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Gold Price Administration and Prediction Application using Moving Average Method

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***Abstract*—This research focuses on creating an administration and gold price prediction application using the Moving Average method for The Gold Shop Company. This application is designed to assist the store in managing store administration data, managing gold stocks, and predicting future gold prices by implementing the Simple Moving Average (SMA) method based on historical gold price data. Application testing is carried out using the User Experience Questionnaire (UEQ) method for the mobile version of the application. The implementation of the simple moving average method in predicting gold prices is also measured for accuracy by calculating the error on each price prediction data using the Mean Absolute Percentage Error (MAPE) method approach and the result is that the MAPE value is not more than 10%. This indicates that the simple moving average method has a very high level of accuracy in predicting gold prices.**

Keywords—gold price prediction, moving average, mobile application, website, store administration system

I. INTRODUCTION

The Gold Shop company is one of the gold jewelry shops in Samarinda, East Kalimantan. The Gold Shop company itself has been established since the 1980s. There are several factors or motives why customers want to buy gold, one of which is as a jewelry tool. However, apart from being a jewelry tool, there are also motives for customers to buy and sell gold as an investment tool. However, as the price of gold fluctuates and changes every day, this affects the decision of the customer and the store in determining when is the right time to buy or sell gold. Customers and the shop sometimes only guess whether the price of the gold will go up or down in the next few days, where the estimated price could be wrong or inaccurate.

There are also various requests for gold price information from customers, so the store must be ready to meet the customer's needs by knowing the gold price list on that day. Besides that, some of the customers have a desire to see the stock of gold jewelry that is available at the store without having to come to the store (which can be seen from anywhere). In order to meet customer requirements, the store usually takes photos of each gold jewelry stock that customers want to see. It is certainly inconvenient and time-consuming for the store to send gold stock photos one by one. Customers who buy and sell gold or order services from the store will have their data recorded, whether it be buy, sell, or order data. However, the store does not usually record or store the data consistently. The data that is recorded or stored is sometimes incomplete, so it can be confusing to see the history of sales, purchases, or orders.

Based on the problems described above, the solution offered is to create an application that can help Gold Shop meet customer needs by providing features in the application such as features that can predict gold prices or analyze trends in future gold price movements based on a list of historical gold prices in the past, features that can display information about the current gold price list (up to date), features that can display a list of gold stocks that are currently available (such as digital catalogues), and features that can record and store data such as sales data, purchases, orders, and financial reports in a neat, well-organized, and easy-to-understand manner.

II. LITERATURE REVIEW

A. Gold

Gold is a precious metal that is malleable and a symbol of honor, wealth, and luxury. Gold, which is usually used as a material for jewelry or valuable possessions, has also long been a popular and trusted investment instrument [4]. Real gold has several characteristics, one of which is that it has a shiny color because gold comes from the process of magmatism, which produces special mineral deposits. This type of precious metal has a sparkling and shiny yellow color, in contrast to counterfeit metals, which are usually dark yellow in color. In addition, gold is easy to shape because it is soft and malleable, non-magnetic, not easily damaged, and usually has a certificate as proof of its authenticity. Gold consists of several types, including gold bars, gold jewelry (such as necklaces, rings, bracelets, earrings, and pendants), gold coins, white gold, and others.

B. Mobile Application

Mobile applications are software designed for use on small wireless devices such as tablets and smartphones [3]. Mobile apps can be written in a variety of programming languages and frameworks and can be installed and downloaded from app stores such as the Apple App Store (for iOS operating systems) or the Google Play Store (for Android operating systems). The way a mobile application works to be used or run on the device is that once downloaded, the application is installed, stored on the device, and launched using the device's operating system. The application can communicate with the device's operating system and other built-in software components when the user opens the mobile application to access the device's hardware and services, such as the camera, GPS, Internet connection, and so on.

C. Information System

Information systems are systems that use technology and human work to support management and operational activities [1]. The purpose of developing an information

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system is to produce a product consisting of a collection of information. A system must have different types of data that can be processed so that they can be easily displayed for users to obtain information. A well-designed information system can ensure that the data is properly stored and recorded so that it can be retrieved whenever needed, thus saving time and helping an organization or user manage all the data [10].

D. Moving Average Method

The moving average method is one of the methods used as a technical analysis tool to analyze and predict stock or asset price movements [2]. In other words, this method can calculate stock prices within a certain period of time, for example, a period of 5 (1 week), 20 (1 month), 60 (3 months), or 120 (6 months), to see the movement of stock prices in the form of an average line on a graph using a mathematical formula. The moving average method is part of a lagging indicator, which means that this method explains information about market history data [5]. For example, a 20-day moving average means that the figure is an average of price movements over the past month. The longer the period used, the slower the movement of the line (lagging) compared to the price.

In the context of gold, the moving average method can also be used to predict future gold prices, as this method can read movements or changes in gold prices based on the history of gold price data in previous days. This can be used as a consideration or decision as to when it is a good time to buy or sell gold. This moving average method can be divided into several types, including simple moving average (SMA), weighted moving average (WMA), and exponential moving average (EMA) [6].

The Simple Moving Average (SMA) method is the simplest moving average method compared to other moving average methods. The way this method is calculated is by adding a series of prices over a certain period of time and then dividing by the number of periods. This method can be written as follows:

$$SMA = \frac{p_M + p_{M-1} + \cdots + p_{M-(n-1)}}{\mathrm{n}}$$

Where:
p_M = Mth period price
n = period

The Weighted Moving Average (WMA) method is an evolution of the Simple Moving Average (SMA) method. The difference is that in the Simple Moving Average (SMA) method, each price data is assumed to have the same weight, but in this Weighted Moving Average (WMA) method, the price data is actually given a different weight, with the latest price data having a greater weight than the old data, in order to achieve higher calculation accuracy [7]. This method can be written as follows:

$$WMA_M = \frac{np_M + (n-1)p_{M-1} + \cdots + 2p_{(M-n+2)} + p_{(M-n+1)}}{\mathrm{n} + (\mathrm{n}-1) + \cdots + 2 + 1}$$

The Exponential Moving Average (EMA) is a type of moving average that gives greater weight and significance to the most recent data points, such as the current gold price. Due to the weighting factor, this method tends to be more sensitive to price changes than the Simple Moving Average (SMA) method. To calculate the exponential moving average (EMA), first calculate the moving average using the simple moving average (SMA) over a given period. Then calculate the weighting (smoothing) factor of the EMA; the formula is 2/(n+1). For example, for a 20-day moving average, the weighting factor is [2/(20+1)] = 0.0952. The weighting (smoothing) factor is then combined with the previous EMA to obtain the current value. Thus, the EMA gives more weight to the current price. This method can be expressed as follows:

$$EMA_{today} = EMA_{yesterday} + \alpha \times (price_{today} - EMA_{yesterday})$$

Where:
$EMA_{yesterday}$ = SMA value for the nth period
α = EMA weighting factor, formula 2/(n+1)
$price_{today}$ = Today's closing stock price or n+1

This method can also be formulated as follows:

$$EMA_t = \left[V_t \times \left(\frac{s}{1+d}\right)\right] + EMA_y \times \left[1 - \left(\frac{s}{1+d}\right)\right]$$

Where:
$EMA_t = EMA_{today}$
V_t = Value today
$EMA_y = EMA_{yesterday}$
s = smoothing
d = number of days

III. SYSTEM ANALYSIS AND DESIGN

This section will discuss further about the system analysis and design to develop the Gold Shop application.

A. Problem Analysis

Here is the list of problem analyses that the Gold Shop has:

- The price of gold is volatile, which means that the price of gold can change at any time (uncertain). This affects customers' and the shop's decisions as to when it is the right time to buy or sell gold.
- There are various requests for gold price information from customers, so the store must be ready to meet customer needs by knowing the gold price list on that day.
- The desire of some of The Gold Shop's customers is to see the stock of gold jewelry that is available at the store without having to come to the store (which can be seen from anywhere). Therefore, the store usually takes photos of various gold jewelry stocks and then sends them to the customers.
- Store data management (such as recording and storing data) is still poorly managed by the store [8].

B. Requirement Analysis

Based on the problem analyses described above, a system is needed that can help Gold Shop overcome the problems, such as:

- A program that can predict the price of gold or analyze the trend of gold price movements in the future based on a historical list of gold prices in the past.
- A program, such as a digital catalog, that can display a list of gold stocks currently available in the store, along with detailed information about the gold, such as its type, grade, weight, manufacturer, and item description [9].

- A program that can record and store data such as sales data, purchases, orders, and financial reports in an organized manner.

C. Business Process Analysis

The business process of Gold Shop is divided into several parts, namely:

1) Sales Process

The gold sale process between the customer and the gold shop begins when the customer comes to the shop and gives the shop the gold they want to sell. The store checks the customer's gold to see if it is real or fake and asks for a gold purchase receipt. If it does not meet these requirements, the gold will be returned to the customer. In the meantime, if the store accepts the gold that the customer wishes to sell, it will provide a price quote for that day. At this stage, the customer can negotiate the price of the gold they wish to sell with the store. If an agreement is reached, the store will accept the gold, pay the customer, and issue a sales receipt as proof of payment. This process of selling gold is shown in Fig. 1.

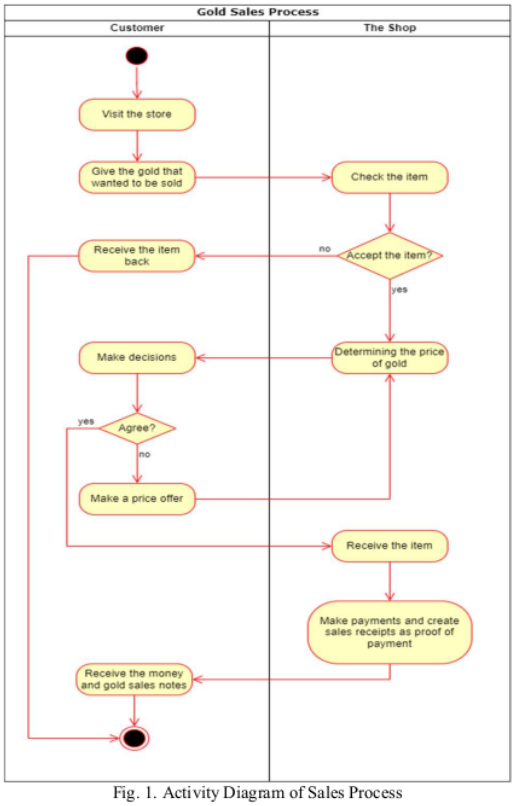

Fig. 1. Activity Diagram of Sales Process

D. System Design

This section shows the design of the system for the application to be built, such as the use case diagram and the entity relationship diagram.

1) Use Case Diagram

Fig. 2. below is a use-case diagram of the system that will be created for Gold Shop. There are two actors that can interact with the system, namely the store, which acts as an admin, and the store's customers, which act as users. Admins can use various features such as login, account management, inventory management to manage gold jewelry stock, order verification, provide appointment status, enter gold buying and selling data, enter gold service order data, financial reports, display a list of today's gold prices, provide gold price forecasts, and provide a gold price range to customers when they want to sell gold. Meanwhile, users can use features such as register, login, account management, and a and a digital catalog to view the various gold jewelry stocks available, filter gold jewelry stocks, and place orders for gold services such as damaged gold repair services, gold washing, gold melting, or gold jewelry model design services. In addition, the user can also use the appointment setting feature if the customer wishes to arrange a time with the store to buy and sell gold or for other purposes. The user can also use the feature to check the current gold price and get information about the price range of the gold the user wants to sell.

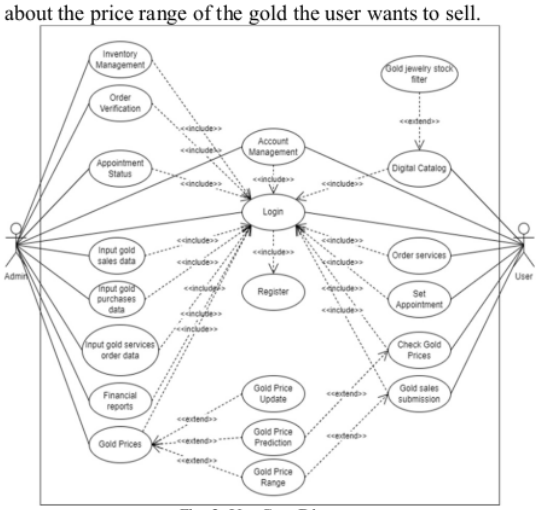

Fig. 2. Use Case Diagram

2) Entity Relationship Diagram

Fig. 3. below is a crow's foot entity relationship diagram containing tables that play a role in storing data for the Gold Shop system.

Fig. 3. Entity Relationship Diagram with Crow's Foot notation

IV. RESULT AND DISCUSSION

This section will discuss further about some of the application designs, application testing results, and testing results of the gold price prediction.

A. Application Design

The mobile version of the Gold Shop application page display is divided into two themes, namely the dark mode theme and the light mode theme. The mobile version of the Gold Shop application view can also adjust the screen size of the device, either portrait or landscape.

1) Home Page

The home page displays some information, one of which is today's gold price information. If the user clicks on the gold price information, the user will be redirected to today's gold price page. In addition to today's gold price information, there is also a table of gold price data over the last 7 days, showing the date and the price of gold on that date. Clicking on the table will take the user to the historical gold price data page. There are also buttons on this home page to view the gold stock currently available, such as necklaces, bracelets, rings, earrings, pendants, and precious metals. For example, if the user clicks on the bracelet button, they will be taken to the digital catalog page where the condition of the gold stock is displayed (filter), which is a list of gold stock in the form of bracelets. There is also a navigation bar at the bottom of the home page with the home, my activities, and profile buttons. The display of the home page in the mobile version of the Gold Shop application is shown in Fig. 4.

Fig. 4. Home Page on Mobile Version Application

2) Historical Gold Price Data Page

The Gold Price History page is a page that displays a list of gold price history for the last 1000 days. This gold price history list is displayed in a table with the date and gold price information for that date. On this page, there is a facility to filter the gold price data by year. For example, if the user filters the year 2022, then the list of data displayed will be a list of gold prices in 2022. The amount of gold price data loaded for each page is 20 data points. If the user wants to see the following or previous data, then the user can click on the previous or next button on the page. The display of the historical gold price data page is shown in Fig. 5.

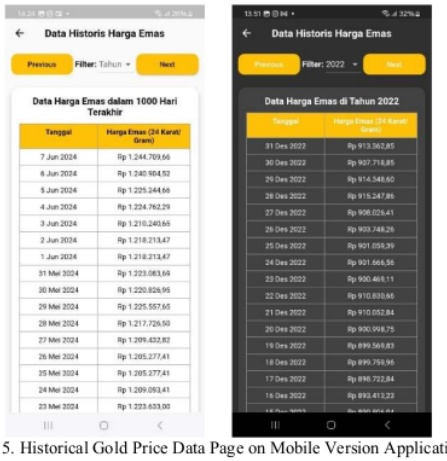

Fig. 5. Historical Gold Price Data Page on Mobile Version Application

In addition to displaying historical gold price data in tabular form, historical gold price data is also displayed in graphical form. There are functions for zooming the price data on the gold price graph, including Zoom all, which displays the gold price graph as a whole; Zoom YTD (year to date), which displays the gold price graph for the period from the beginning of the year to the present; Zoom 1m, which displays the price graph for the last 1 month; Zoom 3m, which displays the price graph for the last 3 months; and Zoom 6m (the default zoom function on the website version of the application), which displays the gold price graph for the last 6 months. The gold price chart displayed on the historical gold price data page on website version is shown in Fig. 6.

Fig. 6. Display of the Gold Price Graph on the Website Version of the Application

The display of the gold price chart changes according to the zoom chart option used by the user. In addition to the zoom chart function, the chart on the website version of this application has a predictive/analysis function for gold prices using the Simple Moving Average (SMA) method. With this method, users can find out the trend or forecast of gold prices in the future based on this gold price history data. If the user wishes to use this method, the user must enter the period according to the analysis needs (long or short term); for example, the input period is 30 days. Users can also forecast gold prices using more than one simple moving average method at the same time by entering more than one period if they want to analyze or forecast gold prices using a combination of these periods. The graph generated by

implementing one simple moving average method is shown in Fig. 7, while the graph generated by implementing more than one simple moving average method with different periods is shown in Fig. 8.

Fig. 7. Gold Price Chart Display with Gold Price Prediction Method with 1 SMA on the Website Version of the Application

Fig. 8. Gold Price Chart Display with Gold Price Prediction Method with More than 1 SMA on the Website Version of the Application

3) Digital Catalog Page

The digital catalog page is a page that displays the gold stock that is currently available. Users can view different types of gold as a whole or by filtering the gold stock; for example, if users filter by necklaces, then the system will only display a list of gold stock in the form of necklaces on the digital catalog page. Users can also view the details of the gold stock by clicking on the item that users wish to view the details of. The digital catalog page is shown in Fig. 9.

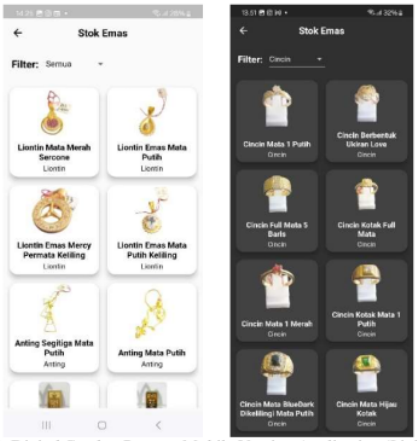

Figure 9. Digital Catalog Page on Mobile Version Application (Light Mode & Dark Mode)

B. Application Testing Results Data

The Gold Shop application that has been created, both the website version and the mobile version, needs to be further evaluated to find out how good the application is. The evaluation of the application will largely be from the user's point of view when using the application. In order to conclude how good and effective the application is, participants need to test the Gold Shop application. For the mobile version of the application, after testing the application, users are asked to complete a user testing questionnaire for the Gold Shop mobile application. There were 22 participants who took part in testing and completing questionnaires. The questions in the questionnaire were taken from the User Experience Questionnaire (UEQ) method, which can be accessed via the website https://www.ueq-online.org/.

Data from respondents or participants is then processed using the UEQ data analysis tool. Respondent or participant data contained in the questionnaire can be entered into the "Data" sheet in the Excel file. The data will be processed to produce a score or average value for each UEQ method rating scale. To find out how good the average value obtained is, the data can be compared with the benchmark data contained in the benchmark column or sheet in the Excel file. The results of the comparison between questionnaire data and benchmark data in tabular form can be seen in Table 1, while the results of the comparison between questionnaire data and benchmark data in graphical form can be seen in Fig. 10.

Table 1. Table of Comparison Results of Questionnaire Data with Benchmark Data

Scale	Mean	Comparison to Benchmark	Interpretation
Attractiveness	1,80	**Good**	10% of results better, 75% of results worse
Perspicuity	1,89	**Good**	10% of results better, 75% of results worse
Efficiency	1,88	**Good**	10% of results better, 75% of results worse
Dependability	1,75	**Excellent**	In the range of the 10% best results
Stimulation	1,13	**Above Average**	25% of results better, 50% of results worse
Novelty	0,73	**Above Average**	25% of results better, 50% of results worse

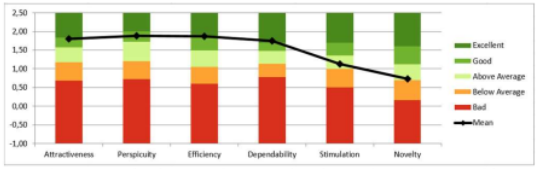

Fig. 10. Graph of Comparison Results of Questionnaire Data with Benchmark Data

From the results of the comparison between the questionnaire data and the benchmark data, it can be seen that for each rating scale, the mobile version of the Gold Shop application scores quite well and exceeds the average rating when compared to the benchmark data, so it can be concluded that the mobile version of the Gold Shop application has been successfully designed and developed.

V. CONCLUSION

Based on the test results of the application, it can be concluded that the implementation of the moving average method in predicting the gold prices in the future has been successfully carried out and has a high level of accuracy, as the mean absolute percentage error (MAPE) value is not more than 10%. This has been demonstrated by calculating the error for each gold price forecast with different parameters, starting from the short, medium, and long terms. The period index used as a test in predicting gold prices includes the 10-day period (short term) with a MAPE of 0.87%, the 50-day period (medium term) with a MAPE of 2.04%, and the 200-day period (long term) with a MAPE of 4.74%.

In addition, all features of the Gold Shop application, both the website version and the mobile version, can function properly. The application has also gone through the testing phase by conducting user testing. The mobile app version was tested by 22 participants in application trials. The participants then completed a questionnaire about the use of the application. The result is that the mobile app version gets good results on every scale of evaluation and exceeds the average evaluation when compared to the data of the benchmark, so it can be concluded that the mobile version of the Gold Shop application has been successfully created and developed properly. As for user testing and evaluation of the website version of the application, this is done directly by the shop owner as a representative of the shop. The results of user testing and evaluation of both the website and mobile versions of the application are that, overall, the Gold Shop application is easy to use and understand, and the features included in the application can facilitate the store's performance in meeting customer needs.

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