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# IMPLEMENTATION OF TIME SERIES FORECASTING ALGORITHM IN THE 'MUSLIMAH CALENDAR' APPLICATION

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**Abstract:** Menstruation is blood that comes out of the farji (genitals) of a woman who is nine years old. In the book Risalah Haidl, it is explained that in several situations a Muslim woman who experiences menstruation is obliged to change her prayer. This Muslimah calendar aims to make it easier for users to predict the arrival of menstruation and record the prayer obligations incurred by a Muslimah. The algorithm implemented is the Time Series Forecasting Algorithm with Data Driven Prediction Exponential Smoothing Method, the sistem development method is waterfall, and the sistem design uses UML (Unified Modeling Language). This application uses the Flutter framework. The result of this research is an application that can estimate the start date of the menstrual period, the start date of the holy period and reminders of prayers that have not been done.

**Keywords:** Algoritma Forecasting, Method Exponential, Flutter, Waterfall

## 1. INTRODUCTION

Menstruation in language means "to flow." According to Islamic law (Syara'), it is the blood that flows from a woman's genitalia who has reached the age of nine years, not due to childbirth but in a healthy condition, with the blood color being reddish-black (Fathul Qorib:10). The maximum period for a woman to menstruate is 15 days and nights. However, typically, women menstruate for 6 or 7 days and nights. This is based on Imam Syafi'i's research on Arab women in the Middle East (Minhaju al-Qawim:29). Forecasting or prediction is needed to provide preparation in carrying out an activity (Purwanti, 2019).

Time series is a prediction method using historical data. Forecasting is the activity of predicting what will happen in the future based on relevant data from the past and placing it into the future with a systematic model. Exponential Smoothing (ES) is a moving average forecasting technique that weighs past data (Aceng, 2020).

By analyzing time series, one can determine past variation patterns that can be used to predict future values and assist in operational management and planning, including: (1) Single Exponential Smoothing is used when the data does not have a seasonal pattern, so this time series forecasting method is essentially applied. SES formula: $s'_t = \alpha x_t + (1-\alpha)s'_{t-1}$ (2). Double Exponential Smoothing is a forecasting method used for time series when the data has a linear trend and no seasonal pattern. DES formula $s''_t = \alpha s'_t + (1-\alpha)s''_{t-1}$ (3) Triple Exponential Smoothing is applied to time series forecasting when the data has a linear trend and a seasonal pattern. TES formula: $s'''_t = \alpha s''_t + (1-\alpha)s'''$ (Kurniawan, 2020). Forecasting cannot be separated from the interaction of humans and equipment. Humans can control equipment so that it can be used to support the success of human activities (Subakti, 2022).

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## 2. METHOD

The method used by the author to collect data, which will later be analyzed and processed by the researcher, allows the researcher to identify the problem and find solutions for solving it. There are two approaches used in the data collection process: (1) Literature Study: Data collection is done by reading and understanding journals, articles, and books related to the research. (2) Interviews: Interviews are used to gather data, information, and subjects for the research. Interviews were conducted with the students of PP Nawwir Quluubanaa.

The system development method used in this research is the waterfall method. The stages of this method will serve as a reference in this study. This method includes the development of a time series forecasting algorithm (Landjo, 2021).

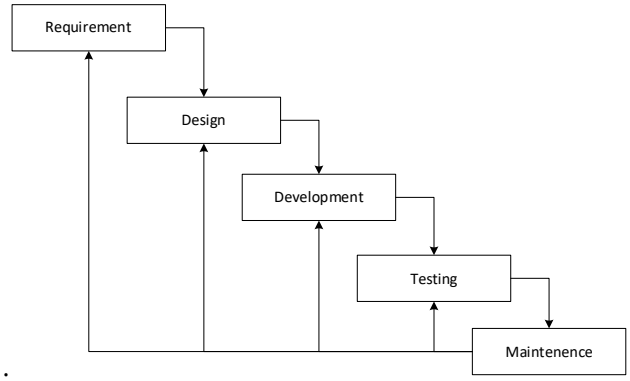


Fig 1. Development method

(1) Requirement, in this phase, the researcher conducts surveys and interviews with the students of PP Nawwir Quluubanaa to gather the necessary information and data. (2) Design, in this phase, the researcher creates a plan or sketch that will display the appearance and functionality of the application to be developed. (3) Development, in this phase, the researcher develops the Muslimah calendar application according to the idea or concept that was previously created, using Visual Studio Code. (4) Testing, the researcher performs testing using the black box method to check the functionality of the program. (5) Maintenance, the researcher performs maintenance and fixes the application that has been developed.

## 3. RESULT AND DISCUSSION

### 3.1. Data Analysis using the Double Exponential Smoothing Method

The application of the Double Exponential Smoothing Method involves smoothing the data twice, followed by forecasting. However, before smoothing is performed, the smoothing parameter (α) must be determined, which will be used to smooth the actual time series data. In determining the smoothing parameter (α), which is between 0<α<1, it is found through trial and error and selected based on the minimum MAPE (Mean Absolute Percentage Error) value. The process of solving using the Double Exponential Smoothing Method involves several steps according to the predefined formulas:

a. Determining the first smoothing value (s') using the parameter α=0.1 with the equation: $s'_t = \alpha x_t + (1-\alpha)s'_{t-1}$
b. Determining the second smoothing value (s'') using the equation: $s''_t = \alpha s'_t + (1-\alpha)s''_{t-1}$
c. Determining the constant value ($a_t$) using the equation $a_t = 2s'_t - s''_t$
d. Determining the constant value ($b_t$) using the equation $b_t = \frac{\alpha}{1-\alpha}(s'_t - s''_t)$
e. Determining the forecast value ($F_{(t+m)}$) using the equation $F_{t+m} = a_t + b_t m$

### 3.2. Menentukan Parameter ($\alpha$) Terbaik

In this research, the best parameter (α) is chosen based on the smallest MAPE (Mean Absolute Percentage Error) value. The parameter values range between 0.1 and 0.9. The smaller the MAPE value obtained, the closer the estimated value is to the actual value. The parameter error can be calculated using the formula: $PE = \left(\frac{X_t - F_t}{X_t}\right) 100\%$ After calculating the percentage error, the next step is to

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calculate the MAPE (Mean Absolute Percentage Error) using the formula: $MAPE = \frac{100\%}{n}\sum_{t=1}^{n}|\frac{X_t - F_t}{X_t}|$

### 3.3. Application Design

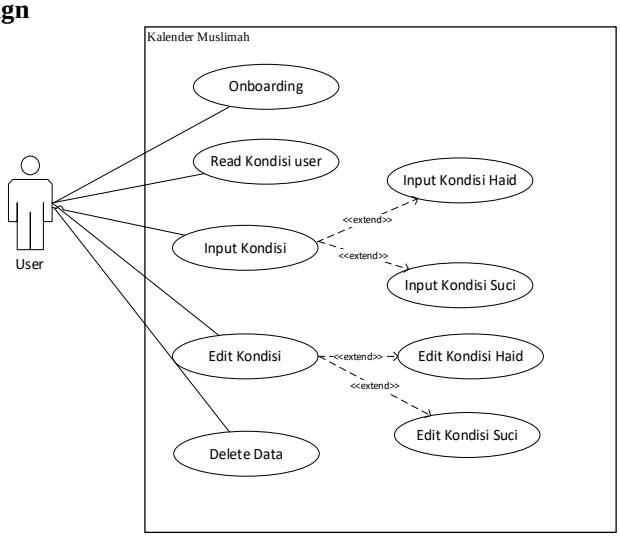


**Fig 2. Use Case Diagram**

In the diagram above, there is one actor, which is the user, and several use cases such as onboarding, reading condition, inputting condition, editing condition, and deleting condition. In the use case for inputting condition, there is an extended use case for inputting menstrual condition. In the use case for editing condition, there is an extended use case for editing menstrual condition. In the use case for deleting condition, there is an extended use case for deleting menstrual condition.

### 3.4. Application User Interface Display

a. Onboarding User Interface
On the onboarding page, if the user clicks the "next" button, they will be directed to the next onboarding page. If the user clicks the "skip" button, they will be taken directly to the main page.

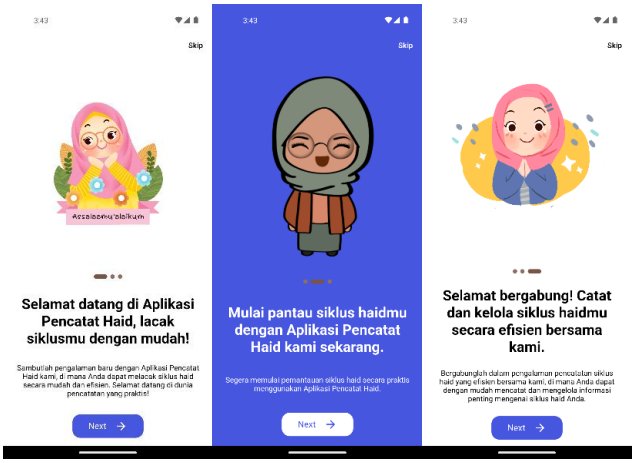


Fig 3. Onboarding UI

b. Muslimah Calendar User Interface
In this display, there is a "bleeding" button to indicate that the user will mark the calendar. A pop-up will then appear asking about prayer, and after that, the color on the calendar will change according to the user's condition.

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Fig 4. Muslimah Calendar UI

c. Prayer Debt Pop-Up UI
In this display, a pop-up appears to the user after they press the "bleeding" button.


Fig 5. Prayer Debt Pop-Up UI

d. Menstruation User Interface
In this display, the user is in a menstruation condition, and there is an indication of the estimated purification date (end of menstruation) marked on the calendar.

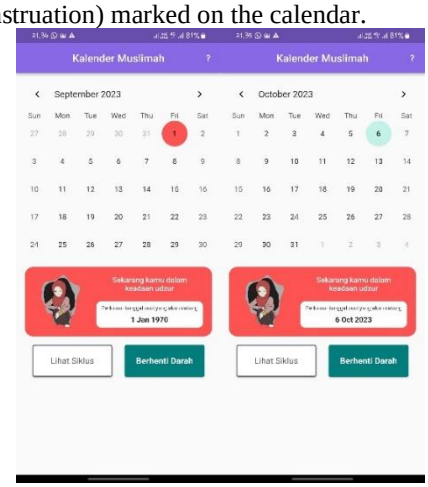


Fig 6. Menstruation User Interface

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e. User Interface Display During Purity (Post-Menstruation)
In this display, the user is in a state of purity (post-menstruation), and there is a marker indicating that the user has outstanding prayer obligations. In the second image, there is a marker showing the estimated date of the next menstruation on the calendar, along with a reminder for any prayers that have not yet been performed.

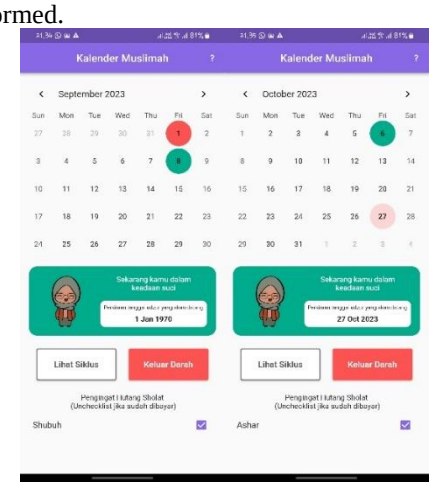


Fig 7. Post-Menstruation UI

f. User Interface Display During Uncheck
In this display, there is a confirmation where the user unchecks their prayer debt.


Fig 8. Uncheck UI

g. Edit User Interface
In this display, there is a cycle data view where the user can see and edit their menstrual cycle information.

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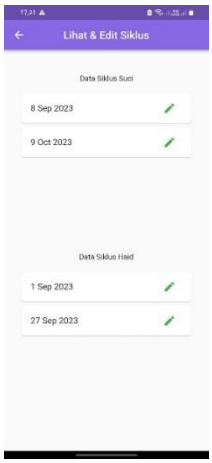


Fig 9. Edit UI

h. Info User Interface Display
In this display, the user is viewing information within the application, and they also have the option to reset the application


Fig 10. Info UI

i. Application Reset User Interface
In this display, the user is in the process of resetting the application.


Fig 11. Reset UI

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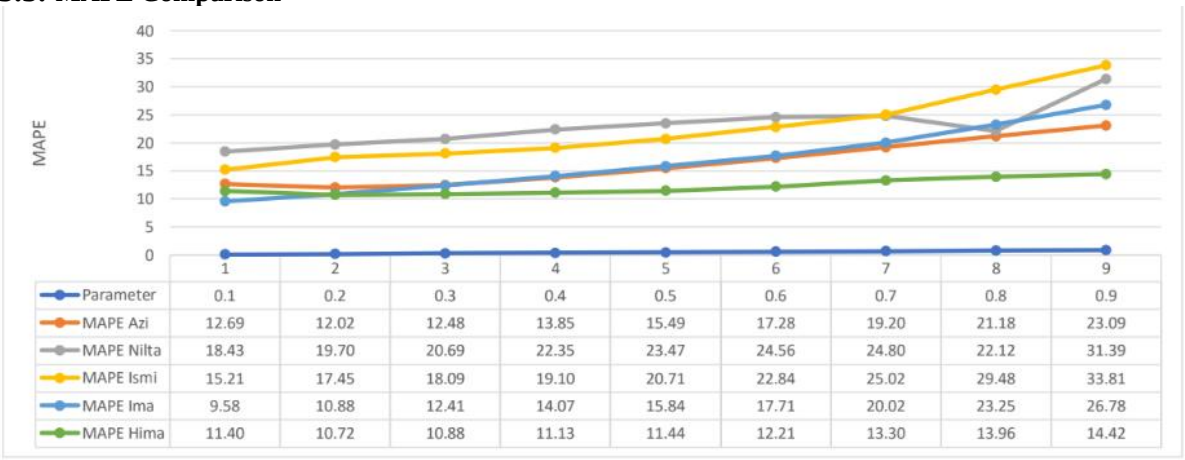
### 3.5. MAPE Comparison




| Parameter | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 |
|---|---|---|---|---|---|---|---|---|---|
| MAPE Azi | 12.69 | 12.02 | 12.48 | 13.85 | 15.49 | 17.28 | 19.20 | 21.18 | 23.09 |
| MAPE Nilta | 18.43 | 19.70 | 20.69 | 22.35 | 23.47 | 24.56 | 24.80 | 22.12 | 31.39 |
| MAPE Ismi | 15.21 | 17.45 | 18.09 | 19.10 | 20.71 | 22.84 | 25.02 | 29.48 | 33.81 |
| MAPE Ima | 9.58 | 10.88 | 12.41 | 14.07 | 15.84 | 17.71 | 20.02 | 23.25 | 26.78 |
| MAPE Hima | 11.40 | 10.72 | 10.88 | 11.13 | 11.44 | 12.21 | 13.30 | 13.96 | 14.42 |

Fig 12. MAPE Comparison

From the comparison of MAPE values above, it can be seen that the smallest MAPE represents the best alpha for calculating the prediction of the next menstrual period. In the prediction calculations for each user, the best alpha is not always the same for every user, as the determination of the best alpha depends on the fluctuation of each user's data.

## 4. CONCLUSION

The implementation of the Time Series Forecasting Algorithm in the "Muslimah Calendar" application using the Data Driven Method Exponential Smoothing can predict the end of mens truation by adding the estimated menstrual duration to the latest start date, and likewise predict the start of menstruation by adding the estimated duration of purity to the latest start of purity. The application can display the estimated start of menstruation and purity with the smallest MAPE value of 8.7543 using a parameter of 0.2. Additionally, the application can accurately display the user's outstanding prayer obligations, achieving a 100% success rate after several trials.

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