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Streamlining Inventory Forecasting with Weighted Moving Average Method at Parta Trading Companies

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ABSTRACT

The process that is currently running at Parta trading companies, along with its development, problems that often occur in the warehouse section arise, namely the accumulation of stock of goods, there are even some stock items that are not available in the warehouse. This happens because the demand for goods from consumers is uncertain at any time, because the warehouse staff still use manual methods, namely making guesses in controlling stock checks and resulting in orders for stock of goods to be purchased that do not match the number of consumer needs at any time. In overcoming the problems experienced by Parta trading companies, the author built an inventory forecasting information system, where this system can assist in the inventory forecasting process which can calculate the estimated number of goods to be purchased based on previous sales data. Based on Black Box Testing, this system runs as expected. From the problems and solutions described above, a website-based inventory forecasting system was created with the ability to predict a product or item in the future, where this system plays a very important role in being used for stock availability in the warehouse at Parta trading companies. This result of forecasting test was carried out by analyzing the sales of ceramic products sold at Parta trading companies for a period of 1 year and 12 months, where in the test using the 3-month method in month 12, the MAD error value was 100.66666666667, in the 4-month method in month 12, the MAD error value was 186, in the 5-month method in month 12, the MAD error value was 166.2, the 6-month method in month 12, the MAD error value was 160.619048.

1. Introduction

In this era of increasingly rapid technological development and progress, business people have to continue to innovate following current developments. The development of information technology is increasingly advanced, giving rise to tight competition between trading companies in today's business world (Aslam et al., 2020; Bereznoy, 2019; Marion & Fixson, 2021). Inventory of goods is very important for every company. Inventory of goods is needed in every company, one of which operates in the trading business sector, to create sales with the aim of generating profits (Shahnia et al., 2020), therefore inventory is also a current asset which has quite a high risk in the company's activities if it is not paid attention to properly and correctly (Mahdi & Khaddafi, 2020; Rony et al., 2023).

Goods inventory forecasting is an important thing and needs to be paid attention to in a company, especially those related to business because goods inventory forecasting is a reference for determining the forecast of monthly stock availability in the warehouse (Ivanov et al., 2021; Tadayonrad & Ndiaye,

2023). Having a good goods inventory forecasting system can provide convenience for companies in regarding inventory of goods. Inventory forecasting needs to be organized and controlled in an inventory forecasting system so that it is coordinated properly and correctly (Fildes et al., 2022; Harianto et al., 2022; Rony et al., 2019).

Parta is a trading companies that sells building materials which was established on September 27 2019. Parta trading campanies sells various kinds of building materials including cement, sand, coral, bricks, iron, tiles, various types of paint, electrical equipment, wood, and so on. Along with its development, problems that often occur in the warehouse section arise, namely the accumulation of stock of goods, there are even some stock items that are not available in the warehouse. This happens because the demand for goods from consumers is uncertain at any time, because the warehouse staff still use manual methods, namely making guesses in controlling stock checks and resulting in orders for stock of goods to be purchased that do not match the number of consumer needs at any time (Apriyansyah et al., 2024; Atmaja & Anandita, 2021; Wiguna et al., 2023). This resulted in the author being interested in conducting research at Parta trading companies is due to the lack of a computerized inventory forecasting system at this time. Parta trading companies must be able to calculate estimates of the number of goods to be purchased based on previous sales data. These predictions have a big influence on the decision to determine the amount of stock that will be provided by Parta trading companies for data for the next sales period. In this research, a system was designed to help companies in the inventory forecasting process that can calculate estimates of the number of goods to be purchased based on previous sales data using computerized media.

Implementing the WMA (Weighted Moving Average) method is a model for forecasting. This technique is used to predict demand by calculating the average value of the actual demand value from a specific number of previous periods. Each new forecast is set for a long period and replaced with requests from a new period, so that the data in the calculation moves over time according to the name Moving Average. Compared to other methods, the WMA method is most appropriate to use in this forecasting because it can help leaders in making decisions. to determine the inventory process for goods in the future with a performance level of forecasting accuracy reaching 98% compared to other forecasting methods. Based on the problems described above, a computerized inventory forecasting system is needed which can be a solution to these problems. The implication of this research is to design an inventory forecasting system using the Weighted Moving Average method, this system is expected to help companies in the warehouse section in terms of overcoming the problem of managing stock needs.

2. Literature Review

As consideration in this research, five previous research results have been included as a comparison between the research made by the author and previous research. The five previous studies are as follows. The first research was conducted (Pang et al., 2019) in his research entitled Implementation of a Goods Inventory Forecasting System Using the Moving Average Method at PT. XYZ. At PT. XYZ's problem is that the goods expire because in certain periods the amount of stock accumulates due to low demand which results in the company making a loss. This research aims to design and build a Sales Forecasting System Using the Weighted Moving Average Method at PT. XYZ. This research is desktop based. This system produces forecasting output which is expected to make things easier for PT. XYZ in making decisions about the products and raw materials that must be purchased. The second research (Riyadi et al., 2019) discusses the problem of difficulties in forecasting sales of a number of products which results in product shortages and product excesses. The design of this system uses Use Case Diagrams, this system was built using PHP and MySQL as the database and the testing uses Black Box Testing (Desnanjaya et al., 2023; Sarasvananda et al., 2022). The third research by (Burinskiene, 2022) discusses the problem of difficulties in predicting future product supplies based on previously recorded pharmacies data (Kolade, 2019). Next research discusses the problems faced by problem of inventory at markets, because there is still using conventional method (Mumpuni & Alhakim, 2020). There are many books stacked for reporting each transaction carried out. This causes employees to re-check the data if they are asked to report by the leadership. Another problem faced by this shop is that there are often out-of-stocks for certain items

due to the lack of sales records or adequate stock records (Jiang, 2021). This can cause the shop's profits to decrease and there will be quite a large stock of unsold goods. This results in huge losses. This research aims to create a sales forecasting application by looking at the stock of goods in the warehouse to find out and estimate market events and profits in the future so as to minimize losses (Khan et al., 2020). Another research (Gunarti et al., 2023) discussing the purchasing process which often experiences difficulties in determining how much stock of goods must be purchased for the next period. Forecasting that requires taking historical data to be processed in order to produce a decision on how much stock is predicted to be needed for the next period (Putri et al., 2023). The aim of this research is to simplify and speed up forecasting using the weighted moving average (WMA) approach through the development of an information technology-based system (Puspitasari et al., 2023).

3. Research Methods

3.1 Data Collection and Processing

Table 1 is data on sales of goods in 2021 which was collected and combined by month from a total of 22 products or goods sold, then the data was processed by sorting or checking the data in Microsoft Excel form to avoid duplication or redundancy of data. Data on accumulated sales of goods for 2021 is shown in table 1:

Table 1. Sales Data for 2021

No	Month	Year	Total Sales
1	January	2021	5.260
2	February	2021	6.776
3	March	2021	2.914
4	April	2021	6.122
5	May	2021	3.475
6	June	2021	4.802
7	July	2021	7.729
8	Agust	2021	3.950
9	September	2021	3.704
10	October	2021	3.618
11	November	2021	5.588
12	December	2021	4.495

3.2 Weighted Moving Average Method

The WMA (Weighted Moving Average) method is a method that has a technique of giving different weights to the available data so that the most recent data is the most relevant data for forecasting so that it is given a greater weight (Ajiono & Hariguna, 2023). The weight is determined in such a way that the total amount is equal to one.

The Weighted Moving Average method is a forecasting method that gives different weights to each historical data (Anbarasu & Prakash, 2020). This method is used to forecast future demand or inventory of goods based on existing historical data. In forecasting the company's inventory of goods, the Weighted Moving Average method can be used to forecast future inventory of goods based on historical data of existing inventory of goods. The weight given to each historical data can be adjusted according to the importance and characteristics of the data. The closer the historical data is to the forecasting period, the greater the weight given. The Weighted Moving Average method can assist companies in optimizing inventory and avoiding excess or shortage of inventory that can affect company performance.

Based on the data that has been processed, the data is then analyzed using the Moving Average method (Chong et al., 2021), which is shown in table 1:

$$S_{t+1} = \frac{X_{y+}\ X_{t-1+\cdots xt-n+1}}{n} \quad (1)$$

Description:
S_{t+1} = Prediction for period t+1 n = Number of periods used to calculate the moving average
X_t = Data for period i

To forecast the supply of goods for the coming period, namely December 2021, a test was carried out using the Moving Average Method with a moving period of 3 months. The following is the calculation for forecasting Moving Average goods inventory:

$$MA = (n1.1 + n2.2 + n3.3 + \cdots)/n \quad (2)$$

Description:
MA = Moving Average
n1 = first period data
n2 = second period data
n3 = third period data
n = number of moving average periods

3.3. Pengujian Menggunakan Metode Mean Absolute Deviation (MAD)

Mean Absolute Deviation (MAD) is a calculation used to calculate the average absolute error. MAD is used when an analyst wants to measure the forecasting error in the same unit of measure as the original data. MAD measures forecast accuracy by averaging the forecast errors (the absolute value of each error) (Hu et al., 2021). MAD is useful when measuring the forecast error in the same units as the original series. MAD is the first measure of overall forecasting error for a model. Testing the error value in the forecasting process of this study is by using the average absolute deviation MAD (Mean Absolute Deviation), which is the value calculated by taking the sum of the absolute values of each forecasting error divided by the number of data periods (n) . By testing the error value in the inventory forecasting process, namely by using the average absolute deviation (MAD), which is the value calculated by taking the sum of the absolute values of each forecasting error divided by the number of data periods (n). The following is the calculation of the MAD (Mean Absolute Deviation) error value (Prado et al., 2020):

$$\text{Mean Absolute Deviation} = \frac{\sum(Actual - Forecast)}{n} \quad (3)$$

Desciption:
MAD = Mean Absolute Deviation
∑ actual = nilai actual persediaan barang
∑ forecast = nilai hasil peramalan barang
n = number of moving average periods

4. Results and Discussions

4.1. Data Analysis

There is data on sales of goods in 2021 which is collected and united by month from a total of 22 products or goods sold, then the data is processed by sorting or checking the data in the form of Microsoft Excel to avoid data duplication or reudancy. The sales data of goods at Parta trading companies is a research dataset used in the process of forecasting goods. Based on the data that has been processed, the data is then analyzed using the Moving Average method, namely using equation (2) so that the following calculation results are obtained.

MA_{2021} = (3704.1+3618.2+5588.3)/6
MA_{2021} = (3704+7236+16.764)/6
MA_{2021} = 4617.33333

Table 2. Moving Average Forecasting Results

No	Month	Year	Total Sales	MA
1	January	2021	5.260	-
2	February	2021	6.776	-
3	March	2021	2.914	-
4	April	2021	6.122	4592.33333
5	May	2021	3.475	5161.66666
6	June	2021	4.802	4263.83333
7	July	2021	7.729	4579.66666
8	Agust	2021	3.950	6044.33333
9	September	2021	3.704	5351.66666
10	October	2021	3.618	4456.83333
11	November	2021	5.588	3702
12	December	2021	4.495	4617.33333
			58.433	**39067.70365**

Based on table 1, it can be explained that there is data on sales of goods from January to December 2021 with total sales being the actual sales data, using the MA forecasting method, the estimated value of the total moving average is 3907.70365.

4.2. System Overview

The system that will be built is a website-based system. This system will manage product data at UD. Parta will later produce information starting from information regarding inputting product data, supplier data, detailed forecasting data. This system can help UD. Parta, especially in the warehouse section, starting from the process of inputting product data, supplier data and data from the results of inventory forecasting which are compiled into one can later be used to create a final report.

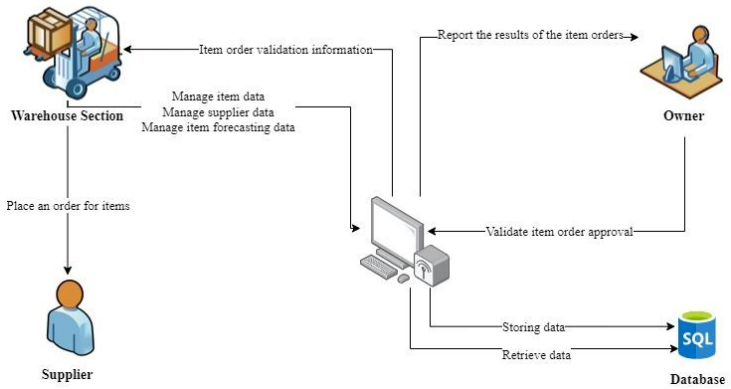

Fig.1. System Overview

4.3. System Design

This study uses Unified Modeling Language (UML) design to develop information systems utilizing graphical notations. utilizing UML to design firm inventory forecasting information systems helps the development team communicate and collaborate by utilizing graphical notations that everyone can understand. UML notations can explain system structure, function, and component interaction, helping developers build systems faster. This study uses Unified Modeling Language (UML) design to develop information systems utilizing graphical notations. UML's graphical notations make it easier for the development team to communicate and collaborate on the company's inventory forecasting information system. UML notations can be used to represent system structure, function, and component interaction, helping developers build systems faster. Figure 1 shows a usecase diagram.

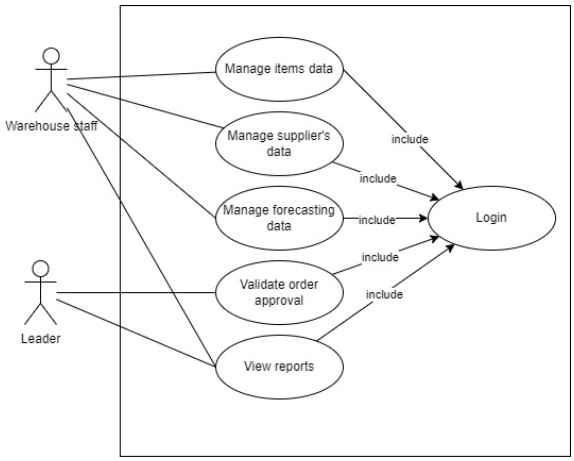

Fig.2. Usecase Diagram

Based on Figure 1, it can be explained that there is a use case diagram that has two actors, namely warehouse staff and leaders, here warehouse staff can manage item data, manage supplier data, manage forecasting data and view reports, then warehouse staff log in. While the leader here is tasked with validating order approval and viewing reports, then the leader logs in.

4.4. System Implementation

The implementation of this inventory forecasting information system will be limited according to the research methodology, which includes:

1. Admin has access rights to implement the display, which consists of: login, dashboard display, adding user data, adding supplier data, adding item data, forecasting inventory, managing sales transactions, managing ordering transactions, and managing reports.
2. Leaders have access rights to the implementation of the display, which consists of: login, dashboard display, displaying order transaction data, validating orders, and displaying reports.

Dashboard Page

Figure 3 is a display of the home page (dashboard). This home page (dashboard) displays general information about user data, supplier data, goods data, inventory forecasting, transactions and reports.

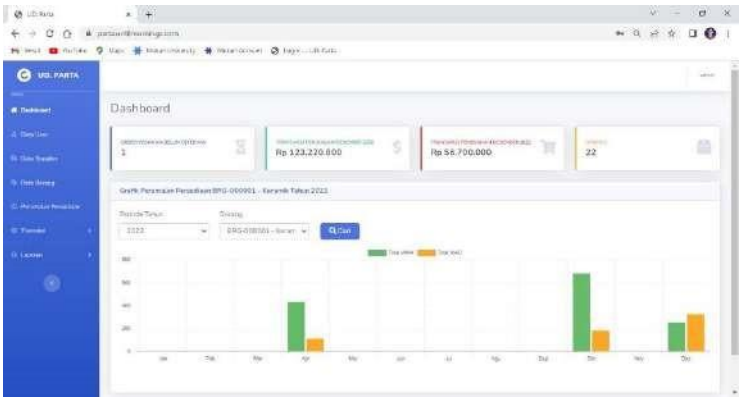

Fig.3. Dashboard Page

Inventory Forecasting Data Page

Figure 4 is a page display of inventory forecasting data and additional inventory forecasting data. On this inventory forecasting page the admin will add a new inventory forecast starting from filling in the name of the item you want to forecast, select the month and year you want to forecast. This forecasting process uses the WMA method with a moving period of 3 months whose formula has been included above and using the testing method, namely MAD, more accurate data will appear in forecasting and the admin can also delete forecasting data that has been stored.

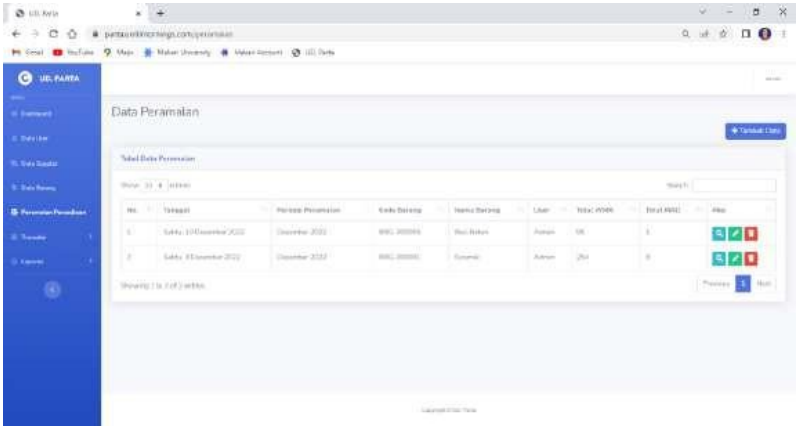

Fig.4. Inventory Forecasting Data Page

Inventory Forecasting Report Page

Figure 5 is a display of the inventory forecasting report data page. On the data page of this inventory forecasting report.

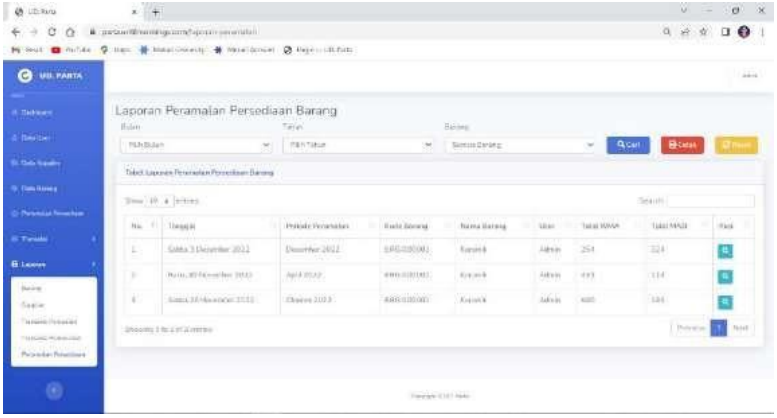

Fig.5. Inventory Forecasting Report Data Page

4.5. Forecasting Calculation Testing

In this research, testing MA forecasting results by applying Mean Absolute Deviation (MAD) testing. By applying MAD, it is intended to determine the error value of each forecasting result for each month in 2021. The calculation of forecasting data testing using equation (3) is shown in table 2 below.

Table 2. MAD Calculation Result

No	Month	Year	Total Sales	MA	MAD
1	January	2021	5.260	-	-
2	February	2021	6.776	-	-
3	March	2021	2.914	-	-
4	April	2021	6.122	4592.33333	**191.208334**
5	May	2021	3.475	5161.66666	**240.952381**
6	June	2021	4.802	4263.83333	**89.694445**
7	July	2021	7.729	4579.66666	**629.866668**
8	Agust	2021	3.950	6044.33333	**523.583333**
9	September	2021	3.704	5351.66666	**549.22222**
10	October	2021	3.618	4456.83333	**419.426665**
11	November	2021	5.588	3702	**18886**

12	December	2021	4.495	4617.33333	**132.6667**

Based on table 2, it shows the results of the calculation of the MAD error value within a period of 1 year and 12 months, the error value is obtained from the equation 5 formula above so that the result is an MAD error value of 132.66667 in December 2021. The test scenario uses calculations from data for 3 months, 4 months, 5 months and 6 months as a comparison in determining the smallest error value of Mean Absolute Deviation (MAD). This test was carried out by analyzing the sales of ceramic products sold at Parta trading companies for a period of 1 year and 12 months, where in the test using the 3-month method in month 12, the MAD error value was 100.66666666667, in the 4-month method in month 12, the MAD error value was 186, in the 5-month method in month 12, the MAD error value was 166.2, the 6-month method in month 12, the MAD error value was 160.619048.

5. Conclusion

Based on research that has been carried out by analyzing, designing and building an inventory forecasting information system, the following conclusions can be drawn: 1) The inventory forecasting information system uses the WMA (Weighted Moving Average) method atParta trading companies was designed starting from collecting data regarding existing problems at Parta trading companies related to the process of ordering existing inventory of goods. The author carried out several stages, starting with the interview, observation, documentation and literature stages. Then to describe the flow of the system built using Unified Modeling Language (UML) modeling which consists of use case diagrams, narrative use cases, activity diagrams, sequence diagrams and class diagrams. Next, the appearance of the system is described using the user interface. After that, it is tested using black box testing 2) This inventory forecasting information system has features, namely dashboard, user data, supplier data, goods data, inventory forecasting, sales transaction data, order transaction data, order validation by management, goods data reports, supplier data reports, data reports sales transactions, order data reports and inventory forecasting data reports. 3) Based on the results of MAD testing, it shows that the value of the 3-month method gets the smallest average value of 100.66666666667 compared to 4, 5 and 6 month which are much larger, the 3-month method is more accurate in use in this study compared to other methods.

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