

PILLPOP CS RESEARCH PROJECT

A PROJECT REPORT SUBMITTED TO THE FACULTY OF ENGINEERING, DESIGN AND TECHNOLOGY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF BACHELOR OF SCIENCE IN COMPUTER SCIENCE / BACHELOR OF SCIENCE IN INFORMATION TECHNOLOGY OF UGANDA CHRISTIAN UNIVERSITY

May, 2024



**UGANDA CHRISTIAN
UNIVERSITY**

A Centre of Excellence in the Heart of Africa

Declaration


We, as Pillpop declare that the contents of this study have not been published or submitted for any other degree award to any other universities before and the study of this project is original.

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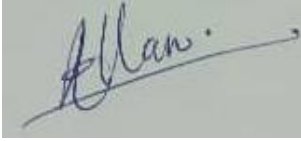
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Dedication

We dedicate this to every young Ugandan who has had to watch a friend or relative suffer in pain because of inaccessibility to proper medical services. May Pillpop act as a beacon of hope for a healthier future.

Acknowledgments

We would like to thank our parents for enabling us to study at this institution. We would also like to thank the CS Research instructors for their back-to-back personalized feedback on this project. Sarah thank you for driving this team to the finish line, Joshua for being amazing at conflict resolution, Hassan for taking the time to teach us the skills we did not know, Daphine for the dedicated persistence she has shown to this project, Gordon for the laughs he has given the team, and Allan our newest member, thank you for choosing to join our journey.

Abstract

A web application aimed at reminding users to take their medications which is a major problem in Uganda also called medication non-adherence called Pillpop was developed to solve this problem with additional features to further solve this problem,

The application was developed due to a recent study on the health sector, which displayed that medication non-adherence is one of the problems troubling the health sector. Moreover, the problem was reflected in my lifestyle when it came to taking medications.

The development of the application was done based on using email as a format of reminding users and all the other features within rotated based on the user's data. Using different technologies e.g Nextjs and Django to develop the application, which relies on the data storage or backend a lot, and displays through the frontend hence the need for an interface that is easy to navigate for the users.

During the application development, a lot of hostility was found especially when it came to collecting data and the effectiveness of reminding a user which is hard to achieve 100% because it all draws back to user integrity and I found that it not possible to solve all the problems within the one application but instead one problem at a time is better.

The significance of the findings is that investment in technology can help or improve the efficiency of health since the digital generation/age is now the common or the norm meaning with the help of technology, the health of the users can improve, and it also a call to find ways of utilizing the available technology to improve one's life quality .

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1. Introduction

Pillpop is a software application that helps users stay on track with their medication by providing timely reminders, and health insights such as reports, providing a medical history for all medicines taken in the past ([Pillpop, 2023](#)). Pillpop also helps people to find affordable medication near them, it provides people with a phonebook for easy access to pharmacies and a side effects chat for people to find out possible side effects of a drug that they have been prescribed.

1.1. Background

In a personal interview conducted with ([Kaguya,2024](#)), a local health worker at Mulago Hospital, we gained insight into Maama Nampeera's story. The experience of Maama Nampeera, a single 30-year-old mother of two suffering from chronic illness was an inspiration for us to create Pillpop. Nampeera was the sole provider of her household until she fell sick. Her sister Lisa came in to come and take care of her during this worrying time. Lisa took Nampeera to the hospital and they were able to get medication prescribed to them by the doctor but the challenge came in when they failed to find the medication at a price they could afford. It took them three days of intensive searching to find this medication and in this time Nampeera got worse and could no longer walk by herself.

When they managed to buy the medication, the prescription was poorly written and Lisa, the now caretaker of Nampeera could not understand the prescription because it was poorly written so she had to go back to the pharmacy. She returned home to find Nampeera in a more critical condition than she had left her, she was crying on the floor of her bedroom in pain.

The first dose of the medication was administered and Nampeera started to improve slightly. As this happened, Lisa's schedule became packed due to upcoming deadlines from work. With the responsibility of taking care of the house, looking after Nampeera's two boys, and ensuring they are prepared and ready for school on time. Lisa began to become forgetful. She would give the doses to Nampeera late if she recalled and there were times she would forget which pill she had already given her and would re-administer pills more than the required frequency.

Due to this inconsistency, Nampeera worsened and was hospitalized. The bacteria in her body had multiplied and become resistant to the medication. After three days of consistent vomiting and fluid loss, she passed on.

1.2. Problem statement

Studies from the National Library of Medicine [_\(Jimmy, Jose, & J, 2011\)](#), show that more than 30,000 patients Worldwide are having trouble sticking to their medication plans. This happens because 3 in 5 patients tend to forget to take their medications, others can't afford their medicine, and about 55% just don't understand their prescriptions [_\(Morris, 2023\)](#). These can lead to serious consequences, like hospitalization and death.

1.3. Objectives and Goals

Pillpop aims at getting patients to stay consistent with their medication so that they can get better and be able to live healthy lives again, to improve the standard of living of these individuals.

1.3.1. Specific Objectives

Specific objectives of Pillpop include:

- To enable people to take their medication on time so that they have a higher recovery rate.
- To enable people to have a comprehensive medical history of medication they have been given in the past.

- To enable people to have a summary of their drug intake to keep track of their consistency through a report.
- To enable people to have a way to access medication at a price they can afford, by showcasing different pharmacy options.
- To enable people to have quick access to pharmacies and to consult on already prescribed medications that they have bought from that pharmacy.
- To enable people to have access to emergency contacts at hospitals or clinics in Uganda in case of a serious situation.
- To enable people to find out possible side effects of a drug they are currently taking so that they can share these findings with their doctor to figure out a way forward.

1.4. Project Scope

The scope of this project is Mukono. This is because most of the pharmacies we have partnered with are in Mukono. We have also partnered with one pharmacy in Ntinda and one in Mbale, but our main scope is Mukono. From these pharmacies, we obtained a list of common drugs taken in Uganda and their current prices, which are shown in our system.

1.5. Significance of the System/Importance

Pillpop has multiple features, each aimed at solving the issue of medication non-adherence:

Medical Reminder: This helps remind patients to remember to take their medications on time so that they recover faster.

Dashboard: This shows the user their current medications alongside their status, such as whether they were taken missed or pending.

Medical History: This shows the user a comprehensive overview of all their medications from the past and they can use this at the doctors to show them what drug they took and how long they took it

Report: This shows an aggregated summary of all taken, missed, and pending drugs to give a user their overall summary of their consistency with their medication.

Med Prices: This shows a user where to get medication from different pharmacies at a price that is affordable to them. We do this because we do not want people to miss out on getting treatment simply because they cannot afford it, we want people to take the medication prescribed to them so that they can live healthier lives.

Phonebook: This feature is used to provide a user with contacts so that they can call a pharmacy they have bought from medication for clarity on a poorly written prescription or to discuss side effects they are facing with the facility they got the medication from.

Emergency: This feature shows the user emergency contacts they can call in terms of a medical emergency. These contacts include ambulance lines that work 24/7 for given hospitals.

Side effects Chat: This feature helps a user get clarity on which drug could be causing them a given side effect so that they can communicate it with the doctor and get more help. We also put this feature there because of the dishonesty trend going on with many health facilities where they are not honest about the side effects of a given drug because they want people to just buy the drug from them regardless. This is especially common with birth control for women.

2. Literature Review

2.1. Introduction

Pillpop manages the fundamental assessment of medication compliance across diverse patients. Research consistently demonstrates the crucial impact of adherence on the outcomes of medical therapy.

According to (brody, 2017)₂, when patients stop taking their medications as prescribed, outcomes may include treatment failure, hospital stays, and increased health care expenses.

In response to this assessment, Pillpop aims to promote a mobile application that involves patients, enhances the delivery of medical services, and ultimately promotes prescription adherence.

Through the integration of diverse perspectives from academic literature, business reports, and mechanical systems, the audit will inform the development process on an effective and customer-focused plan.

2.2. Relevance to Medication Adherence

Comprehension and resolution of the complex issues surrounding medication adherence are essential components of Pillpop's aim. Frequently encountered obstacles encompass forgetfulness, challenges in adhering to intricate drug regimens, deficiency in drive, and encountering adverse reactions. This review will examine previous studies that have looked into these issues and how they affect adherence. The following studies, assessing the efficacy of different therapies, will be examined:

Email reminders and push alerts: Simple warning updates, particularly for individuals with ongoing conditions, may effectively improve adherence, according to research.

Content for education: Patients can participate more actively in their treatment regimens when they have access to clear and accessible information regarding their diseases and medicines. The research examines the suitability of educational materials integrated inside portable applications, such as medication records, personalized medication recommendations, and user-friendly assessments, to further develop prescription information and adherence.

Through a critical analysis of the advantages and disadvantages of various current therapies, the Pillpop project seeks to create an all-encompassing, empirically supported solution that promotes sustained adherence..

2.3. Exploration of Technological Solutions

The evaluation of the literature delves into the rapidly emerging field of medical service innovation that promotes patient adherence and enhances the delivery of medical care. This includes a comprehensive investigation of:

Applications for mobile health (mHealth): With the ability to provide patients with useful gadgets for prescription updates, reorder requests, side effect monitoring, and communication with medical service providers, mHealth applications have emerged as an amazing power in the medical services industry. Reviews of current mHealth apps with features for medical executives are conducted, and their highlights, user interfaces, and claimed effects on adherence are evaluated [\(Sun Kyung Kim, Park, Hwang, & Park, 2023\)](#).

Systems for electronic health records (EHRs): EHR frameworks provide a uniform platform for prescription data, dosage guidelines, and prospective pharmaceutical collaborations, which holds the potential to significantly enhance medication adherence.

The review examines how Pillpop can integrate with current EHR systems in order to use patient information and enhance drug executives functionalities.

Digital health platforms: Digital health platforms offer a more extensive biological system for medical services executives, frequently joining mHealth applications with telehealth discussions, remote observing capacities, and information examination instruments. The survey will dissect how computerized wellbeing stages can be utilized to help prescription adherence through highlights like customized medicine plans, drug adherence reports imparted to medical services suppliers, and coordination with wearable gadgets for prescription following.

By evaluating the strengths and limitations of existing technologies, Pillpop seeks to leverage best practices and innovative approaches to optimise its user experience and clinical efficacy. The review will identify gaps in existing solutions and explore emerging technologies that

can be harnessed to create a more comprehensive and effective medication adherence platform.

2.4. Frameworks and Methodologies

The literature review will look into theoretical frameworks, techniques, and conceptual models related to medication adherence and digital health interventions in order to create a user-centered and practical solution. Using fields of study like:

Personality psychology: Significant insights on comprehending and modifying prescription-taking behaviors can be gained from behavioral psychology. Systems that address elements influencing adherence, such as health acceptance and modelability and the benefits of treatment, might guide the design of interventions. Examples of such systems are the Transtheoretical Model (TTM) and the Health Belief Model (HBM) [\(PsychologyWriting, 2023\)](#).

Human-computer interaction (HCI): Pillpop is guaranteed to be intuitive, natural, and accessible to a diverse range of patients with varying levels of specialist competence by HCI criteria. Convenience testing theories and configuration best practices will be examined in the survey in order to create a user interface that promotes good client interactions and fosters long-term commitment.

Health informatics: The Pillpop application's safe storage and management of patient data will depend heavily on your skill in this area. To ensure patient safety and HIPAA compliance, the audit will look into established information security frameworks and best practices for mHealth apps.

3. Methodology

This chapter dives into the exciting world of tools and technologies that will bring the Pillpop application to life! consisting of a team of skilled developers working together, using these elements to create a robust, user-friendly, and secure platform to help you stay on top of your medications. Here's a breakdown of how we'll make Pillpop a reality:

3.1. Development Approach: Working in Sprints

The Pillpop project embraces an adaptable and cooperative methodology called Agile Development, explicitly utilizing a Scrum structure, continually getting criticism and making enhancements along the way. This is how it works:

Features: We started by creating a big list of everything Pillpop could potentially do, like medication reminders. This list is called a product backlog.

Sprint Planning: We then break down the project into manageable chunks of time called sprints, typically lasting 1-2 weeks. At the beginning of each sprint, the team picked a set of the most important features from the backlog to focus on completing within that time frame.

Building and Testing: During the run, the engineers utilized the devices and advancements referenced underneath to rejuvenate those picked highlights. Simultaneously, thorough testing will end up guaranteeing everything works without a hitch and is not difficult to utilize.

Daily Check-ins: To keep everybody on track, the group had short day to day gatherings to examine progress, address any difficulties, and ensure all that's on target.

Sprint Review and Retrospective: When a sprint is finished, there's a celebratory review meeting to grandstand the finished elements and assemble input from all interested parties. We also had a review meeting to recognize regions where we can further develop the improvement interaction for the following run.

This approach offers several benefits:

Adaptability: We can easily adjust to new ideas or user feedback as the project progresses.

Reduced Risk: By focusing on smaller chunks of work, we can identify and fix any issues quickly.

Top Quality: Continuous testing ensures a high-quality application that truly meets your needs.

Teamwork Makes the Dream Work: Daily meetings and reviews foster communication and transparency within the development team.

3.2. Tools and Technologies: Building Blocks of Pillpop

The Pillpop application was built using a combination of technologies for both the user interface (what you see on the screen) and the back-end (the engine that makes everything work) to deliver a user-friendly experience. Here's a closer look at the key tools and technologies involved:

Creating the User Interface (UI):

Next.js: Next.js as a powerful toolkit built on top of React, a popular technology for creating user interfaces. Next.js allows us to build a beautiful and interactive interface for Pillpop with features like:

Fast Loading: Next.js helps make sure the app loads quickly and feels snappy, even on slower internet connections.

Search Engine Friendly: This tool helps Pillpop rank higher in search engine results, making it easier for you to find the app.

Easy Navigation: Next.js simplifies building the navigation system within the app, ensuring you can easily find the features you need.

React: At the heart of Next.js lies React, a powerful library that allows us to design dynamic and engaging user interfaces..

The Back-End:

Node.js: The engine that runs everything behind the scenes in Pillpop. It's a powerful technology that allows us to build real-time applications, meaning information updates instantly, keeping you in the loop.

Storing Your Data Securely:

PostgreSQL: This secure and reliable database system will be used to store all your valuable medication information. PostgreSQL is known for its:

Structured Storage: Data is organized in a way that makes it easy to search and retrieve.

Scalability: The database can grow and handle more information as Pillpop becomes more popular.

Open-Source Community: Being open-source means a large community of developers contributes to its ongoing improvements and security.

3.3. Description of the technology

PillPop is a medical application designed to simplify medication management for users. It offers features aimed at enhancing medication adherence and health awareness.

3.3.1. Key Features:

- Medication Tracker: Users can easily add their medications and schedule reminders, ensuring they take their medications on time.
- Intake Report The app tracks medication intake and generates comprehensive reports, this helps users to keep up with a consistent medication intake.
- Health Directory: Pill Pop includes a phonebook feature that lists emergency contacts and health facilities nearby, providing quick access to medical resources.

- **Price Comparison:** It displays medication prices across different locations, empowering users to find affordable options and make informed purchasing decisions.
- **Community Contributions:** Users contribute to the app's database by uploading their medication sources, which PillPop incorporates into its growing list of resources.
- **Chatbot Consultation:** The chat feature allows users to inquire about the medications they are taking and instantly receive information on potential side effects.

3.3.2. Benefits:

- Enhances medication compliance through timely reminders and tracking.
- Facilitates access to emergency contacts and healthcare facilities.
- Promotes cost-effective healthcare by comparing medication prices.
- Fosters a community-driven approach to sharing trusted medication sources.
- Provides immediate access to information regarding side effects, fostering informed health decisions.

3.4. Specifications of the technology

3.4.1. Technical Specifications:

- **Platform Compatibility:** The application is available on web, iOS, and Android devices.
- **User Interface:** User-friendly, with easy navigation.
- **Notifications:** Reliable medication reminders.
- **Data Storage:** Secure cloud storage for user data and medication history.

- Connectivity: Requires internet connection for database updates.
- Privacy: Adheres to HIPAA regulations for user data protection.
- Functional Specifications:
 - Authorization and authentication: Users should be able to create an account and also be able to sign in thus only those that are authorised can access the application.
 - Medication Addition: Allows users to input medication details such as name, dosage, and frequency.
 - Medication viewing: Enables users to view their added medications.
 - Reminder System: Smart alarm system that notifies users when it's time to take their medication.
 - Tracking and Reports: Automated tracking of medication intake with the option to generate and export reports.
 - Emergency Directory: A list of emergency contacts and nearby health facilities, accessible without an internet connection.
 - Price Comparison Engine: Real-time price comparison feature for medications across different pharmacies.
 - Database: User-generated database of medication sources that is verified and updated regularly.
 - Chatbot: AI-powered chatbot that provides instant information on medication side effects.

3.5. Requirements

3.5.1. User Requirements:

- Usability: The app must be user-friendly, allowing all users to navigate and utilize its features without difficulty.

- **Reliability:** PillPop should provide accurate reminders, ensuring users can trust the app with their medication schedules.
- **Accessibility:** The app needs to be accessible to users with varying levels of tech-savviness and should support multiple operating systems for wider reach.

3.5.2. System Requirements:

- **Performance:** The app is intended to handle multiple user inputs and data without slowing down.
- **Scalability:** PillPop is designed to be scalable to accommodate an increasing number of users and database entries.
- **Security:** User data, including health information and personal contacts, must be securely stored and transmitted.

3.5.3. Functional Requirements:

- **Notification System:** The app must have a reliable notification system to remind users to take their medication on time.
- **Data Management:** Effectively manage user data, allowing tracking, reporting, and updating medication information.
- **Network Connectivity:** The app requires internet connectivity for features like accessing the health facilities database.

3.5.4. Regulatory Requirements:

- **Compliance:** PillPop should comply with health information regulations such as HIPAA to ensure user data privacy and security.
- **Accuracy:** The app must provide accurate and up-to-date information on medications and their side effects for the chat feature.

3.6. Results and Discussions

3.6.1. Results

The presentation of the project to the stakeholders was delivered directly and concisely, wherein the project objectives were explicated clearly and potential solutions were presented comprehensively. The presentation was deemed to be a valuable tool for the health industry. However, the stakeholders made several critical observations and provided feedback, which was duly noted in the following manner:

Evaluation of Project UI:

The project's user interface (UI) received a commendation for its cleanliness and user-friendly design. This positive assessment underscores the project team's emphasis on creating an intuitive and visually appealing interface, enhancing the overall user experience.

User Data Protection Measures:

Comprehensive details were provided regarding the strategies implemented to safeguard user data within the project. This included explaining how the application is safeguarding the user data by using the method of access token to gain access to your user hence requiring the user to always log in. This method isn't robust enough but provides a start to data protection.

Customizable Dosage Times:

It was demonstrated that users have the flexibility to adjust dosage times according to their individual needs and preferences directly within the application. This feature enhances user control and personalization, contributing to the application's usability and practicality.

Non-Promotion of Self-Medication:

Clarification was provided that the project does not promote or encourage self-medication practices. This stance underscores the project's commitment to responsible healthcare solutions and emphasizes the importance of seeking professional medical advice.

Accessibility Progress as a Progressive Web App (PWA):

Regarding accessibility across various devices, it was highlighted that the project is currently in the development phase of transitioning into a progressive web application (PWA). This strategic move aims to ensure broader accessibility and compatibility, allowing users to access the application seamlessly across different platforms and devices.

In summary, the project presentation outcomes underscored positive feedback on the UI design, highlighted user-centric features such as customizable dosage times, reaffirmed responsible healthcare practices, and outlined strategic steps toward enhancing accessibility through PWA development. These observations collectively reflect a proactive approach toward delivering a user-friendly, secure, and inclusive application experience.

3.6.2. Analysis of results in relation to the project goals:

Analyzing the results in relation to the project goals reveals significant alignment and progress toward achieving the defined objectives:

Customizable Dosage Times (Goal: Understanding the medical perception):

The capability for users to adjust dosage times directly within the application reflects progress toward empowering users and enhancing their control over medication schedules. This feature aligns with the goal of improving user engagement and satisfaction.

Responsible Healthcare Practices (Goal: Affordability):

Clarification on the project's stance against promoting self-medication underscores the commitment to responsible healthcare practices. This aligns with the goal of promoting, providing access to safe and informed usage of healthcare technologies and facilities.

Accessibility as a Progressive Web App (Goal: Accessibility):

The ongoing development towards becoming a progressive web application (PWA) demonstrates a strategic approach to achieving the goal of ensuring wide accessibility. Transitioning to a PWA will enable broader reach across various devices and platforms, enhancing the project's impact and usability.

In conclusion, the analysis of results in relation to the project goals highlights significant progress and alignment with the overarching objectives. The outcomes presented during the project presentation demonstrate a proactive approach towards promoting responsible healthcare practices and expanding accessibility. These achievements contribute towards the successful realization of the project's goals and objectives.

3.6.3. Discussion

After thoroughly examining the outcomes of the project, we delved into the implications of the findings and identified potential avenues for future work. We paid close attention to the feedback and observations provided by the stakeholders during the presentation of the project, which helped us to gain a deeper understanding of their needs and preferences. Taking into account all of these factors, we were able to create a comprehensive plan for future endeavors that will help to ensure even greater success moving forward;

Discussion of Implications and Potential Future Work:

Implications of Project Outcomes:

The positive evaluation of the project's UI design underscores the importance of prioritizing user experience in healthcare applications. A clean and intuitive interface not only enhances usability but also contributes to user engagement and overall satisfaction. Moving forward, this outcome emphasizes the significance of continuous refinement and user-centered design practices in similar projects.

Customization and User Control:

The capability for users to adjust dosage times reflects a personalized approach to medication management. This outcome suggests the potential impact of user-centric features in improving adherence and treatment outcomes. Future efforts could explore additional customization options based on user feedback and evolving healthcare needs.

Healthcare Ethics and Responsibility:

The project's stance against promoting self-medication aligns with ethical considerations in healthcare technology. This outcome underscores the project's commitment to patient safety and responsible healthcare practices. Going forward, similar projects should prioritize patient education and collaboration with healthcare professionals.

Future Development as a Progressive Web App:

The transition towards becoming a progressive web application (PWA) signals a strategic move towards enhancing accessibility and scalability. This decision opens up opportunities for broader reach and cross-platform compatibility. Future work could focus on optimizing PWA capabilities and addressing specific challenges associated with web-based healthcare applications.

Potential Future Work:

Moving ahead, potential future work could involve:

Conducting user studies and gathering feedback to iteratively improve the UI and user experience.

Enhancing data protection measures through continuous monitoring and updates.

Exploring additional features to further empower users in managing their healthcare needs.

Collaborating with healthcare professionals to integrate the application into clinical workflows.

Expanding accessibility through advanced PWA features and optimizations.

4. System Design

4.1. Collection of Different System Design Diagrams

4.1.1. Architectural Design

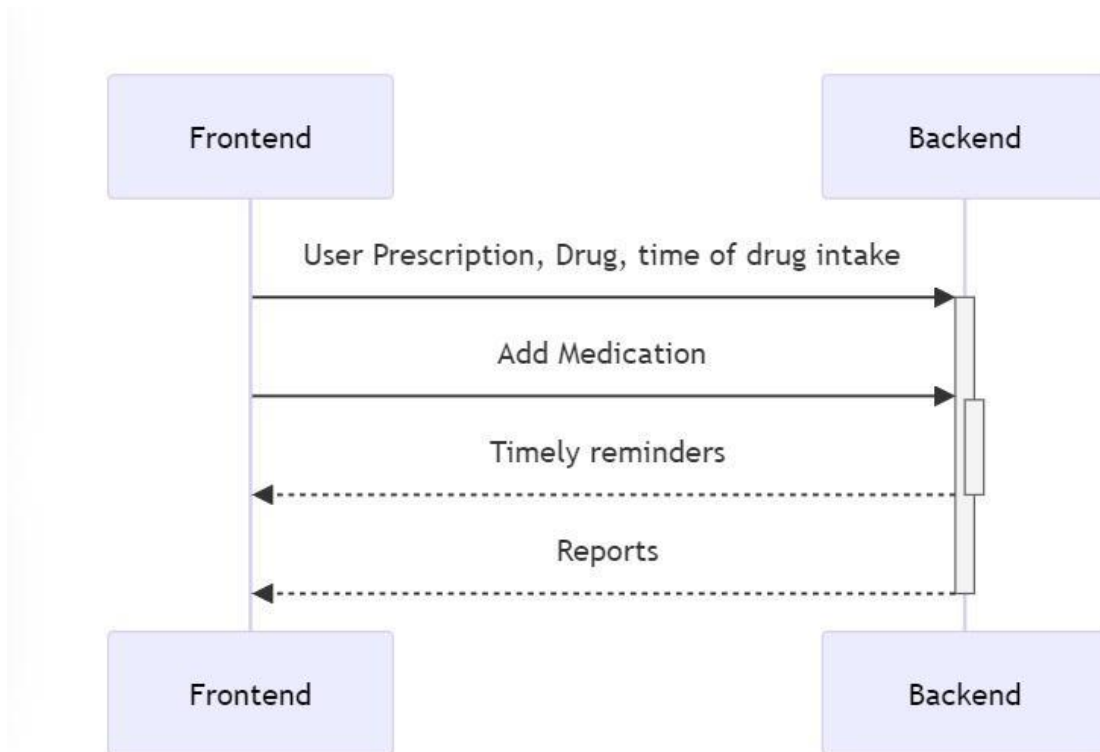


Figure 1: Pillpop Architectural Design

4.1.2. Component breakdown

Backend (Django)

1. API Endpoints:

- Created Django API endpoints to handle CRUD (Create, Read, Update, Delete) operations for user profiles, medications, and reminders.

- Used Django REST framework to simplify API development.

2. Database (Django Models):

- Defined Django models to represent entities such as User, Medication, and Reminder.
- Utilized a relational database (PostgreSQL) to store user data securely.

3. Business Logic

- Implemented business logic to handle medication scheduling and reminder generation.
- Used Django signals or background tasks to trigger reminders at the specified prescription times.

4. Authentication and Authorization:

- Implemented user authentication and authorization using Django's built-in authentication system and customized it.
- Ensured that only authorized users can access and modify their data.

5. Data Validation and Sanitization:

- Validated and sanitized user input to prevent data inconsistencies and enhance application security.

6. Error Handling:

- Implemented robust error handling mechanisms to provide meaningful feedback to users and log errors for debugging.

7. Security Measures:

- Implement security measures such as HTTPS, secure password storage (using Django's hashing mechanisms), and input validation to protect against common security threats.

Front end:

- The frontend communicates with the backend to display to our user.
- This involves pulling of data to show data like pharmacy names , drug history , aggregated data to make reports, side effects from our database as well as contacts

4.1.3. Data Flow Diagram

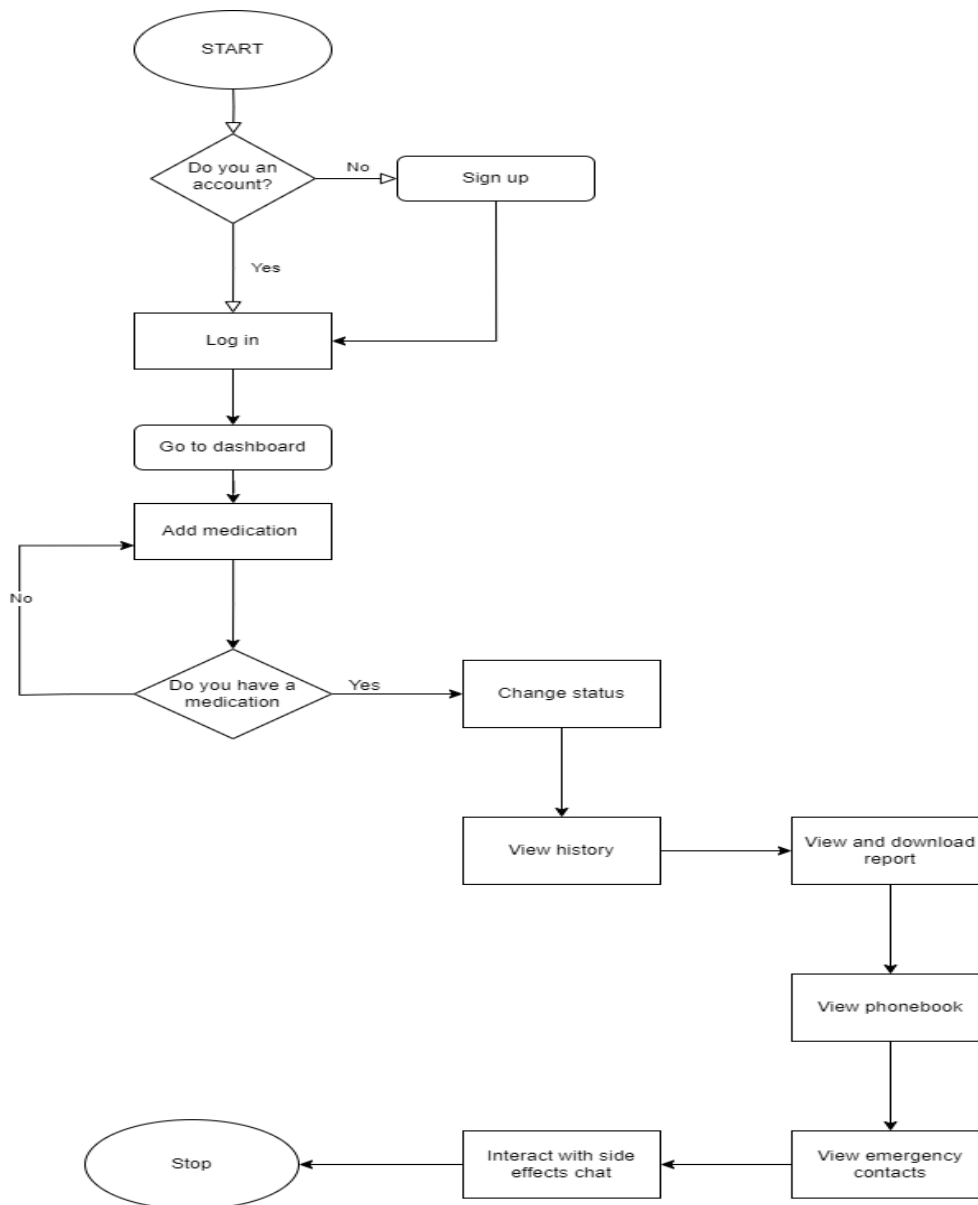


Figure 2: Pillpop User Flow Diagram

4.1.4. Database Design

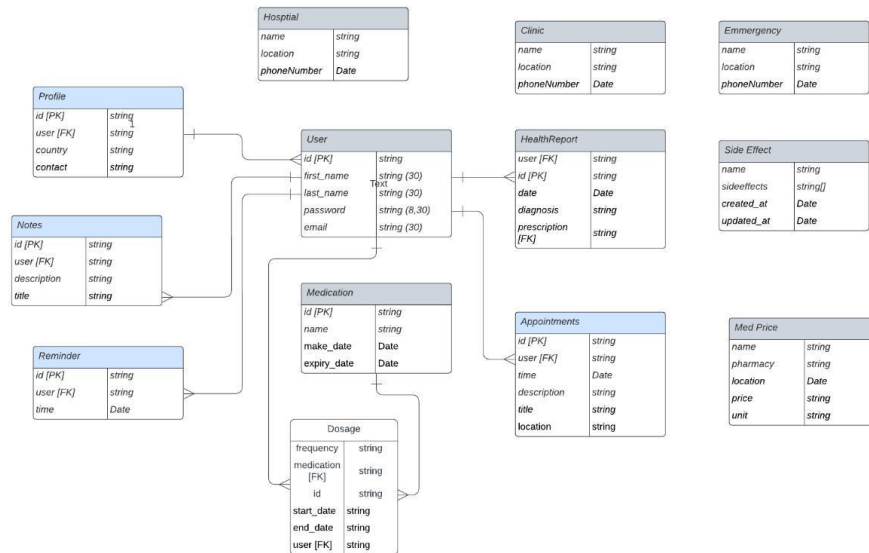


Figure 3: Pillpop Database Design

4.1.5. Component Design

The PillPop app activity flow diagram is an essential tool for all users. By depicting the step-by-step process of the app's functionalities, it enables users to understand how to navigate and utilize the app's features with ease. Don't get lost in the sea of options. Use the activity flow diagram to streamline your experience and get the most out of the PillPop app.

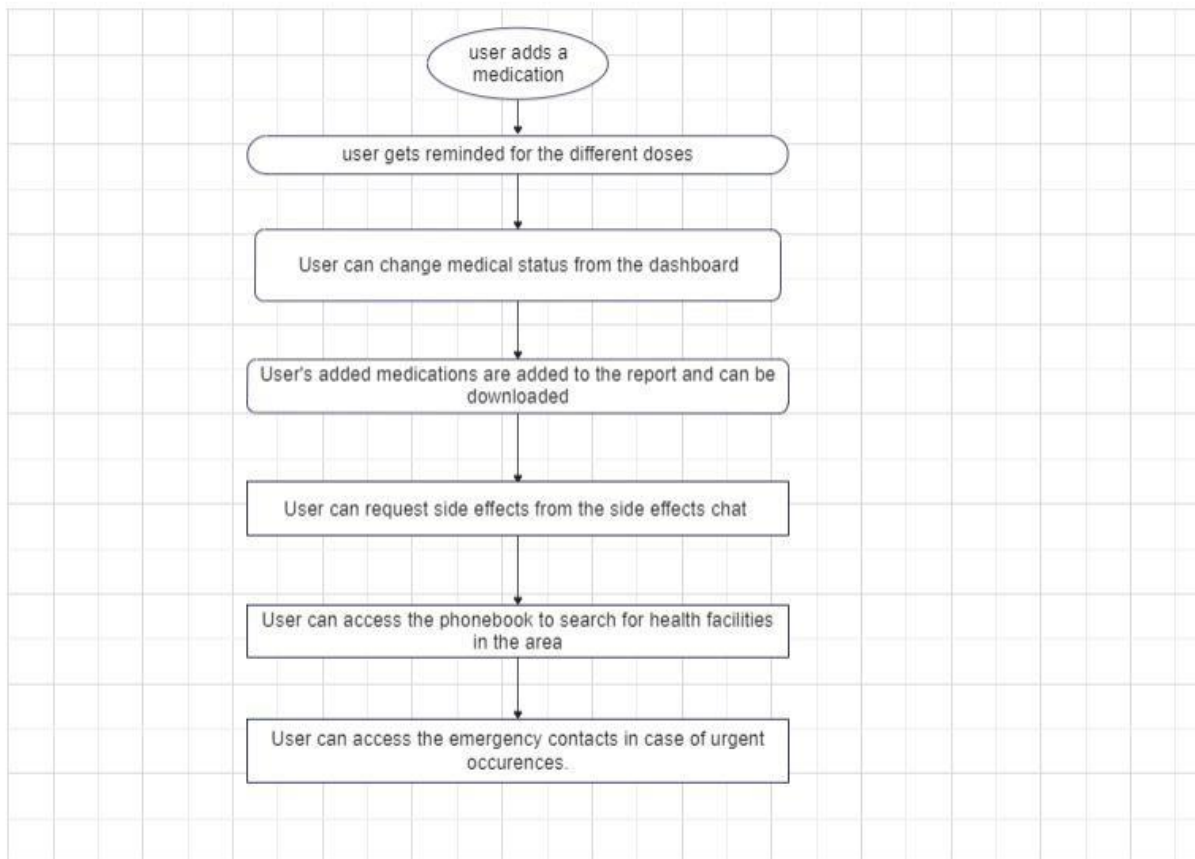


Figure 4: Activity Flow Diagram

4.1.6. Human Interface Design

Pillpop has a user-friendly interface consisting of:

Medical Reminder: This helps remind patients to take their medications on time so that they recover faster.

- Dashboard: This shows the user their current medications alongside their status such as taken missed or pending.

- Medical History: This shows the user a comprehensive overview of all their medications from the past and they can use this at the doctors to show them what drug they took and how long they took it
- Report: This shows an aggregated summary of all taken, missed, and pending drugs to give a user their overall summary of their consistency with their medication.
- Med Prices: This shows a user where to get medication from different pharmacies at a price that is affordable to them. We do this because we do not want people to miss out on getting treatment simply because they cannot afford it, we want people to take the medication prescribed to them so that they can live healthier lives.
- Phonebook: This feature is used to provide a user with contacts so that they can call a pharmacy they have bought from medication for clarity on a poorly written prescription or to discuss side effects they are facing with the facility they got the medication from.
- Emergency: This feature shows the user emergency contacts they can call in terms of a medical emergency. These contacts include ambulance lines that work 24/7 for given hospitals.
- Side effects Chat: This feature helps a user get clarity on which drug could be causing them a given side effect so that they can communicate it with the doctor and get more help. We also put this feature there because of the dishonesty trend going on with many health facilities where they are not honest about the side effects of a given drug because they want people to just buy the drug from them regardless. This is especially common with birth control for women.

5. Implementation

5.1. Languages , Architecture and Integration

- Programming languages that were used were :
 - Frontend- JavaScript(Next.js as the react framework), tailwind CSS, Typescript, Figma for the UI/UX design, Shad-cn for UI components
 - Backend - Python (Django as a framework), NodeJS(Express as a framework)
- Architecture used for the application:
 - Backend server- Used a Model View Controller (MVC) for the internal API architecture. Used a REST(Representational State Transfer) api for content delivery.
 - Database management - PostgreSQL, a relational database
- Integration of the different components:
 - Front-End and Back-End Integration: The user interface, developed using Next.js a React for the front-end, communicates with the back-end server through RESTful APIs. This ensures a smooth interaction between the user's actions on the app and the server's responses.
 - Database Connectivity: The back-end server uses a database management system; PostgreSQL to store and retrieve user data. The connection is established using ORM (Object-Relational Mapping) tools, which help in efficiently handling data and ensuring its consistency across the app.

- **Notification System:** The reminder system is built with NodeJS and integrates with the database to listen for when a medication is due and sends emails, allowing PillPop to send alerts even when the app is not actively running.
- **Health facilities Database:** The database is updated in real-time whenever users submit the data and a request is made to the APIs . This allows users to upload their medication sources, and the app immediately reflects these updates in the list available to all users.
- **Chatbot Feature:** The AI-powered chatbot is integrated with APIs that perform a deep search thus analysing the user's queries about medications and provide instant responses regarding side effects.

5.2. Limitations of the Technology and Challenges

General Limitations:

One of the limitations of the technology is the basis/fact that it is fully online based or can't operate offline, meaning users have to be connected at all times.

Another limitation of the technology is its ability to be accessible to all devices i.e. trying to make USSD accessible for buttoned phones hence leaving out a big number of potential users.

Another limitation of the technology is the ways of reminding users to take their medications for example not everyone checks their emails which was the only way to achieve the goal of the technology due to budget technicalities.

Another limitation of the technology is the amount of data availed to the technology, especially for the medical prices and phone book features which rely so much on the data availed in order to return valuable to the users.

General Problems:

Data collection. During the data collection for health facilities and medical prices, some facilities were willing to share their information, while others resisted because the technology was seen as a threat to their businesses.

Limited Budget. The limited budget hinders a lot of the possible implementations or functionality of the application for example; the automated calls that could have been implemented highly depended on the budget due to services like Africa's talking

5.3. Recommendations and future work

Refilling Alerts. The application can also include refill alerts reminding the users to refill their prescriptions which can ensure continuous treatment.

Data Backup and Recovery. The application can ensure user data is regularly updated and provide options for data backup in case the user loses their data or a system failure happens.

Privacy and Security. The applications can implement encryption protocols and other methods e.g. adhering to strict privacy policies and other standards/policies e.g. HIPPA to reduce the chances of cyber-attacks.

5.4. Conclusion

One promising solution to promote medication adherence in Uganda is the PillPop application. Reminders, tracking, pharmacy information, and side effect information are just a few of the tools it provides to assist users in managing their prescription regimens.

Principal Advantages

Fulfills a vital need: PillPop addresses the important problem of medication non-adherence, which can have detrimental effects on one's health.

User-friendly design: People of all ages and technical backgrounds will find the application straightforward to use.

Comprehensiveness: In addition to standard reminders, PillPop provides a number of features, such as prescription histories, price comparisons, and emergency contacts.

Community-driven approach: A collaborative environment is fostered by allowing people to add to the database of medicine suppliers.

Points of Improvement

Security: The paper emphasizes the need for more robust data encryption mechanisms, even while token security protections are now in place.

Offline functionality: The use of the application is restricted in places with inadequate connectivity due to its reliance on an internet connection.

Accessibility: It's critical to reach more people with basic phones by using USSD or other reminder systems.

Data accessibility: A thorough database is necessary for features like pricing comparison and the phone book to function well.

All things considered, Pillpop shows a solid basis for a useful medical instrument. The application has the potential to greatly enhance medication adherence and health outcomes for Ugandans by addressing its limitations and implementing the suggested changes.

6. Testing and Evaluation

6.1. Testing

- Testing individual units: These Tests were performed on individual units or components of Pill Pop to ensure they function correctly.
- Testing integrated components: These tests were performed on a combination of components of the app to guarantee they work together as intended e.g. adding a medication and viewing medications that have been added.
- Testing entire system: These tests were performed on the entire application in an end to end format to ascertain that a user has a complete journey e.g. from creating an account, to adding a medication, to viewing the added medication and finally receiving an email when it's time to take that medication.
- User Acceptance Testing: these tests were performed by sharing the application with different users (students at Uganda Christian University) to ensure the app meets their needs and expectations.

6.2. Evaluation

This evaluation supports the Pillpop project, which achieved the main goal of solving the medication non-adherence problem in Uganda. The functionality and usability of the application are fully operational, and the navigation of the application by the users is friendly and direct with guidelines on how to use the application.

The Pillpop project has areas that need improvement, for example, the area of security of the application to ensure the safety of the users' data since, in the meantime, the application is using token security measures.

The main challenge the Pillpop application faced was the issue of low budget, which limited most of the proper functionality of the application, for example, automated phone calls alongside other features that could have been implemented to their full stage.

Overall, the pill pop application provided the solution to the problem of medication non-adherence, and the usability of the application is user-friendly.

7. References

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8. Appendix

Appendix A : Link to live version of the application: [Pillpop - Live Version](#)

Appendix B: Link to Pillpop Wireframe on Google Drive: [Pillpop Wireframe](#)

Appendix C: Link to Pillpop prototype: [Pillpop Prototype](#)

Appendix D : Link to Pillpop repository for code : [Repository](#)