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OmwanaThrive: A Neonatal Survival App

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Date: June 12, 2020

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OmwanaThrive: A Neonatal Survival App

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ABSTRACT

Uganda's infant mortality rate is alarmingly high, ranking twenty-first in the world for highest infant mortality; eighty-one babies die within their first month of life each day in Uganda. The UN reports the greatest risk factors are rural location, prematurity, and young impoverished mothers with limited educational opportunities. Thus, young women are giving birth to children before they even learn about how to take care of their newborn infant. Our solution to this problem is in the form of a mobile application called OmwanaThrive: Neonatal Survival App. The purpose of the app is to educate women about how to properly care for their children and improve health outcomes in neonates. This mobile app will include educational lessons with culturally relevant graphics and limited text, maps to affordable clinics, and an Admin Portal to recommend messages new mothers. Our platform focuses on rural mothers with low literacy rates, broadening their community of care, social capital, and access to healthcare. Our ultimate goal is to make health education accessible to Uganda women and decrease neonatal mortality.

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Chapter 1

Introduction

1.1 Motivation

The infant mortality rate is about 49 deaths out of every 1,000 live births, which puts Uganda at a rank of 21 in a list of infant mortality. Readily-accessible information about how to properly take care of infants is scarce, and the average age of a Ugandan woman to bear her first child is 18.9 years. In addition, according to the World Health Organization, 94 percent of all maternal deaths around the world occur in developing nations. Compared to that, most First World countries do not appear until past rank 100. Major factors that contribute to this issue include the lack of access to contraceptives, and women having a lower role in society. This ultimately leads to rural Ugandan mothers not receiving the necessary education on how to take care of their newborn infants, especially given that there is only 1 physician per 11,000 people.

1.2 Solution

Our solution to this problem is a mobile application that provides rural Ugandan mothers with the information they need to properly care for their child. In order to address the low literacy and low education levels, the information will be in the form of storytelling. Our app will also provide information on preventative measures for common diseases and simple solutions for minor ailments. Additionally, there will be recommended messages to remind mothers when they should schedule a doctor's appointment and when to get certain vaccines.

While there are existing solutions that provide infant health information for new mothers, these solutions are often geared towards mothers in developed nations where the average user has a much higher level of education. Thus, these resources are not only difficult for mothers in developing nations to understand, but also fail to teach the very basics of infant care.

Currently, any information or education regarding infant health is spread to new mothers in Uganda through word of mouth, either by other experienced parents or limited interactions with doctors and nurses. In the United States, in comparison, mothers and their newborns are sent home from the hospital with informational booklets that they can refer to as the baby goes through early developmental stages. This provides mothers with enough information and education to guide them through common illnesses and evaluate if their baby needs medical attention from a doctor. Our application would function similarly, with additional considerations and accommodations specific to mothers in Uganda, such as literacy rates, language barriers, and cultural differences.

Lastly, the key stakeholders for our app include the hospital clinicians who will interact with and use the app firsthand, as well as the new mothers who will be guided through the app by clinicians. In addition, Rose Academies, the non-profit supporting the app development, will also be a major stakeholder.

Chapter 2

Requirements

2.1 Functional

- Critical
  - Educational Modules
    - Allow user to view educational story modules
  - Resources Map
    - View list of local resources, along with location and service details if applicable
  - Admin Portal
    - Login system for authorized users to access and edit database information
    - Allow admin to view, add, edit, or delete a mother's information in the database
    - Provide admin a list of relevant messages to be sent to mothers
    - Allow admin to customize text message templates to send to mothers
- Recommended
  - Assistive voice to read educational modules aloud
- Suggested
  - App is simple and light
  - Available in multiple languages
  - Backup system to recover database of mother information

2.2 Non-Functional

- Sensitive information on individuals is secure in the database
- App is user friendly for mothers, clinic employees, midwives, and Rose Academy volunteers
- Intuitive user interface

2.3 Design Constraints

- Designed in React Native
- Compatible with Android phones and tablets
  - Specifically the model used by Rose Academies (High Performance RCA 7 Inch 1GB RAM 16G Tablet MTK Quad Core Dual Camera Touch IPS Screen 1024 x 600 WiFi Bluetooth Android 7.0 Black)
- Major functionality available offline
  - Information is stored locally on device

Chapter 3

Use Cases

As seen in Figure 3.1, we have two primary types of users. The first is an Administrator (who in this case will be volunteers at clinics in partnership with Rose Academies). Both administrators and mothers will have access to the Educational Modules and Resources Map. The admin portal will allow the administrator to access the databases of mothers as well as interact with the mothers message recommendation portal. The Admin Portal is password protected to ensure that all the sensitive mother data is secure.

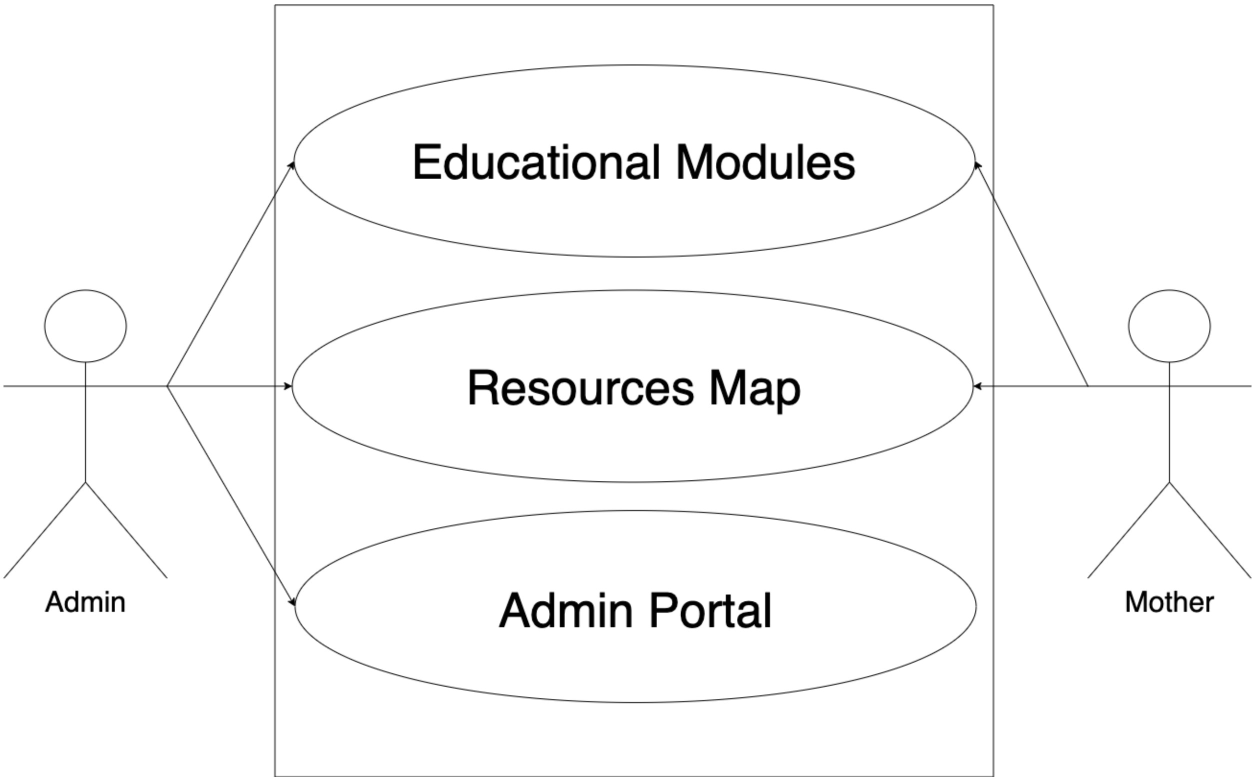


Figure 3.1: Use Cases for Admins and Mothers

Chapter 4

Activity Diagrams

4.1 Introduction

For a better understanding of OmwanaThrive, Figure 4.1 illustrates a diagram that traces the user actions and activity flow of the application. All potential users are taken to a page with the options to start reading a story module or view maps of nearby resources. Admin users are able to sign up for an account and login to the Admin portal where they will be able to add new mothers to the database or edit existing mother information. They will also be able to edit the recommended messages that are displayed daily, based on the timeline of each mother in the database.

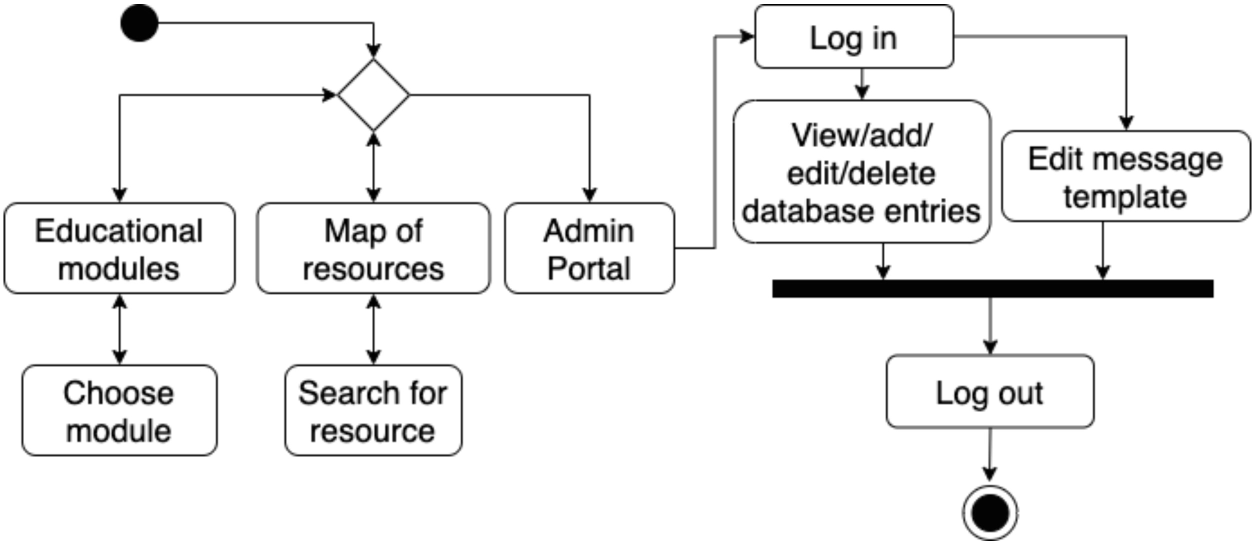


Figure 4.1: Activity Diagram

Chapter 5

Technologies Used

5.1 React Native

For this application, the main technology used was React Native, an open-source mobile framework that is functional across iOS and Android platforms. Additionally, it is adaptable across different sizes of devices, whether they are mobile devices or tablets. This worked for us since the main devices we were working to build the app on were Android tablets. To store the mother and child information locally, our team used React Native's built-in feature, AsyncStorage, an unencrypted, asynchronous, persistent, key-value storage system that is global to the app. To protect this sensitive data, it is password protected, so only admins will have access to this data. For source control, GitHub was used to store and share files among team members.

Chapter 6

Design Rationale

6.1 User Interface

The conceptual models were designed to ensure an intuitive and simple interface so that all users interacting with it can navigate around with ease and familiarity. They clearly indicate which modules the user is using the app for, and once a module is selected, only relevant information related to the module will be shown further.

We also based the design lightly off of HedhiHelp, another app that was distributed by Rose Academies, since we know that app was successful among its audience, so can assume that the UI was easy to navigate for them.

In addition, we used a deliberate color palette that matches that of the art slides in our educational modules in order to keep the app consistent throughout. We also used pink tones from the color palette specifically because our contact from Rose Academies in Uganda suggested that this would help make the mothers feel more comfortable while using the app.

6.2 Technologies Used

React Native allows this application to be easily transferred between various types of phones and tablets, which will allow it to reach a broader audience as well as be easy to scale for future use. For security purposes, the data about specific mothers and their children will be stored locally on the device using React Native's AsyncStorage. This prevented any network attacks or SQL injections, which are common in database configurations in the cloud. Finally, GitHub is an industry standard source control system, with which each of the group members have previous experience using. This provided a clear and simply way for each team member to keep track of code changes.

Chapter 7

Architectural Diagram

7.1 Mobile App Architecture

For this app, using React Native's AsyncStorage, all of the data about mothers and the messages to send them is stored locally on the device. This design decision was made to account for the lack of WiFi in the areas for our client users in rural Uganda. Therefore, the front-end components and back-end database are stored within the tablet itself as seen in the left side of Figure 8.1. We recognized that there is a high probability that one of these tablets could get lost or broken. Therefore, we needed to come up with an alternative to a cloud-based back up system to restore data that may be lost. Our solution was to create an email backup system as seen in the right side of Figure 8.1. To implement this, all of the data concerning the mothers and their children was written to a file in JSON format. Next the file was sent to email account that the Admin used to login to the Admin Portal. This allows the Admin to store the file locally by downloading the file onto their restored or new device. Next, they upload that file into the OmwanaThrive app to restore the database.

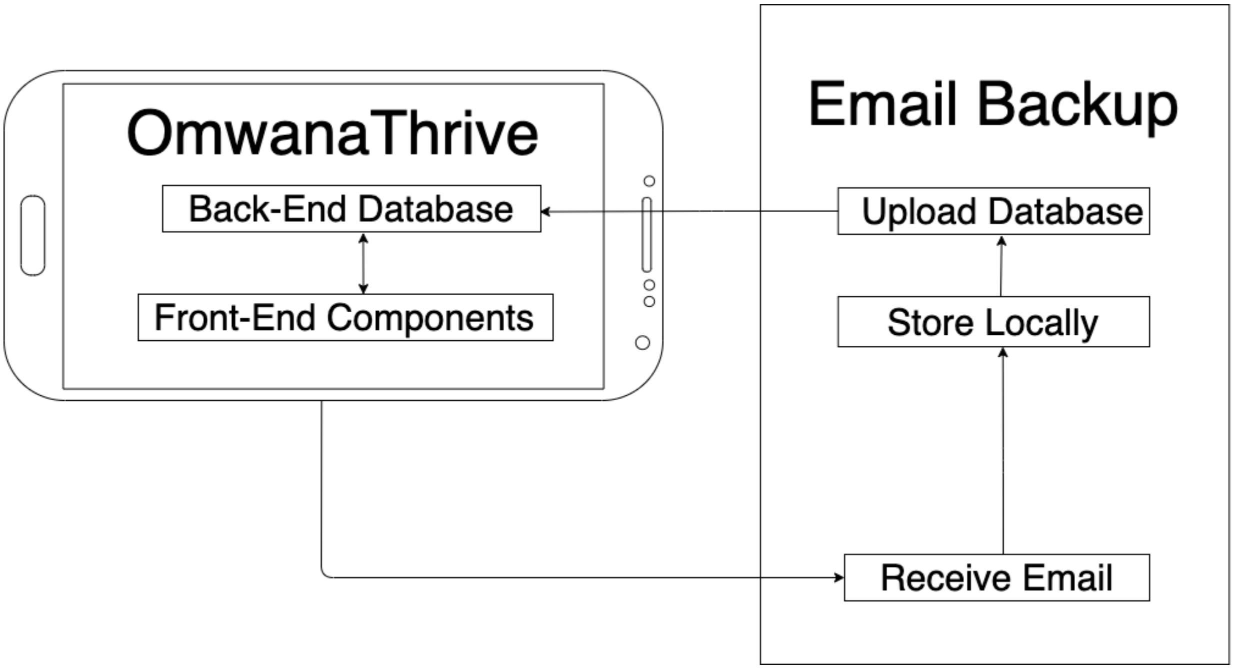


Figure 7.1: Architecture Diagram Displaying the Backup Data Flow

Chapter 8

Test Plan

8.1 White Box Testing

As we progressed in the design process, we tested each of the three main features of the system: the educational modules, resources map, and the admin portal. This was to ensure basic functionality as we moved forward and minimize errors in the future.

8.2 Black Box Testing

Before travelling to Uganda, we planned to have a functional app with all features complete. While in Uganda, we hoped to test the app with clinicians, midwives, and mothers in addition to teaching them how to use it. Feedback from this testing would help us further improve the app and optimize its impact with the real users of the app. During our time in Uganda, we planned to conduct many different forms of black box testing including:

- Teaching clinicians and midwives, who are volunteers of Rose Academies how to use the app and how to teach with it
- Holding focus groups with pregnant women and new mothers
- Presenting our work at local universities and asking for feedback from faculty, staff, and current students
- Conducting a focus group of students and professors for feedback and the opportunity to share our knowledge and code-base to local students to maintain and update code as needed for future generations

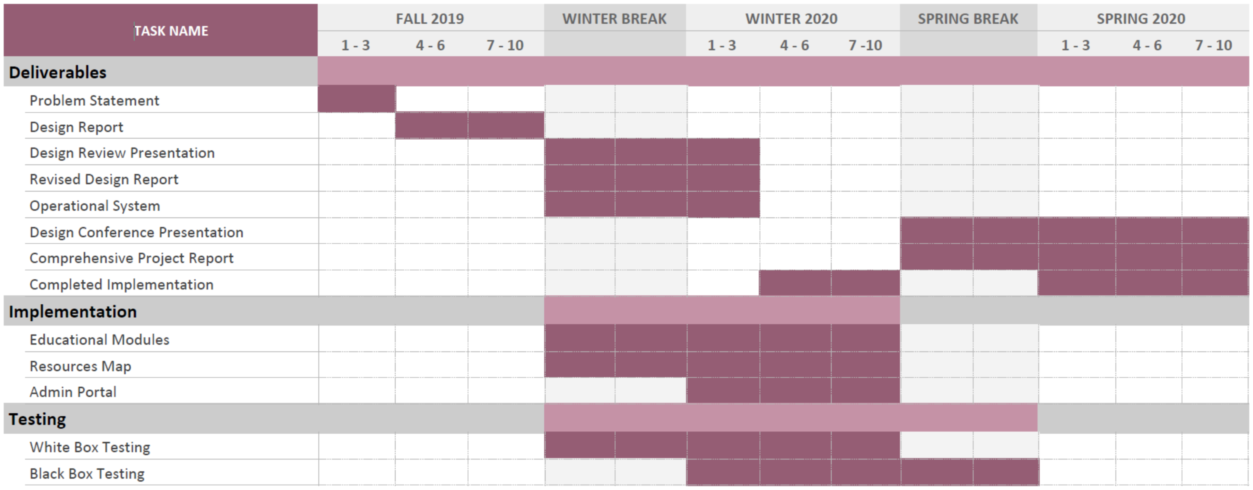
However, due to the pandemic and travel restrictions, our travel plans were cancelled and we were unable to conduct black box testing.

Chapter 9

Development Timeline

9.1 Gantt Chart

Figure 11.1 shown below describes the development timeline of the project over the course of the school year. Time is divided by academic quarters and breaks, and each quarter is divided into three to four week periods.



TASK NAME	FALL 2019			WINTER BREAK		WINTER 2020			SPRING BREAK		SPRING 2020		
	1 - 3	4 - 6	7 - 10			1 - 3	4 - 6	7 -10			1 - 3	4 - 6	7 - 10
Deliverables	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
Problem Statement	■												
Design Report		■	■										
Design Review Presentation				■	■	■							
Revised Design Report				■	■	■							
Operational System				■	■	■							
Design Conference Presentation									■	■	■	■	■
Comprehensive Project Report									■	■	■	■	■
Completed Implementation							■	■			■	■	■
Implementation				▨	▨	▨	▨	▨					
Educational Modules				■	■	■	■	■					
Resources Map				■	■	■	■	■					
Admin Portal						■	■	■					
Testing				▨	▨	▨	▨	▨	▨	▨			
White Box Testing				■	■	■	■	■					
Black Box Testing						■	■	■	■	■			

Figure 9.1: Development Timeline

Chapter 10

Suggested Changes

In the future, this app can be improved in various ways. Due to our team's inability to travel to Uganda for blackbox testing, we would like to see this come to fruition for the OmwanaThrive app in the future. Next, we would like for the backup process of the database being sent to the admin's email to be automated. Additionally, we could add an assistive voice to address lower literacy rates in rural Uganda. Lastly, we could enable multiple languages within the app, so that the app can be used to assist mothers in other regions in the future.

There are also many ways to improve app security. For example, we could encrypt the file of mother data sent in email backup. Additionally, we could improve sign in through verifying the user's email. The passwords could also be more secure. Currently, passwords must be at least six characters long and they must contain at least one character. To make the password requirements more secure, we could require at least one capitol letter, extend the length of the total characters in the password, and add a special character.

Chapter 11

Lessons Learned

Throughout the course of this project, we took away some valuable lessons through overcoming obstacles. First, we learned that we must be adaptable to all types of changes. Due to COVID-19, we were unable to travel to Uganda to execute our black box testing plan. As a result, we had to not only change some of our plans for the app, but also change the way that we communicated with all of the team members while working on the project remotely.

We also were able to develop skills in React Native and Git, which for the former, none of us had used before this project. We became more familiar with Git commands while working with it for the project as well. These were valuable experiences that we learned through both making and fixing mistakes along the way.

Lastly, we learned more about how to collaborate on a software engineering team project by combining skills, research, and knowledge. Not only did we have the experience of working with fellow software engineers, but we also learned how to work with interdisciplinary fields of public health, biology, and art. Shifting our entire team's communication to online/remote was also a new endeavor, but we were able to find ways to adapt.

Chapter 12

Societal Issues

OmwanaThrive engages in a number of societal issues. With each of these issues, we thought critically about our work and its impacts as we consulted a number of resources, such as ACM's Code of Ethics and various ethical frameworks.

12.1 Ethical

The OmwanaThrive team aspires to follow ethical practices and has followed many of the points in ACM's Code of Ethics. For example, Section 1.1 states that ethical computer scientists will "Contribute to society and to human well-being, acknowledging that all people are stakeholders in computing." With this section taken seriously, the stakeholders of the OmwanaThrive app are the clinicians, midwives, and mothers in rural Uganda, who do not have the proper instruction about how to care for their children. Therefore, our app will save many lives of newborns through merely educating the community about the best ways to care for their baby.

Section 1.4 states, "Be fair and take action not to discriminate." OmwanaThrive does this through providing education to those where there is a lack of resources in the communities we are serving. Therefore, our goal is to create a fair environment to save all lives. We do not believe that people in certain communities deserve the right to education or health practices any more than others, thus we refuse to discriminate. Yet, we recognize that OmwanaThrive is not a perfect solution. Our Rose Academies partners, who spend time with our target audience in rural Uganda, advised us to create the app in English, which most educated individuals in Uganda will be able to read and understand. However, some of the mothers may not fully understand the educational modules, which therefore may or may not be relevant. Here, our assumption is that mothers will use the app in conjunction with either clinicians or midwives walking them through each module. We assume that these individuals will be able to clarify any confusing text in the native language. Therefore, we are doing our best to refuse to discriminate by education level.

Section 3.1 states "Ensure that the public good is the central concern during all professional computing work." Throughout the process of creating the OmwanaThrive app, we have constantly ensured that the public good is central to our mission. We aspire to educate those who do not otherwise have access to the proper information about healthy medical practices for their newborns.

We have also considered our project under multiple ethical approaches, such as the Rights Approach. Our project seeks to promote the dignity of the new mothers. Per the Rights Approach, these women have a right to be treated as an ends themselves and not merely as means to other ends. The engagements with the mothers ensure their own health and wellbeing, not simply regarding them as a means to having babies.

12.2 Social

We worked to understand the prevalent social issues in rural Uganda to further optimize the impact of our app. One of the biggest issues concerning women in Uganda currently is that men demand milk from women, which takes those nutrients away from the babies. Therefore, OmwanaThrive has an educational module specifically to address this issue because we believe it is our social responsibility to share this information with the mothers to help protect their children from a lack of nutrients.

OmwanaThrive also seeks to increase accessibility to health education and health care for both mothers and neonates in the area. As it currently stands, there is no established system in rural Uganda to educate new mothers on how to care for their newborns with consideration of common problems in lactation, hygiene, and other illnesses. OmwanaThrive accomplishes this by providing customized educational modules that are culturally relevant to the community. Additionally, there is no common directory or resource to show information on available health clinics in the area, such as locations, phone numbers, or images. Through OmwanaThrive's resource map, the app is able to increase visibility and accessibility of these resources by providing all this information in one place, so should a mother and baby need to see a clinician, the mother can easily identify and locate the clinic that best fits her needs.

12.3 Political

Our biggest political impact would be fulfilling the rights to education and care. OmwanaThrive is providing access to educational resources and health care institutions. These resources are not otherwise available to poor young women of rural Uganda, the target audience for our app.

In addition to fulfilling the rights of our audience, we also consider our app to be a means of distributive justice. In terms of distribution of social goods, the principles of liberal justice calls us to go to the "original position" and presume a veil of ignorance in which we do not know which position in society we will have. The way we would structure society is to maximize the minimum position. For this project, we are seeking to make educational and health resources available to the minimum position. In this situation, the good in need of just distribution is the educational and health resources, and the minimum position is the poor and often illiterate women of rural Uganda. We are working to maximize their position by making these common resources free and accessible to them as they are for people in higher positions in society.

12.4 Economic

In consideration of our target audience, we knew that internet connectivity would pose as a barrier. Therefore, we designed the app to have its major functionalities available offline. This meant avoiding cloud storage and communication services, as to not incur additional costs for the user.

12.5 Health and Safety

One of our top priorities was the privacy and confidentiality of our users. With the OmwanaThrive app, one of our constraints is that we do not use a remote cloud database system. This eliminates the possibility of network attacks. Additionally, only admin users with an account will have access to the device's locally stored content with sensitive information about mothers and their children. Additionally, we ensure that there will be no persistent login, meaning that each time a user wishes to view the sensitive database information, they must re-enter their credentials. This will ensure that an unattended tablet, even in the hands of a malicious person, will not allow access to medical information. However, we currently do not have a system in place to verify that users are a clinician or an admin while creating an account. Therefore, this could lead to the possibility of an unauthenticated user could create an account and view data that should not be able to view. Due to the time limitations of this project, we have not yet found a solution to the issue of how to verify new users when they are creating accounts. Therefore, this is not the perfect solution, but it is a start to respecting privacy and honoring confidentiality.

12.6 Manufacturability

App deployment is fairly simple. The app can be exported as an Android Package Kit (APK), which can be downloaded directly on an Android device. For future versions of the project, the app could be placed on an app store to improve scalability.

12.7 Sustainability

Our app's information, such as educational modules content and local resource details, will remain useful and accurate for a reasonable amount of time. The app may need to be updated to include new educational content as different social issues become more prevalent, and more clinics may become available. When this happens, Rose Academies will be able to simply change the content of the app without having to change the app functionality.

12.8 Environmental Impact

Our app has an indirect environmental impact, since its use requires a tablet that has a carbon footprint impact. However, many of the intended users already have a tablet.

12.9 Usability

OmwanaThrive is very usable due to its simple interface. The app flow and functionality is intuitive with minimal text and no clutter.

12.10 Lifelong Learning

In working on this project, we had to learn how to use new and unfamiliar technologies, namely React Native. We did not have experience or knowledge about React Native before this project. We learned the importance of studying and researching a technology before trying to implement it.

12.11 Compassion

When Rose Academies and the Frugal Innovation Hub came to our group with this project, we had compassion for the organization's mission and the women in rural Uganda that we would be serving. This app will provide access to education and health resources, which will in turn save lives.

Chapter 13

User Manual

13.1 Admin User

13.1.1 Create an Account

After accessing the admin page with the ”Admin Portal” button, select ”New User? Sign Up” at the bottom. Passwords must be at least six characters long and contain one number. The email used to sign up will be receiving the database backup files. Please note, we cannot verify if a new account belongs to a truly authorized user.

13.1.2 Login

Login to your admin account using the registered email and password. You will now be able to access the database and message templates.

13.1.3 Log Out

Simply navigate back to the Home Screen, containing the buttons for Educational Modules, Resources Map, and Administrator. The admin will automatically be logged out, and login will be required to access the admin page again.

13.1.4 Add a Mother Entry to Database

To add a new mother to the database, first access the Mother Portal using the ”Database” button on the Admin Page. Select the expandable item titled ”New Mother” and fill out the fields. Select the ”Submit” button and the new mother will be added to the list of mothers.

13.1.5 Delete a Mother Entry

To remove a specific mother from the database, open the mother’s information by selecting her name. Select the ”Delete” button to remove that mother from the database.

13.1.6 Delete All Mother Entries

To remove all mothers from the database, scroll to the bottom of the Mother Portal. Select the ”Delete All” button, and all mothers will be deleted.

13.1.7 Backup Database

Select ”Backup” at the top of the Mother Portal. This will send a file containing all current database information to the admin email.

13.1.8 Restore Database

Download the most recent backup file from your admin email to the desired device. On the Mother Portal, press ”Upload File” and choose the appropriate backup file. This will overwrite any existing entries on the tablet and restore the version saved on the file.

13.1.9 Add a New Message Template

Access the Messaging Portal using the ”Messages” button on the Admin Page. Select the expandable item titled ”New Message” and fill out the fields. ”Message” should be the desired message content to send to the mother. ”Scheduled for” should be a number indicating the desired number of days after the baby’s birth at which the message should be sent. Select the ”Submit” button and the new message will be added to the list of messages.

13.1.10 Delete a Message Template

To remove a specific message from the list, open the message details. Select the ”Delete” button to remove that message from the list.

13.1.11 Delete All Messages

To remove all messages from the list, scroll to the bottom of the Messaging Portal. Select the ”Delete All” button, and all messages will be deleted.

13.2 Mother User

13.2.1 Educational Modules

Access the Educational Modules from the Home Screen. On the Educational Modules page, choose a module by selecting the button with the desired topic. To view the next slide in a module, swipe from right to left until you reach the end. Press the back button on the top of the screen to return to all the Educational Modules.

13.2.2 Resources Map

Access the Resources Map from the Home Screen. Tap the desired resource to view more information about the location. Tap again to view less information. Scroll vertically to see the full list of resources.

Chapter 14

API Documentation

14.1 Components

```
<ExpandableItem title="Name of Tab"><ExpandableItem>
```

An expandable tab item. Accepts a title and any child elements.

14.2 Login and Sign-up Screens

State Variables

```
string email
string password
```

Functions

```
async login(string email, string password)
```

Searches existing login database for email, and if found compares the passwords. Redirects user to Admin Portal if passwords match.

```
async storeUser(string email, string pass)
```

Saves email and password to the login database if conditions are satisfied.

14.3 Messages Screen

State Variables

```
string body
string schedule
array messages[]
```

Functions

```
handleMessages()
```

Event handler for the new message form. Saves message fields to corresponding state variables.

```
async getMessages()
```

Fetches messages from AsyncStorage and processes it into an array.

```
async removeAll()
```

Removes all message objects from the state variable messages and from AsyncStorage.

```
aync removeMessage(object message)
```

Removes the message object from the state variable messages and from AsyncStorage.

```
async saveMessages(array messages)
```

Saves an array of messages to AsyncStorage.

```
async updateMessages(object message)
```

Adds a new message object to the state variable messages and AsyncStorage.

14.4 Database Screen

State Variables

```
string MotherName
string ChildName
string DoB
string Born
string Phone
string Notes
array mothers
```

Functions

All Message.js functions are also available in Database.js. To use, change ”Message/s” to ”Mother/s.”

Chapter 15

Installation and Maintenance Guide

15.1 Initial Set-Up

Install Node.js. If you have homebrew, use the command above. The version we used for this app is 13.6.0.

```
    brew install node
```

Install Expo-CLI. We used version 3.11.7.

```
    npm install -g expo-cli
```

Clone or fork the repository https://github.com/sdeweese/NeonatalApp.git.

```
    git clone https://github.com/sdeweese/NeonatalApp.git
```

Navigate to the otapp folder to install all dependencies.

```
    npm install
```

Start the app.

```
    npm start
```

15.2 App Specific Dependencies

Here's a list of all the individual packages required for the app.

```
    npm install react-navigation
    npm install react-native-gesture-handler
    npm install react-navigation-stack
    npm install @react-native-community/masked-view
    npm install react-native-safe-area-context
    npm install twilio
    npm install @sendgrid/mail
    npm install react-native-datepicker
    expo install expo-file-system
```

15.3 Login Information

Gmail:

username: omwanathrive

password: omwanathrive123

Sendgrid

username: omwanathrive@gmail.com

password: omwanathrive123

Twilio

username: omwanathrive@gmail.com

password: omwanathrive123

15.4 Set-up SendGrid Environment

Your specific API key must be obtained from the SendGrid account.

```
echo "export SENDGRID_API_KEY=YOUR_API_KEY" > sendgrid.env
echo "sendgrid.env" >> .gitignore
source ./sendgrid.env
```

15.5 Create an APK file

Guide: https://docs.expo.io/distribution/building-standalone-apps/

Create an account. Make sure there is an “android” section in app.json. Build the file. (Note: this will take a while)

```
expo build:android
```

Download the APK file. Upload it to a Google Drive or send it via email to be downloaded on the tablet itself.