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Title: A Dynamic Milk Matters Mobile Application

Building a cross-platform mobile application to support breast milk donors

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Category	Min	Max	Chosen
Requirement Analysis and Design	0	20	20
Theoretical Analysis	0	25	0
Experiment Design and Execution	0	20	0
System Development and Implementation	0	20	15
Results, Findings and Conclusions	10	20	15
Aim Formulation and Background Work	10	15	10
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A Dynamic Milk Matters Mobile Application

Building a cross-platform mobile application to support breast milk donors

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ABSTRACT

This paper outlines the methodology, design, and analysis and evaluation of a dynamic Milk Matters mobile application. Through a process of co-design, adapted due to COVID-19 pandemic, we gained a wholistic view of the milk donation process and the nuances of the donor experience. We aimed to support breast milk donors with a mobile application containing up-to-date content, features that support donor tasks, and which enable increased interaction and communication with Milk Matters. Through this we hope to support their donation journey, leading to an increase in the number of donors and ultimately an increased availability of donor breast milk. The paper also explores the context of co-design with breastfeeding mothers during a pandemic and developing software with an NPO.

CCS CONCEPTS

• Dynamic and static content • Database • Cloud Technologies • User Experience • Co-Design • Mobile Application Design

KEYWORDS

Co-Design, Breast Milk Donation, Flutter, Human Computer Interaction, User Experience, Cross Platform, Supporting System

1   Introduction

In 2016, two UCT students studying towards their honours degree in Computer Science undertook a project to develop an Android[1] application for Milk Matters [2] , a non-profit, human milk bank based in Cape Town [15]. Their goal was to develop an application which improved the motivation of milk donors to donate milk. The application was fully designed and developed in collaboration with donor mothers and Milk Matters staff. While the project was a success, its long-term impact was reduced by the application's static nature, ultimately being removed from the Google Play Store due to its out-of-date content.

This year, my research partners and I aimed to redevelop and improve the old Milk Matters application. Our primary goals were to replicate and improve the primary functionality created by Wardle et al. [28, 29] and allow Milk Matters to manage and update the content presented on the new, 'dynamic', cross-platform (available on both Android and iOS[3] devices) mobile application. In addition to the mobile application a Milk Matters web-app was to be developed for managing the application's content, as well as a back-end system for data storage and to act as an intermediary between the donor application and Milk Matters web-app.

To develop a mobile application that remained aligned with our stakeholder's goals and intentions the team followed a co-design approach – involving both Milk Matters staff and donor research participants throughout the development process [7]. We conducted a three-stage interview and development process in collaboration with both Milk Matters and our donor participants, allowing each stage to inform and lead development. The three stages took us through an introductory and exploratory session with donor participants, followed by a prototype evaluation and a final evaluation of the developed application reviewed by the donor participants and Milk Matters.

We had to adapt our co-design and project management approaches to work within the constraints of the COVID-19 pandemic. All interactions with both Milk Matters and our donor participants had to be conducted remotely via Jitsi[4]. This included meetings, interviews and prototype and final application evaluations. In addition to interactions with our participants, internal team communications also had to be adjusted to accommodate for social distancing protocols.

This project is significant on several levels. First and foremost, the mobile application and supporting systems aim to aid communication and interaction between Milk Matters and their donors. Through this, we intend to increase awareness on the importance of milk donation and milk banks, ultimately increasing the number of milk donors in Cape Town. By technologically assisting the donor experience we aim to improve donor motivation and self-efficacy. Finally, this project provides motivation and inspiration for other NPO's who wish to improve their digital presence. By developing a dynamic mobile application and supporting systems, within a limited timeframe with minimal financial capital and operating costs, this project acts as a scaffold for the development of similar systems.

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2 Background

2.1 Milk Banks and Breast Milk Donation

The benefits of feeding infants with human breast milk have been studied extensively with the consensus that it is the recommended way of supporting the growth and health of infants, especially those born prematurely [1, 30]. Apart from improving feeding tolerance, it has beneficial effects on cardiovascular health, immune system development, and prevents Necrotising Enterocolitis - a concern when formula feeding preterm infants [1, 5].

Milk banks play an integral role in providing donor milk, with the vast majority feeding critically ill or preterm infants cared for in Neonatal Intensive Care Units (NICUs) [13]. Acting as an intermediary between donors and recipients, milk banks ensure the safety of the donated milk. This is of utmost importance due to the potentially deadly implications of providing tainted breast milk to at-risk infants [1]. This involves rigorous screening of donors and the preparation of donated milk (pasteurisation and fortification) to maintain microbial safety and to ensure the absence of any chemical pollutants [1]. In addition, milk banks are also a primary creator of educational resources to encourage new mothers to become milk donors [22].

2.2 Milk Matters

Milk Matters is a community-based breast milk bank in Cape Town [15]. They manage the pasteurisation and distribution of donations from screened milk donors to premature, ill, and vulnerable infants whose mothers are unable to produce the necessary breast milk.

Potential donors become involved by word-of-mouth and advertising in clinics and hospitals, however social media is playing an increasingly important role where most communication and news updates happen over email, Facebook[5] and WhatsApp[6]. Prospective donors need to complete a screening process before they can become registered donors and start collecting their expressed milk. Once they have collected enough frozen expressed milk, they can drop their donations off at a depot – usually a pharmacy or clinic - which collects and holds frozen milk donations until Milk Matters can collect them.

3 Related Work

3.1 Breast Milk Donor Motivations

Several authors have identified motivators for breast milk donors, however the main motivating factor is classical altruism: the desire to help others at one's own expense [12, 21, 22]. While altruism is the primary source of motivation for donors to

continue to donate, other factors play a role in motivating people who lactate to become breast milk donors. Many donors are initially introduced to the concept by health professionals who explain the importance of milk donation and, if possible, recommend that new mothers become donors themselves [12, 22].

3.2 Designing with Breastfeeding Mothers

Several methods have been utilised when performing design with mothers with varying popularity and success. D'Ignazio et al. followed a participatory design approach, involving 1000 mothers when identifying issues with existing breast pump technologies [8]. Yurman, in their research into the intersection of motherhood and technology, utilised cultural probes, design-led workshops and collaborative analysis to explore and define the design space [31]. In the development of Feedfinder, Balaam et al. made use of an iterative user-centred design cycle [2]. They too employed design workshops and cooperative evaluation to better understand the context of breastfeeding people. Wardle et al., in their work with Milk Matters, utilised several different methods when exploring co-design with breastfeeding mothers [28, 29].

A common theme throughout the existing literature is the attention paid to exploring, understanding, and remaining conscious of the sensitivities of motherhood. Feminist HCI, viewing interactions with technology through the lens of marginalised user groups, inspired and guided much of the aforementioned methodology and approaches [3, 8].

Working with breastfeeding mothers presents certain challenges, inherent to the nature of motherhood. Workshops and interviews can be interrupted by unhappy babies or feeding sessions [2, 29]. New mothers often have limited availability, which impacts their ability to participate in workshops or interviews [2, 29]. However, the constraints of the COVID-19 pandemic provided a unique opportunity to put Wardle et al., and Pedersen and Buur's recommendation of conducting research with new mothers online to the test [20, 29].

3.3 Persuasive Technology

Technology is being increasingly utilised to persuade or motivate people to embody certain behaviours or attitudes. Within the field of persuasive technology, two main avenues of implementation exist: persuasive design and gamification [14]. Gamification aims to incorporate features often found in digital games. Compared to traditional persuasive design, gamification aims to evoke a user's intrinsic motivations through "gameful experiences and affordances" [14]. Persuasive design aims to support a user's desire to have a behaviour or perform a task, or to persuade them to adopt a desired behaviour [10]. In the case of an application for milk donors, the persuasive system would play a supporting role for those who already have the desire to donate.

As the designer of a supporting system I had to consider the behaviour which the system is intending to support. All reviewed literature share the sentiment that the system's supporting

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[5] https://www.facebook.com/
[6] https://www.whatsapp.com/

techniques must be well planned and directed to have any effect on the user's behaviour or attitudes [14, 18, 27].

There are many ethical concerns regarding persuasive systems. A persuasive system ultimately aims to alter the user's behaviour according to the designer's intended result. Thus, there exists potential for the abuse of such power. By involving the donors in the co-design process, their input and opinions balance the power dynamic, allowing them to independently raise any concerns. Above and beyond this, as researchers we had to ensure that any persuasive system that we designed must be ethically sound.

4 Software Development Methodology

4.1 Project Management

An agile software development methodology was used, allowing the team to adjust according to any requirement changes or feedback received from Milk Matters and donor participants alike [4]. Each stage in the co-design process yielded insights into the functionality and its implementation. Following an agile methodology suited the project's short duration, avoiding the development of unwanted features.

To ensure all deadlines were met, the team adopted a SCRUM inspired daily meeting routine [24]. Each day, team members shared a voice message outlining their previous day's work, the work intended to be completed that day, and any issues which had arisen since the previous daily update. By following this strategy we maintained a clear understanding of our development progress and were able to coordinate integration of the systems components [24]. An outline of the project workload distribution can be found in Appendix E.

Integration of the system components was undertaken as early as possible in the development process. When functionality was developed on the back-end system its corresponding mobile application feature would be implemented, integrating the two systems. This forced the early resolution of any integration challenges, allowing us to avoid any potentially catastrophic integration bugs later in the development. In addition, by integrating the system components early, they could be regularly tested as they were now relied upon by the mobile application.

4.2 Development Tools

To develop, debug, and test the mobile application two Integrated Development Environments (IDEs) were utilized. Android Studio [7], the recommended IDE for developing Android applications, was used to develop and test the application on virtual Android devices. Due to the build requirements of iOS applications, the IDE XCode[8] was used to build, test, and debug the iOS version of

the application. Git was used as the version control system, and GitHub[9] as a remote code repository.

4.3 Testing

The functionality provided by the application is simple, and as such the testing approach aimed to test the overall functionality provided rather than individual parts of the code. A testing document was developed (see Appendix D), outlining the expected functionality of the various features. In this way, we ensured that the functionality worked as intended across a breadth of potential use cases.

4.4 Iterative Co-Design

To create an application that would be useful to donors, as well as remain within the various functional and non-functional requirements outlined by Milk Matters, all parties had to be integrally involved in the design and development of the application [7]. We had to ensure that our design and functionality decisions were drawn from the expert insights and perspectives of the intended users, rather than our own as the designers [23].

Donor participants were recruited by Milk Matters, reaching out to current donors and those who had recently stopped donating. While there was initially very minimal interest shown from potential donor participants, Milk Matters were able to reach out to and recruit four donor participants for the research.

Apart from our initial meeting with Milk Matters, engagements with both participant groups were organized into a 3-stage co-design process. Each stage had its own focus and overarching goals (see Fig. 1 for outline, and section 6 for further discussion). The first stage focused on introduction and exploration, which enabled the team to understand the context of the Milk Matters, milk donors and milk donation. Stage 2 was focused on to the mobile application prototype evaluation by the donor participants. Stage 3 saw the evaluation of the developed application, which evolved from the prototype and was developed between stages 2 and 3.

This research was granted ethical clearance by the University of Cape Town Ethics Committee. Informed consent was obtained from each participant, and we took great care to ensure that participants were always comfortable with the research and their participation in it. We remained flexible when scheduling and conducting interviews with Milk Matters staff and donor participants, remaining mindful of their contexts and constraints.

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[7] https://developer.android.com/studio
[8] https://developer.apple.com/xcode/

[9] https://github.com/

Stage	Date	Interaction	Participants	Objectives	Tools
1	7 April	Online meeting	Milk Matters CEO, Chelsea Wardle & research team	Introduce team to Milk Matters. Discuss project goals	Jitsi
1	9 July	Online meeting	Milk Matters CEO & research team	Define functional and nonfunctional requirements. Discuss shortcomings of old application	Jitsi
1	22 – 24 July	Online meeting	Milk Matters staff	Gain an overview of the organization, further discuss requirements and constraints. Finalise back-end solution (deciding whether to use Firebase or UCT-based server)	Jitsi
1	3 – 11 August	Online Survey	Milk Donors	Investigate donor experience, feature discovery, social media and technology usage, and bandwidth constraints	Google Forms
1	13 – 15 August	Online meeting	Donor participants	Further investigation of the donor experience, requirements discovery and analysis, and contextual exploration	Jitsi
2	20 – 22 August	Online Prototype Evaluation	Donor participants	Donor evaluation of the medium fidelity, Moqups prototype. Complete tasks and go through evaluation questions.	Jitsi & Moqups
3	11 – 17 September	Online Application Evaluation	Donor participants	Donor evaluation of the developed application. Complete evaluation tasks and go through evaluation questions.	Jitsi, Android Studio Emulator
3	15 September	Online Application Evaluation	Milk Matters staff	Demonstrate and showcase donor application and go through several evaluation questions.	Jitsi, Android Studio Emulator

Figure 1: Participant Engagement Overview

4.5 Co-Design in a Pandemic

The effect of the pandemic on the co-design process was significant. We had to adapt and focus on remote methods of engagement rather than face-to-face interactions. An adapted co-design approach was undertaken without the usual workshops, in-person interviews, and brainstorm sessions [7]; instead we leveraged online surveys , remote interviews, and virtual evaluation sessions. Although the online co-design process was hindered by the lack of face-to-face interaction, meeting times could be organized without transport and time related restrictions (besides those due to daily schedules).

Online interactions with Milk Matters and donor participants were conducted via Jitsi, a free and secure web-conferencing tool. It was chosen due to its free usage policy, its ease of use (interviewees need only to connect via the provided link, secured with a password), and its screen-sharing capabilities. Two researchers were present for each interview, with one acting as interviewer while the other transcribed. Importantly, the scribe introduced themselves in the beginning of the interview and then turned off their microphone and video camera to transcribe discreetly. This provided a more relaxed and informal interview environment for our participants.

5 Application Design and Development

5.1 System Architecture

The architectural design of the system (see Appendix C, Fig. 14) was greatly influenced by the need to utilize dynamic content – content that is stored remotely and which can be changed over time. This led us to follow a client-server architecture; each mobile application is a client that connects to and interacts with a server hosted and managed in the Google Cloud ecosystem – specifically Firebase.

5.1.1 Firebase

Google's Firebase [10] , a cloud platform which provides functionality such as a database, user authentication and analytics tools, was chosen to provide the required back-end functionality for the application. Firebase was chosen as a back-end platform for multiple reasons: it is entirely cloud-based, thus leveraging advantages such as high availability, scalability, low infrastructure costs and a pay-per-use cost model. This aligns with current software development trends and approaches, as well as the low overhead and start-up costs that are attractive for Milk Matters. Firebase's Realtime Database boasts built-in offline capabilities, enabling offline access by storing data locally. This ensured that bandwidth constrained users would still be able to use the mobile application.

5.1.2 Flutter and Dart

An integral requirement (see Appendix A) of the mobile application was that it should be available on both Android and iOS. In the past this required developers to create and maintain an independent, but functionally identical, application and codebase for each platform. Apart from increasing the workload and maintenance overhead, developers would need to be proficient in both Java/Kotlin (for Android development) and Swift (for iOS development) to develop both applications.

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[10] https://firebase.google.com/

The Flutter[11] framework built in Dart[12] - both developed and maintained by Google - was chosen for the development of the application as it reduces these overheads by allowing both Android and iOS applications to be built from a single codebase. In addition, Flutter compiles native applications, leveraging platform specific architectures and user interface standards.

The architecture of the mobile application, due to its reliance on content stored in a cloud database, heavily utilized Dart's asynchronous library. The Provider design pattern - the recommended approach to state management enabled by the Provider Package [13] - was used extensively to provide asynchronous access to the application's content stored in the cloud. A full package diagram of the mobile application can be found in Appendix C (Fig. 15).

5.2 Design

5.2.1 Design Language

The application's design follows Google's Material Design[14], which provides guidelines for designing visually attractive and user-friendly digital interfaces. The mobile application utilizes Material components - such as floating buttons and cards[15] - extensively. Expandable cards (Appendix B, Fig. 4.2 & 7.1) were used, reducing screen clutter and allowing users to view extra information for items they wish to better understand [16, 26]. The mobile application's design also leverages familiar mobile design iconography to help guide users in their interactions and navigation of the application.

5.2.2 Look, Feel and The User Experience

The mobile application was designed to align with the existing Milk Matters website and marketing material, utilizing their logo and similar colour palette to make it as distinguishable as possible. The colour palette chosen for the application (Appendix B, Fig. 13) served to create a soft and comforting interface.

A significant focus was placed on designing an intuitive and rewarding user experience. User interface guidelines, such as those described by Schneiderman et al. [26] and Nielsen [16], were closely adhered to when designing the interface and overall user experience. Form and input field validation was implemented throughout the application, allowing user errors to be corrected by providing informative and useful feedback [16, 26]. In addition, Flutter packages which provide widgets (functional interface components) in-line with either Android or iOS's design were used to uphold platform-specific design paradigms – Material Design for Android, and Cupertino[16] for iOS.

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[11] https://flutter.dev/
[12] https://dart.dev/
[13] https://pub.dev/packages/provider
[14] https://material.io/
[15] https://material.io/components/cards
[16] https://developer.apple.com/design/

The application's screens are consistent in their format [26] containing a title for the current screen and a navigation icon. This is either a menu icon to open the navigation drawer (Appendix B, Fig. 3.1 & 3.2), or a back button (e.g. Appendix B, Fig. 4.3). This feedback provides users with a clear understanding of the application's navigation, as well as their current location in the application [16]. Due to the application's reliance on asynchronous operations, loading wheels (Appendix B, Fig. 11 & 12) are used to clearly show the user when loading is occurring, providing insight into the systems operations [26].

5.3 Functionality

Much of the mobile application's functionality was ported from the old application, however additional features were added. In line with the requirements (Appendix A), all content shown on the educational resources, news and events and depot locator screens is retrieved from the cloud database.

5.3.1 Authentication

When first accessing the applications, users are required to login (Appendix B, Fig. 2.1) or create an account (Appendix B, Fig. 2.2). To grant more control, users can also reset a forgotten password (Appendix B, Fig. 2.3) using their email address. User accounts are automatically remembered on a device, improving the user experience by avoiding redundant logins.

User authentication provides the necessary credentials to securely manage the applications content, as well as allowing Milk Matters to monitor and analyse the application's usage. User accounts also facilitate the protection of sensitive content (such as milk depot locations) on the application. Before accessing locked areas of the application, users are required to enter their donor numbers. If their entered donor number is valid, they can view the sensitive content (Appendix B, Fig. 5.4 & 6.4). If not, they are provided with a message informing them of the specific issue [16].

5.3.2 Home Screen

The *Home screen* (Appendix B, Fig. 3.1) is the first screen users are shown once they have logged in. Its goal is to provide users with important, commonly accessed information.

It displays summaries of their donation amounts – namely their total donated amount, and the number of days of 50 ml feeds provided. These cards, when pressed, navigate the user to the *Donation Graphs screen* (Appendix B, Fig. 5.5 & 5.6). Below this, users are provided with buttons which redirect them to the respective social media application, or website if the application is not installed. This provides users with a way of connecting with Milk Matters online (Appendix A). The remaining space is occupied by a news and events feed, displaying news and events items added by Milk Matters in descending order by the date they were added.

5.3.3 Educational Resources

The educational resources section of the application consists of three screens, the *Education Categories screen* (Appendix B, Fig. 4.1), *Education Articles screen* (Appendix B, Fig. 4.2), and the *Suggest an Article screen* (Appendix B, Fig. 2.3).

Users can use the educational screens to explore educational articles approved by Milk Matters. Eight categories are shown on the education categories screen, which when pressed will navigate to the respective *Education Articles screen*. Each article can be shared directly from the application (Appendix A), allowing users to further engage with the content by sharing it with friends via social media, email, or other platforms. Importantly, shared articles inform the recipient that the content came from the Milk Matters mobile application, creating awareness for Milk Matters and the application.

In addition to reading articles, users can use the Floating Action Button (Appendix B, Fig. 4.1 & 4.2) on the categories and articles screens to navigate to the *Suggest an Article screen*. Users can further engage with Milk Matters by suggesting educational articles that they believe should be added to the application.

5.3.4 Donation Tracker

Donors can use the donation tracker to record milk donations, view their donation history, visualize the impact of their donations, and declare donation drop-offs at a depot.

The *Donation Tracker screen* (Appendix B, Fig. 5.1) contains several elements. Two buttons at the top of the screen indicate the total amount of milk donated, and the number of days of 50 ml feeds that the donor has provided. When pressed, the user is navigated to the *Donation Graphs screen* (Appendix B, Fig. 5.5 & 5.6) which displays two tabs, each containing a graph. These show cumulative line graphs of their donations, and the number of days of 50ml feeds. The graphs are fully interactive, supporting both zooming and panning (Appendix B, Fig. 5.7).

Donors can record donations by pressing the *'Record a Donation'* button to navigate to the *Record a Donation screen* and entering in the donation amount and date. A donation history list, titled *'Your Donations'*, provides donors with their donation history and whether the donation has been dropped off at a depot [16]. Donors can also use the *Declare a Drop-off screen* declare a donation drop-off (Appendix B, Fig. 5.3), selecting which donations they dropped off and at which depot. This improves donor engagement with Milk Matters and reduces donor admin overhead, allowing them to declare drop-offs via the application rather than informing Milk Matters manually.

5.3.4 Depot Locator

The *Depot Locator screen* (Appendix B, Fig. 6.1) displays a familiar Google Maps map on which several pins are placed, each indicating the location of a depot. Each pin, when pressed,

provides the user with depot specific information (Appendix B, Fig. 6.2). If a user selects a pin, they are shown two buttons which open their default navigation application, either showing the location of the depot or providing directions to that depot. If the user grants the required permissions (Appendix B, Fig. 6.5) their live location will be shown on the map, improving usability [26].

The *'Find My Nearest Depot'* button allows users to find their nearest depot [16]. The *'Depot List'* button navigates the user to the *Depot List screen*, which displays a list of the depots (Appendix B, Fig. 6.3), their details, and several buttons which, when pressed, focus the map on that depot's location. Both buttons improve the usability of the depot locator.

5.3.5 News and Events Feed

The *News and Events screen* (Appendix B, Fig. 7.1 & 7.2) display a list of Milk Matters news and upcoming events. Each news and events item is shown as a separate expandable card, providing details on the specific item. Each unexpanded card displays the title, date posted and URL to the item. Once expanded, it provides a longer description of the item. As with the education articles, news and events items can be shared using the *'Share'* button.

5.2.6 Frequently Asked Questions

The *Frequently Asked Questions screen* allows users to find answers to common questions without leaving the application (Appendix B, Fig. 8). This is a valuable resource for both prospective donors and current donors. Each question is shown on an expandable card, which when expanded provides the answer to the specific question.

5.2.7 Become a Donor

The *Become a Donor screen* (Appendix B, Fig. 10) provides prospective donors with a short pre-screening questionnaire; brief and information questions whose answers are required by Milk Matters before beginning the donor screening process. Once the user has answered all the questions, they can press the *'Submit Application'* button. This opens a new email on their device's email client, populated with generated text outlining their answers to the questions and informing Milk Matters that the questionnaire was answered on the mobile application. This can then be sent to Milk Matters at the user's discretion.

5.2.8 Contact Milk Matters

A *Contact Milk Matters screen* (Appendix B, Fig. 9) is included in the application to provide users with general information about Milk Matters, namely their mission, values, and contact information.

6 Findings

6.1 Requirements Analysis and Contextual Discovery

6.1.1 Introductory Milk Matters Meetings

In our first, introductory meeting with Milk Matters we discussed the previous application, its shortcomings, and their envisioned outcomes for the project. A rough outline of the functional and nonfunctional requirements was created, which were expanded and refined in our second meeting (see Appendix A). These initial meetings provided an opportunity for the team to discuss milk banking, its contextual sensitivities, milk donor recruitment and the project goals.

6.1.2 Donor Survey

Our initial interaction with Milk Matters donors was via an online survey [17]. It investigated several aspects about the donors: their personal experience with milk donation, features they would like to see in Milk Matters mobile application, their technology and social media use, and their bandwidth constraints.

The 7 responses to the survey yielded valuable insight. Almost all respondents felt that a Milk Matters mobile application should provide the same functionality as the old application. We confirmed that a cross-platform application was required, with an almost even split of iOS and Android users. We discovered that almost all the donors were active on some social media (the majority being Facebook [18]), would share Milk Matters related content, and were not bandwidth constrained.

6.1.3 Milk Matters Interview

Our first interview with the two Milk Matters staff members focused on gaining an overview of the organization, and their operational and limitations. The underlying need for managing the application's content was discussed; Milk Matters must be able to update the application's content, allowing them to ensure that it remains true and up to date. Furthermore, updating the content ensures the application's long-term impact and value. Milk Matters also wanted to leverage the dynamic nature of the application, using its operational data to aid decision making. The issue of security was also raised, and it was reiterated that access to sensitive content, such as depot locations, had to be restricted to current donors.

An important goal of the application was to aid interaction between donors and Milk Matters; however, this would need to remain conscious of their limitations as relatively small NPO.

The sensitive context of milk donation was discussed extensively, focusing on the value of donor milk [25]. Any amount of donated milk is valuable, and the application had to reinforce this. The application's functionality and design had to be mindful of the uniqueness of donors and their milk production by affirming and supporting them regardless of their donation amounts [29].

6.1.4 Donor Interview

Through our initial interviews with donor participants we gained exposure to the nuances of the donor experience. Our participants' donation history differed and included both first- and second-time donors.

The participants all donate for altruistic reasons; however, some simply donated their excess expressed milk [12, 21, 22]. They express and store milk which they value, and instead of letting it go to waste, choose to donate it [12]. The donor participants all felt motivated by knowing the impact of their donation. Receiving feedback from and interacting with Milk Matters also provided a motivational boost to some of the donors. The sentiment that becoming a Milk Matters donor was a simple task was shared by almost all the donors, however, one donor found the task challenging due to her busy schedule.

Interestingly, all the donor participants are not, or no longer, tracking their donations, but expressed a keen interest in using the mobile application to do so. They also all made use of online educational resources, most of which are from relevant social media groups [29].

The donor's sentiment about sharing their donor status, either in person or on social media, varied. Some felt proud to be donors, and shared milk donation related content on social media or encouraged friends to donate, while a few felt hesitant about speaking about breast milk donation in their social circles due to the associated stigma [22].

6.2 Prototype Evaluation

6.2.1 Approach

The usual in-person low-fidelity prototype evaluation process needed to be reimagined due to the social distancing constraints. The team decided to create an online paper prototype using Moqups [19], a web-app which enables teams to collaboratively develop digital prototypes. The evaluations were conducted online similarly to those in section 6.1, however the interviewer acted as an intermediary between the participant and the prototype by following and acting upon their instructions. The evaluation consisted of a series of tasks (Appendix E) which the participant would attempt 'through' the interviewer while explaining their mental processes [17], followed by several questions about the prototype and the evaluation process.

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[17]docs.google.com/forms/d/1wzBX3FdJ-
YkAUyAOlHSaI5DVZFzGLEw3YldgDilQjk8
[18] www.facebook.com

[19] https://moqups.com/

6.2.2 Donor Evaluation

The application's functionality was positively received; however, several usability issues were raised. All the participants struggled to login into the application, assuming that they would already have accounts. The issues of lacking a password reset option and remembering an account after login were also raised.

When someone becomes a Milk Matters donor, they receive a donor number. The prototype's user experience required donors to register their donor number, so that it could be verified by Milk Matters. Donors could then use this verified donor number to access sensitive information on the application. Completing this proved challenging for most of the participants, sharing sentiments such as, "I wouldn't know what to click", and "How would I do that?" when being asked to register their donor number. The confusion felt by the participants was captured by a particular comment, "Wouldn't I be registered already?".

Sensitive content was secured by requiring users to enter their donor numbers. All the participants took issue with this, with comments such as, "I'm not sure why it's necessary, I would do away with it.". Another participant, when asked about their least favourite aspect of the prototype said, "… having to enter my donor number at each stage".

Most of the participants praised the donation tracker and its accompanying functionality. Almost all felt that this was their favourite feature, particularly the graphs providing a visual representation of their donated amounts.

6.3   Application Evaluation

6.3.1 Approach

The final application was developed between stages 2 and 3 and evaluated in a similar manner to the prototype. The application was run on an Android emulator on the interviewer's computer, who shared their screen to allow the participant to see the running application. As in stage 2, participants would dictate instructions, which were then carried out by the interviewer. First, participants attempted several tasks (Appendix E), which reviewed all the application's functionality [17]. After this, they were asked several questions about the application to discuss the overall design, any challenges they faced, and their user experience.

6.3.2 Donor Evaluation

The participants were able to complete the tasks, often on their first attempt. When questioned about the application's usability all participants answered positively, sharing that "It's self-explanatory, it's not difficult to find anything". The introduction of input validation added positively to the user experience. When participants made input errors, they were able to correct the mistake by following the error prompts without any direction from the interviewer [26]. Tasks that were challenging to participants in the prototype evaluation, such as finding contact information or their nearest depot, were completed with ease in

the final application. The participants were also pleased with the streamlining of the user experience, with one participant stating that "It's simple and straight-forward".

When discussing the application's colour scheme the participants responded positively, with one stating that "it fits Milk Matters really well". In addition, no colour interference or readability issues were raised. The participants expressed similar sentiments when discussing the design of the interface, saying that it looks "all light and neat", and "… really good, super impressive".

Donors expressed their appreciation of the donation tracker and associated functionality with comments such as, "I've donated so much, but I had no visual representation of it", when discussing the donation graphs. Two of the donors were particularly pleased with the donation drop-off functionality and its ability to reduce their admin, "Before I used to email Milk Matters when I dropped off milk, which is a bit extra on your admin list. But now you can just go on the app and declare the donation".

Overall, the participants were pleased with the application and its user experience. One shared that the functionality it provides "makes it a lot easier to donate". As in the prototype evaluation, most felt that the donation tracker was their favourite feature – "It's nice to know you've donated so much milk and fed so many babies. It makes it more real".

While much of the feedback we received was positive, a few usability concerns were raised. Some participants were confused by their interaction with the become a donor screen, or where to tap to edit a donation date. Another participant raised the issue of the "confusing" website icon. However, one participant stated, "It's not obvious, but I'd figure it out". In summary, the usability issues that were uncovered in the final evaluation had a minimal impact on the application's usability.

6.3.3 Milk Matters Evaluation

The Milk Matters staff members received the mobile application well and were pleased with its overall appearance and design. Both staff members were pleased with the colour scheme, feeling that it remained consistent with the existing Milk Matters aesthetic. They believed that the graphs and donation tracking features would be a good motivator for donors. They were also grateful for the interactivity that the back-end system provided for the application, specifically the declaring of donation drop-offs, and that the completed pre-screening questionnaire would be sent directly to Milk Matters.

7 Discussion and Analysis

7.1 Application Evolution

7.1.1 Implementing Stakeholder Requirements

As the application is primarily a tool for Milk Matters, it needed to strictly adhere to their requirements, even when the implications were met with resistance from the donor participants. One such example is the security checks to limit the access of sensitive content. Almost all the participants took issue with the security check, deeming it a "stumbling block" in the user experience. However, after discussing and explaining the need to secure the application's sensitive content they all valued its inclusion. It was clear that although it negatively impacted the user experience, the donors were willing to compromise once they had been informed of its purpose. Thus, to better inform users of the security check's purpose, short explanations of its necessary inclusion were added to the relevant screens (Appendix B, Fig. 5.4 & 6.4).

7.1.2 Improving the User Experience

During the prototype evaluation the participants raised the issue of the experience of registering their own donor numbers, interpreting it as "strange". It became clear that it was a confusing interaction that they weren't expecting. Following these complaints, that aspect of the user experience and functionality was removed from the application. Instead, the registering of donor number became Milk Matters' responsibility. While this did slightly increase the overhead for Milk Matters, it improved the overall user experience which is the most important aspect of any application.

From the interviews with the donors we were made aware of the value placed on any interaction and feedback they receive from Milk Matters. To leverage this, various 'pop-ups' (Appendix B, Fig. 6.6) were included in the user experience to provide further interaction, such as thanking the users for declaring a donation drop-off or suggesting an article.

Several improvements were made to the application's interface and user experience based on the feedback from both evaluations. Greater freedom was provided to donors, for example, allowing them to individually select which donations are included in a drop-off declaration, as well as allowing users to reset their account passwords. Additional labels were added to the user interface elements when the lack thereof caused confusion [16, 26]. Menu items were renamed to make their purpose more understandable, such as changing 'About Milk Matters' to 'Contact Milk Matters' and 'Education' to 'Educational Resources'. These resulted in a noticeable user experience improvement between the prototype and final application.

7.2 Reflections on Socially Distanced Co-Design

Socially distanced co-design presented a host of challenges to overcome; however, it did come with its advantages as well.

While interactions with both Milk Matters and donor participants were rarely without time consuming technical glitches, holding interviews remotely gave our participants more freedom when choosing interview times. This was particularly important for our donor participants, whose time constraints associated with motherhood were further compounded by the work-from-home dynamic of the pandemic [2, 20, 29]. We also had to remain conscious of our participants new anxieties and stressors caused by the pandemic.

While we did begin this project with the understanding that any donor interaction would potentially be interrupted, it did not present a large issue [2, 29]. In fact, only a few interviews were interrupted by babies, with most taking place without any interruption. This may be due to the freedom afforded by remote interactions, with participants opting for interviews during less busy times. Perhaps due to the interviews being conducted remotely we found that once donors became interrupted and distracted by their babies, they were less inclined to engage with the interviews, answering questions quickly and tersely. This should be a consideration for any future work involving remote interactions with new mothers.

From the onset of the research, we endeavoured to remain aware of the context in which we were working. As three males conducting research into a context as sensitive as motherhood, breastfeeding, and milk donation, we strove to gain as much knowledge of the context, learn from our participants, and always act professionally. The feedback we received from our participants in this regard was positive and rewarding for the researchers. They shared that, "You guys have been very mature, and I haven't felt at all uneasy having to talk to you. You made me feel comfortable", and "You guys were very professional, I felt comfortable". These comments show that our efforts were acknowledged and appreciated.

Milk Matters were pleased with the way in which this project was conducted, praising the team's good communication. Initially the project seemed stalled by the team's lack of understanding and exposure to the contextual nuances of milk donation. However, through discussion and dialogue with Jenny (Milk Matters CEO), the team were able to improve their understanding. Our growth was made clear by Jenny's positive comments in the final application evaluation, stating that all her concerns were addressed and successfully dealt with.

The evaluation methods used for the prototype and final application were received with mixed feelings. Most of the participants noted that they felt "awkward" dictating their interactions. During the evaluations we noticed that the participants were hesitant to explore the interfaces before completing tasks. This may be due to it feeling "unnatural" and the expectation to complete a task rather than merely exploring the interface: "It was a bit strange. I would've immediately touched buttons, but I had to tell you and wait.". This may have

also been the cause of some of the usability challenges that the participants encountered.

During the final application's evaluation, it became clear that the participants were able to navigate the interface easily. When questioned about this, they felt their initial evaluation of the prototype aided their ability to navigate and use the final application. While this was unavoidable, having separate groups of donors evaluating the prototype and final application would have provided a more accurate representation of the application's usability.

7.3   The Duality of Google's Flutter and Firebase

This project required that I learn and become familiar with Dart and the Flutter framework. While Dart's similarity to other object-oriented programming languages made it easy to grasp, Flutter provided a more challenging learning experience. The widget-oriented paradigm utilized by Flutter provides an intuitive way of building interfaces whose code is easy to read and analyse. The available official and third-party Flutter packages proved valuable, providing well designed interface components, simple integration with other services, and out-of-the-box functionality.

The tools made available by Google, particularly Flutter and Firebase, are powerful. The generous free tier, and the pay-per-use cost model are viable options for small NGOs/NPOs, and paired with the Flutter framework results in a valuable toolset which could be used to rapidly develop and improve their digital presences.

While building an application with Google's Firebase and Flutter was effective, one needs to remain mindful of the implications of using the platform. Vendor lock-in, becoming 'locked in' and reliant on a single platform or companies services and infrastructure, can be extremely detrimental due to the inherent difficulty of switching to another service provider and the power dynamic it creates [19]. By using a tech-stack entirely reliant on Google, and by extension Alphabet Inc., we are contributing to the growing power of the, predominantly American, technology corporations. In addition, by utilizing Firebase and ultimately the Google Cloud Platform[20], we contribute valuable usage data which is, in the age of Big Data, used to continuously improve their services [11]. Unfortunately, the value of this data and its impact are often not attributed to the users but used to improve the service without any compensation.

7.4   Research Constraints

7.4.1 Research in a Pandemic

Conducting research in a pandemic was challenging and placed hard limits on how the researchers could communicate with each other and their participants. Meetings had to be held online and

were often plagued with technical and connectivity issues. While an argument can be made for remote meetings allowing greater scheduling freedom, the work-from-home approach comes with its own host of challenges, both collectively and individually. A particularly challenging aspect of the project was the conveying of design, user experience, and technical ideas to fellow researchers; having to describe ideas verbally when a diagram or white-board explanation would have been simpler. However, we were able to adapt and overcome these challenges by maintaining active communication channels, with the team often meeting several times per week. Online tools, such as draw.io[21], paired with screensharing capabilities played an important role in enabling the team to adapt to remote teamwork.

7.4.2 Working with an NPO

Working with Milk Matters, a small non-profit organization, presented certain challenges as well. Due to their small team size, they were often extremely busy [29]. This made scheduling meetings, interviews, and evaluations challenging. In certain circumstances, the requirements defined by Milk Matters conflicted with what the participants wanted. For example, many participants disliked the security checks and felt that it was "a stumbling block" in their user experience; however, this was a firm requirement made by Milk Matters. While the conflict between stakeholder requirements is inherent to software development [6, 9], we had to balance the expectations of both parties and explore potential compromises to maintain a high level of stakeholder satisfaction.

7.4.3 Considering Biases

Our donor participants provided valuable insight and feedback throughout the research, however the possibility that they may be outliers in the milk donor population must be considered [21]. Now more so than before, participating in research is demanding. The fact that our donor participants were voluntarily willing to participate in this research reveals their biases – an interest in the topic and field, and particularly towards milk donation and Milk Matters. By participating and giving up their time, they proved that they have an appreciation for Milk Matters and value milk donation. This may be why primarily positive feedback was received when discussing the mobile application's design and functionality, in both the prototype and final application evaluations. In addition, due to their respect for Milk Matter's work and the fact that the researchers may have been perceived as working for Milk Matters, they may have felt uncomfortable criticizing the organization or the mobile application. While this was unavoidable for this research, it introduced certain biases.

While these factors may have constrained the research, they by no means inhibited the researchers from conducting important research and building valuable software.

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[20] https://cloud.google.com/

[21] https://app.diagrams.net/

7.5   Maintenance and Sustainability

Minimizing the maintenance overhead of the application and the entire system was an important requirement for Milk Matters and guided our approach. By only utilizing cloud technologies we ensured a high level of availability and scalability. We chose this approach over hosting the back-end system on UCT infrastructure. This not only allows Milk Matters to have full control over the system for future development, but it also removes any reliance on UCT infrastructure, avoiding the effects of load shedding, hardware failure and organizational changes.

In decreasing the maintenance requirements for this system, we improved its overall sustainability. We opted to utilize highly adopted technologies, which will be supported for the foreseeable future. This similarly motivated our choice to develop the mobile application in Dart using the Flutter framework. Both have been supported by Google since 2018, with no signs that it will soon falter. By developing the application with a relatively new but supported and widely adopted technology stack we ensured that future projects building on this work can expand upon the software, rather than having to rebuild it. The complete and comprehensive documenting of the system's code (Appendix G) further increases its sustainability, ensuring that any future expansion of the system can be done with ease.

The sustainability of the application was investigated in the final evaluation. All participants stated that they would use the application, showing promising signs for ensuring user retention and the long-term adoption of the application.

8   Conclusions and Future Work

This project aimed to redevelop and improve the old Milk Matters application developed by Wardle et al. [29]. The requirements, outlined by Milk Matters, helped create a roadmap for the applications development with a focus on building an updatable and dynamic cross-platform mobile application.

Through a co-design process, adapted to work within the constraints of the COVID-19 pandemic, we were able to work with donor participants; first creating and evaluating a prototype inspired by the old application, then developing the final application. By following an iterative co-design process, we ensured that both Milk Matters and their donors would receive a valuable tool which met their specific requirements.

Following the evaluation of the final application with both donors and Milk Matters, we believe this project was a success. We managed to meet the requirements and expectations, receiving positive and constructive feedback from Milk Matters and the donor participants. The donors felt that the application would support them as milk donors by improving their motivation to donate and facilitating interactions with Milk Matters.

Future work on the mobile application could include implementing the omitted features, such as tracking the expiry

dates of recorded donations, or exposing general donation statistics to improve motivation and a feeling of involvement [13]. In addition, as Milk Matters moves to a new track-and-trace system, there exists a need integrate it into the mobile application. This would give donors more information about the destination, processing, and impact of their donations, ultimately improving donor motivation and satisfaction [12, 21].

While a long-term evaluation is required to adequately measure the impact of this project, the feedback received was encouraging. By improving the donor experience for Milk Matters donors and providing tools to enable prospective donors to pursue donating, we aimed to increase the awareness of breast milk donation and the availability of donor milk, ultimately saving the lives of vulnerable infants.

10   Acknowledgements

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Appendix

A. Milk Matters Requirements

Functional Requirements

Only the mobile application's requirements have been included for brevity.

Mobile Application Requirements:

- Allow donors to manage their own accounts (create and reset passwords).
- Maintain all functionality from the old Milk Matters application:
    - A depot locator, allowing donors to locate depots and their details.
    - A collection of educational articles covering a range of relevant topics.
    - A donation tracking tool and resulting visualisations of their donations.
    - A donor pre-screening questionnaire.
    - Milk Matters contact information.
- Improve the pre-screening questionnaire and allow users to submit their application to Milk Matters.
- Provide donors with a several frequently asked questions and their answers.
- Allow donors to declare their donation drop-offs at a specific depot via the application.
- Provide functionality to share (via social media, email, etc.) certain content on the mobile application.

Non-Functional Requirements.

System Requirements:

- Seek to remain as cost effective as possible, particularly with the operational costs of the system.
- Minimise the cost, both financial and time, of maintenance or change to the system.

- All sensitive donor data should be stored and accessed securely.
- Ensure the privacy of donor data.
- The system should maintain a high availability.
- Support the updating of mobile application's content.
- Provide dynamic content to the mobile application.

Mobile Application Requirements:

- Support both the Android and iOS operating systems.
- Support offline use, i.e. supporting users with intermittent internet access.
- Improve and draw inspiration from the old Milk Matters application interface.
- Content shown on the application should be dynamic i.e. updatable.
- The application interface design should mimic and draw inspiration from existing Milk Matters content.
- The user experience should be user-friendly and offer functionality to both donors and non-donors.
- Limit access of sensitive content so that it is only available to authorised donors.

User Experience Requirements:

- Remain sensitive to the varying donation amounts that donors donate and support all donations equally.
- Avoid features that could create competition.
- Foster encouragement and support for the donors.
- Provide support and positive reinforcement to donors through in-app notifications, pop-ups, and guiding text.
- Allow donors to engage with Milk Matters on the application:
    - Viewing their social media pages
    - Support sharing of certain in-app content
    - Suggest new educational articles
    - Complete and submit a pre-screening questionnaire

B. Mobile Application Screenshots and Design

Authentication
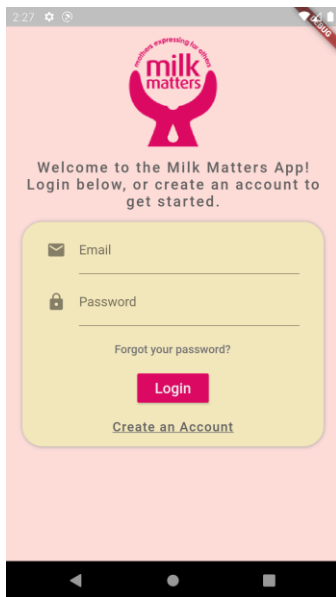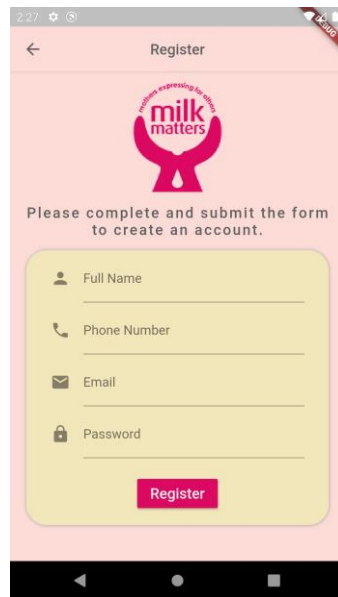
Figure 2.1: Login   **Figure 2.2: Register**   **Figure 2.3: Forgot Password**
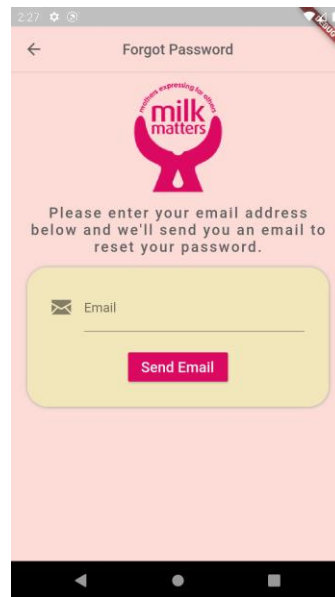
Home Screen
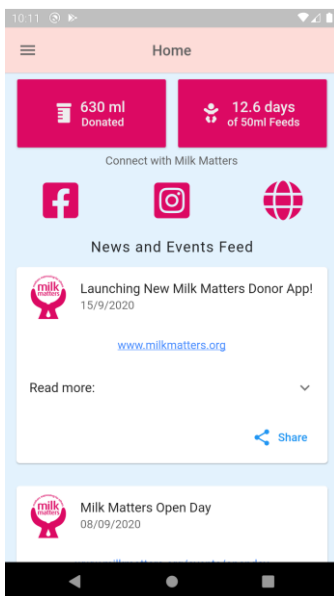
Figure 3.1: Home Screen   **Figure 3.2: Application Navigation**
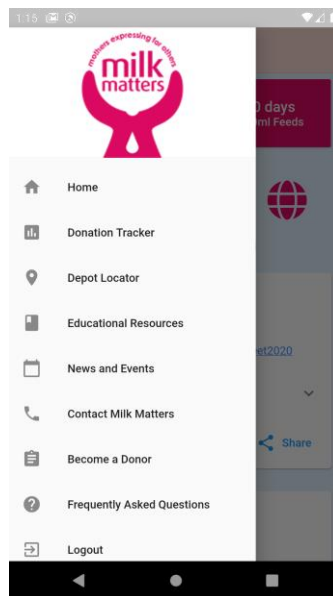
Educational Resources

Figure 4.1: Education Categories
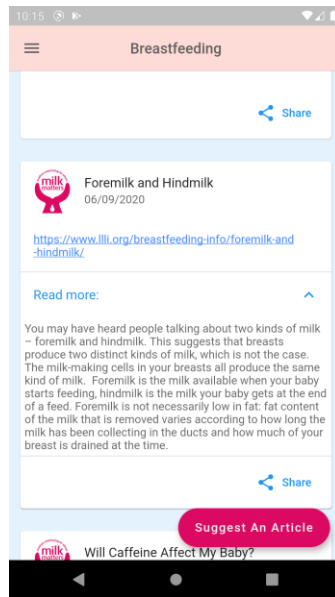
Figure 4.2: Education Articles
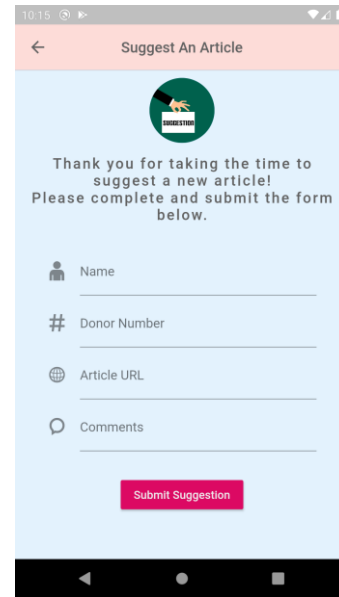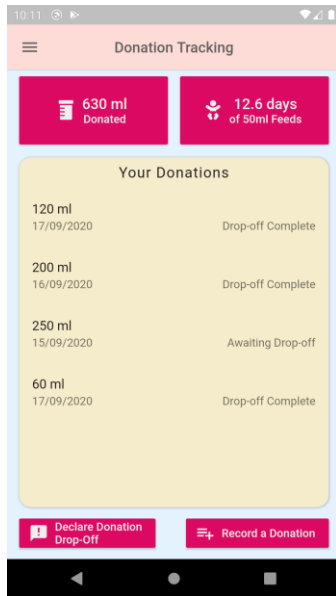

Figure 4.3: Suggest an Article

Donation Tracker

Figure 5.1: Donation Tracker
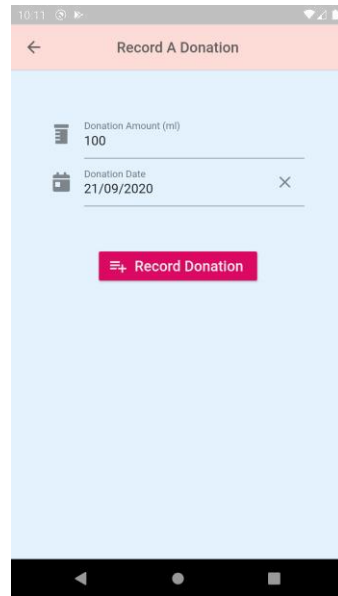
Figure 5.2: Record a Donation
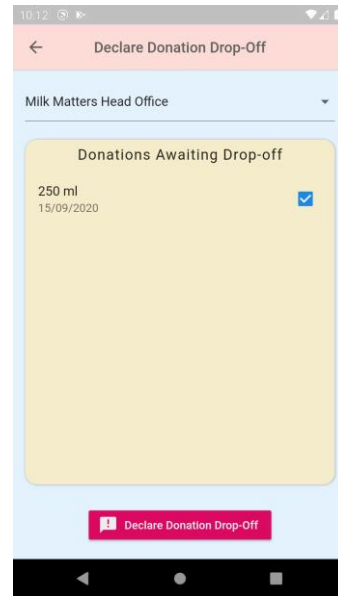
Figure 5.3: Declare a Donation Drop-off
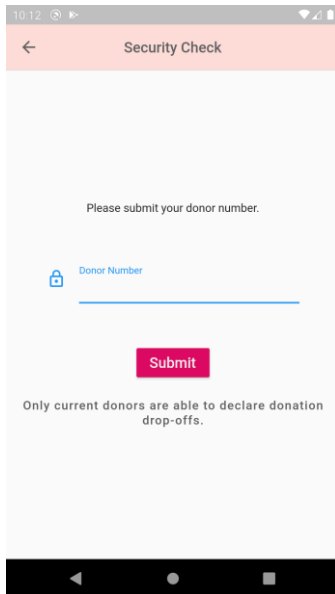
Figure 5.4: Declare Donation Drop-off Security Check
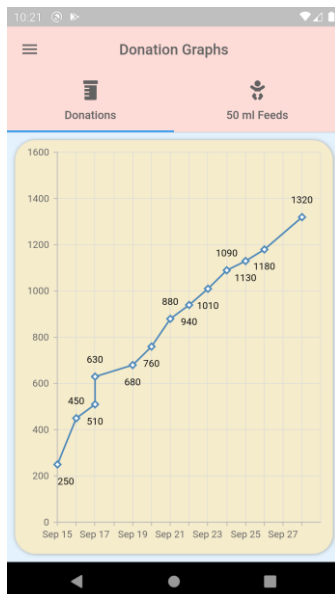
Figure 5.5: Total Donation Amount Graph
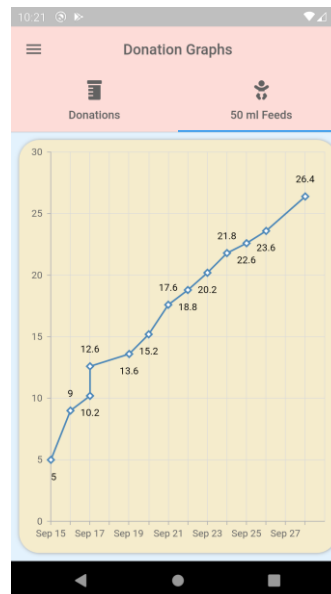
Figure 5.6: 50 ml Feeds Graph
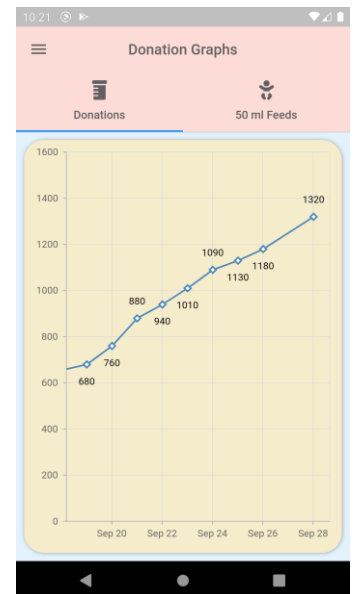
Figure 5.7: Total Donation Amount Graph (zoomed and panned)

Depot Locator
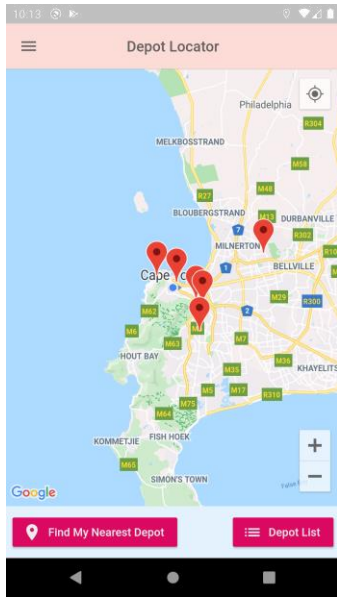
Figure 6.1: Depot Locator
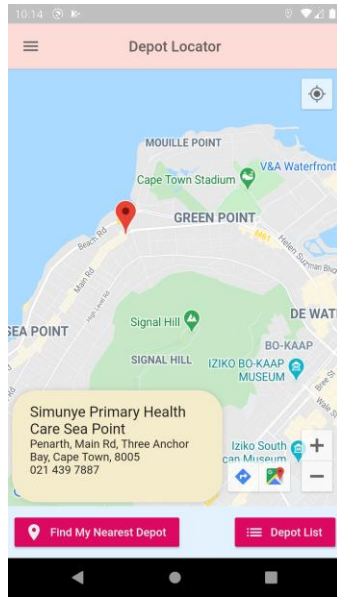
Figure 6.2: Depot Pin
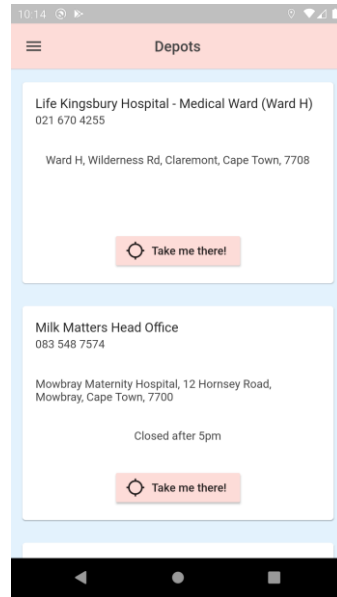
Figure 6.3: Depot List
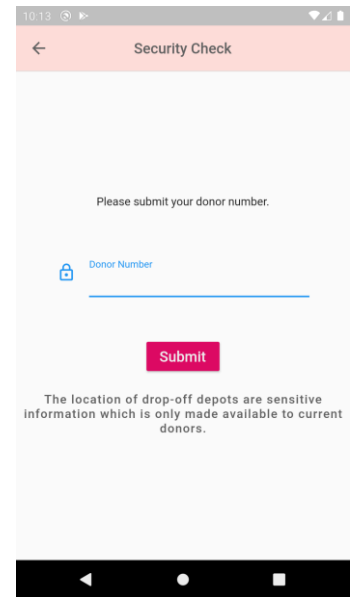
Figure 6.4: Depot Locator Security Check
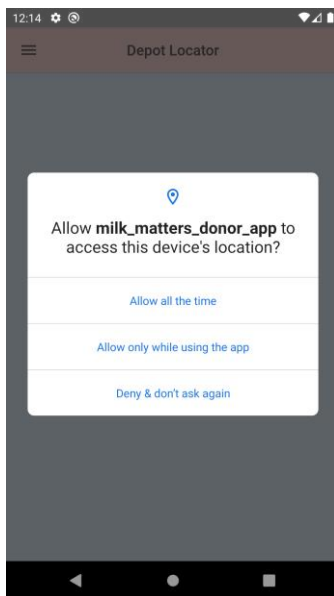
Figure 6.5: Request Location Permissions
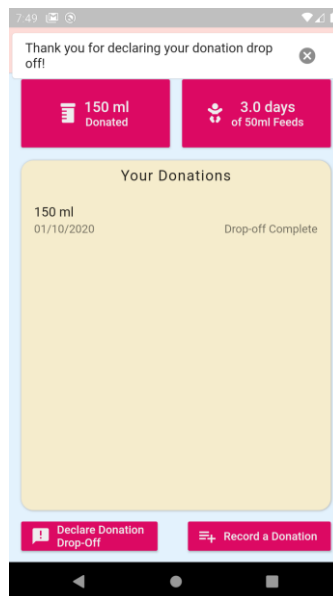
Figure 6.6: Pop-up Notification

News and Events
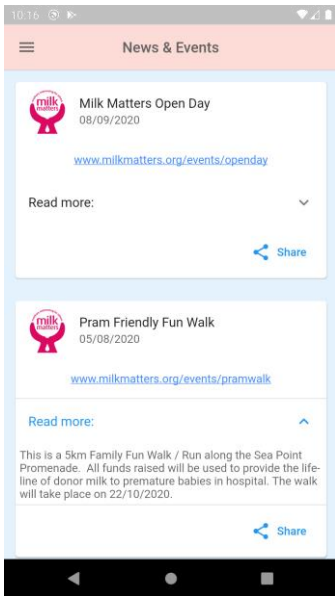
Figure 7.1: News and Events
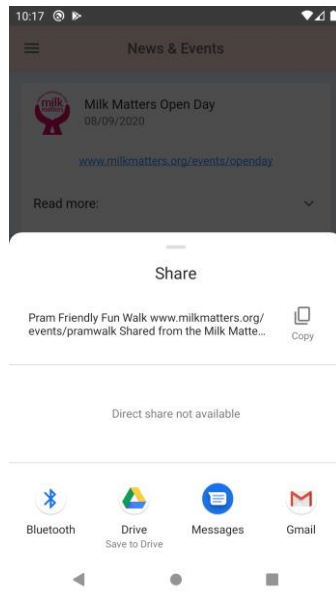
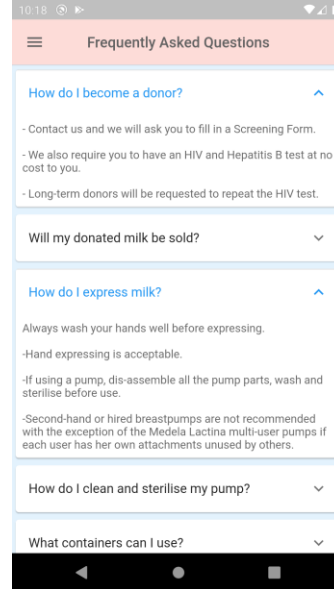**Figure 7.2: Sharing an Event**

Frequently Asked Questions

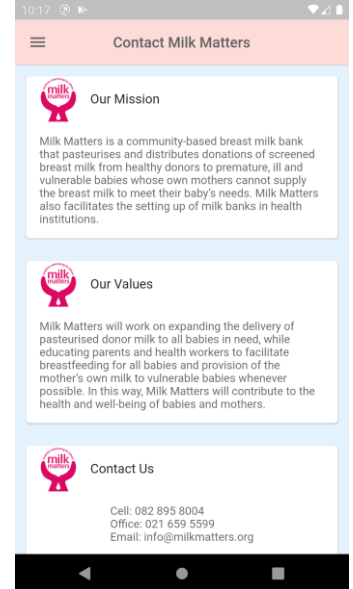**Figure 8: Frequently Asked Questions**

Contact Milk Matters

Figure 9: Contact Milk Matters
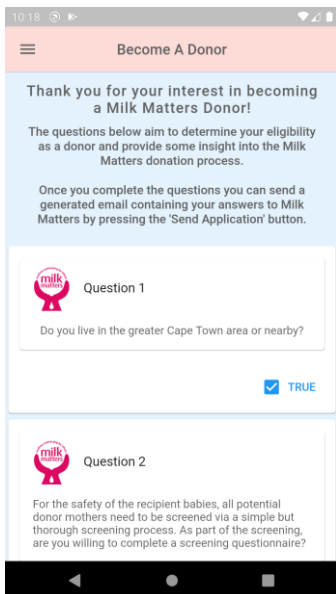
Become a Donor

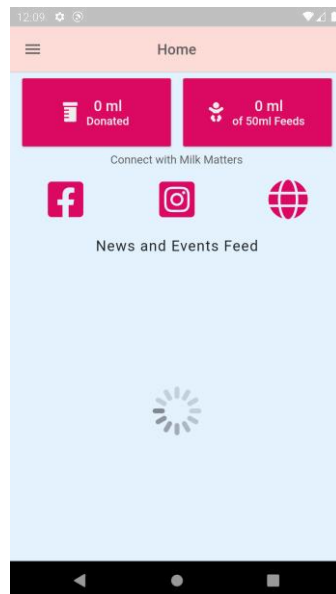**Figure 10: Become a Donor**

Content Loading

Figure 11: Loading Indicator for Dynamic Content
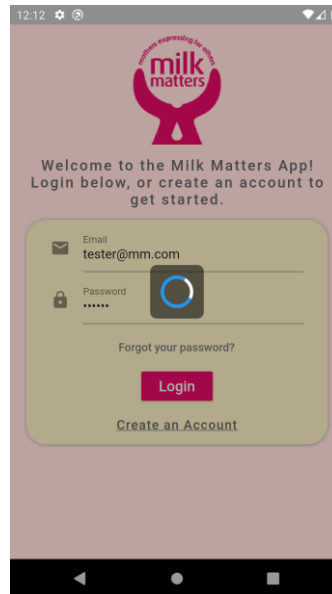
System Visibility

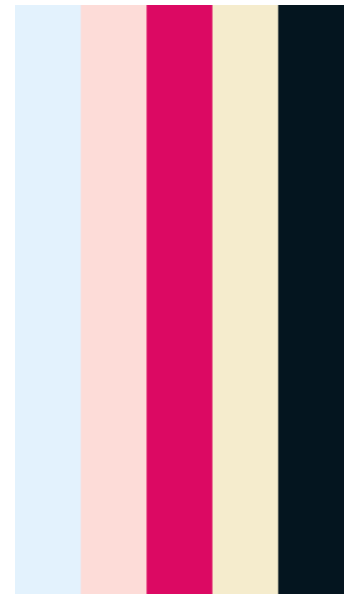**Figure 12: Loading Indicator for System Processing**

Figure 13: Mobile Application Colour Palette

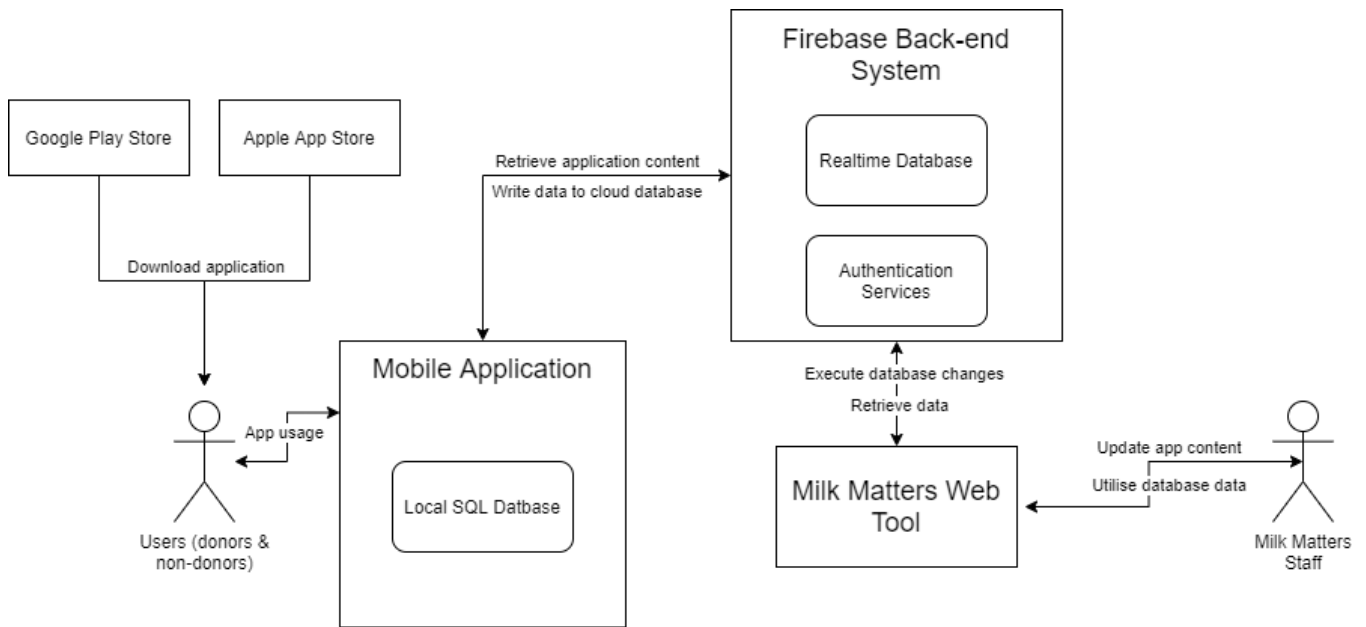## C. System Diagrams

1. High Level System Diagram:

Figure 14: High Level System Diagram
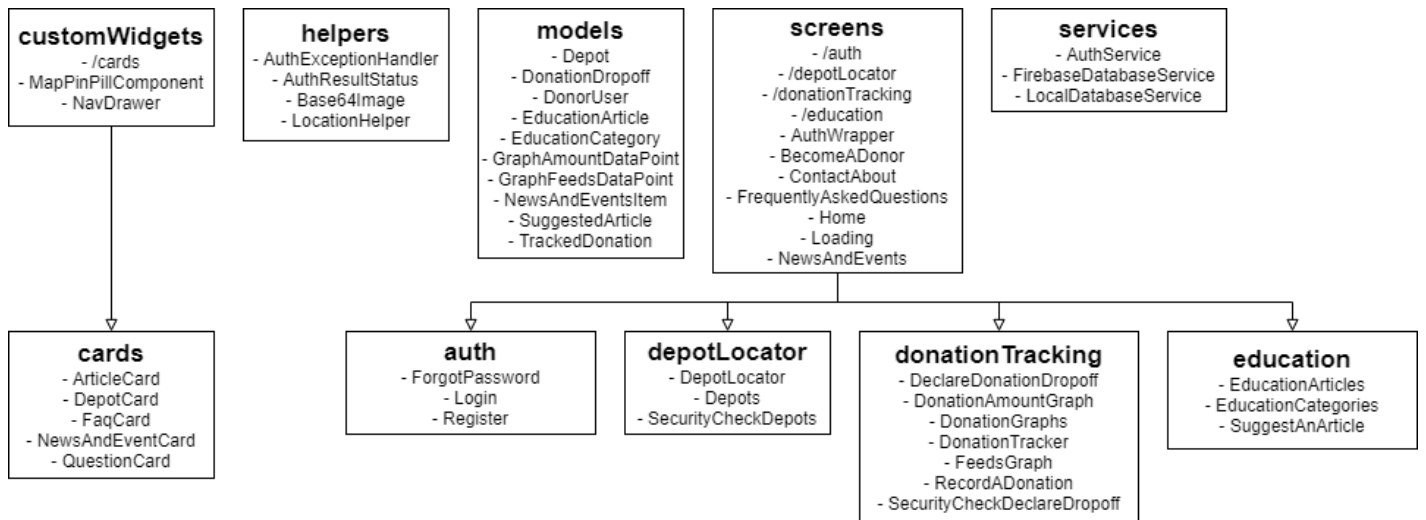
2. Mobile Application Package Diagram:

Figure 15: Mobile Application Package Diagram

D. Application Testing

Since much of the functionality on the application is simplistic, a testing plan was created, covering potential use-cases and the expected behaviour. An evaluation was carried out and successfully completed, ensuring that the functionality works as expected.

Dynamic Content:

- Content updated, added, and deleted on the Milk Matters web-app reflects on the mobile application.

Authentication:

- Only users with valid credentials can login.
- Users can successfully register accounts, creating a Firebase Authentication account and storing user details in the Database.
- Form validation (validating required fields, emails, and phone numbers) works correctly for the login, register and forgot password screens.
- Users without registered accounts cannot request a password-reset email.
- Users without donor numbers are told so when failing a security check.
- Only valid donor numbers can pass security checks.

Education:

- Articles relating to the selected category are shown.
- Article links open the device's browser when pressed.
- Form validation works correctly for suggest an article screen.
- Users can share articles correctly (correct article details are shared, sharing support for all platforms – email, social media, etc.).

Donation Tracking:

- Donation history is shown with the most recent donations first.
- Donation history shows all tracked donations, and with the correct details.
- Form validation works correctly when recording a donation.
- Tracked donations appear correctly, and with the correct information.
- Tracked donations are stored between application sessions (i.e. persisted even when the application is closed).
- Donation graphs reflect actual tracked donations.
- The specific donation graph that is displayed reflects which button was pressed (either donation amount or 50ml feeds).
- Depot dropdown list (on declare donation drop-off screen) is populated with the correct depots.
- Only selected donations are declared for drop-off.
- Declaring a drop-off is reflected on the Milk Matters web-app.

Depot Locator:

- Application requests correct permissions when it is first opened.
- When pressed, the depot pins display the correct information.
- The 'Find My Nearest Depot' finds the nearest depot and does not work when the required permissions are denied.
- The depot list is populated with the correct depots and displays their details correctly.
- The 'Take Me There' buttons on the depot list screen display the correct depot.
- Users can access directions and the depot location from their own, preferred navigation application.

News and Events:

- Users can share news and events correctly (correct article details are shared, sharing support for all platforms – email, social media, etc.).

Become a Donor:

- Submitting the form opens the device's email client, correctly populated with the user's answers.

E. Evaluation Tasks

Both the prototype and final application evaluation required the donor participants to complete several tasks, taking them through the mobile application's functionality. The tasks for the prototype evaluation and the final mobile application evaluation are outlined below. To provide context to the questions and the flow of the evaluation, instructional and informative statements were included.

Prototype Evaluation:

Part 1: Before Donor Registration

Pretend that you have yet to register as a donor with Milk Matters. You have heard that the app allows you to be screened as a donor and have downloaded it to do so.

1.   Create an account.
2.   Login to the account.
3.   Complete the pre-screening questionnaire.
4.   Access Milk Matter's contact information and call their office.

Part 2: After Donor Registers and Receives Donor Number

Some time has passed, and you are now a registered Milk Matters donor. You want to use the app to record a donation of 40ml that you have made.

5.   Record a donation of 40ml.
6.   View your donation graph, to get a visualization of your donation amount.

You now plan on depositing your donation but are not sure where the nearest milk depot is.

7.   Locate your nearest milk depot. (If the user has not yet registered, a popup appears stating: "This account has not been associated with a donor number yet. Please register your donor number to access this part of the app").
      a.   The participant should now register their donor number.
8.   You have just completed your milk drop-off and would now like to declare the drop-off to Milk Matters.

You have heard of an interesting article recently posted to the app, titled "Nutrition in Pregnancy".

9.   Find and view the article.

You recall having heard about the Milk Matters event "Dresses for Lives, 2020".

10.   Find and share the event to your Facebook feed.

You have been doing your own research and have come across an article that you believe would be valuable to other donors using the app.

11.   Suggest the article to Milk Matters.

Final Application Evaluation:

Part 1: Before Donor Registration

Pretend that you have yet to register as a donor with Milk Matters. You have heard that the app allows you to be screened as a donor and have downloaded it to do so.

1.   Create an account, and login.
2.   Complete the pre-screening questionnaire.

You have been extremely busy recently, and it has been a month since you last used the app. You have realized that you have forgotten your password.

3.   Reset your password.
4.   Access Milk Matter's contact information and call their mobile number.

Part 2: After Donor has registered and receives donor number

Congratulations! You have been screened successfully and are now a Milk Matters donor. Your donor number is 2123.

5.   Record a donation of 60ml that you expressed and froze yesterday.
6.   View your 50ml feeds graph, to get a visualization of how many 50ml feeds you have donated.

You are ready to drop this donation off at a milk depot. Pretend that the live location of the device is accurate.

7.   Find the depot nearest to you and view its operating times.

8.   You realise that your nearest depot is not open today. Find another depot to drop your milk at.

You were able to successfully drop off your donation at a milk depot.
9.   Declare your donation drop-off to Milk Matters.

You want to become more involved with Milk Matters and decide that you want to follow them on social media.
10.   Use the app to find and navigate to the Milk Matters Instagram page.

You have some questions about Milk Matters and milk donation.
11.   Use the app to find some answers to your questions.
You have come across a breastfeeding article that you think would really help your friend who has recently had a baby.
12.   Share an article about breastfeeding via email.

You have been doing your own research and have come across an article that you believe would be valuable to other donors using the app.
13.   Suggest a new article for the app.

A friend and fellow donor told you about the Milk Matters Fun Walk but could not remember the date of the event.
14.   Find the date of the next Milk Matters Fun Walk.

F. Work Distribution
The project work was split into three main categories and divided amongst the researchers, detailed in the table below.

Researcher	Responsibilities
Dino Bossi	• Design and development of the mobile application. • Conducting tests on the mobile application. • Design and development of the mobile application and Milk Matters web-app prototypes. • Conducting donor and Milk Matters staff interviews.
Gustavo Amicis M. de Souza Mendes	• Design and development of the Milk Matters web-app. • Conducting tests on the Milk Matters web-app. • Design and development of the mobile application and Milk Matters web-app prototypes. • Conducting donor and Milk Matters staff interviews.
Pieter Gerhard Serton	• Design and development of the Firebase back-end system. • Assisting the development of the mobile application and Milk Matters web-app. • Design and development of the mobile application and Milk Matters web-app prototypes. • Conducting donor and Milk Matters staff interviews.

G. Code Documentation
The code used in the Milk Matters Donor Application is commented extensively, both using in-line comments and a generated documentation website which can be found at: https://gerhardserton.github.io/Milk_Matters_Donor_Facing_App/index.html