%, indicating a smaller percentage error on the MAPE, which implies a more accurate forecast. If the MAPE value is between 10% - 20%, then the forecasting model is considered good.

The result of the implementation phase is the presence of several interface displays on our website-based system. Figure 4 shows the forecasting menu. This menu allows the boutique owner to select which items to forecast and the forecast period. Forecasting is conducted for 3, 4, and 5-month

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periods using the moving average method, and the accuracy of the predictions is calculated using the Mean Absolute Percentage Error (MAPE).

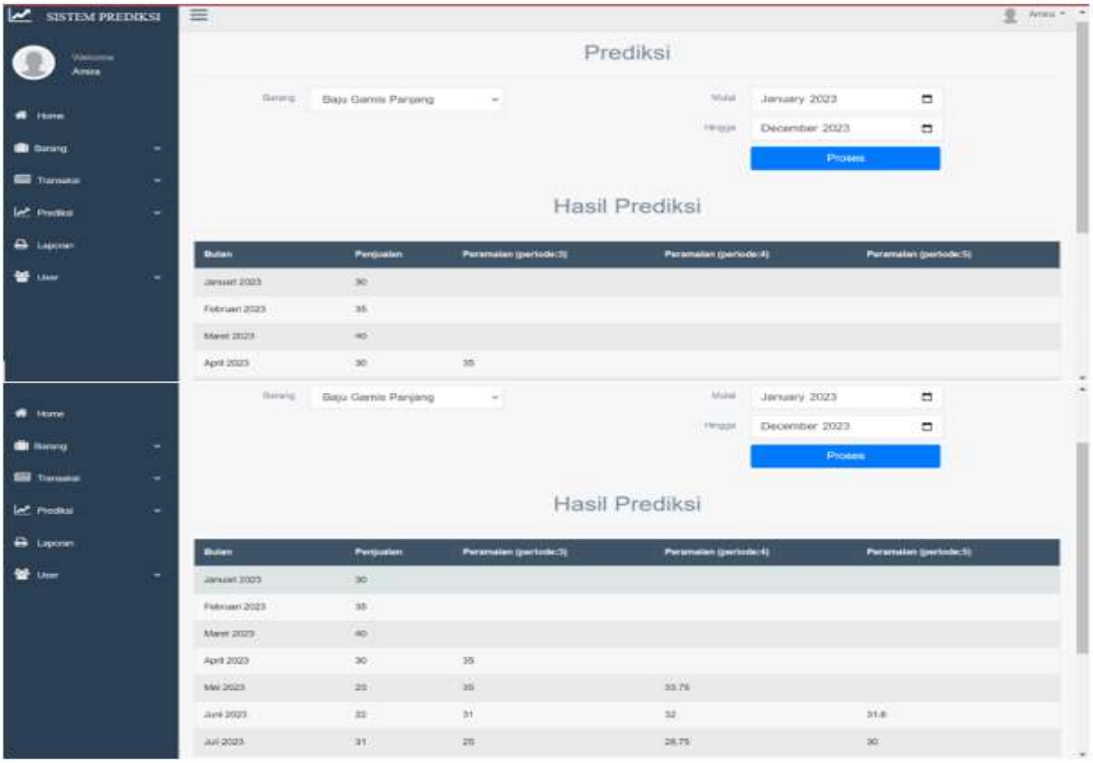

Figure 4. Forecasting Page Interface

During the next phase, system testing will be conducted using black box testing, aiming to discover incorrect functions, interface errors, and performance issues. This will be done by accessing the URL of the website. The testing involves trying out each menu item to ensure its proper functionality.

Table 5. Black Box Testing Result

Test Class	Testing Scenario	Test Result	Status
Login	Entering username and password	Login successful, accessing the main page	Successful
Product Input	Entering product name, stock quantity, price	Product data successfully entered and displayed	Successful
Add Transaction	Entering invoice number, selecting item, purchase date, buyer's name, purchase quantity	Transaction data successfully entered and displayed	Successful
Product Prediction	Selecting item, entering forecast date	Displaying forecast data result	Successful
Prediction Result	Clicking calculation button	Displaying forecast result	Successful
Print Report	Clicking print button	Displaying print result	Successful

In Table 5, it shows the results of black box testing for the clothing sales forecasting system based on a website implementing the moving average method. The testing results presented in Table 5 indicate that all components of this system are functioning properly and can operate according to their respective functions.

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DISCUSSIONS

This research has resulted in a product: a clothing sales forecasting system using the moving average method. Forecasts may not always match reality, so accuracy error calculations are performed using Mean Absolute Percentage Error (MAPE) and Mean Absolute Deviation (MAD) to determine the accuracy level of the forecasts. Based on the results of the Analysis phase through literature review and observation, it motivated the researcher to develop a web-based clothing sales forecasting system to assist boutique owners in predicting future inventory levels. Based on the testing and calculations conducted, using a 5-month period is better than using 3 or 4 months because it has the smallest forecast accuracy value or MAD, which is 3.49, and a error value or MAPE of 12.33%. Therefore, based on these results, it indicates that the forecasting using this method falls into the good category as it is less than 20% and more than 10%. Although it does not have to be identical to the sales value, it is close.

Furthermore, based on the system results, it appears that the system calculation results using Microsoft Excel conducted by the researcher show the same forecast value. This indicates that they have the same algorithmic value, thus, this system can help boutique owners consider optimal clothing inventory levels in the future. Previous research has applied the single exponential smoothing method and the moving average method, and it can be concluded that the moving average method has better accuracy (Asynari et al., 2020). Therefore, this method can be applied in future forecasting system development. However, in other studies, the moving average method is considered less optimal because the data must have a pattern and focus on a 3-month period (Nurlifa & Kusumadewi, 2017). Therefore, to facilitate forecasting in this study, a web-based forecasting system will be developed to compare MAD and MAPE levels over 3, 4, and 5-month periods to find more accurate inventory forecasts. This Forecasting System is in accordance with the analysis and design and has produced a system that can run well and function properly. This statement can be seen based on the testing results conducted with black box testing. The black box testing provided results that are consistent with what is expected in all systems. Additionally, the system can be accessed via the website as long as there is network access.

CONCLUSION

The clothing sales forecasting system we have developed is a web-based forecasting system that applies the moving average method and provides forecasts for 3 different periods. Additionally, the system runs smoothly without any issues or errors based on the results of black box testing. Therefore, this system can also be used by boutique owners as a reference for preparing inventory for the upcoming month. Overall, the web-based clothing sales forecasting system functions as expected.

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