Design and Development of an AI-Driven Mobile Application for Smart Menstrual Cycle Tracking Using Agile Methodology

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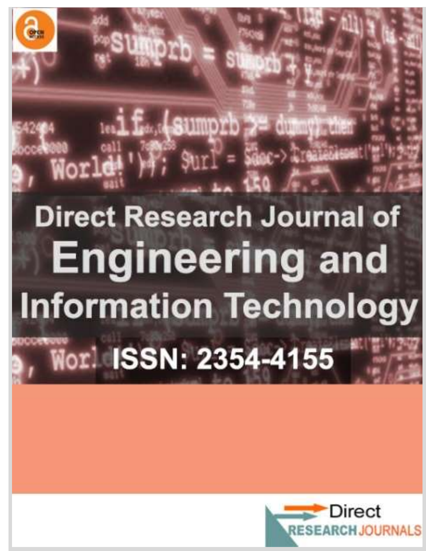
ABSTRACT

In developing countries such as Nigeria, the unavailability of secure and user-friendly menstrual tracking tool presents an all-pervasive problem for young women. Stable menstrual health condition significantly contributes to maintaining public composure and coordinated mental interactions among the women folk. Mobile app-based smart menstrual tracker represents a cutting-edge innovation for enhancing menstrual health. This study developed a model of mobile app that leverages user-friendly interfaces, advanced artificial intelligence algorithms to monitor, analyze and predict menstrual cycles. The app offers personalized insights into cycle patterns, ovulation and fertility windows, as well as track symptoms such as cramps, mood changes and energy level. The study adopted agile methodology software development process to facilitate integration of predictive algorithm for identifying cycle patterns and forecasting likely future occurrence using previous data. This approach harnessed critical hardware and software tools such as visual studio code editor, React.js with Vite, Node.js with Express and MongoDB to develop and implement both the frontend and backend functionalities of the app. It explored AI models to accurately identify menstrual cycle phases using last short-time memory (LSTM) algorithm to advance privacy-preserving reproductive health monitoring. The app was tested using locally accessed real user data assigned pseudo-names, summary results were presented as test-case I, test-case II and test-case III. The results showed optimal performance where the date-based computation model provided accurate outputs that matched the expected results. This study contributes to women's health by enhancing flexible user-centric and personalized menstrual health information management system for improved, secure and precision oriented cycle tracking.

Keywords: *Artificial Intelligence, Agile Methodology, Mobile App, Digital Health, Smartphone*



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INTRODUCTION

Menstrual cycle is a fundamental biological process in the female reproductive system, and accurate tracking and prediction of menstrual cycle phases continue to be an active research area (Kilungeja *et al.*, 2025). In traditional Nigeria societies, menstrual tracking was not always a conscious thing although an inevitable calendar-based practice. Menstrual tracking play's essential role in women's health management, and this was mostly handled through traditional/manual methods. It largely involved a recording technique using calendars or diaries and physical charts to document menstrual periods start and end dates (Kritzer, 2018). Others adopt traditional basal body temperature (BBT) measurement methods, which is susceptible to sleep disruptions, as well as lacking accuracy and practicality (Hazuki *et.* al, 2025). Many women experience great difficulties and uncertainties in predicting their menstrual cycles, resulting in series of mostly unexpected inconveniencing encounters. Women throughout history deployed various manual methods mostly drawn from phases of the moon to track their cycles. In some cultures, even knotted strings were used to count days, while others incorporated menstrual tracking into religious rituals like ceremonial birthing (Anjali, 2022; Hong *et al*., 2024). Due to difficulty in predicting menstrual cycle, most women are unprepared to its untimely occurrence that consequent disrupt general body wellbeing and even sometimes may lead to stigma (Owen, 2024; Lyzwinski, 2024). This underscores the need for a computer-driven support system that facilitates real-time menstrual health management with relative status precision per time. Global wave of trends in computing innovation, brings a gradual strategic realignment and reordering of natural courses geared towards simplifying ways and means of certain hitherto strenuous human undertakings (Adel, 2021; Ma *et al*., 2021; Christopher, 2022). The advent of digital technology in the early 2000s marked a transition from traditional calendars to scientifically informed and more systematic approach to menstrual tracking with significant outcomes (Petal *et al*., 2022; Arbeena *et al*., 2025). Artificial Intelligence (AI) systems play a pivotal role in promoting technology influence in health. For instance, AI facilitates knowledge engineering (acquisition and/or distribution), as well enhances knowledge application to tasks and decision-making process (Rhem, 2021; Odirichukwu *et al.*, 2024). Generally, digital health applications are become prominent innovation tools reshaping healthcare system management through artificial intelligence driven influence. Menstrual tracking apps is about the fourth most popular health app among adults that explore artificial intelligence algorithm in addressing important aspects of women's health (Moglia *et al.*, 2016; Petal *et al.*, 2022). Menstrual app represents a critical tool that leverages algorithms to identify patterns and interpret user-logged data with better precision for actual menstrual status. Mobile health technologies are generally changing the trajectory in healthcare with rapid increase in the emergence of specialized apps that utilize advanced technologies, such as data analytics and predictive algorithms (Jones, 2021). In some instance, it involves integrative technology adoption approach in combining predictive algorithms to provide a comprehensive understanding of AI's role in improving healthcare management across different contexts (Santamato, 2024). Menstrual tracking apps emerged as transformative tools in women's health. They offer a range of benefits that enhance both physical and emotional well-being, and great insights for menstrual cycle management and improved overall health (Arbeena *et al*., 2025). Some of the existing menstrual apps such as Flo, Clue, etc. are very useful, accessible and have provided great support to the management of women health. Issues related to complexity of use and unguaranteed privacy limits uptake for fear of compromising personal menstrual data, hence the need to strike a balance between clinical accuracy with secure and user-friendly experience that resonate public appeal (Taylor and Brown, 2017; Kleinman *et al*., 2021). The combination of user-friendly interfaces with advanced analytics has proven highly supportive to modern menstrual trackers in predicting and identifying potential health concerns with precision and convenience (William and Lee, 2019; Petal *et al*., 2022**.** These features improve user satisfaction and support early detection of health conditions. Technology adoption is largely driven by innovative accessibility options and intuitive interactive designs that promotes seamless interfaces between experts and adaptable solutions/tools (Levy and Romo (2019; Mahalingaiah *et al.* 2023; Arbeena *et al*., 2025). This study considered addressing user security and privacy concerns as imperative for promoting menstrual health education on user safety, convenience and accuracy of prediction result. The main objective of this study was the development of an AI-driven mobile application for smart menstrual cycle tracking using agile methodology. Specific objectives of the study include: to design a user-friendly and interactive application that promotes user convenience and ensure data privacy to implement a functional menstrual tracking app by adopting agile methodology tools, and test/evaluate the functionalities of the application for user data optimization. The study essentially focused on advancing privacy-preserving reproductive/menstrual healthcare by configuring a tool that run on mobile devices such as smartphones, which offers basic user-friendly and personalized innovative functions.

MATERIALS AND METHODS

This system was developed with the aid of relevant materials and it followed standard software development processes. The study harnessed both hardware and software materials useful for the various stages of the app development. In the development process, there are three (3) critical phases which includes process analysis, design and implementation. These stages are well described in the agile methodology adopted for this study and was painstakingly followed to guide realization of study goals.

MATERIALS

The development of this model of smart menstrual cycle tracker application was carried out with identified relevant materials that included both software and hardware components. The required components are summarized in

Table 1: Summary of software and hardware requirements for the system

Requirement	Component	Specification
Hardware	Mobile Device	Smartphone, tablet, laptop or desktop
	RAM	Minimum 1 GB
	Storage	Minimum 10MB free space
	Internet	Stable connection (3 GB or higher recommended)
Software	Frontend Framework	React.js with Vite
	Backend Framework	Node.js with Express
	Database	MongoDB
	Development tool (code editor)	Visual studio code
	Browser	Chrome, Firefox or Edge

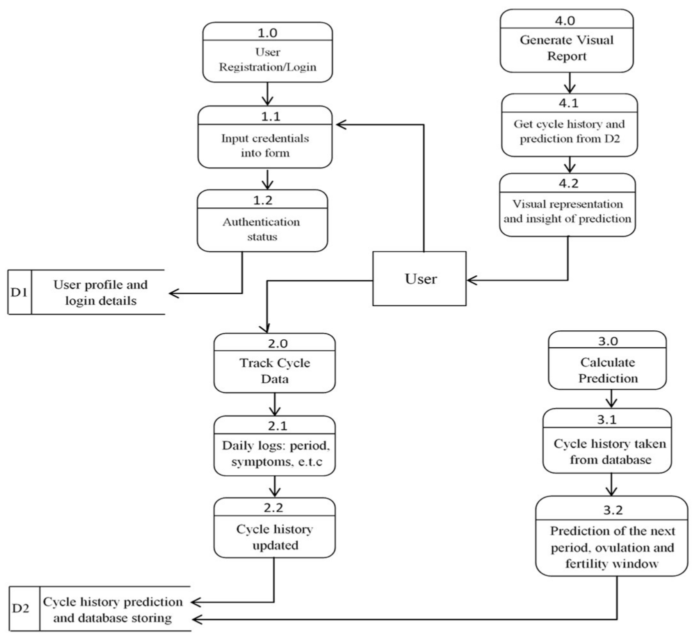

Figure 1: Data-flow process diagram

table 1.

METHODS

The development of this system adopted the agile methodology which is an approach that divides the project into a variety of dynamic segments called sprint. It is an iterative and repetitive development process that supports flexibility and allows continuous improvement for integrating new requirements trends and veritable risks mitigation plans. The system was systematically structured into modular components to facilitate scalability, maintainability, secure user authentication and data privacy, as well for accurate cycle predictions and timely notifications. These modules which formed the operational framework of the app are classified into: (i) frontend/user interface, (ii) backend/cloud-based server side for logic processing, (iii) Secure data repository, (iv) AI module (smart algorithm) for analyzing user data and generating predictions by utilizing simple long short-term memory algorithm LSTM model to determine recurrent features to track menstrual cycles (Rajesh, 2025).

Process analysis

The system was targeted at facilitating and supporting processes for tracking the monthly menstrual cycles of women folks through tech-driven smartphone innovation. This mobile application was based on intellectual menstrual medical tracker using advanced technology, personalized recommendations, and approaches for user to consider restrictions on existing systems. Typically, the system usually collects information through the user inputs and the app-generated data as shown in figure 1. Figure 1 describes the comprehensive data flow process through which the system communicates and transmits varieties of

Table 2: Description of architectural layer design function

Layer	Adopted technology	Functionality
Presentation Layer	React.js with Vite	○ Renders the user interface ○ Collects user inputs ○ Displays predictions and chart
Application Layer	Node.js with Express.js	○ Handles business logic ○ Processes cycle data and symptoms ○ Manages authentication and notifications
Data Layer	MongoDB	○ Stores user profiles, cycle logs and symptoms ○ Provides secure and scalable data access via Mongoose

signals within and around its user domains. There comprises data provided by the users, data processed by the application and input adjustment data. The data provided by the user include details of the menstrual period, symptoms/experience, and information about daily life, medical update and customization preference. Data processed by the application includes learning system, predictions, special proposal for contents and smart reminder. The input adjustment data included feedback parameters and modify errors mode, as well indicating the logical flow of both input and output signals.

Description of functional flow of data in the system

A. Data provided by the users:

i. Details of the period: The user can register major information such as the beginning and end of the period, the duration of the period and the past date that can be help

ii. Symptoms and experience: the application allows users to track emotional symptoms such as change and anxiety, as well as physical symptoms such as cramps, headaches or fatigue. It also adds changes related to lifestyles such as appetite, energy and sleep patterns.

iii. Information about daily life: users manually record factors such as activity level, dietary therapy (e.g., specific cravings for water or food) and stress level, etc.

iv. Medical update: a health condition associated with physiological health, such as drugs that users pay attention to the application, dependent addictive or PCOS or endometriosis

v. Customization preference: the user personalizes the app settings, select desired notification, set confidential management element for data use approach and select preferred language or measurement unit.

B. Data processed by the app:

i. Learning system: past data analysis, applications introduced by the user determines trends and models such as irregular duration or repetitive symptoms.

ii. Prediction: the next period begins, depending on the past cycle and lifestyle of the user, the ovulation and potential fertile windows are predicted.

iii. Special proposal for contents: the app recommend articles, practice or tips for tracking symptoms or models so that users can better manage their health care.
iv. Smart Reminder: the system creates useful notifications such as registering symptoms or drinking enough water every day, which allows each user's unique habit and needs.

C. Input adjustment data:

i. Feedback parameters: the app allows users to check or regulate predictions and notifications, so it can continue to increase accuracy over time.

ii. Modify error: When a user has an error, it introduces the data (for example, adds wrong dates or symptoms), user easily returns and provide correct information.

Process design

The system design is broken down into components of interrelated functions, each handling specific aspect of functionality from the front-end/user interface to backend data management. This process explored the instrumentality of React.js and Vite tools to build the front-end, as well as utilized the Node.js and Express to build the back-end for efficient data handling. In the system architecture, the study designed a modular layered approach where components are loosely coupled for enhanced testability and maintainability. Table 2 captured an extensive description of the functional layers of the system.

These design support tools were used to frame a responsive, intelligent and secure application for the management and monitoring of menstrual health. Figure 2 is the screenshot of the mobile app front-end/interface view, which presents an activity based intuitive smartphone interface of the application for user interactive accessibility.

Main menu design: figure 3 indicated the main menu design with responsive navigation bar and sidebar using React components. It identifies some of activities and

Figure 2: Screenshot of the mobile app interface view

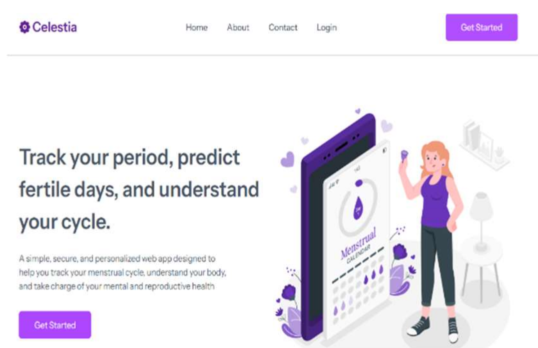

Figure 3: Main menu design of the App

functions undertaken within the app including: dashboard overview of current cycle status and predictions, cycle-log displaying input form for inserting period dates and symptoms, calendar view with interactive display of past predicted cycles and settings which outlines user preferences, notification controls, and account management, etc. The application navigation was performed through the use of React router tool, which ensures smooth transitions between views.

Input design: at the operational mode of the app, it utilizes relevant data entities through input forms for the predictions of menstrual status of users per time. A long short-term memory algorithm (LSTM) is a type of recurrent neural network which was designed to learn patterns over time. In menstrual tracking, it learns from previous cycle lengths, period durations, symptoms (optional) and hormonal indicators (if available). Each user's data is organized as a sequence described in the AI algorithm shown below:

Cycle 1 → Cycle 2 → Cycle 3 → ... → Cycle N

Each cycle may include features such as: cycle length (days), period length, ovulation day (if known) and symptoms (cramps, mood, etc.) being illustrated using the sequence window thus:

[28, 30, 27, 29, 31] → predict next cycle length.

It used a simple LSTM model:

Input Layer
↓
LSTM Layer(s)
↓
Dense (Fully Connected) Layer
↓
Output (predicted cycle length or next period date)

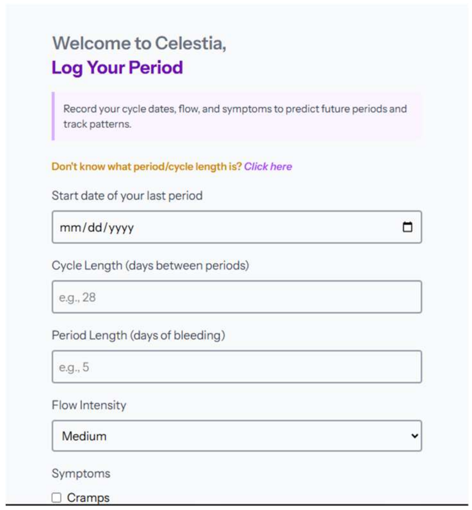

Figure 4: Main cycle data input form

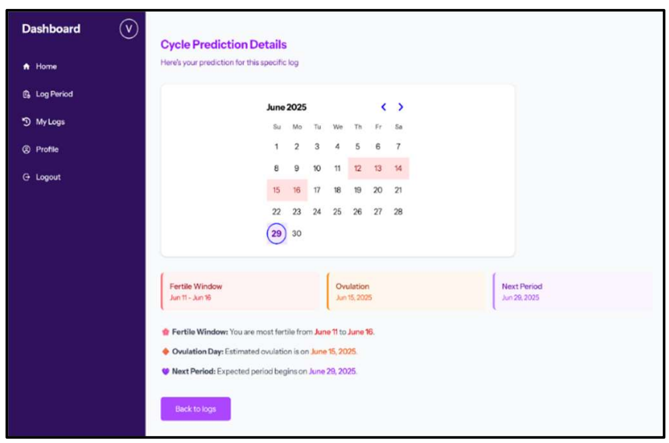

Figure 5: Screenshot of the output display tool

Table 3: Module Design

Module Name	Functionality
Authentication Module	Handles user login and registration
Cycle Module	Manages period data and prediction logic
Symptom Module	Logs and analyzes user symptoms
Notification Module	Schedules and sends alerts
Calendar Module	Displays cycle data visually

In figure 4, there was the presentation of the main input form designed for the system data entry with usability and validation in focus. The form validation is handled using React Hook Form and Yup, ensuring clean and accurate data submission.

Output design: on the other hand, figure 5 shows the design of output form represented in both textual and graphical formats on a dashboard through the use of cards, lines and charts. These outputs emanate from cycle predictions (displayed using cards and charts), symptom trends (displays recurring patterns on lines and bar charts) and notifications (occurring as toasting alerts and schedule periods/ovulation reminders). The charts are rendered using Chart.js, and notifications are managed via browser APIs and backend scheduling.

Program module design: the system was sub-divided into modules that are made up of components and designated service functions described in table 3. Each of these modules were implemented as a separate React component or Express route/controller.

Process implementation

The designed components were implemented by integrating them appropriately through the use of relevant software codes. The main menu was implemented with React functional components and React Router DOM. The menu adapts to screen size using CSS Flexbox/Grid and media queries, ensuring mobile responsiveness. The input forms were built with React Hook, styled using Tailwind CSS and validated with Yup. These inputs forms were connected to the backend APIs via Axios, with clearly defined error handling and loading status. On the other hand, the study outputs implementation was rendered using a systematic configuration of Chart.js for visualizing cycle and symptom data, the React Testify served for notifications and the Custom components were meant for displaying predictions and health tips. Data is fetched from the backend using RESTful endpoints and displayed dynamically. Program Module at the backend were implemented as Express route handlers and services involving authentication (using JWT for secure sessions); cycle prediction (calculates next period using average cycle length and historical data); symptom analysis (aggregates and visualizes user symptoms and notification scheduler (using node-cron to send reminders). The front-end modules are built as re-usable React components with props and state management using the React Context API.

The database implementation was done with the use of MongoDB, which was connected via Mongoose with schemas for each collection. Data is stored in a cloud-hosted MongoDB Atlas instance, ensuring availability and scalability. Secure and data privacy control was achieved through role-based access and encrypted connections. Introducing the use of MongoDB at the backend was a game changer, as it makes for flexible and scalable data storage. The Mongoose ORM facilitates data access with schema validation and indexing for active performance. The system was converted from a development environment to a live production server, which involves migrating the database from local to cloud-based hosting, configuring the web server, securing the application with HTTPS and authentication protocols and finalizing UI/UX elements for public use. The comprehensive system documentation was prepared for both users and developers, which ensures long-term maintainability and scalability of the application.

System performance testing and test result

The app was tested to validate its performance in terms of functionality, usability and reliability, and the modules performed as expected. Inputs were processed using logic models to generate predictions and stored in the database. The testing processes involved test plan, test data and test results generated around the respective modules and/or domains listed below:

i. Users – stores user authentication data
ii. User profiles – stores biological data such as cycle length
iii. Cycle entries – stores user period logs
iv. Predictions – stores calculated results

Test Case	User	Start Date	Cycle Length	Next Period	Ovulation Date	Fertile Window	Status
I	Chimerem Ogovre	May 1, 2025	28 days	May 29, 2025	May 15, 2025	May 11 – May 16, 2025	Successful ✓
II	Victoria Akpanika	May 19, 2025	24 days	June 12, 2025	May 29, 2025	May 25 – May 30, 2025	Successful ✓
III	Kessy Nkorie	May 8, 2025	24 days	May 23, 2025	May 23, 2025	May 5 – May 10, 2025	Successful ✓

Figure 6: System test case results

The test was carried out using locally accessed real user data, which were assigned pseudo-names to ensure preservation of user privacy. The system calculated menstrual cycle predictions including next period date, ovulation day, and fertile window based on user input. The testing process and test results were presented in test case documents shown in figure 6, which indicated the outcome for the three respective users. With the date-based computation model, the system provided accurate outputs that matched expected results.

Conclusion

This study highlighted the potential of mobile applications to bridge gaps in menstrual health education and self-care, especially in regions with limited access to reproductive health resources. The application serves as an essential tool for advancing privacy-preserving reproductive and/or menstrual healthcare. It was configured to promote user convenience, data privacy and personalized innovative functions, as well implemented basic interactive and user-oriented appeals that supports menstrual data optimization and improves user experience. The development of this application marks a significant contribution towards innovation initiatives for menstrual health management, and overall digital health advancement solutions in reproductive wellness. The utilization of locally accessible real user data for testing the application is a conscious step towards demystifying the tool by transferring ownership to the locals, thereby facilitating its adoption. Encouraging technology adoption especially in healthcare, requires a multifaceted approach involving people-oriented strategies for broader healthcare awareness and data-driven insights. The application performance using date-based computation model provided accurate outputs that matched expected results. This system represents a handy for improved flexibility and time-based management of women menstrual health needs.

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