Milk Matters 4.0:

Bridging Milk Donor, Staff and Student Needs towards a Purposeful and Maintainable System

Deborah Talbot

Supervised by
A/Prof Melissa Densmore

Department of Computer Science
University of Cape Town

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This minor dissertation includes preliminary findings I presented as a poster at COMPASS '23 (Talbot and Densmore, 2023).

Chat GPT was used for structural inspiration for the introduction and conclusion, as well as for shortening paragraphs. Grammarly was not used in the writing of this dissertation.

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Abstract

Milk Matters is a Cape Town based non-profit milk bank. Their primary role is to collect expressed breastmilk from donor mothers, pasteurize it and distribute it to recipient infants in need. This dissertation explores the design and deployment of a donor-facing mobile application and staff-facing web application developed with and for the non-profit organisation (NPO) over the course of postgraduate student projects from 2016 to 2023. A particular focus is on the effects that the communication and feedback provided by the application has on donors' motivation to donate breastmilk. The staff-facing web application allows staff to manage the dynamic content of the mobile application. Additionally, we ask questions about the challenges associated with university-NPO collaborations on mobile development and reflect on design for this context. Technical and procedural challenges faced when getting the mobile application into a deployable state were noted. A pilot study was performed with three donors, followed by a deployment evaluation phase with seven donors and two NPO staff. Qualitative evaluation was done through semi-structured interviews and quantitative data was collected through usage analytics. The mobile application has shown the ability to increase donors' motivation to donate through increased communication between the NPO and its donors and result in donors feeling more appreciated. This occurred through direct communication from within the Donor App, automatic in-app feedback and passive app content. The extent to which donors engage with the mobile application and benefit from it, depends on their personal reasoning for becoming a donor. Donors' usage of the application also results in operational benefits for the milk bank. Challenges encountered in the deployment and maintenance of university-led mobile application development for this low-resourced NPO, highlight the effort required to sustain mobile applications in the app stores. To reduce barriers to future project continuity, recommendations include a clear handover of access to all project related accounts to the project supervisor, secure online access to all project related information and planning for continued contact with outgoing students.

Contents

1. Introduction

"Perseverance is not a long race; it is many short races one after the other." - Walter Elliot

1.1. Introduction

Breastmilk donation allows mothers who cannot provide breastmilk to their own infant the chance to use donated breastmilk. The majority of milk donation occurs through milk banks (iThemba Lethu, 2022). Technology can be used to simplify the sign-up process and provide positive feedback and information to donor mothers, potentially increasing the number of donors and motivating them to continue donating breastmilk for longer.

Over multiple years, the University of Cape Town (UCT) and Milk Matters, a Cape Town-based non-profit milk bank, have worked to develop a mobile application, known as the Donor App, aimed at increasing communication with and feedback to their breastmilk donors, in turn motivating them to donate more frequently or for longer. The initial version of the Donor app was released in 2016, but was only available for Android users. Since Milk Matters was unable to update any information within the app, its content quickly became too outdated for them to promote it. A cross-platform re-design of the Donor App began in 2020 and continued in 2021. Alongside it, a staff-facing web application, known as the Staff App, was also introduced. The Staff App was designed to allow Milk Matters staff to manage the Donor App's dynamic content and track where donations had been dropped off. The 2020/2021 version of the Donor App was not approved by Milk Matters for deployment as they still required further development of features such as navigation, email sending and the depot locator before public release. However, the students involved were unable to continue development after the completion of their projects and the Donor app and Staff app were left unpublished (Talbot and Densmore, 2023). In 2023, this project then set out to update the Donor App and the Staff App for deployment. Where possible, and within this project's scope, additional development requested by donor participants or Milk Matters was included. Post-deployment evaluation aimed to determine the effect of usage on communication between the donors and the non-profit organisation (NPO).

Challenges to sustainability are presented when development of these applications is initiated by university researchers partnering with low resourced NPOs. Milk Matters has insufficient resources to independently develop their own applications and a small staff of only three staff members, with limited capacity for additional collaboration. Co-design methods require significant time investment from NPO project partners, such as Milk Matters (Dourish et al., 2020), who often have limited resources available. Considerable challenges also exist in both the development phase and continued maintenance of the applications as project member turnover is high

(Albanna et al., 2022, Nahrkhalaji et al., 2018, Wraikat et al., 2017). The project timeframe, project scope and funding set by the university or research facility are also often limited (Best, 2010), with inadequate or no ongoing maintenance. Despite the input of the NPO, they may be left with no deployable outcome at the end of the university project timeline. While some Information and Communication Technology (ICT) development projects are "failed" by choice (Densmore, 2012), others may fall short of the goals of the NPO simply due to timing or logistical reasons.

1.2. Problem Statement

ICT and the use of mHealth applications within public health has increased in recent years (Padró-Arocas et al., 2021, WHO Director-General, 2018), including applications designed for breastfeeding mothers. There is, however, little research into post-deployment usage of these applications and their effects on breastmilk donor motivation and NPO-donor communication. Previous work with Milk Matters has shown that their donors desire more communication and feedback from the milk bank (Wardle, 2016). Additionally, because of the nature of university-led development projects, the pre-existing cross-platform mobile application developed for Milk Matters had not reached deployment, despite significant input from both the university and the NPO.

1.3. Aims

This research set out to update the existing Milk Matters Donor App and Staff App and deploy them for ongoing use by the NPO and its donors. The application aimed to provide opportunities for both two-way communication and feedback from the NPO to its donors, motivating them to donate their excess breastmilk. Researcher engagement with the donors aimed to gain an understanding of their expectations of the mobile application and the value of the mobile application in providing increased communication and motivation. Additionally, this research sought to gain insights into the challenges associated with university-led mobile application development for low-resourced NPOs and to make recommendations that mitigate the effects of these challenges in future work.

1.4. Research Questions

This research addresses the following research questions:

RQ1. What effect does a mobile application have on a donor's motivation to donate breastmilk to a non-profit milk bank?

To address RQ1, donor participants were questioned about their motivation to donate, how any application features influenced their motivation and their expected continued use of the application. Usage analytics were used to give further insights into the usage of these features.

RQ2. What are the challenges associated with university-led mobile app development for NPOs with limited resources?

Answering RQ2 involved noting all challenges faced in the initial set-up of the applications, their further development and ongoing maintenance. Additionally, the viewpoint of the NPO's staff members was included. Recommendations to address the challenges were made based on the steps that could prevent these difficulties from occurring in future work.

1.5. Approach

This research was divided into two main stages. The first included preparing the existing Milk Matters Donor App and Staff App for the pilot study and subsequent deployment. Document analysis was performed on all previous UCT students' Milk Matters projects. Development was required to get the applications to build, with further

changes needed to meet Milk Matters expectations for deployment. During this process, challenges relating to university-led mobile application development for NPOs were noted.

The second stage included the pilot study; changes made to the Donor App, based on pilot study feedback; and the deployment evaluation. Both the pilot study and deployment evaluation involved semi-structured interviews with donors before they used the Donor App and again two weeks after installation. This provided valuable insights into their expectations of the application, feelings towards communication with Milk Matters and their motivation to donate. The Donor App was publicly announced during the deployment evaluation. Semi-structured endline interviews with Milk Matters staff provided insight into their experience of using the Staff App, perception of donors' Donor App usage and the applications' sustainability within the small NGO context. Usage analytics of the Donor App and Staff App were recorded, offering a deeper understanding of the contextual usage of both applications.

1.6.   Contribution

The mobile application deployed through this study allows for increased communication between a milk bank and their donors, as well as increasing donors' motivation to donate their breastmilk. This has a real-world impact for the vulnerable infants served by the donations. These results can be used to develop similar applications for milk banks within other global contexts. Additionally, the initial usage analysis contributes towards the gap in literature relating to usage of publicly deployed mHealth applications.

Furthermore, the recommendations made to improve the continuity of university-led mobile application development projects with NPOs can be applied to university-NPO projects in other research fields, including outside of the health context.

1.7.   Dissertation Structure

This dissertation consists of seven chapters. The first chapter introduces the project. Chapter 2 provides background to the project and explores existing literature on usage of mHealth mobile applications within the NPO context. Chapter 3 explains the project's methodology. Chapter 4 describes the process and findings relating to getting the Milk Matters applications ready for use. Chapter 5 details the findings of the pilot study and deployment evaluation. Chapter 6 discusses this project's findings in relation to other research. Lastly, Chapter 7, describes the conclusions of the project and suggests future research opportunities.

2. Background and Literature Review

This chapter contextualises the design and usage of ICT in improving communication between a milk bank and their donors as well as fostering donor motivation. The challenges faced in completing mobile application development with both non-profit organisations (NPOs) and breastfeeding mothers are addressed and must be carefully considered to deploy a user-friendly and useful application with long term user engagement.

2.1. Human breastmilk

Breastmilk is the ideal source of nutrition for infants as it is nutritionally complete, easily digestible, protects against allergies, provides immunity and can adapt its composition according to an infant's current needs (Germano et al., 2020, Victora et al., 2016, World Health Organization, 2011). Long term benefits include the reduced risk of obesity and diabetes for the child and the reduction in occurrence of certain cancers (for both mother and child) (Germano et al., 2020, Victora et al., 2016). The benefits of breastmilk are even more apparent for babies born prematurely. These infants may have poor tolerance to breastmilk alternatives, and when compared to infant formula, breastmilk reduces the risk of developing life threatening necrotizing enterocolitis (Altobelli et al., 2020)

Both the World Health Organization and UNICEF recommend initiating breastfeeding within an hour of birth, providing breastmilk exclusively for the first six months of life and continuing breastmilk with complementary foods until two years of age and beyond (Unicef, 2018, World Health Organization, 2017). Globally, these guidelines are poorly adhered to (Padró-Arocas et al., 2021). An improvement in adherence could prevent over 820 000 deaths annually, in children under five years old (Victora et al., 2016).

2.1.1. Breastmilk donation

While it is ideal for a mother to be able to provide breastmilk for her own infant, the possibilities of an insufficient breastmilk supply, certain medication requirements or an ill, absent or deceased mother mean this is not always possible (Gribble, 2014). In these situations donated breastmilk is considered the best alternative (World Health Organization, 2011). A baby weighing under 1kg needs only 50ml of breastmilk to be fed for 24 hours, meaning even small amounts of donated breastmilk can be used for multiple infants. Unfortunately, the need for donated breastmilk often outweighs the supply (Milk Matters, 2015c, Perrin et al., 2016), leaving some infants with inferior alternatives.

Historically, breastmilk was donated through wet nursing (Haiden and Ziegler, 2017). While wet nursing still occurs, it is impractical for wider distribution of breastmilk and poses the potential risk of spreading infection from the donor mother. These days, the majority of milk donation occurs through milk banks, where breastmilk from multiple donor mothers is collected, screened, pasteurized and then distributed as needed. Globally there are over 550 milk banks (Altobelli et al., 2020), with Brazil being the country with the most. In South Africa milk banks are run by the NPOs Milk Matters[1], iThemba Lethu[2] and the South African Breastmilk Reserve[3], as well as in-house in some hospitals (Altobelli et al., 2020).

More recently, there has also been a rise in the use of social networks for peer-to-peer (P2P) sharing, where mothers share directly with other mothers (Fang et al., 2021, Gribble, 2014, Jamil et al., 2021, Perrin et al., 2016). Reasons for choosing P2P donation over the use of a milk bank include unavailability of milk banks close to the donor and the recipient, misconceptions around milk bank costs, strict donor and recipient criteria used by milk banks, religious considerations and donors preferring to choose the recipient directly (Gribble, 2014, Jamil et al., 2021), as they value the personal connection (Paruan et al., 2021, Perrin et al., 2016).

P2P donation, however, carries increased risks as the strict safety protocols, donor screening and standard operating procedures of milk banks are not enforced (dela Cruz and Mendoza, 2017, Jamil et al., 2021). Flash pasteurization, on a stove at home, can mitigate these risks (Chantry et al., 2009, Israel-Ballard et al., 2005), but the use of a milk bank is still arguably the safest route to go. The concept of including some of the benefits of P2P donation in a mobile application, such as detail on where the donors' breastmilk goes to and increased feedback from recipient mothers, should be researched as an avenue to increase donations to a milk bank.

The regulation of breastmilk distribution is viewed differently around the world. Some countries, such as the USA allow private distribution or sale of breastmilk from either donor mothers or private milk banks. In South Africa, however, the National Health Act prohibits monetary compensation of donors for their donated breastmilk, as it is classified as human tissue (Department of Health, 2003). It is also believed that providing monetary compensation could influence a mother to donate breastmilk, at the expense of the requirements of her own child (Kimani-Murage et al., 2019). This could cause further harm, especially to those donors from low socioeconomic groups, as they may deplete their own energy levels and nutritional status in an attempt to produce additional breastmilk (Fang et al., 2021).

2.1.2. Donor motivation

The main motivator for most breastmilk donors is that of altruism (Gribble, 2014, Muri et al., 2022, Wardle et al., 2018). Donor mothers view their breastmilk as a valuable resource that can be shared with other mothers who are not as fortunate as them in terms of milk supply. Some mothers do not want to see their excess stored expressed milk go to waste, so donate it, while others express milk for the sole purpose of donating (Gribble, 2014). Donor mothers appreciate receiving positive feedback about the donations they have made (Muri et al., 2022, Wardle et al., 2018). Barriers to donation include inadequate promotion of donation; lack of guidance on

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[1] Milk Matters. http://milkmatters.org. Last Accessed: 12 October 2023

[2] Ithemba Lethu. https://www.ithembalethu.org.za/breast-milk-bank/. Last Accessed: 12 October 2023

[3] South African Breastmilk Reserve. https://www.sabr.org.za/. Last Accessed: 12 October 2023

how to express, store and donate breastmilk; a mother's limited time; returning to work; a lack of interest in completing the screening and logistical procedures to donate breastmilk and the effort required to deliver breastmilk to the nearest milk bank or collection depot (Muri et al., 2022). A lack of feedback and the time consuming process of donation means many mothers stop donating after four to five months (Wardle et al., 2018).

2.2. Project Partners: Milk Matters

Milk Matters is a Cape Town based non-profit breast milk bank (Milk Matters, 2015a). When Milk Matters was started in 2003, by a group of lactation consultants, the initial intention was to provide donated breastmilk to a local orphanage. Local doctors soon began to request that they provide donor milk to premature infants in their hospitals, causing the focus to quickly switch to providing donor milk to these infants instead. These days, their primary role is still to collect expressed breastmilk from screened breastmilk donors, pasteurize it and distribute it to infants in need. Additionally, they work together with hospitals to help them set up their own in-hospital milk banks, thereby increasing the number of infants that can be supported.

Milk Matters currently has three staff members, an average of around 30 to 40 breastmilk donors at a time and provides donor milk to premature and ill infants in the neonatal Intensive Care Units (NICUs) of up to 30 hospitals within the greater Cape Town area in a year.

2.2.1. The Milk Matters Donation Process

Once a potential donor has expressed interest in donating breastmilk to Milk Matters, they complete an initial screening questionnaire (Milk Matters, 2015b). If they are eligible to become a donor, they are then given details of the most convenient depot for them to drop off their initial breastmilk donation at. A variety of clinics, pharmacies and other medical practice rooms act as depots where donors can deliver their donations. Donations are stored in a Milk Matters designated freezer until they are collected by Milk Matters representatives, to be brought to their office in Mowbray, Cape Town. Following a potential donor's initial donation, they need to complete blood tests to screen for HIV and Hepatitis B. After clear blood test results, they are given a donor number and processing of their breastmilk donation will begin.

The breastmilk is then defrosted, batched, pasteurized and refrozen. Small volumes are sent for microbial testing following pasteurization (Milk Matters, 2015d).

Local hospitals place daily orders for the volumes required by the current infants in their care. The donor milk must be scripted by a doctor and a consent form must be signed by the infant's caregiver. The hospital is responsible for collecting the donor milk from the Milk Matters office.

Donor milk is manually tracked, by Milk Matters, from drop-off at the depot to hand-over to the hospital's courier. Tracking includes donor number, batch number, pasteurization date, best before date and order dispatch details. Hospitals are invoiced for the processing of the donor milk, but not charged for the donor milk itself.

2.2.2. History of Collaboration with Milk Matters

The UCT's Computer Science department has a history of working with Milk Matters. In 2016, an Honours[4] project used co-design to develop an Android mobile application for Milk Matters (Wardle, 2016). It aimed to encourage donor mothers to donate their breastmilk to the milk bank and to improve their donation experience. Application functions included milk donation tracking, allowing a visualisation of the total amount donated and the impact made, described as the number of feeds. Educational articles were also made available, as well as a depot locator for donation drop-off and a quiz to confirm donor eligibility. This application was static and its contents could not be updated by Milk Matters, quickly leaving the application outdated. This research, focusing on ways to improve

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[4] In South Africa, an Honours degree is a postgraduate level degree, done after completion of a Bachelor's degree. Generally, Honours would be a student's fourth year of university study and includes both coursework and a short dissertation.

co-design with breastfeeding mothers, was published at CHI '18 and received an honourable mention (Wardle et al., 2018).

Wardle continued working with Milk Matters for her Masters dissertation, co-designing a chatroom app for the milk bank's donors (Wardle, 2019), as donors reported craving connection with other donors. The chatroom app was, however, not incorporated into the Donor App as Milk Matters was concerned that without sufficient moderation it could lead to the spread of misinformation amongst their donors (Lobola, 2021).

In 2020, a another UCT Honours project set out to develop a new version of the Donor App. It included a staff facing web application, introducing the ability for Milk Matters to dynamically update the variable information and educational content served to donor mothers, as well as adding authentication and cross platform support to the donor mobile app (Bossi, 2020). This version, however, was not made public on any app store.

In 2021, additional improvements were made to usability and an FAQ and Contact Us section were added to the application by a third UCT Honours project group (Lobola, 2021). While this version was developed for cross platform usage, at the onset of my research, it was only available for download by Android users. It had between 10 and 50 downloads between July 2021 and January 2023 and was not promoted by Milk Matters in any way, as they were not yet satisfied that it was ready for deployment.

Future work recommendations made by previous developers included showing testimonials in the application, adding functionality to allow registered donors to update their profile details, allowing a Google sign-in option, further improving the use of dynamic content, incorporating improved location navigation and adding search functionality to educational content and FAQs (Lobola, 2021).

2.3.   Current Milk Matters Application Features

As mentioned above, two applications, that work together, have been developed for Milk Matters. They are the donor facing mobile application, referred to as the Donor App and the staff facing web application, referred to as the Staff App. This section describes the current features of these applications, as used in this project's deployment evaluation.

2.3.1.   Donor App features

The Donor App produced from this project is currently available for download on the Play Store[5] and the App Store[6]. More detail on specific changes made to get deployment approval from Milk Matters will be described in the Methods and Findings sections of this dissertation.

Users are required to register an account to use the Donor App. Registration requires their name, email address and phone number and for a password to be set. Registration allows users access to all donor app features, besides the depot locator and the ability to declare a donation drop-off. These two features are only available to current Milk Matters donors, as the user must enter their donor number to gain access. The donor number must correspond with the registered email address in the donor database.

Once logged in, users are taken to the **Home screen** (Figure 1). A bottom navigation bar links to Home, Donation Tracking, Education, Depot Locator and a More menu.
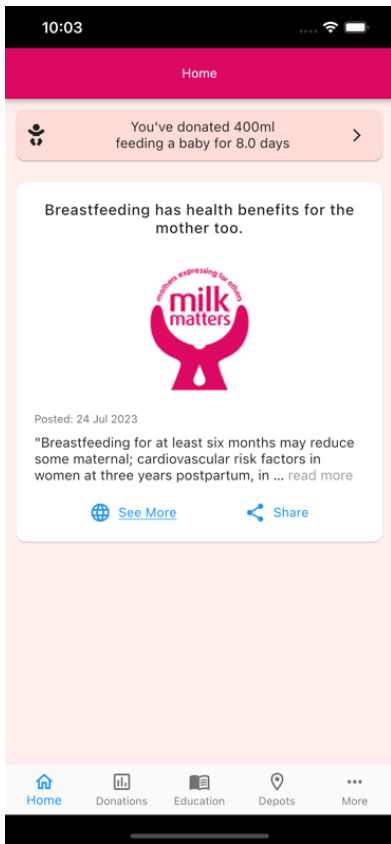

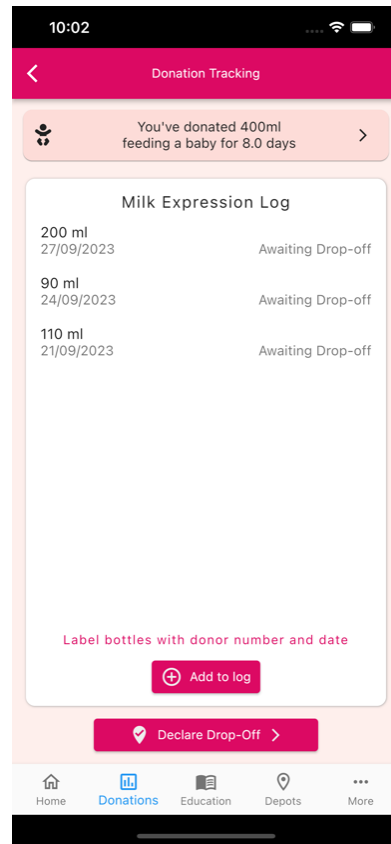
Figure 1: Home Screen

Figure 2: Donation Screen
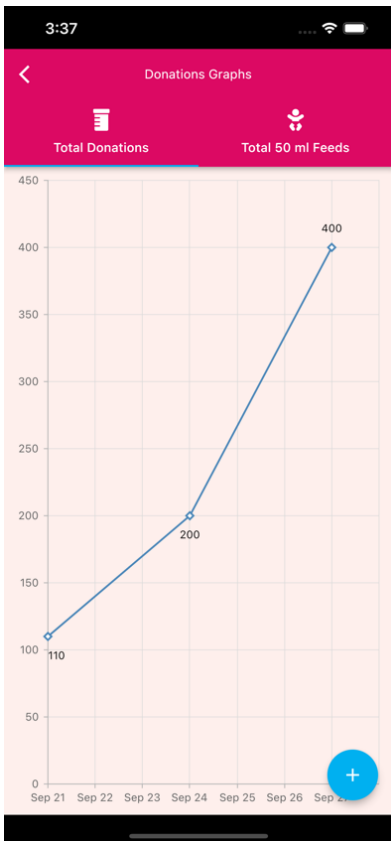
Figure 3: Donation Graph
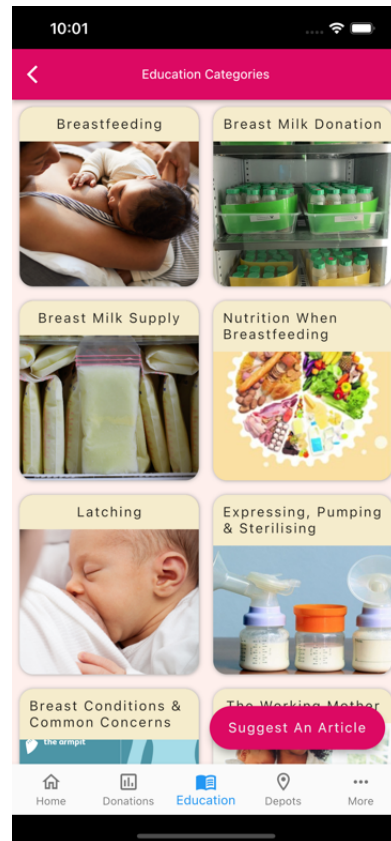
Figure 4: Education Screen

A widget at the top of the home screen summarizes total donations by the user, in both total volume and number of 50ml feeds donated. If they are not yet registered as a donor it instead encourages them to become a donor by linking to the "Become a Donor" screen. Below the widget is a news feed allowing Milk Matters to provide donors with news, updates or upcoming event information.

The **Milk Expression Log**, also referred to as the donation tracker, is on the **Donation screen** (Figure 2). This allows donors to record and track volumes of expressed breastmilk, with the date of expression. From within the app donors can declare a donation drop-off at a depot. This notifies Milk Matters via email and updates the Staff App, so that they can organize collection from the depot.

By clicking on the widget on the top of the home or donation screens they can view their total tracked donations to date on a graph as either total volume donated or total number of 50ml feeds provided (Figure 3).

Categorized educational articles are available to all app users from the **Education screen** (Figure 4). These aim to provide users with evidence-based information and support them through breastfeeding, breastmilk expression and donation. Additionally, users can submit educational article suggestions to Milk Matters for inclusion.

Depots provide a convenient location for donors to drop off their breastmilk donation. Registered donors, logged in with their donor number (Figure 5), can access the depot locator on the **Depot screen** to see depot information in the form of either a list of depots or marked as pins on a Google map (Figure 6). Clicking on a pin displays any additional information related to that depot, such as opening times or contact details. Functionality is included to locate the depot nearest to the donor's current location.
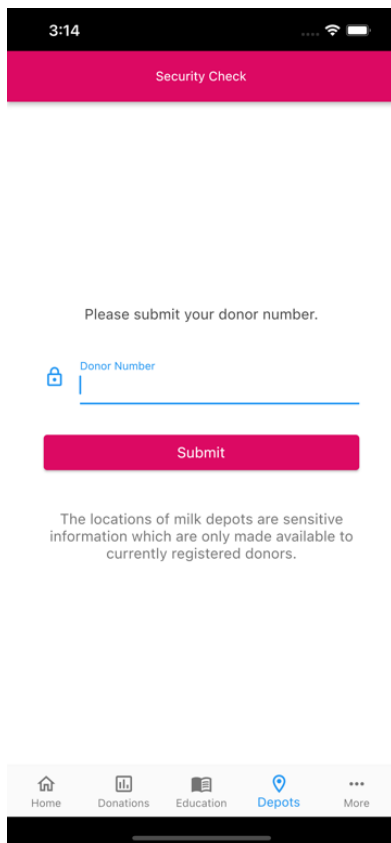
Figure 5: Donor Security Check   **Figure 6: Depot Locator**   **Figure 7: More Screen**
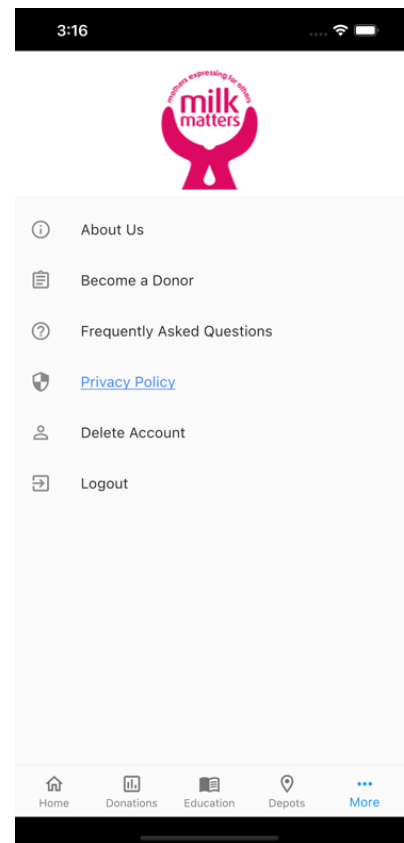
The **More menu screen** (Figure 7) displays links to About Us, Become a Donor, FAQs, Privacy Policy, Delete Account and Logout screens.

"About Us" introduces Milk Matters and the importance of their work. It also provides contact information and social media links. **"Become a Donor"** allows potential donors to complete a pre-screening questionnaire. Results of the questionnaire are emailed directly to Milk Matters, allowing Milk Matters to continue the conversation about registering as a new donor. **"Frequently Asked Questions"** provides answers to commonly asked questions, while **"Privacy Policy"** details the application's privacy policy. **"Delete Account"** allows for a user to automatically delete their registered account details from the application's database.

2.3.2. Staff App

The Staff App was first developed in 2020. It can be accessed online by staff members with log-in credentials. The Staff App (Figure 8) allows staff to update all dynamic information displayed within the Donor App. This includes news snippets displayed on the home screen (Figure 9), depot details (Figure 10), educational content (Figure 11), frequently asked questions and about us information. They can also approve or reject any educational article suggestions submitted by Donor App users.

The Staff App includes account management, allowing staff to add donor numbers and email addresses of registered donors to the database (Figure 12). These are used for authentication of donor numbers when donors use the depot locator or donation drop-off declaration features.

Additionally, the Staff App displays the volume of declared donation drop-offs awaiting collection at all depots. Staff users can "process" these volumes, resetting them to zero.

logout

Milk Matters Home

Dashboard

View milk to be picked up, and browse user suggested articles

Go to Dashboard

Articles

View and edit articles for donor mothers to view on the mobile app

Go to Articles

News and Events

View and edit news items for donor mothers to view on the mobile app

Go to News and Events

Depots

View and edit depots for donor mothers to view on the mobile app

Go to Depots

Account Management

Manage donor numbers and staff accounts, and reset staff passwords

Go to Account Management

FAQs and About us

View and edit the FAQs and About us content for viewing on the mobile app

Go to AboutUs

Figure 8: Staff App Home Screen

News and Events

Breastfeeding has health benefits for the mother too.
https://internationalbreastfeedingjournal.biomedcentral.com/articles/10.1186/s13006-023-00571-3

Date of Event:24 July 2023

Description

Edit   Delete

Teeny tiny babies need our help - in fact they need your help.

Date of Event:2023.10.19

Description

Edit   Delete

The Springboks supported Milk Matters, We support the Springboks!

Date of Event:21 October 2023

Description

Edit   Delete

Don't let your unneeded freezer stash of breastmilk go to waste!

Date of Event:25th October 2023

Description

Edit   Delete

Rugby World Champs!
https://www.facebook.com/MilkMatters/posts/pfbid0zPCsWiwGXf19faoQ9FFw1XS17DtgKa2MgudSEUd8s8f8z5zQ3DGDUQW7BazyYEWFl?

+

Figure 9: Staff App News and Events Screen

Depots

Belhar - Amy
Contact Milk Matters

Contact Number: 0€
Description: Only by arrangement

Approximately 0 ml of milk available

Process Collection   Edit   Delete

Boston
Contact Milk Matters

Contact Number: 0€
Description: Only by arrangement

Approximately 0 ml of milk available

Process Collection   Edit   Delete

Brackenfell   7560

Contact Number: 02
Description: Sr 0   – Fri 9am – 5pm

Approximately 0 ml of milk available

Process Collection   Edit   Delete

Durbanville:

Contact Number: 0
Description: Please contact   advance to arrange collection of containers or a milk drop off. Mon – Thurs 9.30am – 16.30pm Fri 9.30am – 12.30pm

Approximately 0 ml of milk available

Process Collection   Edit   Delete

Hout Bay
Hout Bay, Cape Town

Contact Number: Milk Matters Office 021 659 5599
Description: Donors to be given depot host's number by Milk Matters.

Approximately 0 ml of milk available

+

Figure 10: Staff App Depot Details

Articles

logout

The Sleepy Newborn
milkmatters.org/breastfeeding-breastmilk/your-newborn-baby/
Date Added: 12/6/2023
Category: Breast Conditions & Common Concerns
Description

Edit Delete

Planning for your baby's birth
milkmatters.org/breastfeeding-breastmilk/planning-birth/
Date Added: 19/4/2023
Category: Breast Conditions & Common Concerns
Description

Edit Delete

Medication & Other Drugs
milkmatters.org/breastfeeding-breastmilk/medication-other-drugs/
Date Added: 19/4/2023
Category: Breast Conditions & Common Concerns
Description

Edit Delete

Why is Donor Milk Needed?
milkmatters.org/donating-milk/
Date Added: 19/4/2023
Category: Breast Milk Donation
Description

Figure 11: Staff App Education Articles

14
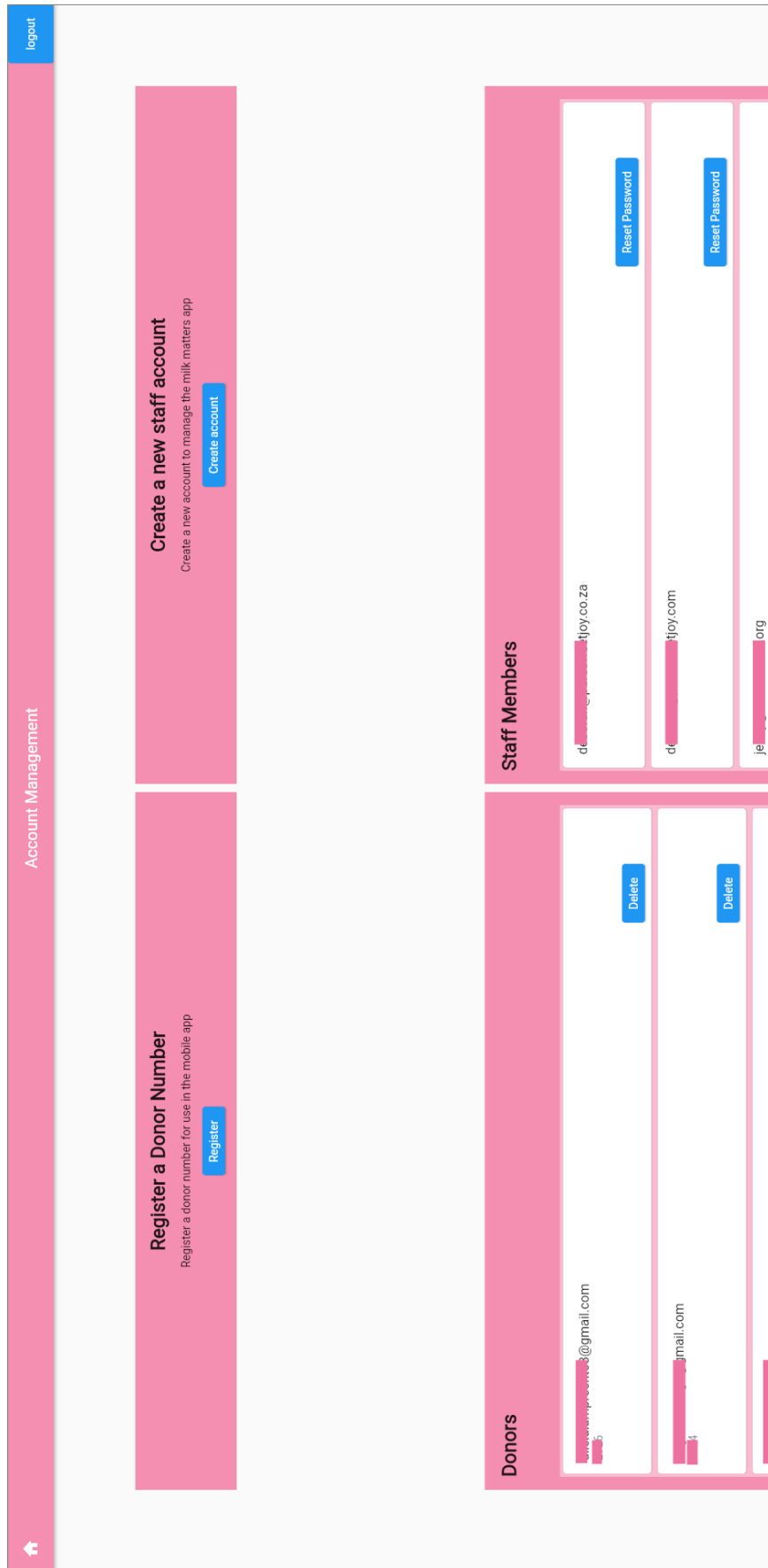
Figure 12: Staff App Account Management

2.4. mHealth

Innovation in ICT and widespread smartphone use has led to an increase in software being used to improve healthcare. The use of mobile phones, or other portable devices, to promote public health is known as mHealth (Greve et al., 2022) and is encouraged by the World Health Organization (WHO Director-General, 2018). mHealth services, which include both text messaging services and mobile applications, address a wide variety of health issues, such as stress management, weight management, cardiovascular health and diabetes management (Padró-Arocas et al., 2021). These services improve quality of care, enhance health information access, and yield positive health and behavioural outcomes (WHO Director-General, 2018). Educational mHealth applications focused on breastfeeding have also been shown to increase the initiating, exclusivity and continuation of breastfeeding (Alnasser et al., 2018, Padró-Arocas et al., 2021) and are recommended by the Institute of Medicine as an important means of breastfeeding promotion going forward (Whitacre and Moats, 2011). Pregnant and postpartum women are among the highest users of online health information services (Meedya et al., 2021).

Effective long term user engagement with an mHealth application requires it be interactive, to yield a positive user experience and to add perceived value to the user, even if it is free to use. Applications that foster habitual use are also more likely to be used long-term (dela Cruz and Mendoza, 2017, Meedya et al., 2021, Schindler-Ruwisch et al., 2018, Yuan et al., 2015).

2.4.1. Breastmilk related mHealth applications

A variety of breastfeeding related mHealth apps are discussed in literature, including features such as educational articles, location data for breastfeeding-friendly public spaces, tracking of feeds and growth tracking (dela Cruz and Mendoza, 2017, Padró-Arocas et al., 2021). LactApp[7], a cross-platform breastfeeding support mobile app with over 100 000 Android downloads, uses a comprehensive decision tree allowing mothers to automatically receive personalized answers to their breastfeeding questions, based on both their profile information and their answers to the questions posed.

The functionality of mHealth apps that cover breastmilk donations differs according to the method of donation. CuidarTech Doe Leite, developed in Brazil, allows logged in donors to schedule home collection of donated breastmilk for use by a local milk bank (Muri et al., 2022). Milktrack and Gmilk, both developed in the Philippines, and Share the Drop[8] and BBy[9], developed in the United States, allow for registration of both donors and requesters, as a P2P donation process is used (dela Cruz and Mendoza, 2017, Paruan et al., 2021). Gmilk and Share the Drop allow requesters to select a donor and then arrange donation directly without payment. BBy also allows for direct P2P donation arrangements but places a strong emphasis on the earning potential of donors. Milktrack uses in-app purchasing for buyers to purchase milk from donors but incorporates the use of a courier to first take the milk to the milk bank for pasteurization, before delivering it to the buyer.

The apps allowing for requesters to register on the app do not have criteria for receiving donated breastmilk. In contrast Milk Matters provides donor breastmilk only to the most vulnerable infants, with strict inclusion criteria and it must be prescribed by the infant's managing doctor.

2.4.2. Usage of mHealth apps

Although research shows that mHealth apps have the potential to positively influence users' behaviour and are well accepted by users in pilot studies and usability studies, many mHealth applications do not move past the pilot stage (Greve et al., 2022). Additionally, uptake and usage of the above-mentioned deployed breastfeeding related mHealth apps has not been greatly studied. There is evidence that most mHealth application users either do not

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[7] LactApp. https://lactapp.com/. Last Accessed: 19 Nov 2023.

[8] Share the Drop. https://sharethedrop.com/. Last Accessed: 12 Nov 2023

[9] Bby. https://apps.apple.com/us/app/bby-milk-sharing/id1236958438?ls=1. Last Accessed: 12 Nov 2023

use the app frequently or stop using it after a limited time period due to loss of interest, hidden costs, a manual data collection burden (Krebs and Duncan, 2015, Yuan et al., 2015) and unmet expectations (dela Cruz and Mendoza, 2017). Many mHealth applications are found to have poor quality content and rely on a high level of user literacy (Schindler-Ruwisch et al., 2018). Further research needs to be conducted into the longevity of such mHealth applications and how to ensure that they foster effective long term user engagement leading to behaviour change as well as larger clinical trials to evaluate their impact on health outcomes (Meedya et al., 2021).

When it comes to apps aimed at the first year of parenting, parents are more likely to choose an app based on its visual appeal and usability than the reliability of its content and security (Virani et al., 2021). Possible reasons include a development focus on evidence-based information, but a lack of inclusion of the features that parents desire, the difficulty to find evidence-based apps due the overwhelming number of poor-quality apps available, as well as limitations to availability and visibility caused by not being available cross-platform. To develop apps that are evidence-based, contain features that parents desire and are visually appealing to parents, it is imperative that parents are included in the development process (Virani et al., 2021).

2.4.3. Co-design in mHealth

Co-design is not well defined within literature, with varying understandings between researchers (Till et al., 2023). For the purposes of this research, co-design is defined as a form of design that includes the end user in the context generation, ideation and concept development of the design process (Sanders and Stappers, 2008). The end user is seen as the expert of their experience and therefore plays a key role in the process. Understanding the user and their context is important for creating systems (or applications), that will be well utilised.

While literature examines general co-design frameworks and methods, the specifics of co-design applied to the context of mHealth applications is poorly researched (Noorbergen et al., 2021). The early phases of design, including user context exploration and idea generation, have been the focus of research, with minimal studies including the post design phase. Given that real-world usage of an application often differs from the designers intention, data gathered once the application is deployed and being used is extremely valuable for refinements to the application and to allow for adaptation as users' needs change, particularly in the health context (Noorbergen et al., 2021). Fostering a multidisciplinary approach, making use of the skills of all partners and organisations, can improve the reach and uptake of mHealth apps (White et al., 2016).

2.4.4. Designing with and for Breastfeeding Mothers

The CuidarTech Doe Leite application was designed by the development team and then usability testing and content validation was done by donor mothers and health care professionals, respectively (Muri et al., 2022). Health care professional input is valuable for an mHealth application to ensure that the content provided is accurate. Additional insights into the users' requirements for the application could have been gained by including donor mothers earlier on in the design and development process. When including breastfeeding mothers in the process, it is important to consider their context as a mother caring for a child. Design tasks required of the mother must be set out in such a way that they are quick to complete and able to be done with one hand (Balaam et al., 2015). Additionally, Balaam et al. (2015) found that design tasks must be able to be paused and resumed, with tasks that began partially completed for the mothers being easier for them to complete and sufficient to provide valuable insights. Further recommendations by Wardle et al. (2018) include completing sessions either in the mother's own home or online, to reduce traveling requirements, focusing on discussion-type interviews rather than ones that require her hands to be available and using mobile application usage logs to automatically gather data without a mother's active input.

Similar desirable design features of the completed application have also been highlighted by mothers. These include being able to accommodate mobile application interactions being interrupted by daily tasks, use of the device with one hand due to needing the other hand for breastfeeding or expressing breastmilk and eliminating features that might distract a baby, such as video, audio or flashing lights (Wardle et al., 2018).

2.5. Digital Transformation in NPOs

Digital transformation can be defined as "a radical rethinking of using technology to change strategy, revenue streams, operations and business models leading to significant impact for customers, partners, and employees" (Nahrkhalaji et al., 2018, p. 1245). In the NPO context this can mean increased efficiency, introducing innovative ways of fundraising, improved communication and collaboration, reduced labour costs, improved donor relationships and a greater long-term social impact (Nahrkhalaji et al., 2018). NPOs contribute important services to many communities, both socially and economically. Services often span multiple sectors, including healthcare, education, employment, housing and the environment, in situations that are often insufficiently managed by governments and for-profit organizations (Huang and Umapathy, 2015). As mentioned above, the adoption of mHealth and ICTs is seen as an integral part of modern medicine by the WHO (WHO Director-General, 2018).

While digital transformation can resolve problems and produce new opportunities, it can also introduce new challenges (Nahrkhalaji et al., 2018). NPOs are often run on limited funding, requiring budget to be allocated to organisational expenses rather than to the innovation of new ICT projects (Wraikat et al., 2017). Organizational inertia and a fear of change by board members or management, can halt transformation before it has even begun (Nahrkhalaji et al., 2018). If adopted, new technology and new social media platforms require changes to be made to the running of the NPO and new skills to be learnt. Both of these are challenging in an organisation with time constraints, high staff turnover and often employing staff with low technological skills (Denison et al., 2020, Huang and Umapathy, 2015, Nahrkhalaji et al., 2018, Wardle et al., 2018). A lack of staff understanding of the benefit of the new system or a perception that it does not provide a benefit leads to a reluctance to adopt the new procedures and give it the time required (Denison et al., 2020, Vilane, 2021).

Social media has a wide variety of uses including promoting an NPO's initiatives, sharing up to date information and engaging with the public on an accessible communication platform (Albanna et al., 2022). The natural sharing of information through online connections and community followings allows messages to reach wider audiences. The most commonly used social media platforms amongst NPOs are Facebook and Twitter, followed by YouTube and Instagram (Albanna et al., 2022). Social media is a useful marketing tool, however, its potential is often not reached due to a lack of resources and little or poor planning of social media strategies.

Appropriate use of social media and other communication techniques has the potential to improve usage and uptake of new ICT projects. However, the associated challenges need to be addressed by decision-makers in a sensitive and appropriate way to ensure the success of both ICT innovation and social media efforts in the NPO setting.

2.6. Conclusion

Human breastmilk is the ideal source of nutrition for infants, especially for premature or ill infants. Milk donation, via milk banks, is a safe and effective way to provide breastmilk to those infants who cannot get it from their own mothers. mHealth applications have the potential to positively influence health behaviours, including those of breastfeeding mothers. There is limited research on the usage and effects of these applications after deployment, particularly how to foster communication between NPOs providing the applications and their community.

The challenges faced by NPOs in the design and adoption of ICT innovation, particularly when led by universities, must be addressed to ensure effective project continuity.

3. Methods

This chapter details how this project went about document analysis, software development, user recruitment, testing and data analysis. The complete system (Milk Matters Donor App and Staff App) has two groups of users: Milk Matters' staff, who use the Staff App, and Milk Matters' breastmilk donors, referred to as "donor participants", who use the Donor App. Ethics clearance was obtained from the University of Cape Town's Faculty of Science Research Ethics Committee (FSREC 018-2023).

An inductive research approach was used for this case study research (Creswell, 2013). The setting of Milk Matters as an NPO, together with their donors was analysed in detail, using multiple data collection methods.

To answer the first research question qualitative data was collected through interviews with donor participants. Questions focused on their motivation to donate, how any application features influenced their motivation and their expected continued use of the application. Usage analytics were used to give further insights into the usage of these features.

To answer the second research question, a document analysis of the project was performed to provide context into the history of the project and challenges that already existed. Further challenges faced in the initial set-up of the applications, their further development and ongoing maintenance were recorded. Qualitative data was obtained through interviews with the NPO's staff members. Recommendations to address the challenges were made based on the steps that could prevent these difficulties from occurring in future work.

For the duration of the project, I volunteered my Friday mornings to do collections from depots and assist with donation processing, order preparation and general office tasks.

3.1. Document analysis

To fully understand the history of the project and the context in which challenges with translation of a student research project into an adopted application have occurred I performed a document analysis (Bowen, 2009) of all previous project write-ups of students involved in the Milk Matters project, namely Green (2016), Wardle (2016), Bossi (2020), Amicis M. de Souza Mendes (2020), Serton (2020), Vilane (2021) and Lobola (2021). All documents were analysed for information on feature development, methods used, challenges encountered and interesting findings. Furthermore, doing this historical document analysis allowed me to gain the perspective of not just my

own interaction as a university student with this particular non-profit organisation (NPO), but also the perspective of several Honours and one other Masters student.

Additionally, to gain the NPO's perspective on the project's history and reasons for continuing, I began a discussion with the Milk Matters CEO by asking: "Why did you agree to carry on collaborating with UCT on this project?".

3.2. Development Processes and Methods

Development started with a meeting with Milk Matters to discuss their needs. Debugging and minor additional feature development of the previous versions of the Donor App and Staff App was then done iteratively, using an Agile[10] approach of cycles of design, development and evaluation. This allowed for continued engagement with Milk Matters throughout the development process and for requirements and design to be adjusted quickly and as needed (Greve et al., 2022). Official meetings were held with Milk Matters, as well as weekly informal discussions during my volunteering sessions. Additionally, donor feedback from the pilot study led to adjustments to the Donor App before deployment as addressing users' feedback is important to support the application's success (Greve et al., 2022).

Flutter[11] was used for both applications, as it allows for cross-platform development and is the framework that was used in both 2020 and 2021. The backend system has remained hosted on Google Firebase[12] due to its benefits of scalability, security and affordable payment model (free for the current requirements). All code is stored on the project's GitHub repository.

3.3. Pilot Study and Deployment Evaluation

Both the pilot study and deployment evaluation of this study used qualitative and quantitative evaluation. The pilot study, including three donor participants, was completed to test the research tools used and ensure all relevant data was being collected (Kallio et al., 2016). The pilot study was also important in providing Milk Matters with confidence that the Donor App would represent them well to their donors. The deployment evaluation followed, using the same methods, with seven donor participants and two staff members.

Approval from the Milk Matters CEO was received before release of the Donor App to deployment evaluation.

3.3.1. User recruitment

Milk Matters selected engaged donors to contact for participation and emailed them directly. The initial email included an introduction to the research and to me, as the researcher. I then contacted interested donors directly to organise a convenient time and location to meet. Three donor participants were recruited for the pilot study and seven donor participants for the deployment evaluation, at which point it was clear that data saturation was attained, as no new ideas were being raised (Marshall, 1996). The number of donors donating to Milk Matters at a time ranges from 30 to 40. Some donors donate once, often donating a stash of frozen breastmilk that they no longer need. Others express extra breastmilk daily for donation, continuing for many months. Most are somewhere in between these two groups and can donate either regularly or sporadically, so it is difficult for Milk Matters to know when a donor has stopped donating. Including ten donors (across the pilot study and deployment evaluation), therefore includes about 25% to 33% of the current Milk Matters donor population.

Milk Matters is a small staff of three, with only two using the Staff App. Both these staff members were included.

Informed consent was obtained from all participants before commencing data collection (Appendix 1).

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[10] Agile Manifesto (2001). https://agilemanifesto.org/. Last accessed: 22 Jan 2024

[11] Flutter is a free and opensource toolkit, developed by Google. It allows for a single codebase, developed in dart, to compile applications for mobile, desktop and web. Available: https://docs.flutter.dev/resources/faq. Last Accessed: 15 January 2024

[12] Firebase. https://firebase.google.com/. Last Accessed: 15 January 2024

3.3.2. Qualitative Evaluation

The qualitative evaluation of this study included work with donor participants and staff, as well as observations made by the researcher relating to project challenges.

3.3.2.1. Donor Participants

A 45–60-minute sensitizing session was organized with each donor participant and used a semi-structured interview (Appendix 2) with open-ended questions. Semi-structured interviews involve a basic question structure to guide discussions relating to the aims of the research (Cridland et al., 2015, Greve et al., 2022, Kallio et al., 2016). Spontaneity, and the ability to ask follow-up questions guided by participants' responses, provides an opportunity for in-depth understanding of participants' unique experiences, perceptions and knowledge (Greve et al., 2022).

The aim of my sessions with donors was to increase awareness about the application, determine user expectations of the application, offer initial installation support and then shift donor participants from awareness to usage of the mobile application. Donors were required to download the application onto their own mobile device and asked to use the application for two weeks. These sessions were done at a location and time convenient to each donor mother, improving the likelihood that donor participants were willing to give of their time to complete the interview (Wardle, 2019). I was available for questions via WhatsApp and email for the duration of the study.

Individual follow-up interviews were performed with donor participants two weeks later. Again, semi-structured interviews were used with open ended questions, allowing for donor participants to provide their own insight into their use of the mobile application, issues encountered and improvement suggestions. Themes from these interviews were analysed using NVivo software. This was done simultaneously to data collection, allowing for ongoing interviews to delve further into topics raised by participants (Greve et al., 2022).

3.3.2.2. Staff users

Training and usage of the Staff App was discussed during weekly volunteering in the Milk Matters office, as well as additional arranged times. This allowed insight into the contextual use of the Staff App post-deployment and observation of any issues that arose. Semi-structured interviews were done with staff four weeks after deployment (Appendix 3). NPO staff have a unique and knowledgeable view of the use of mHealth applications within their context and therefore provide valuable insight into the success and challenges encountered (Greve et al., 2022).

Additionally, challenges I encountered during the initial set-up, development and maintenance of the project are included in answering the question of sustainability.

3.3.3. Quantitative Evaluation

Donor App downloads were measured using App Store Connect[13] and Play Store for iOS and Android devices, respectively. Donor App and Staff App usage was quantitatively measured using Firebase Analytics. While download statistics are helpful to determine the effectiveness of the application promotion strategy, ongoing usage analytics shows whether the application adds value to its users (Greve et al., 2022, White et al., 2016).

All Donor App users were able to consent to or opt-out of usage analytics before logging in to the mobile application. Users were able to change their consent selection at any time. All data was recorded anonymously to ensure privacy of the users. These analytics indicated how often either application was used, which features of the mobile application were used most frequently by donors (or not) and how often content was updated by staff users.

During this time, Milk Matters-initiated communication events, such as emails and social media posts were also tracked. This allowed their possible effect on application downloads and usage to be analysed (White et al., 2016).

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[13] App Store Connect is Apple's platform for managing all Apple application uploads, approvals, sales, downloads and reviews.

3.4.   Positionality Statement

I view my research through the research philosophy of pragmatism (Creswell, 2013), using multiple data collection techniques and focusing on how the research can be applied in a useful manner to real world problems.

I am a woman, a mother to two young children, a registered dietitian and a previous Milk Matters donor. I acknowledge that participants may reasonably assume that I hold a pro-breastfeeding view. While infant feeding choices are a common source of feelings of judgement, I believe that my similar life experiences and friendly manner made me relatable to donor participants, who, by nature of being a breastmilk donor, are themselves invested in the benefits of breastfeeding. Donors spoke freely about parenting and breastfeeding topics, including multiple mothers feeling comfortable enough to breastfeed during our interview sessions. My clinical background also assisted in my volunteer work with Milk Matters as I had a clear understanding of the work they do. Additionally, as an information technology student, married to a software development manager, I view my research through a pro-technology lens.

4. Findings:
Re-launching the Milk Matters Apps

This chapter provides an analysis of the history of previous Milk Matters projects, describes the non-profit organisation's (NPO's) perspective on continuing with the project and details the process required to get the Donor App and Staff App ready for use.

4.1. Analysis of the history of app development

To inform the understanding of the applications as they stand today, I did an analysis of the publications and papers that documented the app development process from 2016 to 2021. This section articulates the history and unpacks the features and architectural decisions as they emerged through different projects.

The initial design of the native Android Donor App (Milk Matters 1.0) in 2016 was described as co-design (Green, 2016, Wardle, 2016). Details of the architecture used for each Donor App version can be found in Appendix 4. This co-design was done with Milk Matters, to ensure it met the organization's requirements, and with the breastmilk donors, to ensure that the end users found it useful and valuable. After an initial meeting with Milk Matters to outline their requirements, a prototyping workshop was held with two donors. Donors were able to give their own proposals for application features and then asked to comment on paper prototypes that had been designed by the students. A survey that was emailed to all donors for comments was completed by 41 donors. These comments were used to create a high-fidelity prototype. Follow-up interviews allowed for additional feedback from the two workshop donors on the high-fidelity prototype. The final application, developed using Java, was then released on the Play Store. The majority of the Donor App's features were introduced in this first production release (Appendix 5), with a variety of anticipated benefits.

The newsfeed on the home screen was intended to increase the sense of communication from Milk Matters to donors. The donation feedback widget, as well as donation graphs, provided tangible feedback on donations

provided by the donor. This was anticipated to motivate the donor to continue donating or to donate increased volumes. The inclusion of education articles was intended to attract new mothers to use the application by providing a reliable information source (Wardle, 2016). Since the depot locator allows donors to find a depot closest to them, it was anticipated that this would make donation more convenient. It was also anticipated that the Become a Donor Quiz would increase the number of donors, as the initial step to becoming a donor was made easier. By making information more available to donors, About Us, Contact Us and FAQs were anticipated to reduce the number of queries Milk Matters needed to respond to, thereby reducing workload. When discussed with Milk Matters, their CEO indicated that they used it for about one year, until depot details were outdated, but they didn't know how much it was being used. Since they couldn't update it, all they needed to do was tell donors about it.

> "It was frustrating to have no idea of the take-up, but it wasn't taking any of our resources. It was just there and we were hoping it was making a difference. We weren't wondering if it was worth our time to do it." – Milk Matters CEO

In 2020, a user centered design approach was used, with co-design elements (Amicis M. de Souza Mendes, 2020), to redesign the application, creating Milk Matters 2.0. Three project phases were used. First, requirements were gathered using a survey and interviews with both Milk Matters donors and staff members. This resulted in a wire-frame prototype of the Staff App and Donor App. Donor mothers and staff members then gave feedback on the Donor App and Staff App, respectively. This feedback was used to develop functional versions of both applications, using the Flutter framework, programmed in Dart. The third phase included evaluation of the functional applications and adjusting according to the feedback received.

Using Flutter allowed the Donor App to be used by donors with either Android or iOS devices, reaching a broader number of donors. The introduction of the Staff App, a web application, allowed for management of dynamic content within the Donor App. A Firebase Realtime database was set up to store the dynamic information, and Firebase authentication was used for user authentication (Serton, 2020). Adding dynamic content management allowed for Milk matters to keep the information in the Donor App updated and use it for communication of news or information. The 2020 version also added the features of declaring a drop-off and using a registered donor's donor number for authentication when accessing sensitive information (Appendix 5). Declaring drop-offs was anticipated to increase communication between Milk Matters and donors, as Milk Matters could immediately respond with a "Thank You" email. It was also anticipated that this would save Milk Matters time, as they would no longer need to phone depots to check if there was donor milk awaiting collection. Adding donor number authentication increased security, as only registered donors were able to access those features and Milk Matters then had control, via the Staff App, over the donor's continued access (Amicis M. de Souza Mendes, 2020, Bossi, 2020, Serton, 2020).

In 2021, the development of both the Donor App and Staff App continued (Milk Matters 3.0), using Flutter v2.0.0 and the same Firebase services. This project performed cognitive walkthrough interviews with four Milk Matters donors, conducted heuristic evaluations with three postgraduate students and the project supervisor and then co-designed adjustments to the applications, based on the feedback received (Lobola, 2021). The introduction screens of the Donor App, before log-in and before the Become a Donor pre-screening questionnaire, were added to give donors a better understanding of the application and donation process before beginning to use it (Lobola, 2021).

According to Milk Matters, students promised further work on the application to get it ready for public deployment, but due to multiple reasons this did not happen.

4.2.   NPO staff member's perspective on project continuation

As described above, at the onset of my research, considerable effort had already been given to the cross-platform mobile application, with no deployable outcome. To continue the project, Milk Matters first needed to agree to be project partners again, which they excitedly did.

When asked why she agreed, the Milk Matters CEO described her belief in the potential of the project to improve their relationship with their donors, but also that the effort the NPO puts into the project cannot continue indefinitely, without a usable outcome.

> *"I agreed because I believed so strongly that we could get it to the point where we could use it and have improved communication with the mothers…to give them more feedback and keep them donating…We got so close that it seemed like a waste of all the effort to not follow through. It will make a big difference if we can get them to use it…If year after year we got to the point where it's almost ready, at some point I've got to call it a day, because I'm giving a lot of effort. It was frustrating how close it got every year." – Milk Matters CEO*

> *"Two things we were aiming for. To have donors feel more appreciated and to have them inspired and encouraged so that they'd donate for longer." – Milk Matters CEO*

The potential of Milk Matters' effort to help other milk banks is another motivating factor.

> *"I also think that other milk banks might be able to benefit as well." – Milk Matters CEO*

Furthermore, there is a feeling of responsibility towards the university, and the project supervisor in particular, for the continued effort that she has given to the project.

> *"I do feel responsibility to carry through with things, to [the project supervisor]. She stood with us through it all. To the amount of effort that the university has put in, but [the project supervisor] as a person who has driven it. I don't want everybody's work to be wasted. It was a dream to have this. We're proud to be associated with UCT." – Milk Matters CEO*

This responsibility would, however, not affect her decision to continue working on the app if it is no longer viable, as displayed by her previous decision to not incorporate the chatroom app, despite considerable work by Wardle (2019).

> *"Responsibility wouldn't affect the decision to continue working on the app…I wouldn't go ahead purely out of obligation." – Milk Matters CEO*

As an NPO, Milk Matters receives frequent requests from other student groups wanting to run projects with them. She tries to assist where they can but needs to be selective due to their limited resources.

> *"Other students come with other projects. I try give them help, but I can't always justify giving them the time. They are taking more than giving." – Milk Matters CEO*

She understands that co-design requires input from her too. When comparing to other work done for them, she can see the benefit in being involved in the design, as well as having students spending time within the milk bank context before doing project development.

> *"I have to put in, if I expect to get out. It is a co-design. If we don't pull our weight, I can't expect students to keep doing things for us" – Milk Matters CEO*

> *"[Other project developers] didn't listen, so what I said wouldn't work doesn't work. [The project supervisor]was very strongly of the opinion that students needed to spend time here, which made a big difference. They got it and were able to bring in ideas and things in the app that have made it where it is. Students who didn't [spend time here] were not able to put that in… I don't think we would've got to where we were without an understanding of the nuance." – Milk Matters CEO*

4.3. Development

This section discusses the process and challenges to get the Donor App and the Staff App up and running again at the commencement of this project. The main goal was not to add new features, but to get the apps working well and deployed so that donors and staff could begin using them. In the process of testing and through interviews with Milk Matters staff, minor changes and improvements were implemented.

4.3.1. Initial development set-up

The codebase for both applications was obtained from the 2021 Milk Matters 3.0 project website[14]. No version control was included, meaning that there was no guarantee that it was the most recent version of the code.

Since development work on the Flutter version of both Milk Matters applications has been done in batches, according to limited university project timelines over the last four years, with significant times of no development, the Flutter version and many of the apps' dependencies were significantly out of date. This resulted in apps that were difficult to update. I used Flutter v3.3.0 to begin development of this phase, as it was the latest stable version at the time. Since the previous project had been done using Flutter v2.0.0, before I was able to build either application successfully multiple libraries required updating including, amongst others, firebase_core, firebase_analytics, url_launcher and location. Oftentimes a required library update resulted in further knock-on library updates being required. Additionally, some of these updates included breaking changes, requiring the use of the library's documentation and appropriate code adjustments. One library included in the Donor App was no longer available from GitHub and needed to be replaced with an alternative. The Gradle version also needed to be updated for the Android version of the Donor App.

Since the Milk Matters project is a continuation of previous work, I anticipated contact with previous postgraduate students who worked on the project to be beneficial. Unfortunately, making contact was challenging. While they were still students, they used their university accounts to communicate with the project supervisor. Once these students were no longer registered with the university, their accounts were deactivated. Other methods of contact such as LinkedIn and Facebook were used to make contact.

Once a previous student involved in 2021 was reached, she mentioned that she thought she'd done additional work on the Staff App that wasn't included in the codebase on their project website. By the time this contact was made it was unfortunately too late to work off the more recent previous codebase as significant work had already been done to the applications to get them to the point where they were able to build.

4.3.1.1. Continuity of access

With the initial redesign of the applications in 2020, the students chose Google Firebase to host the application and its database. The Firebase project was set up using the Google workspace accounts associated with their university accounts. In 2021, access was transferred to the next project members' university accounts, before the 2020 project's members university accounts were deactivated. No postgraduate students continued the project in 2022. By 2023, all previous students' university accounts were deactivated, preventing me from gaining access to the Firebase project associated with the Milk Matters project. Together with previous students, we attempted to recover access to their accounts through both the university's IT staff as well as with Google Firebase support. This was unsuccessful and resulted in significant delays. Consequently, I needed to recreate all Firebase database and project settings in a new Firebase project and connect this to the existing Flutter projects for the applications. All data stored within the previous database was lost and needed to be repopulated in the new database.

Additionally, the app signing keys needed for the Donor App were not available to me for either iOS or Android. This meant the testing track versions from 2021 could not be updated to the current version, but rather I had to create new application listings.

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[14] Milk Matters 3.0. https://projects.cs.uct.ac.za/honsproj/cgi-bin/view/2021/lobola_vilane.zip/. Last Accessed: 16 Oct 2023

4.3.2. Donor App development for pilot study readiness

Once I had completed the upgrades required to get the application to build, bug fixing and further minor development was done. Frequent meetings were held with Milk Matters staff to discuss any changes made and further changes required.

The most significant change I made to the Donor App was to the navigation. Initially navigation consisted of a bottom navigation bar with three menu items and a menu icon in the top left (Figure 13) that opened a left navigation drawer menu with further menu options (Figure 14). Depending on the navigation route the top left menu icon was sometimes replaced with a back arrow. This menu structure was seen as "disjointed and confusing" by Milk Matters.
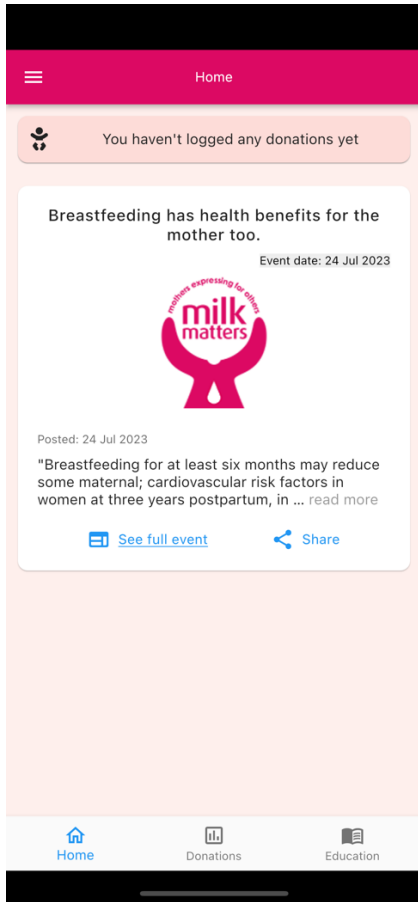
Figure 13: Initial home screen navigation and menu button
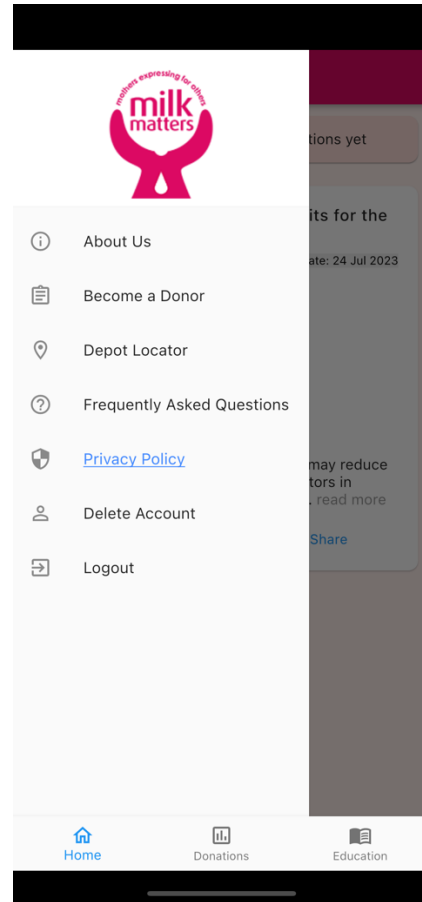
Figure 14: Initial left navigation drawer menu

To improve this, the top left menu icon was removed and replaced by a "More" menu added to the bottom right of the bottom navigation bar (Figure 15). "Depots" was also added to the bottom navigation bar, as it was deemed to be of greater importance than the rest of the features listed in the "More" menu (Figure 16). Any selection made from the "More" menu will result in a back arrow in the top left corner (Figure 17), but main navigation selections are all made from the bottom navigation bar.
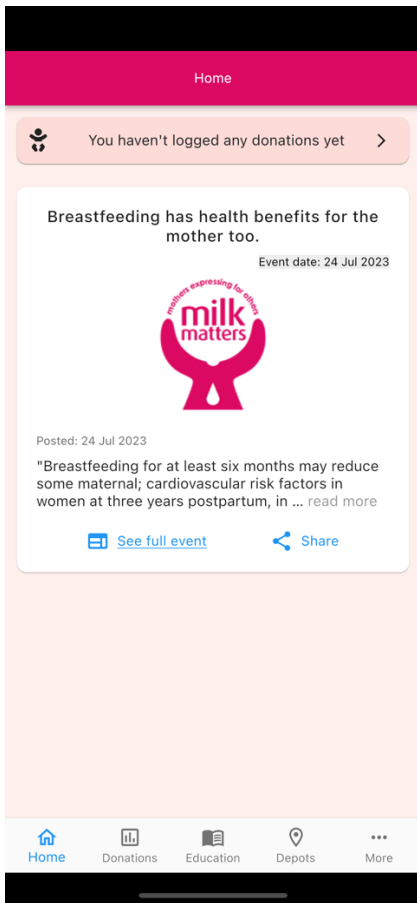
Figure 15: Home screen navigation ready for pilot study
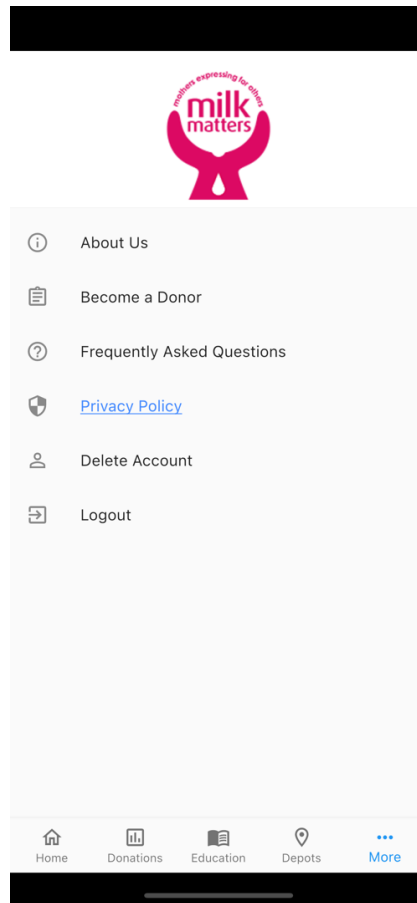
Figure 16: More menu
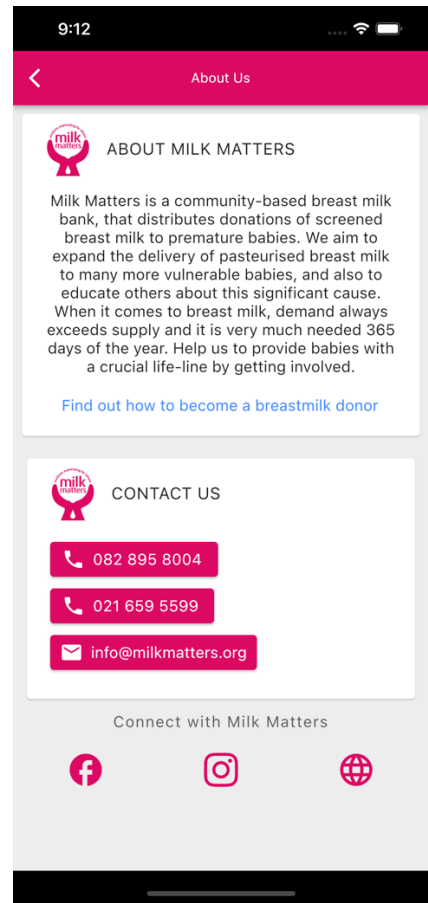
Figure 17: About Us screen navigated to from More menu

One of Milk Matters' goals for the Donor App was to increase communication with their donors. The Donor App was intended to provide two opportunities for auto-generated emails to be sent from users to Milk Matters. One is the pre-screening questionnaire and the other is when a donor declares a donation drop-off. Initially, the drop-off declaration email was not being generated, so this was corrected. The generated email now includes donor name, donor number, depot name, amount dropped off, date declared and a space for any additional details the donor would like to include. The email is generated in the device's default email client and donors are then required to press send themselves. This gives them the opportunity to use the additional details feature.

Multiple cosmetic changes were made to the Donor App. One included adding a right arrow to the Donation Feedback widget displayed at the top of the Home screen and Donation Tracking screen. This improves the affordance of the widget as it makes it clearer that the widget takes you to another screen to display the donation tracking graphs. The change can be seen from Figure 13 to Figure 15.

To comply with Android and iOS requirements a "Delete Account request" screen was added to the More menu of the Donor App. This requires users to enter and confirm their log in details before requesting that their account is deleted. Their user registration details are then automatically deleted from the Firebase database.

Analytics events, tracked by Firebase Analytics, were added to the Donor App. These track usage of all major features and screens. Respect of consent for or against analytics tracking was also introduced. Users who choose not to consent to tracking of their usage analytics can continue to use the app. This consent can be changed at any point by logging out of the app and back in. No personal data is collected.

Wording changes were made to the pre-screening questionnaire and app introduction screens. A simple bottle labelling reminder was also added to the donation tracking screen.

4.3.3. Staff App development for pilot study readiness

Multiple minor changes were made to the Staff App. These included adding analytics events, updating hint texts on the forms, improving incorrect login details feedback, adding allowance for multiline FAQs, updating database rules and fixing an existing error that left the staff list blank in Account Management.

The way in which the latitude and longitude co-ordinates of the depots are recorded was also updated. The previous versions accepted the location in address format, however the conversion to co-ordinates was unreliable, resulting in incorrect pins on the depot locator map, and very slow for mobile users. The current version requires co-ordinate values to be recorded, which can easily be obtained from Google Maps. Instructions are included in the Staff App interface. While this is an extra step for the staff loading the depot details, it is reliable. Future work should include adding a Google Maps API for direct depot location addition.

4.4. Challenges in beginning deployment evaluation

Once the Donor App was approved for deployment by the Milk Matters CEO, it was submitted to both the Play Store and the App Store on 27 September 2023. The Android version was approved and made available in the Play Store within hours. The iOS version was initially rejected by the App Store due to "Unacceptable Business Model Issues". This rule relates to the collection of charitable donations, specified in the App Store Review Guidelines[15] as "collecting funds within the app for charities and fundraisers". I appealed this ruling since the Donor App does not allow for any monetary donations, only the tracking of breastmilk in storage for donation, which is donated independently to the app. It took eight weeks for the app to be re-reviewed and approved, being made available in the App Store on 22 November 2023, without any changes required. This led to significant iOS deployment evaluation delays.

4.5. Chapter Summary

The University of Cape Town (UCT) and Milk Matters have worked together on the Milk Matters Donor App for multiple years, going through numerous iterations of design. This process has highlighted challenges that exist when a university initiates mobile app development for a low resourced NPO. These challenges include the short timeframe of university projects, poor continuity of access to associated accounts and source code when a project is passed on from one group of students to another group, a mismatch between the students' project goals or deliverables and the goals of the NPO and little to no ongoing maintenance of software, as student have completed their projects and moved on. Despite considerable input from Milk Matters, they were twice left with a mobile application that was not yet ready to be released to the public, even though university students were successfully able to complete their projects goals. Regardless, Milk Matters was excited to continue the work with UCT as they had already given significant effort to its development, and they saw the potential benefit of the Donor App to not only them, but also other milk banks.

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[15] App Store Review Guidelines. https://developer.apple.com/app-store/review/guidelines/#business. Last Accessed: 23 November 2023

5. Findings:
Using the Milk Matters Apps

This chapter describes the findings of the pilot study and deployment evaluation that I conducted on Version 4.0 of the Milk Matters Donors App and the updated Staff App. This includes targeted interviews with Milk Matters donors, usage analytics of the apps and details on the changes made in between the pilot and deployment phases.

The pilot study included three donors as participants, who all used Android devices. No iOS users were included simply because of the donors who were assigned by Milk Matters. The pilot study began on 7 August 2023 and, due to logistical struggles with meeting with one participant, ran until 19 September 2023. These participants were encouraged to continue using the Donor App.

The deployment evaluation included seven donors as participants, where data saturation was reached. Three participants used iOS devices, three used Android devices and one used both. Android deployment evaluation began with interview participants on 25 October 2023. Due to delayed App Store approval for the Donor App, iOS deployment evaluation began on 23 November 2023. All interviews were completed by 14 December 2023.

The Donor App was publicly announced by Milk Matters on 30 November 2023 via their Instagram and Facebook accounts. An email was also sent to all recent donors, including details of the Donor App and a link to the app's webpage. I set up this page on the Milk Matters website[16], with basic app details and both app store links, for easy app marketing. Milk Matters promoted the app again in Instagram Stories on 2 December 2023 and across both social media platforms on 28 December 2023. Analytics data from announcement until 10 January 2024 (six weeks later) included both interview participants and other donors who chose to download it.

Throughout this section donor participants are referred to as "P", followed by their sequential number. P1 – P3 took part in the pilot study, while P4 – P10 took part in the deployment evaluation. Comments that could be interpreted as negative feedback towards Milk Matters have been labeled "Anonymous". This is to prevent Milk Matters from being able to link the comments to other identifiable comments made by specific participants.

Two Milk Matters staff members were included in evaluation of the Staff App. These staff had also downloaded the Donor App.

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[16] www.milkmatters.org/app. Last Accessed: 18 Dec 2023

5.1.   Pilot Study vs. Deployment Evaluation

Based on feedback from the pilot study, changes were made to wording and layout within the Donor app before the deployment evaluation. Wording was changed on the home screen to simplify the screen and send a more positive message to first time users. The layout of the donation tracking screen was changed to improve usability. These changes are described in detail later in this chapter. Apart from these changes, the rest of the pilot study feedback was similar to the feedback from the deployment evaluation, so findings from the two studies are reported together. All quotes are labelled with either "Pilot" or "Deployment".

5.2.   Initial Interview Findings

This section details the findings of the initial interviews done with participants, before they had downloaded or used the Donor App. These interviews provided context for donors' reasons for donating breastmilk and provided an understanding of donors' satisfaction with communication received from Milk Matters, prior to use of the Donor App. Additionally, they gave the opportunity to investigate what donors expected from an app from Milk Matters.

5.2.1.   Donors' reasons for donating

All participants chose to donate for altruistic reasons, being willing to put in the effort of expressing breastmilk, sterilizing pumps and dropping off donations to help vulnerable infants.

> *"I had milk in the fridge and didn't want to waste it. I know that there's a baby that needs it now…I can make a difference" – P6, Deployment*

P8, who has donated with two separate babies, donated after her first child was born prematurely and spent time in NICU. While he did not need donor milk, she saw the importance of breastmilk for the other infants. Now, with her second child she is inspired to donate by the memory of two people who passed away while she was pregnant. She has a defined, time-related goal to donate for one year. (See Appendix 8 for detailed quotations)

Both P4 and P5 have donated breastmilk privately, via peer-to-peer donation, while still donating to Milk Matters. For both participants, they saw a specific need from either a friend, colleague or a member of a mutual Facebook Group and decided that they could meet that need, for no reimbursement. P5, did, however, raise concerns about donating directly to a recipient who you have a personal relationship with.

> *"Donating privately can lead to an emotional attachment, which is not always good…I feel responsible for that baby" – P5, Deployment*

For P4, this was not a concern, as the donation was given to a mother who she had no personal relationship with but had just seen her request on Facebook.

While the main reason for donating is to help babies in need, the idea of incentives to maintain motivation was raised. P2 suggested small baby related incentives, such as nappies or a toy when donors reach certain milestones would help to feel more appreciated.

> *"You're incentivized in some sort of way to keep going. Acknowledged… I dropped off that, I got this in exchange. How cool is that? My baby's benefiting from sharing this." – P2, Pilot*

Milk Matters expressed that they have tried to design a way to use incentives, but it is challenging to find a way that shows appreciation, without putting value on one mother's donation over another's.

> "The effort and commitment put in by mothers varies for the same volume…That's why we hope that moms are going to use the app so that when they declare we can send them a personalised, immediate response. It's difficult to know how to acknowledge the donors because what do you base it on. Some may give less contribution because it's more difficult for them, but they're putting in more effort." – Milk Matters

5.2.2. Communication with Milk Matters

The Donor App aims to directly increase communication by automatically generating emails from users when they declare a donation drop-off or when they complete the pre-screening questionnaire. The "About Us" screen also includes contact information that automatically launches an email or a call.

5.2.2.1. Donors' initial communication satisfaction

At the start of the pilot study, two participants felt that additional communication from Milk Matters would be appreciated. They received communication initially about donor registration, but following that, it was largely limited to communication initiated by the donor or if Milk Matters needed to inform the donor that they needed to repeat their blood test.

All participants of the deployment evaluation felt that there was sufficient communication with Milk Matters around initial logistical issues. As in the pilot study, once registered as a donor, communication was initiated by donors, but Milk Matters "responds quickly". Apart from the initial formalities of registering, the majority of participants use WhatsApp or phone calls for ongoing contact with Milk Matters.

The general desire from participants, however, was for more feedback that their donations had been received. The fact that the Milk Matters model uses depot drop-offs, where the donation is handed over to depot staff who are not directly related to Milk Matters, left participants wondering whether their donation had been collected by Milk Matters, whether it was usable (correctly frozen, no microbial growth and no medication concerns) and whether it had actually been used by the infants who need it. This acknowledgement was seen as a way to keep motivated to continue donating.

> "A 'Thank you, we have received your milk' would be nice and feedback if it is not able to be used…Then I can be rest assured that everything is fine." – P6, Deployment

> "And I'm sort of wondering has my milk reached the babies yet? Like, have the people who needed it to be helped, actually even got it yet. So, I think that's the level of communication that would give me peace of mind. It just makes a big difference to motivation, and sort of knowing that you're putting all this time in to express and to make sure over and above what your baby needs, you're helping others and just that it is sort of acknowledged. But I'm scared that it's been forgotten in the fridge, at some physio or whatever. And who knows when it will get to the babies to help or within the expiry date." – P2, Pilot

Additionally, resource limitations mean collections are not always frequent and Milk Matters sometimes don't know who dropped off a donation until they collect it a few weeks later, by which point they feel uncomfortable sending a direct thank you.

> "Thank you becomes awkward when the donations have sat there a few weeks before you collect and you didn't know who the donor was. We don't have resources to go to every depot every time, but that comes with challenges of immediate acknowledgement. That's where the app will make a huge difference, if only the mothers will use it." – Milk Matters

On the contrary, donors who drop off at a Milk Matters staff member's house felt that there was sufficient communication, as they received acknowledgment directly each time.

> *"No, it's sufficient. I just wanna drop off. I don't mind not hearing from them…It's kind of like there's a face to Milk Matters. It kind of feels like a relationship…but I guess there's now nothing to compare to because I haven't been to a depot yet." – P3, Pilot*

Without prompting, multiple participants mentioned that they felt that social media content was aimed at promoting breastmilk donation, and therefore targeted those who were not yet donors. Since participants in this study were already donors, the content didn't always appeal to them and felt repetitive.

> *"As a donor, content isn't relevant. I feel like I might not be the right market. If you're already donating, you already know the stuff that's being put up there." – Anonymous*

Participants suggested including more recipient testimonials, interesting facts about breastmilk (unrelated to donation), details of how many donors Milk Matters has, the hospitals that donor milk is supplied to and specifics of the behind-the-scenes processing at Milk Matters (e.g. pasteurization). They felt that an increased understanding of the workings of Milk Matters, would motivate them to donate more milk or to donate for longer.

> *"Maybe [knowing more behind-the-scenes] would motivate me to donate for longer. It becomes more personal." – Anonymous*

> *"Knowing there may only be 30-40 donors at a time makes me want to keep going, knowing it's needed." – Anonymous, thinking there are many more other donors involved*

This feedback was helpful for Milk Matters and confirmed a new content strategy for the upcoming year, including more posts aimed at current donors. While they do see the main target of social media posts to be potential new donors, posts are intended to also motivate current donors to continue donating.

5.2.3. Expectations of the Donor App

Before seeing the Donor App, participants were asked what their expectations of the application were. Expectations included some features that are part of the current app design and some features that are not currently included.

Included features were donation tracking, educational content (particularly on milk expression), depot location, messaging Milk Matters (currently via email only) and informing Milk Matters that a donation had been dropped off.

Features not currently directly included in the application are the ability to add notes to donations regarding allergens consumed or medications taken, to answer the drop-off questions in the app when declaring a drop-off, an "open now" search option for depots, a way to sign out new donor bottles at depots, receiving a reminder when the next blood test is due, a record of their donor number and a form of chatroom for communication with other donors.

5.3. Donor App Uptake

At the end of the initial interview, participants were requested to download the Donor App and make use of it for two weeks. This section details the download statistics of the Donor App.

During the pilot study (7 August 2023 – 19 September 2023), three interview participants and one Milk Matters staff member downloaded the Donor App, all on Android. From 25 October 2023 – 29 November 2024, seven interview participants were then onboarded for the deployment evaluation, prior to the public launch, as the apps became available in their respective app stores (Figure 18). From the public launch (30 November 2023) onwards statistics include both interview participants and donors from the general public who downloaded it themselves. There were a total of 22 Android downloads and 17 iOS downloads during the full deployment evaluation (25 October 2023 – 10 January 2024). Including the pilot study, the total number of downloads was 43; 26 from Android and 17 from iOS. The Firebase database, however, shows that there were 29 registered users. This discrepancy could be from potential users downloading the app but not following through to register a user account, the same user downloading on multiple devices or from bot activity on the app stores.
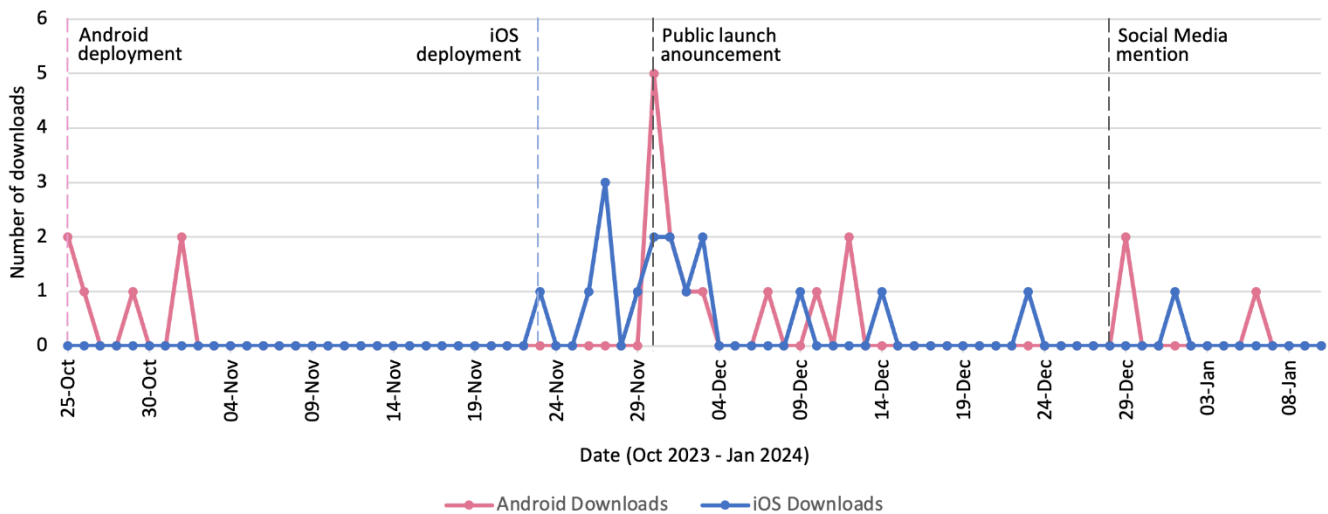
Figure 18: Daily Donor App Downloads to Android and iOS Devices During the Deployment Evaluation

Using a 30-day rolling average of the active Android installed users, on 10 January 2024, 11% of Android users were using Android 14, 53% were using Android 13, 15% were using Android 11 and 21% were using Android 10. iOS version data was not available as it is shared by opt-in only and there were insufficient users who opted in.

Figure 19 shows the daily users of the Donor App during the deployment evaluation. Increased usage can be seen immediately after the public launch announcement on 30 November 2024; however, use has continued without further researcher intervention. Since the public launch, the Donor App has been used by an average of 2.5 users per day.
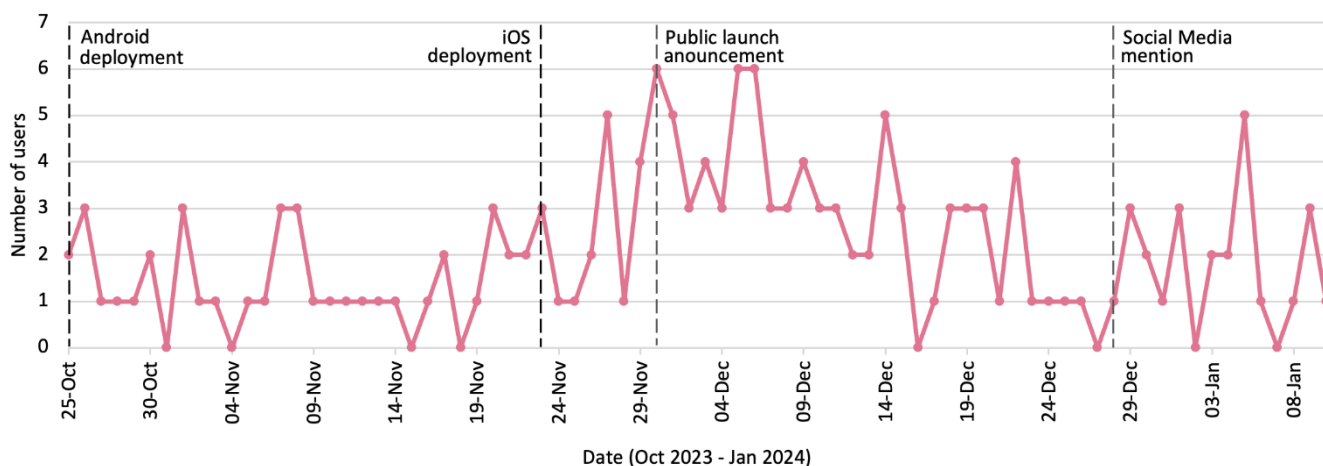
Figure 19: Daily Donor App Users During the Deployment Evaluation

5.4. Follow-up Interview Findings

Two weeks after the initial interview and Donor App download, a second interview was performed with each participant. This interview provided insight into how they had used the Donor App and if it currently had any influence on their motivation to donate. Throughout this section I will interleave the reporting of the quantitative data of the application usage from all the users, both interview participants and general donors, with the qualitative data from the subset of users that we interviewed for the pilot study and deployment evaluation.

5.4.1. Home screen feedback

In the pilot study, both P1 and P2 specifically liked having the widget on the home and donation tracking screens, that gives positive feedback on how many babies their milk has fed. However, historical data, of breastmilk already donated to Milk Matters by a donor, is not included in the app. Capturing of breastmilk volumes in the Milk Expression Log is the responsibility of the donor and is not linked to the official tracking of volumes done by Milk Matters when donations are received. For pilot study participants, when first opening the app, the message displayed in the widget read "You haven't logged any donations yet" (Figure 20). This led to disappointment for P2 and concern that previously donated breastmilk was lost.

> *"So, because now I'm looking at this I'm like 'Ah, but you guys don't know about the six liters, that I gave a few weeks ago'" – P2, Pilot*

This wording was therefore updated to "Tap the Donations tab to begin tracking donations" before the deployment evaluation, with the intention of leading them towards action, rather than highlighting the negative aspect of having not yet recorded any donations (Figure 20A). The same widget on the Donation Tracking screen was also updated, to "Use 'Add to log' to add your first donation" (Figure 21A).
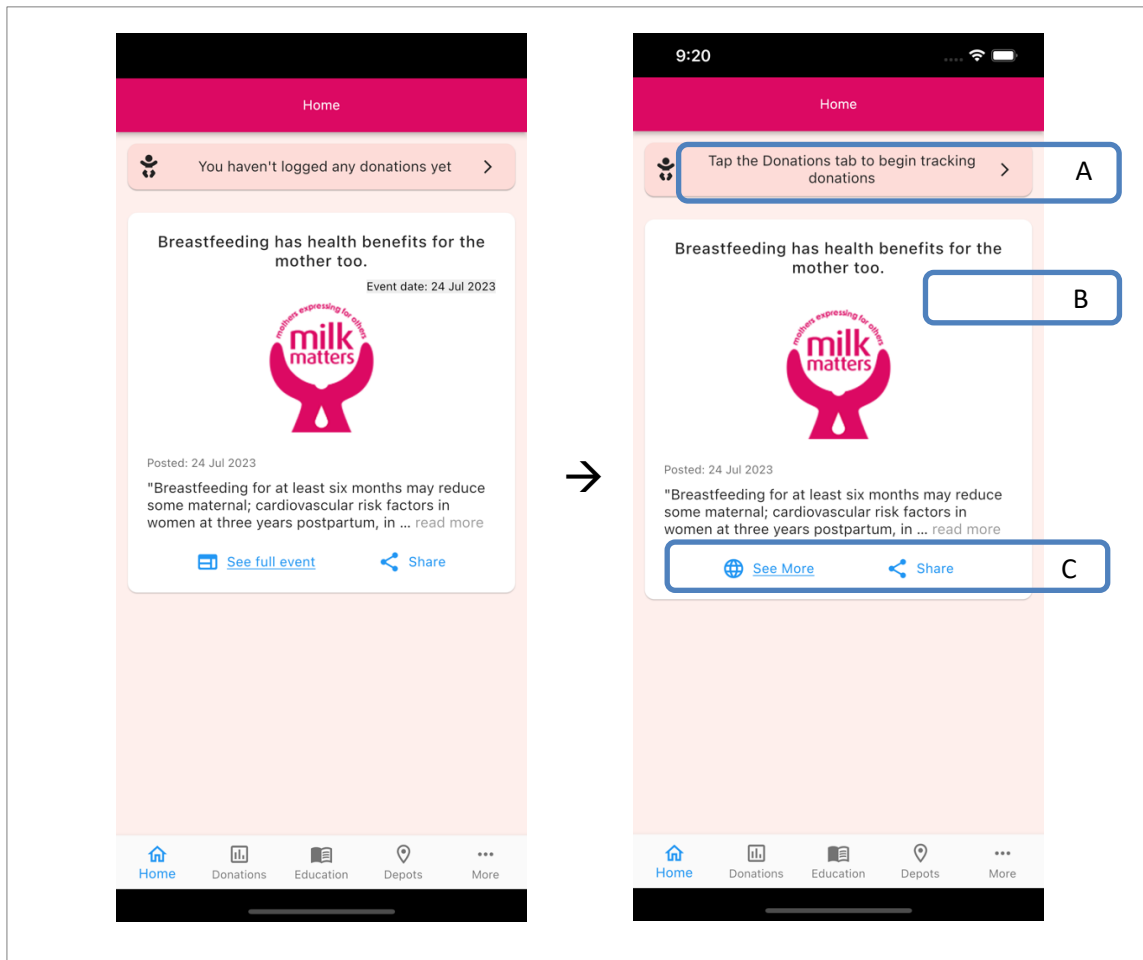
Figure 20: Changes made to Home screen after pilot study

In the deployment evaluation, no participants commented directly on the adjusted text in the donation feedback widget on the home screen page when opening the app for the first time. When loosely prompted about feelings towards it, the desire to see historical data was also raised.

The use of the home screen to provide information in the "News and Events" feed was well received, however some refinement was suggested. Having an event date was leading participants to think the "event" was over, but it wasn't an event in the first place. For this reason, the "event date" was removed after the pilot study, leaving just the "Posted" date and "See full event" text was changed to "See more" (Figure 20B &C).

Pilot study participants conveyed that quick snippets of information or reminders would be preferred, or testimonials from recipient mothers, rather than full articles, as they may not click through to read a full article.

> *"It would be lovely to read feel good stories of real babies or moms that have benefitted from the milk, obviously changing names for confidentiality purposes. Just an idea though as it makes it real and it's a feel-good read" – P2, Pilot*

This sentiment was confirmed by the usage analytics, as the "See More" option was only selected from a home screen snippet three times throughout the subsequent deployment evaluation.

P2 highlighted the importance of using varied graphics on the home screen "News and Events" snippets to quickly capture the user's attention, highlighting that there is something new.

5.4.2. Donation Tracking and Declare Drop-Off Feedback

The Donations screen was the screen most navigated to during the pilot study. It was selected 39 times, three times the navigation selects of the second most viewed screen, Education, with 13 selections (Appendix 6). In the deployment evaluation, the Donations screen was viewed 148 times, more than double the selects of the second most viewed screen, Depots, with 61 selects.

Recording a donation was the most used feature of the application, used 25 times by two users in the pilot study and 136 times by 18 users in the deployment evaluation.

5.4.2.1. Usability changes made from pilot study

During the initial session, pilot study participants found the Donations screen confusing, not being sure whether they should click on "Declare Drop-Off" or the "+" button first (Figure 21). Design changes were therefore needed before continuing to the deployment evaluation.
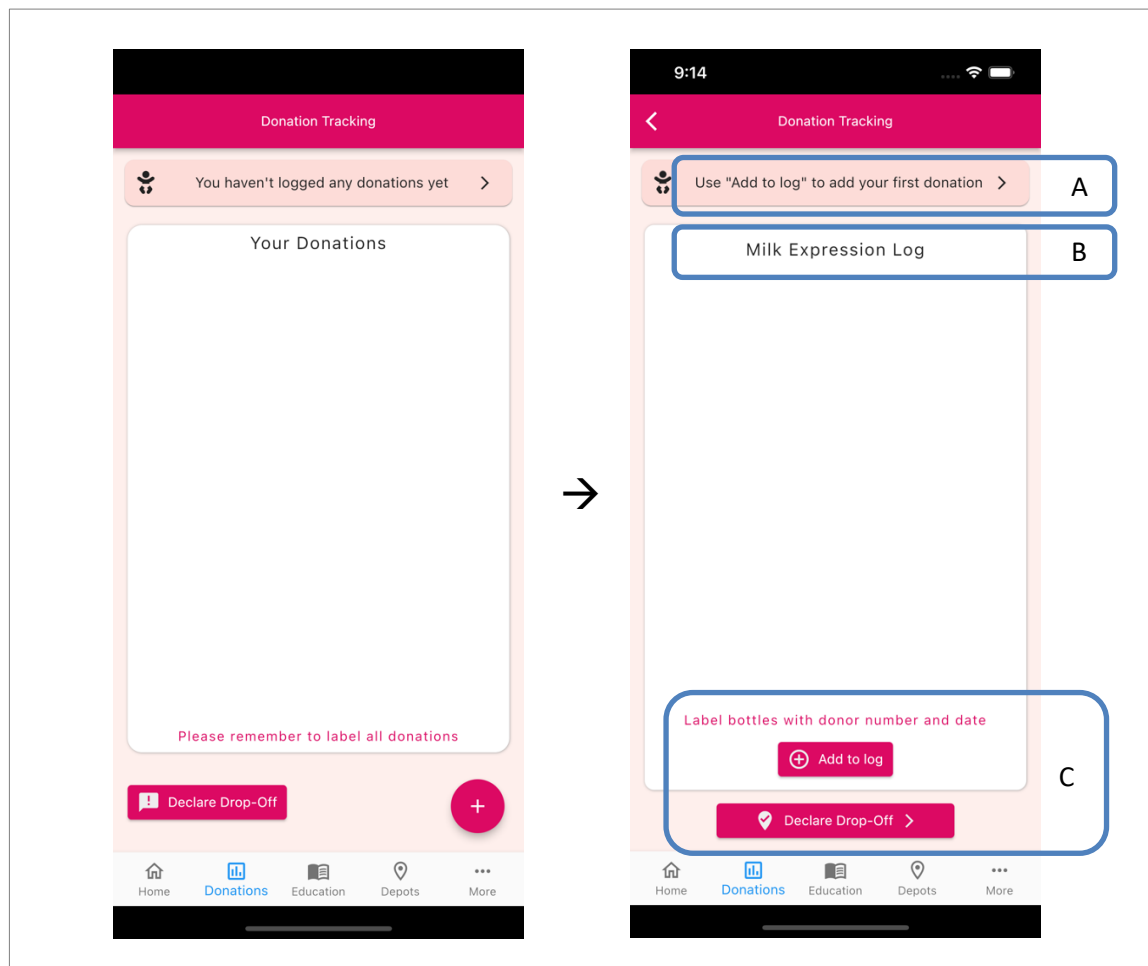
Figure 21: Changes made to Donation Tracking screen after pilot study

The log heading, "Your Donations", confused participants as they thought this was intended to be used for the total volume of each donation drop-off. While this is acceptable use of the app, the initial design intention was that donors could keep track of the donation volumes for each time they expressed breastmilk for donation. It was also confusing as to whether they captured their donations or if Milk Matters did. The heading was therefore changed to "Milk Expression Log" (Figure 21B).

The "+" button was moved to inside the visual black of the log, making it more obvious that it is the log that is being added to (Figure 21C). The text "Add to log" was also added to the button for more clarity. While the

Gutenberg Principle encourages the most used button to be at the bottom of the mobile screen (Tseng, 2019), the design of this screen followed the donation flow from the top to the bottom of the screen. First the donor will express breastmilk, label it and add it to the log. Then once they are ready to drop off their full donation, they will use the "Declare Drop-Off" button.

The icon on the "Declare Drop-off" button was also adjusted to better match the icon of "Depots" and a right arrow was added to indicate that the button takes you to the "Declare Drop-off" screen, rather than being the end of the declaration process (Figure 21C).

During the deployment evaluation, no donors expressed confusion as to how to use the updated design of the new "Milk expression log".

5.4.2.2. Donation tracker: Motivation through feedback

The donation tracker was well received by all participants, except one. P4 was particularly happy to have a donation tracker to track her total donations, as she has set herself a measurable goal of donating at least 100 liters of breastmilk. Using the tracker means she does not have to remember the total volume herself. After using the Donor App, she had set herself another shorter-term goal to donate two years' worth of feeds (730 days' worth of 50ml feeds, or 36.5 liters, on the donation feedback widget), motivating her to keep donating.

> *"I like setting goals. It keeps me motivated" – P4, Deployment*
>
> *"I like to connect and see progress, to see how far I've come. It will make me feel good." – P6, Deployment*

Additionally, for some donors who were not tracking their volumes before using the Donor App, the tracking feature created a positive visual of how much they were donating. For P9, seeing the visual of the total donated volume increasing was a motivator to donate at times when she would otherwise not have donated. While not motivating her to donate for longer, this still results in an increased total donation amount.

> *"I wasn't doing that [tracking] before, but now I can see how much I've donated...It makes it more exciting to see the volume grow...If there's a day I feel particularly tired and I'm not going to express, instead I think I should. The app plays on your mind, it gives a visual. It's more tangible. It makes you realise that every bit adds up." – P9, Deployment*

On the contrary, P8 felt that tracking her donations felt like extra work. Her donations are done as a bulk drop-off when the freezer is getting full of breastmilk that her child has not needed. She does not deliberately express to donate.

> *"It sounds like a lot of work, Which I would not do. I don't know what I drop off. I would not choose to catalogue what I've done. I email them directly when I drop off already and that feels like less effort. I like that and they always respond straight away." – P8, Deployment*
>
> *"It feels like pressure to perform. If it was a requirement, I would not use it. I would either not donate or just donate without tracking and hope for the best." – P8, Deployment*

P4 specified, however, that donation records need to be editable. For one donation she accidentally recorded the wrong volume but could not adjust it. This could lead to frustration with inaccurate data on the donation feedback widget, a widget supposed to motivate donors.

Multiple participants felt that the donation tracker was missing the ability to add a note to a specific donation record, such as medication taken. They suggested that the notes attached to a specific donation pull through to the generated declaration email with the date of the donation.

5.4.2.3. Declare drop-off: Motivation through communication and appreciation

The "Declare Drop-Off" feature was used four times during the pilot study, by two users (Appendix 6) and 17 times by 9 users in the deployment evaluation. The frequency with which donors drop off a donation varies widely

between donors as some donors express for donation almost daily, some express for donation ad-hoc, while others donate their additional breastmilk stash before it reaches its expiry date.

The Milk Matters staff were incredibly excited when they received the first drop-off declaration email. They immediately understood and appreciated the benefits of being able to thank the donor personally and timeously, as well as having an increased awareness of where collections were required, without having to contact the depot themselves.

> *"This is going to make such a big difference to us, and I think to the donors too. Getting the email from the mother means we can quickly and easily reply to her, thanking her and making her know how much we appreciate her donation of milk." – Milk Matters*

> *"When the donors send the declaration email, that is very nice. That decreased my workload… It's nice to stay in contact, otherwise there's no interaction between us." – Milk Matters*

Participants who used the declare drop-off feature appreciated the opportunity to easily communicate extra information related to their donation within the email. Replies from Milk Matters significantly improved their satisfaction with the level of communication received from Milk Matters and left them feeling appreciated, included in the process and reassured that their donation was being handled.

> *"The emails I've gotten after drop off have been so special, so like noticeably different, so that's great…it makes you feel like you've been seen. Your drop off hasn't just been left at a physio." – P2, Pilot*

> *"Declare drop-off was brilliant. I got a reply within a few minutes…I felt more reassured. It felt more personal, like someone's keeping track. It felt lost before, a weird silence." – P9, Deployment*

There are, however, different perspectives on use of the feature. The benefit of increased direct communication was not experienced by participants who did not declare any drop-offs. P5, who actively tracked her donations in the Donor App, dropped off one donation during the interview time, but did not send the declaration email. She felt that she did not need the confirmation from Milk Matters that they'd received her donation. Her tracked total also included some previously donated volumes that she didn't want to declare. For P5, her milk supply is so great, that it's a relief to be able to give it away. On the contrary, P6, would have liked to use the feature, but did not do a drop-off during the interview time.

Regardless of drop-off declarations, the presence of the app itself, and the content that the app provides, has the potential to provide donors with a feeling of being more connected to Milk Matters.

> *"I haven't gotten additional communication, but because the app is available and there is so much information there, I didn't feel like I needed more communication." – P7, Deployment*

Milk Matters, however, relies on receiving the emails to be able to increase direct personal communication via the Donor App. Three weeks after the public announcement the Milk Matters CEO expressed disappointment at the amount of engagement that they had received from the application. She was however encouraged to see the usage analytics of all the other features.

> *I'm hoping it will bring in the personal relationship, but they need to send the email for that." – Milk Matters CEO*

When donors drop off their donation at a depot, they are required to fill in a form including the date range that milk was expressed in, any medications taken during that time and any interruptions to freezing. During the deployment evaluation, Milk Matters proposed future work integrates the fields from the paper form into the generated text of the drop-off declaration email. This allows mothers to manually add the information to the email's text rather than filling in the paper form. In discussion with P4 & P5, it was suggested that, when declaring the drop-off, check boxes in a pop-up could allow for completing the form's information.

Additionally, P4 felt there was not enough contrast between donations that were awaiting drop-off and those that had been declared. She suggested either a filter based on drop-off status or that those already declared as dropped-off are greyed out.

5.4.2.4. Usage patterns of feature

While multiple participants used the application actively, they used the Donation Tracking and Declare Drop-off features in different ways. Some captured each time that they expressed breastmilk to store and donate. While others preferred to track only on the days on which milk was dropped off. This would then be recorded as a single total volume of all the bottles that had been frozen at home since the last time that milk had been dropped off.

P1 expressed breastmilk for donation daily for a set amount of time, resulting in different daily donation volumes. Daily tracking resulted in an accurate total volume of breastmilk stored between donation drop-offs. P2, however, expressed a set volume of breastmilk for donation daily. When dropping off the donation, P2 multiplied the filled bottle count by the consistent volume, calculating the total volume being dropped off. For P2, daily volume tracking had limited benefits, but by capturing the total volume on drop-off days she saved time, while still accurately tracking the total volume donated.

5.4.3. Education screen feedback

In the pilot study, the Education screen was viewed 13 times, with full articles being opened eight times (Appendix 6). In the deployment evaluation the Education screen was viewed 56 times, by 21 users. Full articles were viewed 13 times, by six users.

P1, P4 and P5 who have multiple children, felt the education articles were more useful for sending to a friend than for their own education, but expected it to be helpful for first-time mothers. The articles on the app where, however, viewed as being a reliable source of information.

> "I think if it had been my first born, I probably would have been reading through all the articles, but… I've read through a lot over the last 10 years already, so I've probably read most of those subjects... It might be useful in terms of if you wanted to send to someone who asked you something." – P1, Pilot

> "We're researchers, we look things up and we've both done this before. But for new moms, it would be great. Especially because you get bad advice on social media. It's good to have a reliable source of information." – P5, referring to herself and P4, Deployment

On the contrary, P3 and P6, both first-time moms with young babies, found the articles to be the main focus of their application usage, however both of them were not expressing to donate during the interview period and therefore not using the tracking feature.

> "It was quite insightful. I learnt a lot…Education was the most useful [feature]…It is research based. Google can mislead you." – P6, Deployment

P6, however, did not expect to use the education feature frequently, unless new content was added. This sentiment was reiterated by other participants. Without new content, the education feature will not be revisited by donors.

> "If there was more or it was changing frequently, I would make more effort to go and look." – P9, Deployment

Furthermore, multiple participants suggested using push notifications to alert users of new articles being uploaded. Currently, to find a new article, users would need to manually open each education category and check for new articles, which is time consuming.

> "I would probably read those articles if there was a push notification to say there's an interesting article, then I would click on it to read on…I almost forgot that there were articles, but I did when I remembered. I did enjoy reading it". – P2, Pilot

With the current Donor App version, the news snippet feature on the home page should therefore be used to announce when new articles have been uploaded. This still requires users to open the Donor App to find out there are new articles, but they won't have to search the articles themselves to check.

With regards to the education articles' content, participants suggested repeatedly that more behind-the-scenes information should be included, as well as a list of medications allowed and how long after taking a medication to wait before donating again.

> *"It felt like a duplicate of the website. I would be more interested in behind the scenes. Pasteurization etcetera." – P9, Deployment*

The Suggest An Article feature was, however, not used. This feature requires input of a specific article URL, which is not always possible for donors to suggest and would possibly be better used if it simply required a topic suggestion.

5.4.4. Depot screen feedback

The Depot Locator was used by all three participants of the pilot study, a total of five times (Appendix 6). The Nearest Depot feature was used once, while the depot list view and viewing of the depot pin details were not used. In the deployment evaluation the Depot Locator was viewed 56 times, by 21 users, with the nearest depot and depot pin details used nine times and the depot list viewed ten times.

The ability to drop off at depots was seen as convenient, as depots are located closer to donors than the Milk Matters office. Many participants, however, thought that they were allocated one specific depot that they had to drop-off at and were not aware of where other depots were. Having access to the full depot list, as well as depot opening times was therefore seen as useful, even by donors who were satisfied with their original allocated depot and gave the donors an idea of the bigger picture that they were involved in.

> *"I had errands to run so I checked the app for a closer depot." – P5, Deployment*

> *"I didn't need to use the depots, but I didn't realise I could drop off anywhere. Seeing the depots made it feel like I'm part of a bigger thing." – P9, Deployment*

Before using the donor app, P7 recounted a time when she attempted to drop off her donation at her assigned depot, only to find it closed. To prevent the breastmilk from defrosting she had to take it back home before continuing with her day. She recognized that the depot locator and depot details would firstly give her the opportunity to prevent this, by checking opening times before leaving home, and secondly to rectify it by finding another convenient depot that was still open, rather than having to go home. Interestingly, once using the app, the exact scenario happened again, with her assigned depot being closed earlier than expected. She was able to locate another convenient depot and call ahead to check that they would still be open.

> *"I had to look through the app and see what other depots were available. I managed to find an alternative and didn't need to go home." – P7, Deployment*

While convenient, the lack of personal interaction with Milk Matters staff was however, seen as a disadvantage of depot drop-offs. Both P1 and P2 have donated to other milk banks, previously or while on vacation, where the donations are dropped-off at the NICU where the breastmilk is used. They both found that experience motivating.

> *Dropping the milk off where it's going to be used was really, really special…literally life changing… whereas with Milk Matters, it's super convenient, but it's in a physio's room. There's no baby feel. It's not as personal or impactful" – P2, Pilot*

> *"The immense amount of gratitude that those nurses gave at the previous milk bank was enough to make me want to breastfeed for another year longer than I would have" – P2, Pilot*

5.4.5. More screen feedback

During the pilot study, the More Screen was viewed 8 times, by 3 users. In the deployment evaluation it was viewed 51 times by 19 users. The total number of selection events from the More menu in the deployment evaluation was only 16. Notably, the Become a Donor screen was viewed three times, with one new potential donor, who found the app organically, completing the pre-screening questionnaire.

The ability to email or call Milk Matters from the About Us page was not used by any users.

5.5. Usage of the Staff App

During the pilot study the Staff App captured a total of five usage events, by Milk Matters staff (Appendix 7). Log in details were only given to Milk Matters after P1 and P2 were already using the Donor App. Feedback was given to Milk Matters from P1 and P2 relating to the updating of the newsfeed snippets and their images displayed on the Donor App. Although the donor participants continued to use the Donor App, no updates were made to the newsfeed snippets by Milk Matters during the pilot study.

At the time that log in details were given, Milk Matters was dealing with important procurement issues, so there was no time available for using the Staff App. One staff member then went on leave for two weeks, increasing workload considerably. With only pilot study participants using the Donor App and time pressure for staff, updating the Donor App was not a priority.

Additional training was performed before final deployment began, resulting in a total of 352 events being recorded by staff (Appendix 7). A considerable portion of these was adding all recent donors to the database, so that they would have access to restricted screens upon downloading the app. This job was delegated to a Milk Matters volunteer, who was given her own staff account and shown what to do by a staff member. The Newsfeed was updated more regularly by Milk Matters too, adding nine new snippets during the deployment evaluation. Three new depots and one new education article were added to the database.

Staff members found it "very easy" to use, however limited time was the biggest challenge.

> *"The biggest thing is probably time and because we're all under pressure already…the time and staff capacity is the limiting thing… It's doable, but I've got to get into a routine of putting things on there because I can't schedule things." – Milk Matters*

Milk Matters' motivation to use the Staff App, was also affected by how much the Donor App was being used. Since staff are only aware of Donor App usage when they receive a declaration email, the potential of a usage report was discussed.

> *"It would be encouraging for us if we can see that there's been uptake [via a usage report]. Then it feels like a valid use of time. If it saves a phone call then it's time saving, but it's extra work if not enough mothers are using it… I have to justify to the board why I'm spending time on the app. I don't have data to share that." – Milk Matters*

5.6.   Unanticipated additional insights

The semi-structured nature of the interviews allowed participants to raise additional insights, not directly questioned. There is currently no clear communication path for donors to provide thoughts and feedback on their experience or the donation process. The research project itself therefore improved communication between donors and the non-profit organisation (NPO), by having a researcher as a feedback intermediary. These insights, while not related to the Donor App, help Milk Matters to gain a better perspective of their donors' experience and made the donors feel heard.

While most donors are proud of the fact that they are donating breastmilk and want to encourage others to do the same, it is not true for them all. One participant feared telling other mothers or colleagues as she did not want them to judge her or to feel that she was judging them for using formula to feed their babies.

> *"I don't want them to think I'm a goodie two shoes." - Anonymous*

During the time of this project, procurement issues meant Milk Matters had to change the storage bottles given to donors from reusable bottles to single use bottles. I was able to explore donors' feelings towards the new bottles. Donors liked that the single use bottles could be labeled directly, without the need for removable tape, but preferred the shape of the reusable bottles as they could screw directly into some brands of breast pumps. Additionally, the single use bottles do not have measurements on them, meaning donors who would like to track volumes need to check the volume expressed before transferring their breastmilk to the storage bottle.

5.7.   Chapter summary

Ten donor participants and two Milk Matters Staff members were included in the pilot study and deployment evaluation combined. The Donor App was generally well accepted by donors, with a particular focus on the use of the donation tracking features and declaration of drop-offs. The feedback provided within the app when tracking donation volumes allowed mothers to determine their own goals and showed the ability to increase their motivation to donate by creating a visual representation of how much they had donated. Direct communication was increased by auto-generated emails when donors declared a donation drop-off or completed the pre-screening questionnaire. The quick responses of appreciation also motivated donors to continue donating. Furthermore, educational content available within the app provided a form of passive communication, where donors felt that Milk Matters was providing them with useful content, without ongoing effort from Milk Matters themselves.

Milk Matters staff found the Staff App easy to use and saw the benefit of increased communication with their donors from the very first auto-generated email that they received from a donor.

6. Discussion

This chapter discusses the findings of the Milk Matters 4.0 project, with a focus on the two research questions asked. Firstly, looking at the effect of the applications on donor motivation examines the ability of the applications to function as a purposeful system. Secondly, discussing the challenges associated with university-led mobile app development for low resourced NPOs highlights the need for a maintainable system.

6.1. Influencing donor's motivation to donate: Towards a purposeful system

Breastmilk donors are essential to the functioning of any milk bank. While cultivating strong relationships with donors is important, many NPOs do not have the staff capacity to make it a focus (Wiggill, 2014). Finding efficient ways to strengthen this relationship, and investigating factors that influence donors to either initiate donating or continue donating are therefore valuable for improving donated breastmilk supply.

Given the structure of Milk Matters, where donations are dropped off at satellite depots, interaction between donors and staff is limited after the initial donor registration. Both this study and previous work by Wardle (2016) and Green (2016) highlight donors' strong desire for more feedback from Milk Matters, particularly regarding the processing of their donations. Additionally, while depot drop-offs are convenient, they result in a less impactful donation experience, compared to milk banks that collect donations directly at the NICU. For donors, seeing where the donations are used and the difference they make first-hand is a powerful motivator to continue donating. Without this experience Milk Matters needs to use other ways to provide motivation and encourage continued donating, leading to this dissertation's first research question: "**What effect does a mobile application have on a donor's motivation to donate breastmilk to a non-profit milk bank?**"

The primary goal of the Donor App was therefore to increase donors' motivation to donate, through increased communication, feedback and appreciation. The Donor App was generally well received by participants and the continued daily usage shows it provided value to its users (White et al., 2016).

Reasons for registering as a donor by participants in this project are similar to those seen in other studies (Dos Santos and Perrin, 2022, Doshmangir et al., 2019). These include a desire to feed vulnerable infants, relieving the

discomfort of excess milk supply without wasting breastmilk, processing a traumatic birth experience, experiences within the NICU (both positive and negative) and donating in memory of loved ones who have passed away.

Similarly to participants in work by Kimani-Murage et al. (2019), although altruistic reasons are the main motivator in most Milk Matters donor registrations, some participants appreciate the concept of a non-monetary incentive as a sign of appreciation for their considerable donation efforts. Although Milk Matters recognises the potential benefit of incentives, creating a plan that is both fair to all donors' effort and cost effective for the milk bank has been challenging.

6.1.1. Donation tracking as a motivator to donate

Donation tracking was well received by participants and was the most used feature of the Donor App. Among breastfeeding related apps, those including tracking features tend to have higher ratings in both app stores (Dinour and Pole, 2022). Additionally, Wardle et al. (2018) found that features which provided breastfeeding mothers control, such as breastmilk tracking or the depot locator, were best received. Donors' varied expression habits lead to a wide range in donation volumes and frequency at which breastmilk is donated and dropped-off, as seen in a scoping review by Dos Santos and Perrin (2022). Usage of the donation tracking feature (daily vs. per drop-off) depended on these expression habits and how each donor could maximize their tracking ability, while saving themselves time. The simplicity of the donation tracker enabled donors to use it in the way that suited them best.

The donation feedback widget, featured on the home and donations screens, was also well-received. While it doesn't provide a visit to the NICU, it does provide a tangible count of the feeds provided to babies in need. While the Donor App does not specify goals or include direct gamification, as even small donations are valuable; tracking of the volume and number of feeds allows donors to set personalized goals for themselves easily. The visualizations, including graphs, underscore the value of each contribution, serving as direct motivation for donors to express when they might not have otherwise. Simple visualisations, such as graphs, have demonstrated providing intrinsic motivation in other mHealth applications (Kettner et al., 2019), especially when combined with a text summary (Alshehhi et al., 2023).

On the contrary, tracking within the Donor App may potentially increase the perceived donation workload for some donors. For donors motivated by external factors (such as doing good deeds in the name of a deceased loved one) or simply to responsibly manage an oversupply of breastmilk, the total donation volume may be irrelevant. As explained by Toyama (2011), "technology is merely a tool that multiplies human capacity in the direction of human intent". The positive impact of technology depends on the willingness and capabilities of its users. Technology, such as the Donor App, does not have the ability to create capacity or intent for donors to donate, but can magnify the intent and motivation of those already interested and capable to use it. It is therefore important that tracking within the Donor App remains optional, allowing interested users to maximize its benefits while allowing those uninterested to ignore it.

6.1.2. Communication as a motivator to donate

In the Donor App, active communication occurs through emails that are generated by the app and responded to by staff, while passive communication occurs through the education resources and feedback widget. The generated email used most frequently was the drop-off declaration email.

Participants using the drop-off declaration feature and receiving direct email responses from Milk Matters reported increased satisfaction with communication. Donors felt recognized, appreciated, and more confident about the collection and processing of their breastmilk, avoiding concerns about it being forgotten at a depot. Milk Matters staff were excited to receive email notifications for drop-offs, allowing them to respond promptly and saving time on depot check-ins. This can increase donors' satisfaction with their relationship with the NPO and lengthen the time they spend as a donor (Wiggill, 2014). However, a small proportion of donors did not feel the need to declare drop-offs, aligning with findings by Candelaria et al. (2018), where some donors felt that knowing they helped a vulnerable infant was sufficient acknowledgment. To maximize the application's

effectiveness in fostering donor-NPO communication, donors need to use the features that generate email communication.

If a donor uses the app to track milk expression, but is satisfied to not declare donations, then the benefit of increased communication with the NPO is decreased and the organisational time saving benefit for Milk Matters is lost. Donors may also be unaware that it will lead to a benefit of increased communication since that is not explicitly stated in the app itself. This mismatch in goals of app usage between the NPO and their donors results in a reduction in the overall benefit of the app.

To get maximum benefit from increased communication, Milk Matters will need to clearly promote the use of the application and the specific "Declare Drop-off" feature to its donors. Suggestions to Milk Matters include detailing the use of the app when welcoming new donors, including a donor testimonial about how the increased communication improved their experience and adding signage at depots encouraging use of "Declare drop-off". Active donors who are not using the feature could also be contacted directly via Milk Matters' usual communication channels, with an encouragement to use it. There is also potential for future work to add a third user group to the declaration process – the depots. Allowing depots to declare when donations have been dropped-off harnesses the long-term NPO-donor relationship, while ensuring the NPO gains the maximum logistical benefit, independent of donors' use of the declaration feature.

After deployment, both Milk Matters and participating donors expressed the desire to make more use of the declaration email by using it to replace the paper form that currently needs to be included in the donation packet. Given that the perceived value of an mHealth application influences its use (Greve et al., 2022), enhancing the functionality of the drop-off declaration may motivate donors initially uninterested in communication or appreciation to use it for increased convenience of drop-off, potentially increasing communication as a side-effect. This could form part of future work.

Despite participants having suggestions for missing educational content, the Suggest An Article feature, co-designed in Milk Matters 1.0 with previous participants (Wardle, 2016), was not used. A more flexible suggestion feature allowing donors to suggest topics, rather than specific article URLs, may result in more engagement.

Most other features of the Donor App are either static or require input from the NPO to be updated. While content updates to the home screen's news snippets feature can be easily noticed upon opening the app, updates to features such as Education or FAQs, are less clear. Participants suggested implementing push notifications to communicate updates to this slow-moving content. This is supported by White et al. (2019) who found appropriately timed push notifications for new content to be the main trigger for app usage in a breastfeeding education app designed for fathers. Future work could explore the effect of push notifications on slow-moving content usage. In the current Donor App, to increase the feeling of being "communicated" with, Milk Matters should prioritise regular updates to news snippets and include details of new content uploads there. Furthermore, testimonials should be included, as participants in this project, as well as previous work (Green, 2016, Lobola, 2021), expressed that testimonials made donating feel more real and provided motivation to continue donating.

Another valuable form of communication between an NPO and its donors, as well as the broader community is social media. It is important that the messages communicated by the NPO develop greater trust in the organisation and lead to long-term relationship building (Albanna et al., 2022). However, posting regularly to social media and to the Donor App's news snippets is time consuming, especially for NPOs with limited resources. To enhance efficiency, a strategic content plan should be created (Albanna et al., 2022), including donor-requested topics, content for potential donors and promotion of the mobile application. As expected, this study observed a spike in mobile application downloads following social media mentions (White et al., 2016).

When designing for breastmilk donors, software designers must consider the needs of the donors. From this study, the following aspects should be considered in future:

- Be quick and easy to use;
- Include flexibility, allowing donors to use it in a way that suits their habits;
- Provide tracking feedback, such that donors can determine their own goals and see progress.

Importantly, features that could be perceived as increasing donors' workload, should be promoted as optional. To promote long-term usage, features must be designed to add value to users and the value must be clearly publicised.

6.2. Challenges associated with university-led development for NPOs: Towards a maintainable system

The connection between an NPO and a university forms a unique platform for ICT development projects. NPOs are often resource limited (Dourish et al., 2020), but with vast opportunities for development that can make a real difference in people's lives. Universities have students with technical skills, who need to complete projects as part of their programs, but do not need to be paid. Allowing university students to collaborate with NPOs therefore provides opportunities for development not otherwise available to many NPOs. There are, however, also unique challenges to this relationship. While these challenges must be carefully considered before beginning a collaborative project, they should be seen as opportunities to develop new strategies and benefit communities, rather than barriers (Raspopović and Vasić, 2014). This led to the development of this dissertation's second research question: **"What are the challenges associated with university-led mobile app development for NPOs with limited resources?"**

The nature of ongoing university projects is that work will need to be passed on to the next student/s. Without incoming students having continuity of access to project related files and accounts, work may need to be replicated and important data may be lost. For mobile applications, access to signing keys is required to update a project's mobile applications within the same app store listings and maintain users' access to the mobile application and its associated data.

The following recommendations may help to prevent these challenges from occurring in future work (Talbot and Densmore, 2023):

- Admin or Owner access should be granted to at least one project supervisor or staff member who is expected to remain in relationship with the university and therefore retain access to all project related accounts. They would then be able to grant access to any future students working on the project.
- All project related information, such as application signing keys, should be stored in a secure online location, with supervisor access.
- Permission to use personal contact information, such as email address and contact number, should be requested from students working on a project that will be continued in the future. This would allow for incoming students to easily contact previous students, regardless of their post-university activities.

University project timelines are short and hold a narrow scope, often limited to design or usability studies, without a focus on deployment (Best, 2010). For the ongoing Milk Matters project, this resulted in three short phases of development, over a four-year period, before deploying a new cross-platform Donor App version. During this time the NPO dedicated their time for co-design and made their donors available for interviews and workshops. While all students involved met their course requirements, the NPO's goal of a deployable cross-platform app; increasing motivation, communication and appreciation; was not met until the completion of my development phase. A misalignment of goals between university students and the NPO led to frustration and can negatively affect the ongoing relationship.

Setting clear expectations of scope from the onset of the project is important, ensuring that the NPO understands the anticipated outcomes and possible technological limitations (Chirambo et al., 2019, Raspopović and Vasić, 2014, White et al., 2016). To maintain NPO-university relationships, continued clear communication on progress and shifts in plans is important throughout the project (Raspopović and Vasić, 2014). In this case, further development, beyond the scope of university course requirements, to reach deployment was promised by previous students, but did not happen.

Another challenge brought about by breaks in development between university project groups is that of maintenance. Third-party software libraries quickly become outdated without updates. Not only does this make

it more challenging for the next students to get the applications running again, it also leads to security risks if vulnerabilities are discovered and fixed by the library but never updated in the application or system.

Google and Apple have strict requirements for the API or Xcode versions that are required to make apps available on the Play Store or App Store, respectively. For Android, the target API level for new apps or app updates must be within one year of the latest major Android OS version (Google Support, 2023). To remain available to users, apps already on the Play Store must target an API level within two years of the last major Android OS release. If the app's API level targets two or more years below the latest version, it will only be available to users using the targeted level or below. These requirements increase by one Android version annually on August 31st (Google Support, 2023). This means that by October 2024, when Android 15 is due for release, the current version of the Donor App, which targets Android 13 (API level 33), will require an API target update before any other updates can be made. By October 2025, when Android 16 will be due for release, the current version of the Donor App will no longer be available in the Play Store to anyone using Android 14 or below.

Without the ability of the university to create new research opportunities within the project, either the university is left to maintain the application for no university scope benefit, or the NPO must find funding or volunteers to maintain the application (Chirambo et al., 2019). If the application is left unmaintained it will become outdated and unable to be downloaded by those using recent mobile operating systems. Currently 64% of Android Donor App users are using an Android version within the latest two versions. If the same Android version proportions persist, without updates to the Donor App, almost two-thirds of new Android Donor App users will be unable to download the current version by October 2025. Further research is required to develop ways to ensure self-sustainability of these projects (Best, 2010).

When working with NPOs, their limited resources must be strongly considered. Factors influencing the usage the Staff App were time constraints, lack of experience with the application, the perceived level of benefit provided and security concerns. This corresponds to the technology acceptance study done by Zayyad and Toycan (2018). It is important to design applications in such a way that staff's usage can easily become part of their routine (Chirambo et al., 2019). The ability to schedule news snippets should therefore be looked at in future work. Additionally, if the NPO does not see the value in the effort they are putting in, they will not sustain the effort. It is therefore important to share usage analytics with the NPO, as, in this case, only limited features of the mobile application produce tangible engagement with the NPO, even though other features are still achieving the NPO's aims.

While a university-led development project comes with challenges, this project also provided some unexpected benefits for the NPO. Having a researcher engage with donors in an open-ended manner itself increases communication, as the researcher can feed back insights and encouraging anecdotal stories to the NPO. These insights, not directly related to the application, may not have been brought up otherwise and can be fed back into the running of the NPO. Examples include feedback on donors donation experience, with both Milk Matters and other organisations; an increased understanding of donors' stories and the people instrumental in getting them to become donors, allowing the NPO to directly thank those people and encourage them to keep promoting the milk bank; understanding that not all donors want to tell other people that they donate breastmilk and therefore don't promote donation, as seen by Bossi (2020) and Candelaria et al. (2018); and greater insights into the digital content that donors would like to receive, allowing for adjustment to social media stategies. Additionally, for the duration of my study, I volunteered my Friday mornings to do collections from depots and assist with donation processing, order preparation and general office tasks.

Software deployments are a partnership, from design through to deployment, promotion and maintenance. Partnering with NPOs provides opportunities for real change to be realised, however their limited resources must be accounted for. A strategic plan for development and maintenance should be communicated to all partners, particularly when development is done by university students.

7. Conclusions and Future Work

This chapter describes the conclusions of the Milk Matters 4.0 project. It begins with a summary of the key findings, related to the research questions, and the contribution that these offer. This is followed by a discussion of the limitations of the study and future research opportunities.

This study aimed to investigate the effect of a mobile application (and its corresponding web application) on donors' motivation to donate to a non-profit milk bank through increased communication, feedback and appreciation. The mobile application was able to increase active communication between the two parties, provided the communication features are used by donors. Additionally, the presence of the application itself reduced the need for active communication, as the information contained within the application provided donors a sense of passive connection. As a result, donors felt an increased sense of appreciation from the milk bank and increased inclusion in the process, as well as improved confidence that their donations were not overlooked.

Furthermore, together with increased communication, the tracking and visualisation of donation quantities had the ability increase a donor's motivation to donate. Donation feedback provided within the application, allowed the creation of personal donation goals by donors and created a visual of the impact provided by each donation, no matter how small the donation was. This, however, depended on the donor's personal reasons for donating. Design and usage requirements of a mobile application for breastmilk donors must consider that mothers may not feel that they have additional capacity to complete the tasks required by the application without feeling overwhelmed. To maximise donors' donations, features that are motivating for some donors, but have the potential to be a barrier to donation for others, must be kept optional. Donors' usage of the application also resulted in operational benefits for the milk bank.

Additionally, this study asked about the challenges associated with university-led mobile app development for non-profit organisations (NPOs) with limited resources. Challenges encountered were related to continuity of access between student projects, misaligned stakeholder outcome goals and ongoing sustainability concerns. To enable future project continuity, this study recommends a clear handover of access to all project related accounts

to the project supervisor, secure online access to all project related information and planning for continued contact with outgoing students.

This study produced a deployed mobile application for use by a milk bank, that can increase donor motivation and NPO-donor communication. Given the importance of donated breastmilk to premature infants, any improvements in the donation experience or increase to donations received, can lead to positive health outcomes for the infants served. Findings can be used to guide design of similar applications for milk banks within different settings. By describing initial usage of the mobile application, this study contributes towards a gap in literature relating to the usage of publicly deployed mHealth applications. Importantly, recommendations made with regards to university-led development for low resourced NPOs can be more broadly applied to improve the continuity of university student projects involving NPOs, even outside the health context.

This study has some limitations. The donor participants were selected by the NPO, favouring active donors more likely to declare a drop-off during their participation time. Some donors that were approached did not respond. This potentially introduces bias towards more active and willing donors, who may hold a more positive view of using the Donor App. Included participants did, however, make up a large proportion of the total donor population. Additionally, use of the Donor App by donors who are dropping off donations more frequently will have the biggest impact on operational benefits for the NPO, even without uptake by all donors.

Future research can look at long-term usage of the mobile application and staff web application, measuring the impact on usage by new features. Examples of such new features include donor push notifications for new content, personalised content based on a user's profile, the ability for staff to schedule content and adding additional scope to the drop-off declaration feature to increase the number of donors who find it beneficial. Furthermore, the addition of a third user group, the depots, can be investigated. This has the potential to provide operational benefits to the NPO, independent of donor mobile application uptake, and capitalise on the longer term NPO-depot relationship.

By leveraging technology, this study sought to bridge the needs of breastmilk donors, university postgraduate students and staff of a low resourced NPO. Overall, the findings suggest that a mobile application and web application developed for this NPO have the potential to increase communication between staff and donors, the sense of appreciation experienced by donors and provide direct passive feedback to donors, thereby increasing donors' motivation to donate. Careful design consideration must be given not to increase the workload required of donors. The NPO-university development relationship comes with challenges, but careful planning and following the recommendations set out in this thesis can lead to improved project continuity in future work.

8. Personal Reflection

I first came to know about Milk Matters in 2012, while completing my Honours in Nutrition and Dietetics at UCT. An outing to Mowbray Maternity Hospital, where Milk Matters is based, provided first-hand insight into the importance of donated breastmilk.

In 2014, I completed my community service year[17] as a dietitian in a resource-limited hospital in rural Mpumalanga. Moms of premature infants would spend their day in a hot, crowded maternity ward, only allowed short visits to their baby in the hospital's nursery every three hours to feed. Mothers who needed to express breastmilk were only allowed to use breastmilk that had been expressed while in the nursery. They had no manual or electric breast pumps, only their hands, and no access to donor breastmilk. That is no easy task!

When I became a mom in 2017, I was fortunate to have an easy breastfeeding journey. Driven by my professional identity as a dietitian, similar to mothers in work by Oreg and Appe (2020), and encouraged by my midwives, I become a Milk Matters donor. I only dropped off a donation once. When my second child was born in 2020, we were still in strict lockdown due to Covid-19, and my midwives (who had been my Milk Matters depot) had closed their practice. This meant I did not donate again. Looking back, knowing what I know now, and that breastmilk donation is limited to such a short time in one's life, I wish that I had made the effort to donate more. Had there been more of a feeling of belonging or more communication with Milk Matters, maybe I would have.

After years of effort from both Milk Matters and the Human Computer Interaction lab at UCT to get the Donor App published, my sincere hope is that it will be a joy to use, help motivate mothers to donate more breastmilk and result in more tiny babies being able to be fed potentially life-saving donated milk.

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[17] In South Africa, most health care professions place graduates at a public healthcare facility, where they are required to work for one year before they can register as an independent practitioner in their field.

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Appendices

Appendix 1: Informed Consent

DEPARTMENT OF COMPUTER SCIENCE

UNIVERSITY OF CAPE TOWN	RESEARCHER:	Deborah Talbot
PRIVATE BAG X3	TELEPHONE:	+27-83-294-9837
RONDEBOSCH 7701	E-MAIL:	mxxdeb001@myuct.ac.za
SOUTH AFRICA	URL:	https://sit.uct.ac.za/

Informed Voluntary Consent to Participate in Research Study

Project Title: Milk Matters 4.0: User uptake and usage of a co-designed NPO mobile application. A post deployment evaluation

Invitation to participate, and benefits: You are invited to participate in a research study conducted with Milk Matters and the UCT Department of Computer Science. The study aim is to evaluate the uptake of a mobile application designed for use by breastmilk donors. I believe that your experience would be a valuable source of information, and hope that by participating you may gain useful knowledge.

Procedures: During this study, you will be asked to install the mobile application on your phone, to use it for three weeks and then to provide feedback in an interview. The app will track your usage of the individual features; this data may be shared with us when you are connected to the internet. If possible, we would like to visit your home to observe the context in which you will use the app. These can be done in your own home or chosen location.

Recording: Audio of the interviews will be recorded as part of the study. These will be used to transcribe interview notes and then deleted. Photographs may be used to provide context, however no identifying features will be included or they will be blurred. If you object to either of these, please indicate below.

Risks: There are no potentially harmful risks related to your participation in this study.

Feedback: A summary of key results will be emailed to study participants, as well as a link to download the final application. A report will also be included in the Milk Matters newsletter.

Disclaimer/Withdrawal: Your participation is completely voluntary; you may refuse to participate, and you may withdraw at any time without having to state a reason and without any prejudice or penalty against you. Should you choose to withdraw, the researcher commits not to use any of the information you have provided without your signed consent. Note that the researcher may also withdraw you from the study at any time.

Confidentiality: All information collected in this study will be kept private in that you will not be identified by name. If specific examples are required, confidentiality and anonymity will be maintained using pseudonyms. The affiliation of participants to Milk Matters, as breastmilk donors, will be described in the research.

What signing this form means: By signing this consent form, you agree to participate in this research study. The aim, procedures to be used, as well as the potential risks and benefits of your participation have been explained verbally to you in detail, using this form. Refusal to participate in or withdrawal from this study at any time will have no effect on you in any way. You are free to contact me, to ask questions or request further information, at any time during this research.

I agree to participate in this research (tick one box)	☐ Yes	☐ No	_____ (Initials)
I agree to be audio-recorded	☐ Yes	☐ No	_____ (Initials)
I agree to be photographed	☐ Yes	☐ No	_____ (Initials)

_____   _____   _____

Name of Participant   Signature of Participant   Date

_____   _____   _____

Name of Researcher   Signature of Researcher   Date

Appendix 2: Interview script for donors

Donor App Installation Session Plan

Note: Ensure that participant's donor number is available and has been added to the database in order for depot locator and drop-off declaration to be accessible to them.

Goal of Session:

- increase awareness about the application
- determine user expectations of the application
- offer initial installation support
- shift donor participants from awareness to usage of the mobile application.

Interview Script:

Hello. Thank you for meeting with me. My name is Deborah Talbot, and I am a Masters of IT student studying at the University of Cape Town. The purpose of today's session is to get the Milk Matters App installed on your phone and to make you aware of the features that are available to you.

The app was initially developed in 2020 and 2021 by Computer Science honours students, and is now being deployed for donor mothers to use. It's uptake and usage are being studied.

For the purpose of research analysis, I would like to record this session. Do I have your permission to record?

[If yes, start recording. If no, take good notes. Thank them either way]

1. Let's go over the consent form…

We want to find out how donor mothers of Milk Matters use the mobile app and which features are used most. I will ask you a few questions and will assist with the installation of the app onto your mobile phone.

About Participant

1. Please tell me about yourself.
2. Your age, what you do.
3. Which race group do you identify with?
4. What is your level of education?
5. How long have you been a Milk Matters Donor?

User expectations

6. What communication are you currently getting from Milk Matters?
7. What communication would you like to get from MM?
8. How do you feel about the level of engagement?
9. How motivated do you feel to donate?
10. What are your expectations of the Milk Matters Mobile App?
    o What would you expect to be able to do with an app from Milk Matters?

App installation

Guide to app store, search for app and then download.

Now that your app has been installed, you'll see that the app does take your personal information i.e. email, phone number, name, and surname. This is purely for administrative purposes for Milk Matters, and this will not be used as part of this project. We will be tracking how frequently various features of the app are used, but usage is never linked to a particular person. All features of the app can still be used if you do not consent to analytics, however it will be less useful for the purposes of this research.

[Press the consent button]

[Allow user to register an account and look around app for a few minutes.]

Increase awareness of application features

I'd like to briefly go through the features of the app with you and then I'll leave you to use it as you'd like.

- Home screen shows News and Events, which can be shared with others straight from the app.
- Donations – Allows for tracking the volume of each donation and for donation drop-offs to be declared, i.e. sends an email to Milk Matters to let them know. This includes a graph of your total captured donation volume to date.
- Education – Useful educational articles. Includes the ability to suggest new articles for Milk Matters to include.
- About Us – includes general information about Milk Matters, as well as links to social media pages and contact information.
- Become a Donor – Pre-screening questionnaire for potential donors, submits straight to Milk Matters.
- Depot Locator – Access depot information via an interactive map.
- FAQs
- Privacy Policy
- Delete Account – Account information will be removed from the database.

Final Questions

11. Are there any things that you can already tell that you like or don't like about the app?

Conclude

Thank you so much for agreeing to meet with me and participating in this session. I would like to meet with you again in two weeks time to discuss any feedback you may have on your usage of the app, issues/challenges that you found and any improvement suggestions. Would you be willing to meet again? [Organise time and location]

12. Do you have any questions you'd like to ask me? [If yes, answer questions. If no, conclude] Thank you again, goodbye.

Donor App Follow-up Session Plan

Goal of Session:
- Allow for them to give feedback on their app usage
- Issues encountered
- Improvement suggestions

Interview Script

Thank you for meeting with me again today. The purpose of today's session is to follow-up on your usage of the Milk Matters app and to get any feedback that you may have.

1. Did you use the app since we last spoke?
   o What did you find most useful?

     o If not: Why not?

2. Did you feel like there was a difference in communication from MM since starting to use the app?

3. Did you encounter any errors or issues while you were using it?

4. Walk through features they haven't used… (to see why it wasn't useful)

5. Do you expect to continue using it?

     o Which features are you most likely to continue using?

6. Do you have any other feedback or improvement suggestions that you would like to give?

Thank you so much for your time.

Appendix 3: Interview script for staff

Thank you for taking the time to speak with me about your use of the Staff App and how you feel about the Donor App. It has been wonderful to work with you to get these apps to where they are now.

Use these questions as a guide:

1. How have you found using the Staff App?
   o What difficulties, if any, did you encounter?
2. Do you feel that there is value in the Staff App? If so, what value?
3. How has the Staff App had an impact on your workload?
4. Have you seen any perceived change in donors' behaviour? Can you describe it?
5. How do you perceive the app's sustainability?
   o Do you perceive any challenges in the ongoing project development and maintenance or future work.

This is also a good chance for me to give you some feedback on the current usage statistics of the Donor App. [Discuss current usage graphs of top features and other noteworthy stats].
[Give examples of some success stories from donors, according to any issues they perceive the Donor App to have, or where they feel that the uptake has not been good.]

Appendix 4: Architecture used for each Milk matters version

Donor App Version	Architecture
Milk Matters 1.0	Java [a]
Milk Matters 2.0	Flutter 1.20.0, Firebase Realtime Database [b]
Milk Matters 3.0	Flutter 2.0.0, Firebase Realtime Database [c]
Milk Matters 4.0	Flutter 3.3.0, Firebase Realtime Database

[a] Wardle (2016), [b] Bossi (2020), [c] Lobola (2021)

Appendix 5: Year in which features were added to the Donor App

Feature	Year first added	Source
Introduction Screens	2021	Milk Matters suggestion [a]
Home		
Donation Feedback Widget on home screen	2016	Milk Matters requirements [b]
Newsfeed Announcement	2016	Milk Matters requirements [c]
Donation Tracking		
Recording Donations	2016	Milk Matters requirements [b]
Donation Graphs	2016	Milk Matters requirements [b]
Drop-Off Declaration	2020	Researcher suggestion [d]
Donor Number Authentication	2020	Milk Matters outlined problem, Researcher suggested solution [d]
Education		
Education Screen	2016	Milk Matters requirements [c]
Suggest an Article	2016	Donor suggestion [c]
Depots		
Depot Locator Map	2016	Milk Matters requirements [c]
Depot Details	2016	Workshop with Donors [c]
Nearest Depot Button	2016	Workshop with Donors [c]
More		
About Screen	2016	Milk Matters requirements [c]
Become a Donor Quiz	2016 (Greatly adjusted in subsequent years)	Researcher suggestion [b]
FAQ	2020	Milk Matters requirements [d]

[a] Lobola (2021), [b] Green (2016), [c] Wardle (2016), [d] Bossi (2020)

Appendix 6: Usage Analytics of the Donor App

Event name	Pilot Study (7 Aug 2023 – 19 Sep 2023)		Deployment Evaluation (25 Oct 2023 – 10 Jan 2024)	
	Event count	Total users	Event count	Total users
Home				
Home Screen (to navigate back to Home)	9	3	53	17
See Full Event / See More	4	2	3	3
Donation Tracking				
Donations Screen	39	3	148	26
Record Donation	25	2	136	18
Declare Drop-Off	4	2	17	9
View Donation Graph from donations	3	1	62	21
Click Graph Tab - volume	3	1	18	10
Click Graph Tab - feeds	3	1	17	12
Become a Donor (Donation Feedback widget)	1	1	2	2
Education				
Education Screen	13	3	56	21
Read Full Article	8	2	13	6
Suggest an article	-	-	-	-
Depots				
Depot Locator Screen	5	3	61	22
Nearest Depot	1	1	9	4
Depot pin details	-	-	9	4
Depot List	-	-	10	8
More				
More Screen	8	3	51	19
FAQs	2	2	4	4
About	1	1	2	2
Instagram	-	-	1	1
Become a Donor (More Menu)	1	1	3	2
Send Pre-screening Email	-	-	1	1
Privacy Policy	-	-	1	1
User Logout	1	1	4	3
Delete Account Screen	-	-	2	2

Appendix 7: Usage Analytics of the Staff App

Event name	Pilot Study (7 Aug 2023 – 19 Sep 2023)		Deployment Evaluation (25 Oct 2023 – 10 Jan 2024)	
	Event count	Total users	Event count	Total users
Staff Login	1	1	22	7
View Dashboard	1	1	7	4
View FAQs and About	-	-	4	3
Account Management				
View Account Management screen	-	-	22	7
Add new donor number	-	-	232	4
Add new staff account	-	-	3	3
Depots				
View Depots screen from Home	-	-	6	5
View Depots screen from Dashboard	1	1	3	3
Add depot	-	-	3	1
Edit Depot	-	-	3	1
Process Collection	-	-	17	2
News Snippets				
View News screen	1	1	11	3
Add News Snippet	-	-	9	1
Edit News Snippet	-	-	3	1
Education				
View Articles screen	1	1	5	4
View Suggested Articles	-	-	1	1
Add new article	-	-	1	1

Appendix 8: Additional Interview Quotes

Additional quotes from participant interviews

Donors' reasons for donating

"I've got so much milk. It's a relief to give it to someone who actually needs it. To give back" – P7, whose son received Milk Matters donor milk.

"I'm not doing it for anything in return at all. It is an effort, but I do it out of a love of knowing that I can" – P9

"I just donated because I don't want to keep it in the freezer, because it's just gonna go to waste...It also felt like I was helping people, giving a bit back...Donating motivates me to keep breastfeeding." – P10

"I know it's important because of my son's NICU journey. I just felt really grateful that we didn't need it. And I understood that my breastmilk helped get him out of the NICU and how powerful it was, so I wanted to give back. It was quite a traumatic birth and traumatic experience and so it was something that helped me process that.", "I had such a sense of responsibility. I've been given this amazing gift, there's enough for my baby. It's not that difficult to express a bit more." – P8, on her motivation to donate the first time.

"I'm doing it in the name of two important people that passed away while I was pregnant, one of whom was a donor for a long time. It's part of my processing with that...I decided that I'll do it for her first year." – P8, on her motivation to donate the second time.

Donors initial communication satisfaction

"The only other thing they would send me is I need to do another test. If I ask any questions, they'll answer me." – P1, Pilot

"I haven't really had much communication other than the start of the process...if that's the only communication I'm sort of gonna get from them, I would say it's almost not enough but if they engage with me, after my next drop off I get an e-mail saying we received your next batch, "these are the mls" or "thank you for your donation" or anything, it would be great." – P2, Pilot

"Once in a while a touch base would be nice...Maybe a thanks, we've received this." – P7, Deployment

"I wouldn't mind knowing that they've picked it up" – P1, Pilot

"I want to know that they know there is milk to collect." – P4, Deployment

"I would like confirmation 'we have received your milk'. Or feedback if it's not able to be used." – P6, Deployment

"I would like them to notify me once they've received my milk." – P7, Deployment

"I want to know when milk is collected or who I should notify that it's there." – P9, Deployment

"Instagram posts seem to say the same thing every time. More like advertising." – Anonymous

Home screen feedback

"It would be cool to see what you have donated so far" – P5, Deployment

"I probably wouldn't click on a full article" – P1, Pilot

Declare drop-off feedback

> *"The second use of the Milk Matters App and it has once again made my day! This time the usefulness of the place to add additional details was made use of and have a look at what [donor name] said. So special!" – Milk Matters*

> *"The app is making such a difference, even with just the 2 moms using it." – Milk Matters, during the pilot study*

> *"I used the additional info section to let them know about a sterilization issue. It was valuable to get a reply. Then I know that they know there is milk to collect." – P4, Deployment*

> *"I don't care about the email. In some sense Milk Matters is doing me the favour just by taking the milk. I don't put in work to express the milk." – P5, Deployment*

> *"I didn't get to utilize as I wanted to…there was no difference in communication." – P6, Deployment*

Usage patterns of donation tracking feature

> *"I used it primarily just to record how much I pumped for the day. It was nice and easy because it comes up with the day there…I found it very convenient to record." – P1, Pilot*

> *"I used it every day to track" – P5, Deployment*

> *"I was only really using the app when I needed to go drop off milk…but you sort of almost forget that the app's there. Because it's not interactive" – P2, Pilot*

Education screen feedback

> *"It depends on being updated. I've already read it." – P6, Deployment*

> *"Maybe you should send a notification if a new article goes up so you don't have to go check every time." – P9, Deployment*

> *"I would like a notification when a new article is posted." – P10, Deployment*

> *"You sort of almost forget that the apps there because it's not interactive" – P2, Pilot*