Master of Science in Geospatial Technologies

Supporting forced migrant resettlement with a location-based freecycling service

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I hereby declare that this thesis is all my own work, except as indicated in the text:

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Date _____ . _____ . _____

Abstract

Forced migrants face many challenges when trying to settle into life in a new city. Social isolation is one common consequence of the upheaval they experience. Research has shown that technology can ease various parts of the resettlement process, but work is needed to see how it can address social isolation in particular. We hypothesized that a location-based freecycling service would be particularly suitable for this purpose, due to freecycling's potential to bolster social engagement and location-based services' ability to adapt to the user's context. We conducted needs assessment interviews with five forced migrants and six freecyclers in Münster, Germany. We analyzed the results of the interviews to develop user requirements for a theoretical service. We implemented a subset of the user requirements as part of a prototype mobile app. Then we evaluated the app with 6 forced migrants and 16 freecyclers during a two-week trial. Our investigation showed that, with careful design, a location-based freecycling service can meet the needs of both locally established freecyclers and forced migrants seeking to reduce their social isolation. These findings contribute to literature on the needs of forced migrants and how to meet those needs with geospatial technologies. Our findings can benefit researchers of forced migrant social isolation and developers of location-based and other services to support forced migrant resettlement.

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Chapter 1

Introduction

Forced migrants (including refugees, internally displaced people and asylum seekers) face enormous challenges when they arrive in the city where they settle. The geography, language, and the other residents of their new home are often completely unknown. This upheaval has numerous negative consequences, but one major theme is social isolation (Almohamed & Vyas, 2016a). Social isolation is closely linked with poor psychological health and is thus an obstacle to forced migrant well-being during resettlement (Simich, Beiser, & Mawani, 2003; Schweitzer, Melville, Steel, & Lacherez, 2006).

Several studies have investigated how forced migrant resettlement can be eased by the use of novel technologies (Almohamed & Vyas, 2016b; Schreieck, Zitzelsberger, Siepe, Wiesche, & Krcmar, 2017; Ngan, Lifanova, Jarke, & Broer, 2016; Brown & Grinter, 2016). Alam and Imran (2015) found that digital inclusion and social inclusion are linked issues for refugees. A study in New Zealand found that in order to promote the social inclusion of refugees, researchers and policy makers *must* consider information and communication technologies (ICT) (Díaz Andrade & Doolin, 2016). On the other hand, forced migrants face many unique challenges when using novel technologies, for example, making do with limited access to internet, navigating text-rich services despite limited functional literacy, and overcoming their limited experience with geospatial services (Bustamante Duarte, Degbelo, & Kray, 2018). To date, little to no research has focused on the appropriate design and implementation of geospatial services for this vulnerable user group.

One unexplored type of geospatial service, the location-based service (LBS), has the potential to address the social isolation of forced migrants in several ways. Location-based social networks facilitate arranging to meet in person and the exploration of one's environment (Declan Traynor & Kevin Curran, 2013). Location-based context filtering makes services easier to use by reducing information overload and tailoring what is offered to the individual user. Tailoring to a local context may be particularly powerful when the goal is to create social contact, because the probability of social connection between two individuals decreases with the physical distance between them (Scellato, Noulas, Lambiotte, & Mascolo, 2011). Even in online social networks, the physical location of a person's social contacts can be used to accurately estimate the person's own location (Backstrom, Sun, & Marlow, 2010).

In this thesis, we argue that freecycling platforms are one kind of location-based service with unique potential to reduce the social isolation of forced migrants. Freecycling is the act of getting rid of something you do not need any more by giving it to someone else who does need it, with no financial charge. Freecycling platforms depend on knowing users' locations in order to provide users with listings that can be picked up without undue cost to the collector. Such co-located exchanges of material goods, both among forced migrants and between forced migrants and locals who are not forced migrants, could address social isolation quite effectively.

In addition to its environmental benefits and appeal to people with limited resources, freecycling leads to trust-filled interactions outside of kin groups (Nelson & Rademacher, 2009), encourages civil engagement (Nelson, Rademacher, & Paek, 2007), and blurs binary boundaries of needs and consumption (Eden, 2017). All of these benefits have significant potential to support forced migrant resettlement, but have yet to be researched as such.

Thus, the research question of this thesis is: *How can a location-based freecycling application reduce the social isolation of forced migrants?*

The objective of the thesis was threefold: first, to identify and triangulate the needs of forced migrants, non-migrant locals, and moderators with respect to a freecycling service; second, to develop a location-based freecycling service that addresses those needs; and third, to evaluate the usability of the service and develop design recommendations for

future location-based services that have forced migrants as an intended audience.

The study was broken up into three phases: needs identification, prototype development, and prototype evaluation. Throughout the whole study, we were guided by the human-centered design process defined by the International Organization for Standardization in *ISO 9241-210:2010 Ergonomics of human-system interaction – Part 210: Human-centred design for interactive systems* (2010).

We used interviews to identify the unique and intersecting needs of three user groups: forced migrants, local freecyclers, and freecycling moderators. We developed user requirements for a theoretical system from those needs. We found a great deal of overlap between the forced migrant and the freecycler context in Münster, Germany. This allowed us to design a system that simultaneously attempted to address both parties' needs.

We built a prototype mobile app based on a subset of the user requirements. We used free and open source technologies to show that development of such a service is feasible without great financial investment. We came up with a number of design recommendations for LBS for forced migrants during this process.

We evaluated the prototype during a two-week trial involving 6 forced migrants and 16 other residents of Münster. After the trial, we surveyed all participants about the usability of the service. We also surveyed participants and analyzed data logged on their devices to assess the potential of the service to reduce social isolation.

We found that the service was quite usable by both user groups. The prototype showed potential for reducing the social isolation of forced migrants in Münster, however a longer evaluation period with more participants is necessary to give conclusive results in that regard.

The remainder of this thesis is organized into seven more chapters. The next chapter, chapter 2, provides an overview of related work and background information on social isolation, technology for forced migrants, freecycling, and human-centered design. Chapter 3 explains our overall research method and gives an overview of the three phases of the study, which are then explained in detail in the following three chapters. Chapter 4 describes how we assessed and analyzed the needs of forced migrants and freecyclers in

Münster, and the results of that process. Chapter 5 describes the implementation of a prototype location-based freecycling service using the findings of the needs assessment. Chapter 6 reports on the evaluation of the service. Chapter 7 highlights the most significant findings of this work and discusses the broader implications of these results in the context of the field of geospatial technologies. Finally, chapter 8 summarizes the thesis with suggestions for future research on the topic.

Chapter 2

Related Work

The design of a location-based freecycling service that reduces the social isolation of forced migrants requires a) an understanding of social isolation as it occurs in forced migrant communities, b) a consideration of the best practices and common concerns when developing ICT to address forced migrant challenges, c) an evaluation of the unique strengths and weaknesses of geospatial technologies in this area, d) an understanding of the strengths and limitations of freecycling platforms for promoting positive social contact, and e) the selection of a design process that effectively meets forced migrant needs. Following is a short summary of past research on each of these five topics.

2.1 Social Isolation and Forced Migrants

Introduction

Social isolation is defined as "the absence of social interactions, contacts, and relationships with family and friends, with neighbors on an individual level, and with 'society at large' on a broader level" (Institute of Medicine (U.S.), 1992).

According to Beacker, Sellen, Crosskey, Boscart, and Barbosa Neves (2014), social isolation is not the same thing as loneliness. One can feel lonely even when one has frequent contact with others. One can also choose to isolate oneself from others and not

feel lonely. However, when one is forced into social isolation, as is often the case with forced migrants, the isolation commonly leads to loneliness.

Cornwell and Waite (2009) consider loneliness to be a part of social isolation, but still divide social isolation into two components: social disconnectedness and perceived isolation. Social disconnectedness implies either a small social network or a lack of activity within one's social network. Perceived isolation comes from a lack of support and loneliness.

Similarly, forced migrant integration can be divided into two categories, practical integration and emotional integration (Colic-Peisker, 2002). Social disconnectedness is an obstacle to practical integration and loneliness is an obstacle to emotional integration. Clearly, both are important and interrelated. In this thesis, however, we focus primarily on social disconnectedness because it is simpler to measure (e.g. by counting instances of social contact) and because changes are more readily observed, even over a short period of time.

Causes

There are two distinct causes of social isolation among forced migrants. One cause is the physical displacement from one's home, which leads to alienation from one's family and other former social circles. Another cause, however, is cultural alienation in one's new environment (Northcote, Hancock, & Casimiro, 2006). Thus, forced migrants face isolation from two different angles at the same time, making it that much harder to avoid the negative effects of isolation.

Living in dedicated forced-migrant housing has been shown to cause shame among newcomer children and thus lead to their social isolation when they don't invite friends over to play. Members of established migrant communities sometimes exclude newcomers. Invitations into others' homes, common interests like sports, and mutual support are key to making social contact. Open classrooms and opportunities for expression are helpful, but not if the "refugee-friendliness" feels too fabricated (Anderson, 2001).

Patterns of Occurrence

Among forced migrants, social isolation is prevalent in the early stages of resettlement as a consequence of not having meaningful and supportive relationships (Simich et al., 2003). It remains a common issue even after years of living in the host country, especially when other challenges of resettlement are not overcome. For example, those who are unable to learn the local language and those who have difficulty finding work often experience social isolation that only intensifies with time (Almohamed & Vyas, 2016a, p. 166). The problem becomes a vicious cycle because creating new relationships, learning the local language, and finding employment are all much harder when one is socially isolated.

While Northcote et al. (2006) describe how social isolation can become a self-reinforcing negative cycle, in this thesis we explore if the opposite is also true. Following the same principles, social contact should also be self-reinforcing: contact with well-connected individuals could lead to exponentially more contact thereafter.

Some newcomers face greater risk of social isolation because of intersectional issues. Those with cultural traditions of gender separation have fewer opportunities to create new social contacts (Almohamed & Vyas, 2016a). Women newcomers are more often socially isolated than men (Hynie, Crooks, & Barragan, 2011). Muslim refugee women are even further marginalized in Australian society due to animosity towards the Muslim expression of religious traditions (Casimiro, Hancock, & Northcote, 2007).

Strategies for Addressing Social Isolation

Some of the highest-quality social contact comes from co-ethnic peer support, and there is room to improve systems that support this kind of contact, especially between asylum seekers and refugees (Almohamed & Vyas, 2016b). However, in many cases newcomer peer support groups are quickly overwhelmed so inter-community contact is also valuable, and necessary. Many newcomers face social exclusion based on discrimination and a deficit of social resources (Hynie et al., 2011). This makes contact with the part of society that is both responsible for the discrimination and in control of the majority of

social resources all the more important.

Social isolation doesn't just come from an inability to reach out to locals. Newcomers also express a need for others to reach out to them first (Almohamed & Vyas, 2016a, p. 166). This means systems aimed at reducing social isolation should include communication channels in both directions.

New technologies are giving forced migrants the ability to reduce their social isolation. On the one hand, modern communication technologies help them maintain ties to family back home, which alleviates the first of the two aforementioned causes of social isolation. This is a dramatic change from the near total isolation that forced migrants of the previous generation experienced (Harney, 2013, p. 553). In this paper, however, we are more interested in how technology can address the second cause of social isolation: disconnection from the host society. ICT has been shown to increase newcomers' ability to participate in the host culture's information society, communicate effectively in the host society, understand the new society, be socially connected and express cultural identity (Díaz Andrade & Doolin, 2016). All of these factors increase newcomers' contact with society and thereby reduce social isolation.

Relation to Geographic Isolation

Social isolation is not the same as geographic isolation, but evidence suggests that the two are linked. In particular, geographic isolation seems to be a contributing factor to social isolation. For example, geographic dispersion (i.e., intentional separation of newcomers from other forced migrants) is a governmental policy in some EU nations that is intended to speed up integration but in reality can increase mental health issues and inhibit the resettlement process when those who don't integrate quickly feel left behind. The geographic separation of couples often leads to relationship problems, which in turn commonly result in the loss of one's closest social contact: one's partner (Carballo, Divino, & Zeric, 1998, p. 939). As discussed previously, geographic isolation in dedicated forced-migrant housing can also intensify social isolation. The lack of a secure or "normal" residence alienates newcomers and inhibits social strategies like inviting others to your home.

Perhaps it is more accurate to call this "geographic loneliness," since the newcomer feels spatially isolated despite being quite close to many other individuals. Still, it is worth noting the importance of spatial factors when addressing social isolation.

2.2 ICT for Forced Migrants

Value

We already discussed how ICT can significantly reduce the first type of social isolation that forced migrants experience: the isolation from their country of origin (Harney, 2013). However ICT has also been shown to help newcomers build social capital in their new city, which is key when working to avoid the second type of social isolation that is often experienced after arrival (Alam & Imran, 2015).

ICT has further been found to build trust by facilitating connections between newcomers and members of the host community, as well as by creating a sense of belonging in a group (Almohamed & Vyas, 2016b).

Challenges

The design of ICT for newcomers involves the unique challenge of balancing multiple cultural contexts in one system (Almohamed & Vyas, 2016a). Designers must also consider users who have a limited abilities in the local language and perhaps with literacy in general, limited internet access, a need to understand particularly complex compliance and geospatial information, a high need for reliability and timeliness, and limited experience with geospatial technologies (Bustamante Duarte, Degbelo, & Kray, 2018).

Best Practices

The following services were all developed to study different ways that ICT can ease the resettlement of forced migrants. In each case, the researchers identified some useful

best practices when designing tech for newcomers.

Lantern (Baranoff, Gonzales, Liu, Yang, & Zheng, 2015) is a service that allows forced migrants in the United States to learn about their new environment by scanning strategically placed NFC stickers with their phone. The creators highlight the value of having a system that is flexible enough to meet diverse and changing needs, is based on technology that forced migrants already have and use, leverages the expertise of more settled forced migrants to support newcomers, empowers newcomers to help themselves and thus reduces the burden on official support workers, and strengthens the overall feeling of community by giving newcomers the opportunity to "give back" to the system.

Rivrtran (Brown & Grinter, 2016) is a mobile app, also from the United States, that helps forced migrants to communicate with people who don't share a common language by providing access to volunteer interpreters. The authors found the strengths of such a service were that it facilitated communication between refugees and people who could provide support, simultaneously supporting and encouraging the users to eventually get by without such a service, and made use of a voice-based user interface to accommodate users with limited literacy. Of particular interest to our research on social isolation, they also found a major benefit of the app was that it supported forced migrants to build social capital simply by engaging in everyday conversation.

Tarjimly is a similar service developed in the United States by Atif Javed, Aziz Alghunaim, and Abubakar Abid (Utley, 2017). It is a Facebook Messenger bot that connects refugees needing translation services with volunteers able to help in the moment. The service shows what happens when you give people a way to support forced migrants without being majorly inconvenienced: thousands of volunteers offer interpretation services that would normally cost a fortune. The creators chose to use Facebook Messenger as their platform because it is a tool that is already familiar to so many users.

Integreat (Schreieck et al., 2017) is a service designed to facilitate information dissemination to forced migrants in Germany. The authors outline a number of best practices when designing software for maximum information transmission in an intercultural context. While the focus of this paper is not on information transmission, Integreat's design principles are also useful when applied to user interfaces intended for other purposes.

For example, icons should always be accompanied by text and services should be usable offline.

Moin (Ngan et al., 2016) is a gamified informal learning app, also from Germany. The authors highlight the value of using a human-centered design process when developing technology for use by forced migrants, and stress the importance of accommodating low language abilities. They also point out how usability depends not only on the design of the system but also the context of the user, and how the contextual differences of forced migrants and German locals meant the app was much less usable for forced migrants.

Bustamante Duarte, Degbelo, and Kray (2018) worked with forced migrants and social workers in Münster, Germany, reviewing 36 apps and services and identifying several best practices and gaps. They observed a lack of services focused on non-Arabic-speakers and supporting offline use. They highlighted the importance of supporting multi-directional exchanges, user collaboration, flexible visualizations, and geovisualizations. They also recommended the use of open-source data platforms to create systems where knowledge can be built up over time by numerous contributors. Finally, they suggested the potential value of better geospatial technologies and location-based features, which up until now have been largely absent from ICT designed for forced migrants. The next section discusses this potential in greater depth.

2.3 Geospatial Technologies for Forced Migrants

Value

Geospatial technologies can be of great value to forced migrants. One participant in our needs assessment study recounted:

> When I fled from my homeland to Germany, my best friend was my cellphone. It really helped me and at the same time I helped many people because of my cellphone and my apps. I installed a navigator that worked offline on my phone and with maps from all the countries [that we were passing through].

> I guided more than 100 people from various countries and the people trusted me because I already said [that] this [would be] happening like this and we are going to a place that is like this and when we got there [it was so].

In addition to supporting navigation during migration, mobile mapping services also help newcomers get around the cities where they resettle.

Location-based social networks facilitate arranging to meet in person and the exploration of one's environment (Declan Traynor & Kevin Curran, 2013). Location-based context filtering makes services easier to use by reducing information overload and tailoring what is offered to the individual user. This may be particularly powerful when the goal is to create social contact, because the probability of having a social connection between two individuals decreases with the distance between them (Scellato et al., 2011).

Lantern, the location-based information service described in the previous section, is an example of an LBS that does not make use of geospatial technologies. The location of the user is determined by knowing the location of the NFC sticker that they scan.

2.4 Freecycling

Introduction

In 2003, Deron Beal coined the term "freecycle," a blend between the words "free" and "recycle," when he founded The Freecycle Network in Tucson, Arizona, in the United States[1]. Making things available for free via the internet, however, has been popular for much longer (think software, music, etc.) (Eden, 2017). There are now innumerable freecycling platforms all over the world. The Freecycle Network alone claims to have millions of members in more than 110 countries.

In Münster, the most notable freecycling platforms take the form of Facebook groups. The biggest is "Verschenk's Münster," a giving-only platform with roughly 28,000 mem-

[1] https://www.freecycle.org/about/background

bers as of this writing[2]. The second largest is "Foodsharing Münster," a group focused specifically on avoiding food waste, which currently had just over 8,000 members at the time of this writing[3]. eBay Kleinanzeigen, a German subsidiary of the international eBay corporation, is a third popular platform for the free peer-to-peer exchange of goods[4].

Value

It has been shown that freecycling leads to trust-filled interactions between individuals with little in common other than their participation in a freecycling group (Nelson & Rademacher, 2009). Freecycling also encourages civil engagement and members tend to be more politically engaged in society than the average citizen (Nelson et al., 2007). Freecycling has also been shown to blur binary boundaries that are normally quite stark in such systems of exchange. Freecycling platforms bring together consumers and producers, givers and receivers, those who have resources and those who do not. Members can embody both roles at the same time. The platforms connect digital and material worlds, demonstrating the potential of virtual communities to have a real-world impact on people's lives. Finally, they unite mainstream and alternative cultures in one community (Eden, 2017). Therefore, participation in such communities could be of great value to socially isolated forced migrants, because these are some of the divisions that lead to their social isolation.

Challenges

Current freecycling systems have several problems that should be addressed in a freecycling system intended to reduce social isolation. Organizational policies tend to tightly control the nature of exchanges due to an overemphasized focus on the environment. These policies contribute to the dominance of user communities by those seeking only "green-washed convenience." Such user communities exhibit less altruism and solidarity when compared with other online groups (Aptekar, 2016).

[2] https://www.facebook.com/groups/473505729373257
[3] https://www.facebook.com/groups/607791439294335
[4] https://themen.ebay-kleinanzeigen.de/ueber-uns/

Freecycling communities are also not the altruistic "gift economies" that platform administrators often claim them to be, since most members expect some kind of generalized reciprocity, i.e. a reciprocal reward that may only come after a delay or from a different person than the recipient of the original "gift". Transactions that take place through such systems are a "hybridized form of exchange", having characteristics of both gift giving and trading (Arsel & Dobscha, 2011).

In order to create a real sense of solidarity (not charity) in generalized exchange platforms, the forging of a group identity is key (Willer, Flynn, & Zak, 2012). Some groups forge such an identity through a common interest in sustainability, but that identity excludes people who could benefit from the service in practical ways, such as by acquiring things for free that they otherwise cannot afford (Aptekar, 2016).

2.5 Human-Centered Design

The methodology of this work is based on the human-centered design process, as defined by the International Organization for Standardization (*ISO 9241-210:2010, Ergonomics of human-system interaction*). The principles of human-centered design have particular relevance when designing for vulnerable populations such as forced migrants. Language barriers, cultural differences, unfamiliarity with a new city – the same challenges which can lead to social isolation – can also keep forced migrants from having any input on the services that are designed for them. If the resulting systems are therefore unusable or of little practical value, forced migrants have one more challenge added to their plates.

Human-centered design leverages the knowledge of the true experts of a system – its users – to develop services of a higher quality. It focuses on improving ease of use and usefulness based on user evaluations of the system (Roth, Ross, & MacEachren, 2015). While Bustamante Duarte, Brendel, Degbelo, and Kray (2018) show that participatory design is even more empowering for users and produces software of an even higher quality, the organization and implementation of design workshops can be quite time intensive and did not fit into the scope of this six-month master's thesis. Thus, human-centered design

was used with the intention of incorporating the maximum amount of user input within the time available.

2.6 Summary

In this chapter, we have attempted to summarize past research on social isolation in the context of forced migration and the use of ICT to address this and other forced migrant challenges. We highlighted areas that need more research, including 1) the development of services that are explicitly designed to reduce the social isolation of forced migrants and 2) the adaptation of existing promising technologies – such as geospatial technologies, location-based services, and freecycling systems – to the unique needs of forced migrants. Our review of this literature led us to our research question and guided our methodology, as explained in the chapter that follows.

Chapter 3

Approach and Methodology

This chapter describes the steps we took to answer the research question *how can a location-based freecycling service reduce the social isolation of forced migrants?*, which we introduced and motivated in chapter 1 and grounded in existing research in chapter 2.

We used human-centered design principles to structure our methodology due to its suitability when designing services for forced migrants, as explained in section 2.5. We applied the human-centered design process in three phases, each correlating to one of our angles of approach. In the first phase we performed a needs assessment study, carrying out interviews and extracting context and user requirements from the data. In the second phase we developed a prototype location-based freecycling service based on the needs identified. In phase three we carried out a user study to evaluate the prototype design.

Each phase answered our research question in a different way and produced a unique contribution. Phase one answered the question theoretically and produced a list of needs and user requirements. Phase two answered the question technologically and produced a working prototype demonstrating the feasibility of the designs. Phase three answered the question in the field and resulted in validation of the usability of the designs and a preliminary assessment of the usefulness of location-based services for the reduction of forced migrant isolation.

The three parts took different forms. First we ran a user study to assess the needs of our user groups and develop user requirements for a hypothetical system. Then we

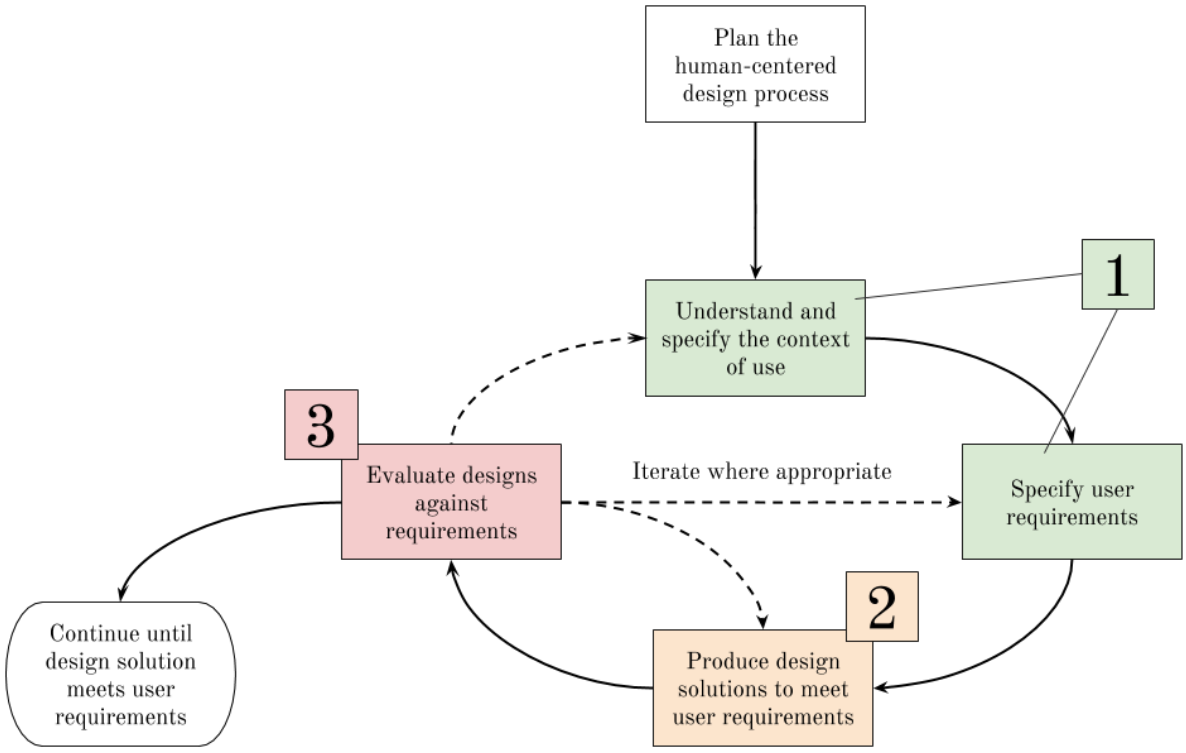

Figure 3.1: The human-centered design process divided into three phases

developed a prototype designed to meet those needs, making the hypothetical real. Finally we ran another user study to evaluate the prototype. The following three chapters describe the needs assessment, prototype development, and prototype evaluation in full detail.

While valuable for its simplicity, the presentation of our methodology as three steps conceals the iterative nature of human-centered design. In this work we did not follow the three steps linearly but rather continually moved among them. Neither are we recommending that others follow a stricter step-by-step process. Continual adjustment of needs assessments, implementations, and evaluations is necessary to address the continually evolving context of forced migrant resettlement.

Per the ISO definition, human-centered design consists of 5 steps, 4 of which may need repeating several times. They are: 1) plan the human-centered design process, 2) understand and specify the context of use, 3) specify user requirements, 4) produce design solutions to meet user requirements, and 5) evaluate designs against requirements. Figure 3.1 shows how these steps proceed in a cyclical manner until a satisfactory solution is achieved. Each of these steps yielded distinct results in this study. Following is a step-by-step overview of how we applied the human-centered design process to address the

research question of this thesis. The exact methodology and results of the process are described in detail in the subsequent three chapters.

1. Planning the human-centered design process. Before beginning this work, we wrote up a detailed plan and assessed the feasibility of the various steps. We outlined roughly when and how each of the four remaining steps would be achieved, leaving room for iteration. We identified three user groups to be at the center of the design process. We verified the availability of potential participants from the three user groups to do context interviews. We also reviewed existing literature about technology for forced migrants and freecycling systems in order to build our understanding of the context of use. The results of this process are discussed in chapter 2.

In this initial phase, we also planned out which technologies we would use as a starting point for the design solutions, and we sketched out a plan for evaluating these designs at the end. We met personally with local experts from forced migrant and freecycling communities to glean their recommendations about how to implement our design process. Young forced migrants expressed interest in new technology and committed to help with the design process and find others to participate too. Freecycling system moderators told us how to get in touch with their users, shared common freecycling challenges and provided assurance that the design of a new freecycling platform for forced migrants would be supported by their communities.

2. Understanding and specifying the context of use. In this study, understanding the context of use meant investigating why and how forced migrants currently make social contact in Münster. Additionally, it meant learning about existing freecycling systems in the city. We used context interviews to achieve both of these tasks. The details of this process are described in chapter 4.

3. Specifying user requirements. In order to identify key user requirements for a location-based freecycling service, we began by extracting implied needs from the context interviews. These in turn were translated into user requirements. See chapter 4 for the results of this process.

4. Producing design solutions to meet user requirements. The second phase of the study was designing and implementing a prototype app. We decided to make a cross-

platform mobile app based on the location-based service app engine called LBS Engine (Einfeldt, 2018). See chapter 5 for a full description of the implementation process and results.

5. Evaluating the designs against the requirements. The designs were evaluated in an iterative fashion, first by having individuals test the prototype in my presence, then by running a pilot deployment to a small group of fellow students, and finally by deploying the prototype app to a larger group for a two-week trial period. During the trial, we collected data from users as we had planned. See chapter 6 for full details and a discussion of the results of the evaluation.

Chapter 4

Needs Assessment Study

4.1 Introduction and Objective

This section covers the first of the three phases of our work to answer our research question. The objective of this first phase was to assess the needs of forced migrants with regards to avoiding social isolation during resettlement.

This needs assessment was necessary because in order to find out how a location-based freecycling application can reduce the social isolation of forced migrants, it is important to identify the strategies forced migrants currently use to avoid social isolation, the associated challenges, and what is needed to overcome these challenges and strengthen the current catalysts of social contact.

A second objective of this study was to assess the needs of the users and moderators of existing freecycling platforms in Münster. An understanding of those needs is essential to the design of a useful and usable location-based freecycling service.

In terms of the human-centered design process, this phase covered steps 1, 2, and 3 (planning, gathering context, and developing requirements). We group them together into one chapter for the sake of simplicity, but still performed them separately in practice, noting the importance of all three steps: careful preparation and context analysis produce usage requirements that are traceable back to the users' reality (Riedemann, 2018).

After talking with experts, we decided to implement the human-centered design process with three user groups. We used in-person interviews to understand and specify the context of use for each group. Finally, we analyzed recordings of the interviews to extract implied needs and usage requirements. Following is an in-depth explanation of each step.

4.2 Participants

In preliminary discussions with experts on forced migrant resettlement and freecycling in Münster, we decided to focus on triangulating the needs of three user groups to develop a user-centered application. The first group was forced migrants living in the general vicinity of Münster. The second group was residents of Münster who participate in some capacity in one of the several freecycling communities in Münster. The third group was the moderators of said groups.

These user groups represented the three perspectives we needed to answer our research question, each group holding the expertise to answer a different critical subquestion. Forced migrants know how to make social contacts as a newcomer. Freecyclers know how to freecycle. And freecycling moderators know how to make a freecycling service safe and easy to use.

We recruited forced migrant participants by approaching acquaintances that we met through mutual friends and by attending newcomer-friendly meet-ups. We contacted the moderators of freecycling services through their publicly available online contact information and obtained their permission to recruit freecyclers by posting directly in the freecycling forums. Further participants joined the study through snowball sampling. For each user group, we continued interviewing until we achieved information saturation; that is, until participants' responses were no longer yielding significant new information about the focus topic.

Five of the interviewees were forced migrants, three were members of existing freecycling platforms in Münster, and three were moderators of these platforms.

Of the five forced migrant participants, two were between the ages of 18 and 25, and

three between 26 and 35. Two migrated from Syria and the other three from Iran, Iraq, and Turkey. We interviewed four men and one woman.

The freecycling interviewees represented a broader age range, between 23 and 50 years old. They all came from Germany except one freecycler who immigrated to Münster from Eastern Europe for his studies. Four of the freecyclers were women and two were men.

4.3 Procedure

As explained in section 2.5, the first step of the human-centered design process is to understand and specify the context in which the system will be used. For this so-called "context analysis," it is common practice to perform a kind of loosely structured interview with various members of the user community known as a "context interview" (Riedemann, 2018). For this study we performed a total of eleven context interviews over a period of 22 days in November 2018. The script we followed for each interview can be found in appendix A.1.

The interviews followed the semi-structured focused interview method. This allowed us to maintain non-directive management of the conversation and still gather very specific information about the topic in question (Flick, Kardorff, & Steinke, 2004). The objective of the interviews was to understand the *context* in which the user community performs the *focus activity*.

The focus activity was different for the different user groups. It should be noted that this is unusual for human-centered design context interviews. Normally, the interviews address several different user groups but always focus on the same activity (Riedemann, 2018). In this study, however, such a structure was not possible. None of the forced migrant participants in the study had experience with freecycling and none of the freecycling participants had experience with resettling in Münster after a forced migration. We explored the possibility of asking all groups about "gift giving" or about "making social connections," but pilot interviews showed that these focus topics were too vague to elicit useful responses. Asking about more specific and relatable activities produced more detailed and consistent results.

The forced migrant interviews focused on making social contact as a newcomer in Münster. The freecycler interviews focused on freecycling and the moderator interviews focused on moderating freecycling. In the end, all user groups gave information about all three topics. Forced migrants and freecyclers talked about the important role of the moderators in their communities. Freecyclers and moderators talked about making friends through their freecycling systems. Moderators talked about their own freecycling practices and forced migrants described the importance of giving generously when making social contacts in a new place. Thus, we identified the context of use for a service that both enables freecycling and reduces social isolation, although no such service existed in Münster at the time.

Context of use is made up of three elements: user goals, user tasks, and user environment (Maguire, 2001). Therefore, in order to perform step two of the human-centered design process, one must answer three different questions:

1. Goals: *What specific goals is the user trying to achieve?*
2. Tasks: *What are the main tasks involved in achieving those goals?*
3. Environment: *What are the unique characteristics of the environment in which the tasks are performed?*

The interviews in this study were made up of five questions, each with its own purpose and each helping to gather information about some of the three context elements (see table 4.1).

Question type	**Purpose**	**Context elements**
1. Opening	Warm up, get to know the person, make them comfortable.	Environment
2. Involvement	Understand how the person currently relates to the focus activity, how they can be supported by a system, and how not.	Environment, goals
3. Prerequisites	Understand challenges and needs when performing the tasks involved.	Tasks, environment
4. Execution	Understand the tasks involved, accompanying challenges, and relevant safety concerns.	Tasks, goals
5. Closing	Learn about problems with existing systems, probe users for solutions.	Environment, goals

Table 4.1: Context interview question types and their purposes

The main guiding questions were supplemented with probing questions in case the

user needed more prompting to cover the topic. The full sheet of guiding questions for each user group can be found in appendix A.

4.4 Analysis

The results of the interviews served as the basis for the rest of the human-centered design process. Learning about the context of use allowed us to identify the core tasks that would need to be performed in the system we were designing. The core tasks, in turn, served as a foundation for all of the subsequent elements of the design process:

$$\text{context} \rightarrow \text{core tasks} \rightarrow \text{implied needs} \rightarrow \text{usage requirements} \rightarrow \text{design}$$

In order to process the interviews, we partially transcribed the recordings into what are known as *context scenarios*. Context scenarios are summaries of the interview responses, formulated in an easy-to-understand and vivid way. Each interview yields one context scenario, so there is overlap between the scenarios. Repeat information is consolidated in the next step. Context scenarios serve as the building blocks from which we derive both implied needs and usage requirements (Riedemann, 2018).

As shown in table 4.2, context scenarios are made up of narrative statements with identifying user information (such as names) removed. An example context scenario can be found in appendix B.1.

The next step is to break down the interviewee's narrative descriptions of their activities into their core tasks and other context elements. This coding method is similar to descriptive coding or process coding (Saldaña, 2009), but focuses specifically on "tasks" or actions taken by the interviewee. The core tasks are phrased as a short verb phrase in the present tense, such as "plan spontaneous meet-ups," "introduce yourself," or "find out about open/safe social opportunities". These were repeated quite often across interviews, allowing the final core task list to be consolidated quite a bit by removing duplicates.

The core tasks translated naturally into implied needs. Implied needs were determined by analyzing each core task and identifying the conditions that must be met in

Context analysis element	Structure
Context scenario	User <verb in present tense>...
Core tasks	<Verb phrase in present tense>
Implied needs	In order to ... , ... must ... .
Usage requirements	The user must be able to ... the system ...

Table 4.2: Context analysis elements and their structure

order for the task to be completable. These conditions were pulled directly from the context scenarios, so they can be linked back to the words of the interviewee.

From implied needs to usage requirements is a small leap. The translation is mostly a grammatical shift to phrase the implied need in terms of a user and an unspecified system.

4.5 Results

Context

We extracted a total of 114 context elements from the five interviews with forced migrants. The five most frequently occurring codes were:

- Characteristic: limited language ability
- Task: Meet an "introducer"
- Task: Find people with common interests
- Task: Plan spontaneous meetups
- Task: Invite others to your home

Tables with all codes and their occurrence rates can be found in appendix B.2.

Implied Needs

We identified 55 different implied needs for the forced migrant user group. The five most prominent needs, each expressed by all five forced migrant interviewees, were:

- accommodation of low language abilities,

- contact with an "introducer",
- contact with people with common interests,
- possibilities for spontaneous social contact, and
- ability to invite others to their home.

A table with all of the needs we identified can be found in appendix B.3.

User Requirements

Out of the context and needs we derived a long list of user requirements for a location-based service to reduce the social isolation of forced migrants, for example:

- The user must be able to choose the language of the system.
- The user must be able to see who is an "introducer" in the system.
- The user must be able to tell the system that they are available to meet up spontaneously.
- The user must be able to see other users in the system that are available to meet up spontaneously.

The full list of user requirements can be found in appendix B.4.

Overlap between User Groups

We performed the same needs assessment with the freecycler and moderator user groups as well. This was necessary in order to develop a service that met the needs of all users.

From the analysis of the freecycler and moderator context interviews we identified many essential user requirements for any freecycling system, for example:

- The user must be able to upload a photo.
- The user must be able to report misuse.
- The user must be able to mark an offer as taken.

We also found significant overlap between the contexts of use of the different user

groups. For example, all three user groups reported the following shared context elements:

- Goal: increasing personal happiness
- Risk: uncertainty about strangers
- Philosophy: patience and openness
- Task: invite others into your home
- Tool: smartphones

This shared context has important implications for location-based freecycling services aimed at reducing the social isolation of forced migrants.

Chapter 5

Location-Based Freecycling Service Prototype

5.1 Introduction and Objective

The second phase of the study was the implementation of a location-based freecycling service prototype called "Geofreebie". The goal of this phase was to develop practical design solutions for a subset of the usage requirements developed in phase one. A secondary goal was to produce a usable prototype that would enable evaluation of the theories developed during the needs assessment.

This chapter discusses the details of the implementation and the rationale behind the design solutions. First we explain the technologies that were used and the rationale for choosing these technologies. Next, we provide an outline of the overall architecture of the system, including the configuration of the various services that make up the application and the interfaces that join them. After that we describe the structure and design of the back-end server and the architecture of the front-end user-facing mobile application. An overview of some key features of the mobile application and the considerations that contributed to their selection and development is discussed later in chapter 7.

5.2 Technologies

We chose to implement the service as a mobile app because forced migrants are more likely to use smartphones than other hardware (Xu & Maitland, 2016). All of our interviewees had smartphones and cited them as their main means of communicating and one of their main tools when making new social contacts. Because most people carry their phones with them throughout the day, mobile apps also open up possibilities for spontaneous social contact in the moment and the location where the context is most apt.

We used the open source LBS-Engine, an application template for the development of location-based services, as a foundation for our app (Einfeldt, 2018). This sped up development by providing an initial framework for displaying a map, navigating via a tab bar and a sidebar, and presenting the user with various settings.

The LBS-Engine uses the open source Cordova framework from Apache, which allows mobile apps to be developed using web app technologies like JavaScript, HTML, and CSS. A major benefit of using Cordova is that once the application is developed, it can be easily ported to several different operating systems without rewriting the code. Currently supported operating systems include Android, iOS, OS X and Windows. This makes services developed with Cordova more accessible because they do not depend on the user having one specific operating system.

The LBS-Engine uses the React JavaScript library with mobile-friendly user interface elements provided by Onsen UI. We decided to maintain these technology choices: React provides a component-based structure that reduces code duplication and thereby cuts back code development and maintenance time and reduces bugs. Onsen UI provides user interface elements that are more intuitive and ergonomic for mobile users, and which adapt to the default styles of the operating system to which they are deployed.

We also continued hosting our fork of the LBS-Engine project as an open source repository on GitHub. The open source nature of the project provided a number of benefits. First, the support for collaboration facilitated the rapid and ongoing translation of the app into many languages. Second, the transparency of the code base increased tech

savvy users' trust of the technology. Third, it allows the app to be reused and adapted for other contexts.

We also continued using the mapping stack included with LBS-Engine. The engine makes use of the open source JavaScript mapping package LeafletJS and freely available basemap data from OpenStreetMap. The React-Leaflet JavaScript package allowed integration of the LeafletJS package into the React framework.

We used the freemium authentication service from Auth0 to handle user authentication. Use of a widely trusted and flexible authentication service allowed us to develop a secure protective layer around the app's user community with relatively little time or effort. It also enabled us to support third-party authentication through Google and Facebook, giving users more choice and convenience when signing up. This met the need for a Facebook-independent platform while still giving Facebook users the convenience of passwordless authentication.

We also used freemium services to host the application's back-end infrastructure. The node back-end API was hosted on Heroku. Heroku has the benefit of built-in integration with git and support for integration with the freemium database hosting service mLab. Thus, we used mLab to store shared user data in a hosted MongoDB database.

The dependence on third-party freemium services has pros and cons. The main advantage is the low cost, which is especially important when developing for a user group with limited financial resources. The services we used only start costing money when the size of the data or number of users surpasses a certain threshold, in other words once the platform becomes widely used. When services reach this point, however, funding from user donations or grants is often feasible. A second advantage is reduced development and maintenance effort.

The major disadvantage is a loss of control. Developers have less control over the service's user interfaces and both developers and users must trust the third-parties' data privacy practices.

5.3 Overall Architecture

The system was structured to maximize security and stability. We followed the recommended best practice of creating distinct services joined by clean and consistent interfaces. In total, the system was made up of five components, two of which we developed ourselves and three of which were developed and managed by third parties (see figure 5.1).

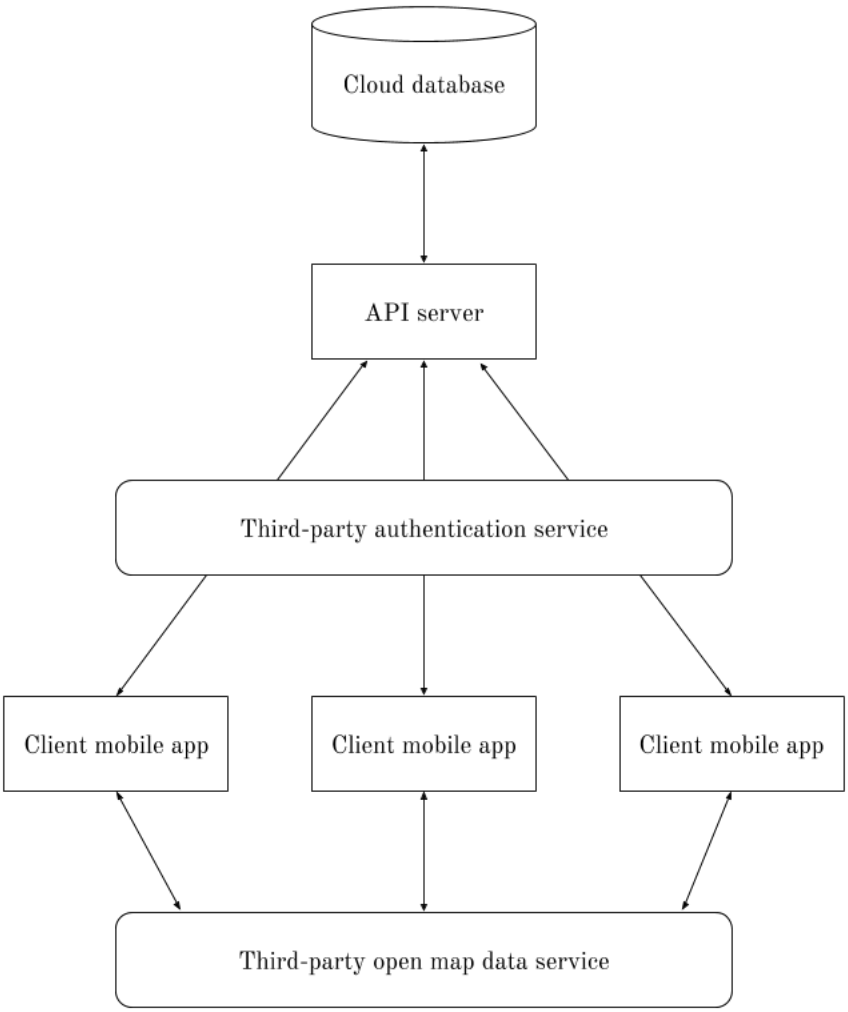

Figure 5.1: Overall architecture of the prototype

All centralized data was stored in one mLab cloud-hosted MongoDB database. The database was comprised of three collections: *users*, *reviews*, and *datapoints*. Since MongoDB is a noSQL database technology, the database schema was not actually determined on mLab, but rather within the logic of the back-end server, which is discussed in de-

tail in section 5.4. In addition to a web-based user interface, mLab provides a built-in API for accessing and modifying their hosted databases. We used the user interface for moderation purposes but the main database connection made use of the API.

The back-end server was the only component that directly interfaced with the database. It served the purpose of controlling data lookups and update requests from the user-facing clients, thereby connecting all the users of the app with each other.

The user-facing client interfaced with the back-end server through a second, custom-built API with whitelisted actions and parameters. Access to this API was federated through a third-party authentication service, provided by Auth0. Implementing authentication directly within the back-end server could have improved stability and efficiency, but we chose the external authentication service in order to reduce development time and limit the risk of security bugs.

The front-end mobile app interfaced with the authentication system by redirecting the user to the Auth0 sign-in page in an in-app browser window. After a successful sign-in attempt, the sign-in page would redirect back to the app, returning a time-limited authentication token. This token could be verified via the Auth0 API whenever a request for user data was initiated.

The mobile app also interfaced with one final service, the OpenStreetMap public API, in order to acquire high-quality basemap tiles for the in-app map. Requests to this interface were handled entirely by the Leaflet.js package, which loads OpenStreetMap basemap data by default.

One advantage of this service-based approach is that each of the five components could be swapped out for another design solution, with only minor reconfiguration of the other components. For example, future implementations could switch to a different database, authentication, or basemap service if the third-party services we selected were not desired. The user-facing client app could easily take other forms too, for example as a browser-based web app.

5.4 Back-End Sever Application

We implemented the back-end server as a typical lightweight Node.js application. This made for easy deployment to Heroku, the free service we chose for hosting, and tight integration with both the MongoDB database and the React front-end via the Express.js package. This combination of MongoDB, Express, React and Node is popular for its flexibility and commonly referred to as the MERN stack.

The server application is made up of five core files, three of which define the database schema. The entire codebase can be found on GitHub.[1]

The main file, *server.js*, contains the core logic of the server including the database connection and API routes. The database connection is handled by Mongoose, an open source node package that provides object-document mapping for MongoDB. The server listener and routing are handled by Express.

The *package.json* file defines these and other dependencies of the application. In addition to Mongoose and Express, we used Body-Parser to parse the HTML requests, and Cors to handle cross-origin requests. The package file also defines other configurations, like the name, version, and license of the app.

The three remaining files specify the database schema and associated models, i.e., how Mongoose should map the database documents into JSON objects and back again. The model defined in the *user.js* file represents one user of the mobile app. This model includes demographic information on the user, user-specific settings, and information about what the user is offering (if anything). In future implementations, we plan to extract offers to their own model, which would allow for more than one offer per user, the saving of old offers, and other functionality that did not make it into the first prototype.

The *review.js* file defines a model representing user feedback on the delivery of an offer to another user. Thus, each review object is linked to two users. The other fields of the review object model contain the users' responses to the questions about the interaction, the date of the review, and information about the offer that was exchanged. This enabled us to perform active experience sampling during the prototype evaluation, as described

[1] https://github.com/lbraun/geofreebie-backend

in section 6.3. We also plan to use these reviews to support the development of user trust and reputation in future implementations, by allowing users to browse public reviews before deciding to meet another user.

The *datapoint.js* file defines a model that solely exists to enable this research project and not to provide any functionality to the user. Each time a user updates something in the system, a datapoint is logged with information about what the user changed. This enabled us to perform passive experience sampling during the prototype evaluation, as described in section 6.3.

The server exposes eight API routes related to the first two models: five for the user model and three for the review model (see table 5.1).

Method	Route	Description
GET	/users	Find all users
POST	/users	Find or create a new user
GET	/offer_pictures/:user_id	Find an offer photo by user id
GET	/users/:user_id	Find a user by id
PUT	/users/:user_id	Update a user by id
GET	/pendingReviews	Create a new review for a given user
POST	/pendingReviews	Find reviews by user
PUT	/pendingReviews/:review_id	Update a review by id

Table 5.1: Prototype back-end API route

Image Storage and Transmission

One key design consideration was how to store and transmit images. According to our needs assessment, images are essential for freecycling because they are often the best way to describe what is being offered. However, images often require separate storage infrastructure, take up a lot of storage resources, and may deplete a user's mobile data quota when loaded on their mobile phone.

We decided to store images as base64 encoded strings. Base64 encoding turns binary image data into ASCII text and is one built-in destination type option of the Cordova camera plugin that we used. The benefit of this format is that it can be stored and transmitted just like all other ASCII text data. In the context of the prototype, this means that an update to an offer's picture works the same way as an update to the offer's

title, and both are stored as the same kind of simple string attribute on the offer object in the application's database.

One common downside to this approach is that handling these "data URLs" can be very memory intensive on a mobile phone and can cause app crashes and errors. This was not a concern for us because users only need to take one photo at a time. Through early testing on an old phone with limited memory, we discovered one photo was not enough to cause problems, even when using a high image quality setting. We additionally reduced the quality of all images to 25 percent of the original quality in order to reduce data use.

A second reason mobile and web developers avoid base64 encoded images is that they are not treated the same way as standard binary-encoded images when loaded by most browsers (including the WebView of Cordova apps). Standard images are loaded last, such that the user does not have to wait for heavy images to load completely before seeing other lighter content. Images will also display partially as they are loaded, slowly growing to their full size.

We implemented a solution that provides these benefits and keeps API payloads small while still using base64 encoding for image uploads and storage. Instead of sending offer photos along with the rest of the offer information, the server sends a URL for another API request to the offer pictures endpoint. This endpoint takes the base64 encoded images from the database and converts them on the fly to serve them as standard PNG encoded images. This delays the downloading of image data until the user really needs it, and allows pictures of offers to load like any other image would.

5.5 Front-End Mobile Application

The structure of the front-end mobile app was defined by Cordova application architecture conventions. Cordova applications have a web application at their core, which is supplemented by Cordova plugins and integrated into the mobile operating system via a special HTML rendering engine called WebView (see figure 5.2).

In this case, the core web application is built with React, so the architecture is also

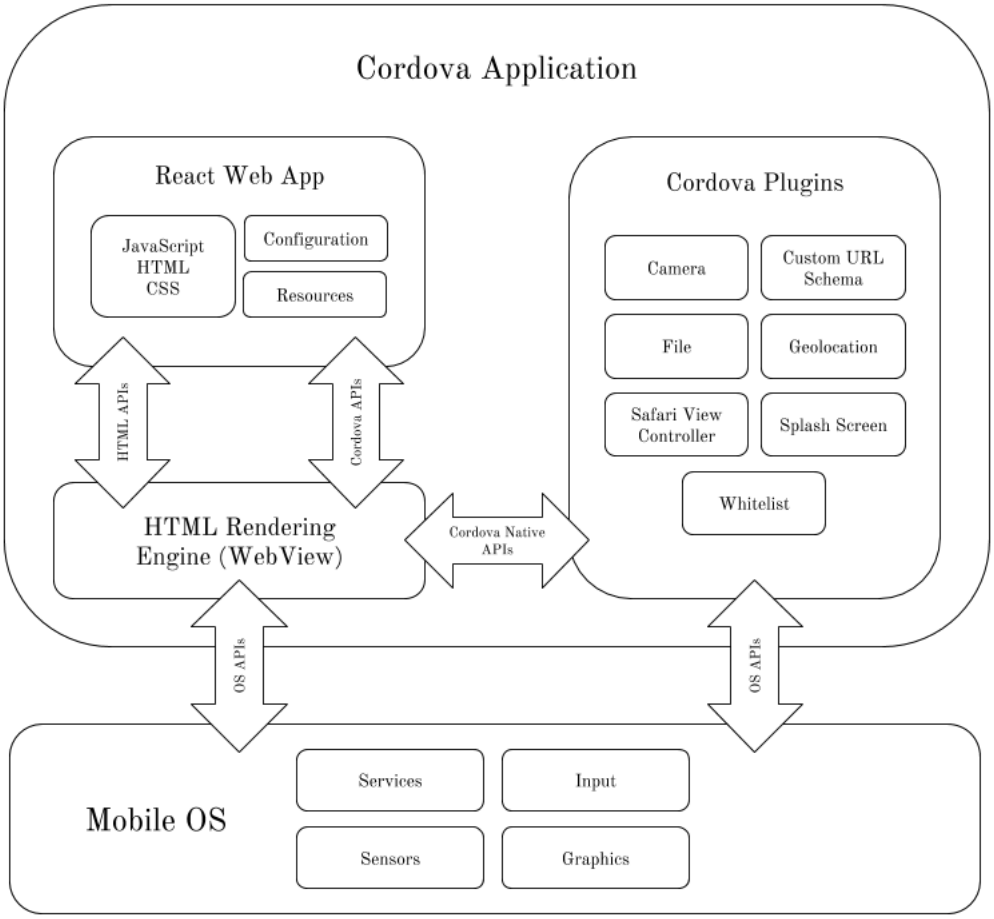

Figure 5.2: Cordova application architecture

influenced by React conventions. We also added one directory to house the source files for a static documentation website. The complete source code for the Cordova application and the documentation website can be found on GitHub.[2] In the following three subsections, we describe the web app, the plugin ecosystem, and the documentation website architecture in greater detail.

React application structure

The files for the React app are primarily contained in four directories: *node_modules*, *res*, *src*, and *www*. Additionally, two configuration files define how the app is packaged for distribution. The first, *config.xml*, is a platform-agnostic global configuration file that contains settings for the entire Cordova app. The second, *package.json*, is a standard

[2] `https://github.com/lbraun/geofreebie`

JavaScript configuration file that controls many aspects of the React app's behavior.

The *node_modules* directory contains all the dependencies of the React app. These dependencies are defined in the *package.json* configuration file.

The *res* directory contains the visual resources required by the Cordova app configuration, such as the application icon and the splash screen graphic at different resolutions for different operating systems. The number and nature of these files is defined in the *config.xml* configuration file.

The *src* directory contains the bulk of the source code for the React application. It is divided into three sub-directories: one for business logic components, one for static data components, and one for user interface components. Figure 5.3 provides an overview of all the UI components and their hierarchy.

The *www* directory contains static web files such as images and the *index.html* file, the container for all the dynamic content. It also contains the *lib* directory, where the Leaflet and Onsen UI source code are housed.

Cordova plugins

The prototype makes use of seven different Cordova plugins, which are contained in the *plugins* directory:

- The *Custom URL Schema* plugin allows the app to be started by calling it with a URL. This is necessary for redirecting back to the app after authenticating with Auth0.
- The *Camera* plugin provides an API for taking photos with the system's camera.
- The *Geolocation* plugin provides information about the device's location as available based on the device's positioning hardware and software.
- The *File* plugin allows the app to access files on the device via an API. This is used for logging in the LBS-Engine.
- The *Safari View Controller* plugin allows the app to make use of browser technologies on iOS and Android platforms that are faster than the built-in WebView, and

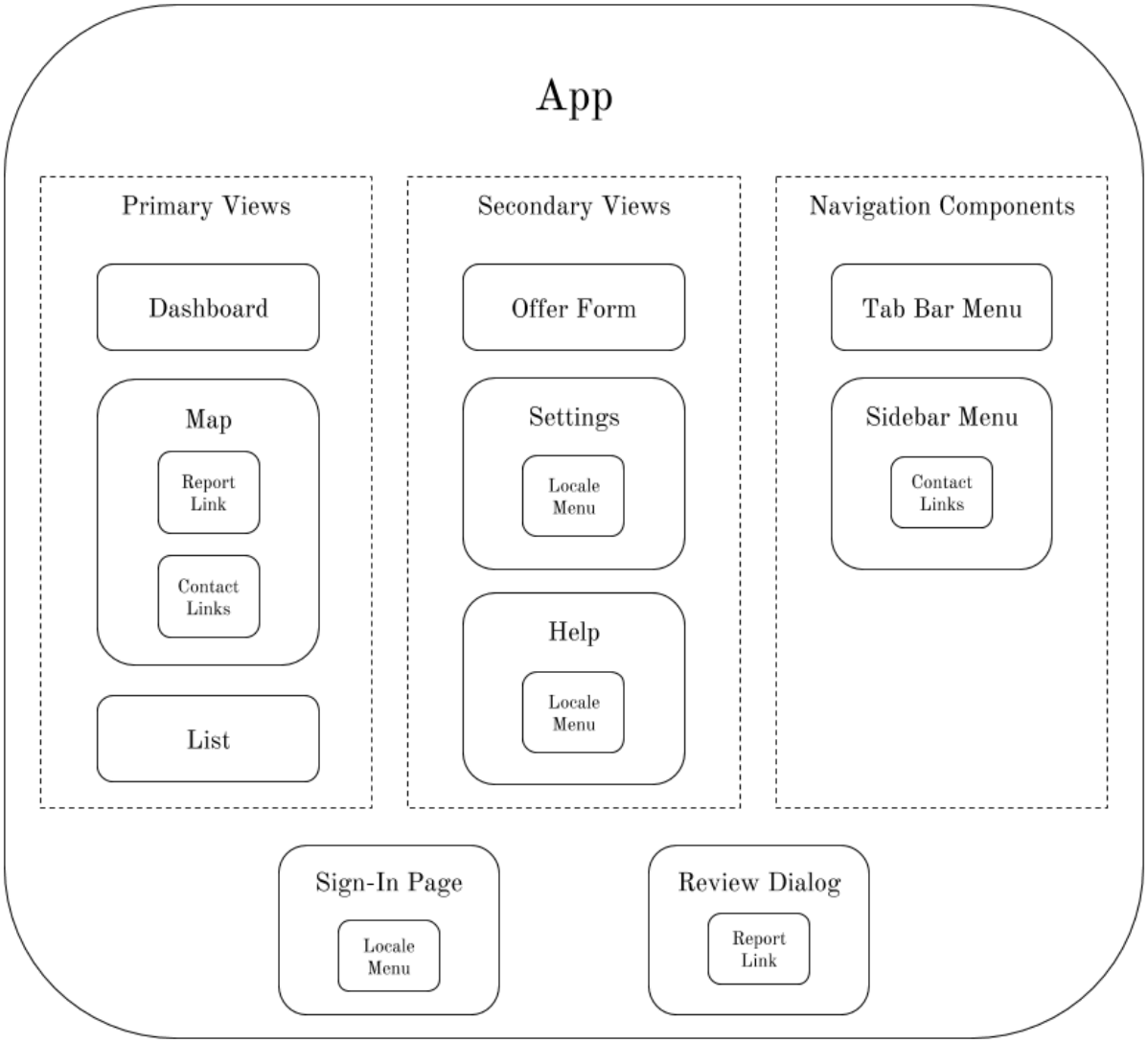

Figure 5.3: UI components of the app

is the recommended way to launch a browser in Cordova apps.

- The *Splash Screen* plugin displays and hides a splash screen during application launch.
- The *Whitelist* plugin controls which URLs are accessible via the in-app browser.

Documentation website architecture

The GitHub repository additionally contains the source files for a static documentation website,[3] served automatically by the GitHub Pages service. The files for the documentation website are all contained in the *docs* directory, as per GitHub Pages con-

[3] `https://lbraun.github.io/geofreebie/`

vention.

The documentation website is made up of four simple HTML web pages and two PDFs. The landing page, *index.html*, gives an overview of the site and provides links to the other resources. *contact.html* provides information about how to contact the app creator. *privacy_policy_de.html* and *privacy_policy_en.html* contain the privacy policy in German and English, respectively. The two PDFs, *consent_form_de.pdf* and *consent_form_en.pdf*, are the study consent form in German and English, respectively.

Chapter 6

Prototype Evaluation Study

6.1 Introduction and Objectives

We conducted an evaluation study of the prototype app in February 2019 with 6 forced migrants and 16 local freecyclers. The objective of the trial was to evaluate the usability and usefulness of the location-based freecycling service we developed in the second phase of the study, with respect to reducing the social isolation of forced migrants.

The independent variable in the study was the user group of the participant (forced migrant or experienced freecycler). The dependent variables that we tested were the reduction of social isolation (i.e., usefulness of the service) and the overall usability of service.

Having defined social isolation as the absence of social contact, we chose to measure reduction of social isolation simply by counting instances of contact with others that could be attributed to the functionality of the prototype service. Recognizing that relationships develop gradually with time, we decided to evaluate the creation of potential for deeper connections, instead of looking for changes in participants' social networks during the two weeks of the trial.

The study was randomized by allowing participants to self-select and by providing no restrictions or requirements for how participants used the app during the two-week

trial period.

6.2 Participants

We recruited forced migrant participants by contacting participants from our first study and by reaching out to other forced migrants we had met during the course of the project. We attended forced migrant meet-ups and helped interested attendees install and sign up for the service in person. We additionally shared a request for participants in a WhatsApp group for forced migrants and other members of a local club for newcomers to Münster.

We recruited freecycling participants by posting in the two largest Münster freecycling platforms and by contacting participants from the first study who had expressed interest in later testing a prototype.

All participants lived in Münster and were 18 years old or older. We did not control for specific age or experience. We motivated participation with a 10 Euro reward, delivered at the end of the study.

Of the 29 people who downloaded the app and created an account during the trial, we approved 25 for the study. From that pool, 22 consented to participate, filled out all of the surveys, and saw the trial through to the very end. Six of these self-identified as forced migrants.

Of the six forced migrant participants, all were between the ages of 18 and 25. Four came from Syria, one from Turkey, and one form Eritrea. Four were men and two were women.

6.3 Procedure

The trial began on a Thursday and ended on a Wednesday in order to give participants two full weekends to try the app. Participants were required to use their own Android

smartphone and internet connection. They installed the app via the Android Play Store.

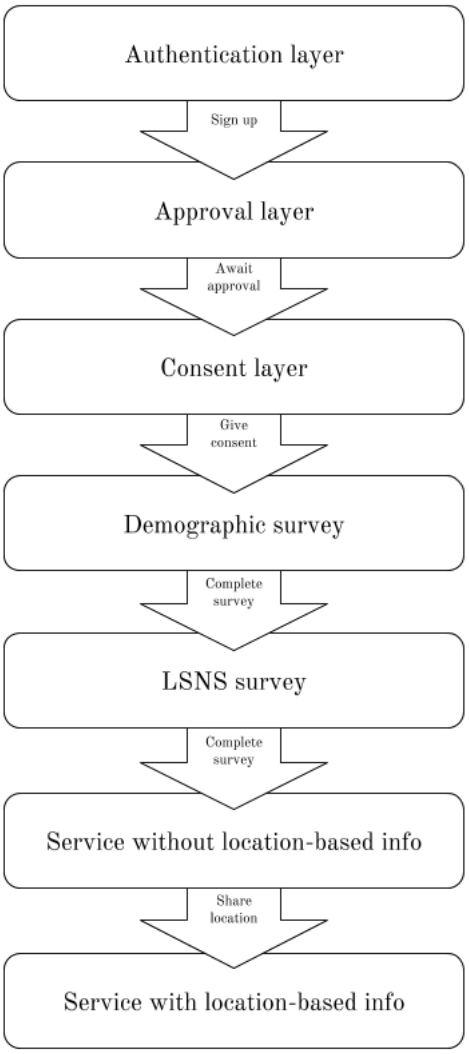

Figure 6.1: Layers of the service and the actions required to reach them

Approval process

After installing the app and signing up for an account, participants were instructed to wait for their account to be approved. We regularly checked for new sign-ups and evaluated each request to join based on past personal contact with the user, Facebook profile information if the user requested to join the study via Facebook, and in the absence of all other information, by sending the user an email requesting them to introduce themselves. Four user accounts were not approved: two because the users signed up from

outside of Germany, one due to insufficient information about the person, and one that was an existing user trying to sign in with a different email address.

Welcome email

After their account was reviewed and approved, participants were sent an email to welcome them to the user community. The welcome email also contained links to instructions on how to get started with the app, the rules of the service, and information about the study. Participants were encouraged to reach out with any questions or concerns.

Consent and Surveys

When participants logged into the app for the first time after approval, they were taken to the in-app consent form. This form asked users to agree to contribute their data to the study and separately requested permission to log particularly sensitive location data. Forced migrant participants received extra information about the consent to address ethical concerns when working with participants from vulnerable populations.

After providing consent, participants filled out a demographic information questionnaire to give us a sense of gender, age, country-of-origin, and user group representation. They also completed the Lubben Social Network Scale (LSNS) six-item survey, a validated self-report measure of social isolation that correlates with negative health effects (Chang, Sha, Chan, & Yip, 2018). We used this survey to obtain a rough impression of the level of social isolation of our participants at the start of the study. The questions from these two surveys are listed in appendix C.1 and appendix C.2. Only after providing consent and completing the two surveys were participants granted full access to the app for the duration of the study.

Passive Sampling Data Logging

Passive sampling was conducted during the study by logging user updates to the system in the back-end server application. The implementation of this data logging is

described in chapter 5. This was intended to help us understand how participants used the app.

Active Sampling Questionnaire

Active sampling was conducted through surveys that appeared to the user on the dashboard of the app as "pending reviews". The survey appeared immediately after completing an offer, the moment when freecyclers usually meet in person, and asked for a brief review of the hand-over. The intention of the active sampling was to collect data on any out-of-app interactions that occurred because of use of the freecycling system. We asked with whom, where, and how the contact was made. We also asked questions about satisfaction and likelihood of meeting up again in an attempt to measure the quality of the social contact. The exact questions of the survey can be found in appendix C.3.

End-of-Study Questionnaire

At the end of the trial, we contacted participants individually to arrange payment of the study reward and collect post-trial data. The app was removed from the Android Play Store and the back-end server was shut down to prevent continued use of the service.

We had participants fill out a questionnaire to measure the usability of the app on the System Usability Scale (SUS) (see appendix C.4). The questionnaire also included ten additional questions with the same answer scale, loosely based on the indicators of social isolation defined by Cornwell and Waite (2009). These were intended to provide additional data on the value of the app for reducing social isolation. See appendix C.5 for the full list of those questions.

6.4 Analysis

All data collected in this third phase of the study was quantitative and required no qualitative analysis. We downloaded the data from the prototype services' database

as three JSON files, one for each collection. The users collection file contained all the demographic and initial social isolation measurement data. The reviews collection file contained the active sampling data, and the datapoints collection file contained the passive sampling data.

We used a Ruby script to clean up the data and convert the JSON files into CSV files. Because the number of users and reviews was small, we could analyze those data by hand, summing and averaging statistics in a spreadsheet.

The larger datapoint dataset required more automated analysis. We wrote a script in Ruby to process and summarize the results. We tallied the datapoints by action, by user, and by action and user. This allowed us to see how many people created offers, updated their profiles, adjusted the app settings, etc.

The responses to the end-of-study SUS questionnaire were analyzed based on the classification of acceptable SUS scores developed by Bangor, Kortum, and Miller (2008). The responses to the questions about usefulness were considered individually.

6.5 Results

Passive Sampling Results

Only 4 of the 23 participants posted offers in the app in total during the two-week trial, which is roughly 1 post for every 6 users. When compared with posting rates in other Münster freecycling platforms, this is abnormally frequent posting. One of the most active freecycling services in Münster had roughly 1 post for every 118 users in the same two-week period as the trial. One of the less active services saw fewer than 1 post per 1000 users. Thus, relative to the size of the community, the posting rate was very high, which indicates the potential to create many opportunities for social contact. It is also possible, however, that participants were motivated to post due to the novelty of the service and the desire to support the study. A longer trial would be required to see if the trend continued.

Active Sampling Results

Just one participant, a forced migrant, reported actually completing an offer. This interaction was reported to be arranged over WhatsApp with a user who was not a forced migrant and took place at the participant's home. The participant reported being satisfied with the interaction and believed they were likely to contact the person again.

Usability Survey Results

We used the System Usability Scale (SUS) to evaluate the usability of the prototype service. The average SUS score across all users was 82.6. Among forced migrant participants, the average score was 82.1 and among freecyclers it was 82.9.

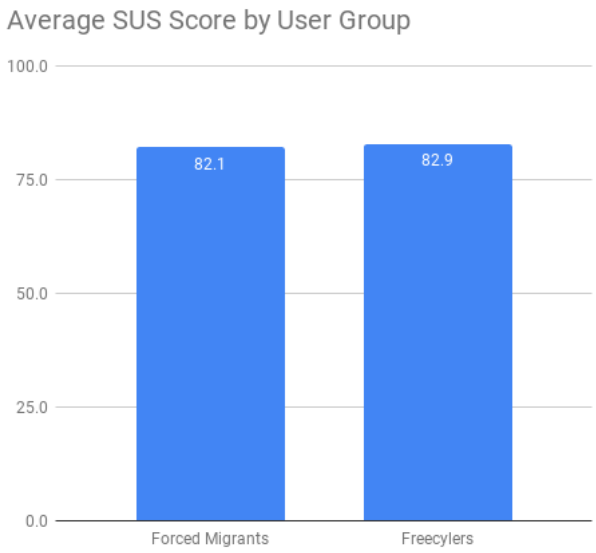

Figure 6.2: Usability survey responses: user group comparison

Usefulness Survey Results

In the final survey about the prototype service's potential to reduce social isolation (see appendix C.5), just one participant said the service led to increased contact with others during the two-week trial: the same participant who completed an offer.

A majority of the participants in both user groups disagreed or strongly disagreed

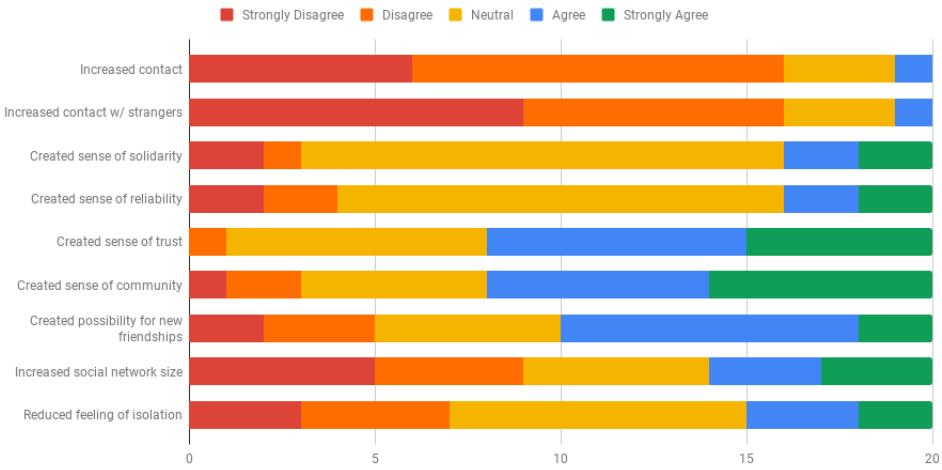

Figure 6.3: Usefulness survey responses: all responses

with the statements "I think using this system increased my contact with others during the last two weeks", "I made contact with people outside of my normal circles through this system", and "I think this app increased the size of my social network in Münster."

On the other hand, a majority of the participants in both user groups agreed or strongly agreed with the statements "I feel like part of a community while using this system" and "I think the contacts made through this app are likely to lead to new friendships."

Furthermore, a majority of both user groups responded neutrally to the statements "I feel like I have a lot in common with other people using this system" and "I found I could rely on the other users of this system."

The two user groups responded oppositely to just one question, the question about social isolation. A majority of the forced migrant participants agreed with the statement "I think this app made me feel less isolated from others in Münster" while a majority of the freecyclers disagreed.

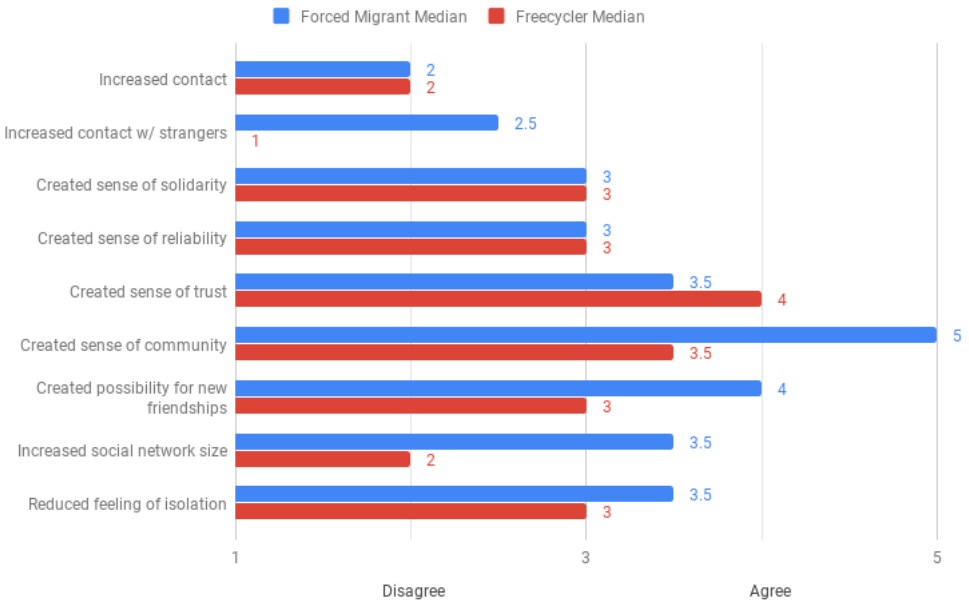

Figure 6.4: Usefulness survey responses: user group comparison

Chapter 7

Discussion

In this chapter we briefly summarize the findings from the previous 3 chapters regarding the needs of forced migrants in Münster, the design of solutions that meet those needs, and the usefulness and usability of the designs that we created. We then discuss these findings in a wider context and clarify the limitations of this work.

7.1 Discussion of Needs

We identified 55 forced migrant needs in regards to reducing social isolation. Here we discuss five key needs which we tried to address with the prototype that we developed.

Contact with a local "introducer"

Similar to the findings of Schreieck et al. (2017, p. 5) that a "local contact person" is the most important source of information for newcomers, we found that meeting an "introducer" is their most important source of social connection.

All of the forced migrants with whom we talked explained the importance of meeting a local with a strong social network who is able to introduce newcomers to potential new contacts. Most described just one key person who had introduced them to many friends.

Home where contact can be developed

Forced migrants commonly invite people into their homes as a strategy to make meaningful social contacts. All of our participants mentioned using this strategy at least once. To do this, however, forced migrants must have a home that can accommodate guests. They must be able to communicate their home's location to others and feel confident and safe doing so.

Accommodation of low language abilities

Perhaps the most discussed topic in our interviews about making social contact in Münster was the challenge of connecting with people without knowing much German. All of our participants experienced and overcame this challenge. They highlighted the need both for translators and translated resources when forced migrants first arrive, but also for opportunities to learn the local language.

Basis to initiate contact

A commonly known strategy for making social contacts, not just among forced migrants but also in many other circles of society, is to seek out people with common interests. All of our participants reported doing this. They explained commonalities provide a basis to initiate a first conversation and an excuse to meet up again.

Element of spontaneity and scheduling flexibility

Newcomers have busy, shifting, and complex schedules due to the wide variety and irregularity of important tasks they must complete in order to settle into their new home (Bustamante Duarte, Degbelo, & Kray, 2018, p. 17). We heard repeatedly that in order to make social contacts, one must find opportunities that fit with one's schedule. Often this means being spontaneous and approaching strangers to join a football match, start a conversation in a public place, or to offer help.

7.2 Discussion of Designs

Overview

We came up with a number of design solutions to meet the above needs with features of a location-based freecycling service. We did this by implementing a subset of the user requirements developed during the needs assessment phase.

Selected Features

Following is a list of some of the more interesting features we implemented. For each feature we describe why we found the feature was important for a location-based freecycling service to reduce social isolation and why we implemented it the way we did.

Authentication

Authentication is essential in any system where it is important to know that users are who they say they are. When freecycling, you have to know the person you are contacting is actually the person who posted the offer in which you are interested. When there is the potential to meet up in person, it becomes even more important that the identity of the users is somehow validated.

We decided to use passwordless authentication to make it easy to sign up and sign in. During the needs assessment we heard that many in our user groups had no desire to create another account and remember yet another password. We chose to allow people to sign in with Facebook and Google because 1) Facebook is the primary platform for freecycling in Münster, meaning most freecyclers are already connected and familiar with it, and 2) among our participants, Facebook and Google/Gmail/YouTube were the two most commonly referenced digital services after WhatsApp, which doesn't provide its own authentication service.

We decided to additionally give users the option to sign up with their email and a

secure password. While having to enter these details is usually less convenient, several participants from our needs assessment study expressed a preference for services that did not require connection with large corporate social networks like Facebook. Providing this third option allowed users to make the choice themselves between convenience and anonymity.

User approval

Approving new users was identified as the primary task of freecycling moderators. Local freecyclers repeatedly mentioned feeling reassured about the trustworthiness of other users because of the approval process. We also learned that forced migrants have their own system for approving new social contacts, often employing the very same strategies as freecycling moderators. These strategies include asking simple questions to see if the other could provide "normal" responses, identifying if the other is a part of a group that the approver trusts, and keeping an eye out for conflicting political beliefs.

User approval serves as an obstacle to spam bots or their social equivalent: people who make new contacts in order to broadcast a message or achieve some financial gain. It also contributes to community safety by prohibiting users with obvious malicious intent from accessing the data of other users.

The downside of user approval is that it makes the service exclusive and requires someone to judge potential new members, which is nearly impossible to do impartially. In fact, moderators indicated that this may be one reason why forced migrants are not well represented in freecycling groups in Münster: when a new user's profile is in another language and does not show signs of already being part of trusted Münster communities, the moderator is likely to reject the membership request.

We implemented approval as a simple boolean attribute on the user object. In the absence of a moderator user interface, the attribute can only be updated via direct access to the database. After signing up, new users are redirected to a screen informing them that they will receive an email when their account is approved.

Location-based services enable an additional means of approval. In the Geofreebie

prototype, users are automatically approved to make an offer available based on their physical presence in Münster. A bounding box geofence surrounds the city limits and users outside of this fence are automatically shown as "unavailable" in the system. This reduces misuse of the system by filtering out users actually located in other cities, which is a common concern among freecycling moderators.

In-app forms

We chose to implement the study consent form and study surveys as in-app forms for a number of reasons. This allowed us to require users to fill out certain forms before using the system, ensuring that consent was timely. This also allowed us to recruit participants without meeting them in person, as no physical paperwork was required to participate in the study.

We implemented the consent form as a page of explanatory text followed by four check boxes and a submit button. We chose this design in order to mimic the paper consent form of our institution. At the top of the consent screen, the user can select the language of the form. This allows users to see the information in multiple languages, which can improve comprehension.

We also require users to fill out two surveys before using the app. Chapter 6 describes the surveys and their purpose within the third phase of the study. These questionnaires are mostly multiple-choice questions, for which we use radio buttons because they are more usable than dropdown menus in a mobile app context. There is also one question about where the participant grew up, which we implemented as a free-text input to allow flexibility in the response. Again, each form is validated for completeness when the user tries to submit it, and access to the app is not allowed until the user completes the questionnaires.

User communication

Communication is an equally essential part of freecycling and making social contacts in a new city. People have a wide variety of preferences and strategies when it comes to

how they communicate. Therefore, we decided to give users a number of communication options to suit their personal preferences.

We designed interactions such that the person making the offer gets to choose the method of communication. This was reported to be common practice on Münster's Facebook-based freecycling platforms, where users would often state if they preferred to be contacted via comment or private message.

Users choose how others can contact them on the settings page (see figure 7.1). Toggle switches control their response to the question "How do you want to be contacted?" and when a certain contact mode is enabled, a text field appears where the contact details for that mode can be entered.

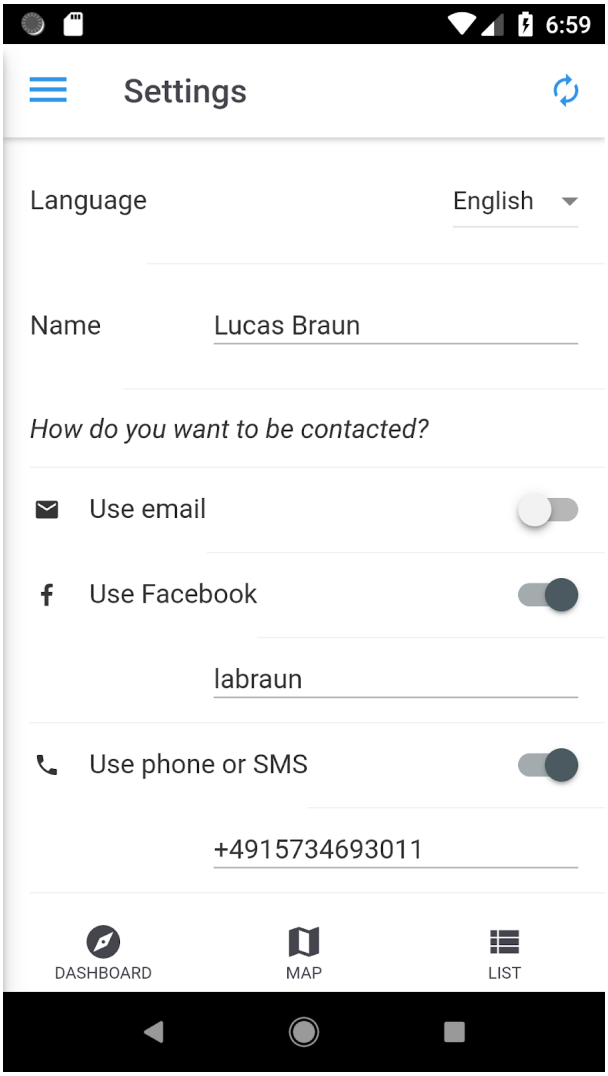

Figure 7.1: Prototype settings page

The four contact options we provided were email, Facebook, phone, and WhatsApp.

These were the four most popular communication methods of the participants in our needs assessment study, matching the findings of Xu and Maitland (2016).

After a user provides contact details, links are automatically generated from this information for other users to click on. Phone links and email links are a standard part of modern HTML (see the first two examples in table 7.1). They provide a way to launch communication in the context of a particular phone number or email address in the default phone or email application of the device on which the link is clicked. At the time of this writing, Facebook and WhatsApp provide a service to enable similar links for their services (see the last two examples in table 7.1). We made use of these links to seamlessly integrate other communication services into our freecycling service. Figure 7.3 shows an example of how these links appeared in the map view.

Action	**Link Format**
Open Phone or SMS	`tel:<phone_number>`
Open Email	`mailto:<email_address>`
Open WhatsApp	`wa.me/<phone_number>`
Open Facebook Messenger	`m.me/<facebook_username>`

Table 7.1: Contact link formats

Language and localization

We decided to make the app available in several languages in order to meet the need for accessibility to those with low German abilities. We implemented a language-switching feature called the locale menu, which is present in a number of places around the app (see figure 7.2).

We implemented the translation of the app's strings in one file: *localizations.json*. This made it simple for more languages to be added: a volunteer translator simply needed to go through and translate the list of 180 short strings, which usually took less than one hour, and then the new strings could be copied and pasted into a new element in the JSON array of localizations. By the time the trial had begun, the app had been translated from English into German, Arabic, Nepali, and Spanish. During the trial, another volunteer stepped forward to help with Amharic, and a Farsi native speaker expressed interest as well.

The fact that the language menu is prominently present in several places (e.g., the help pages, the consent form, the settings page) and not just tucked away between other user preferences, is meant to accommodate those with low ability in one language while still encouraging them to learn other languages.

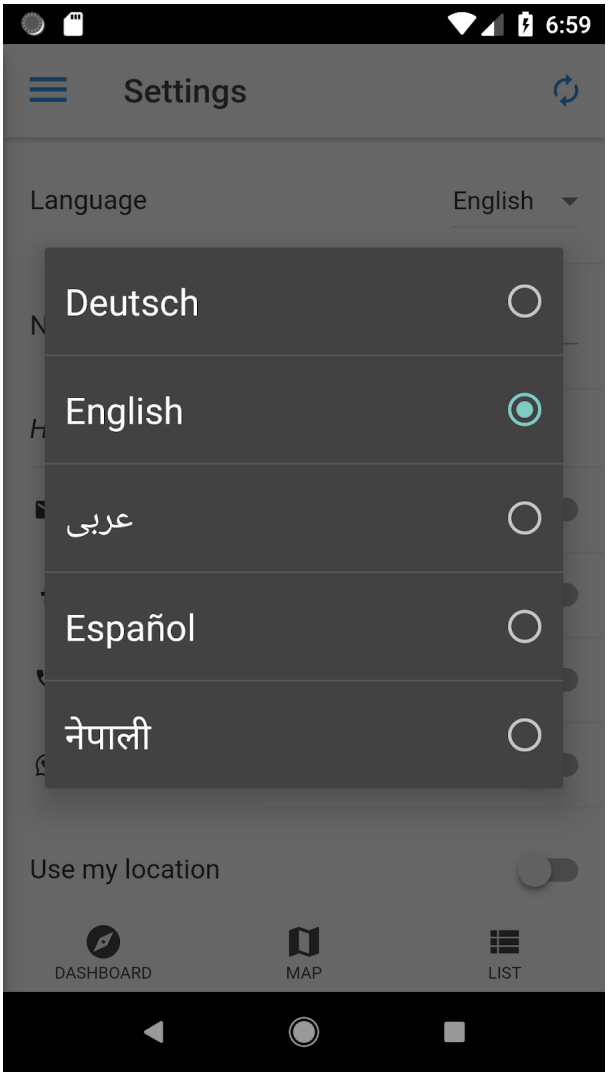

Figure 7.2: Prototype locale settings

Map and list views

The map and list views of the prototype were intended to meet several needs at once (see figure 7.3). The location-based features showing the distance to other users provides a basis to initiate contact (physical proximity) and facilitate those with limited language abilities to better visualize the offer and its location in the city. The Geofreebie star under the name of the person making the offer highlights the number of offers the user

has already successfully delivered, thus indicating their status in the social network of the service and suggesting their potential as an "introducer". The app itself is also intended to play the role of the introducer by presenting potential contacts and suggesting reasons to connect.

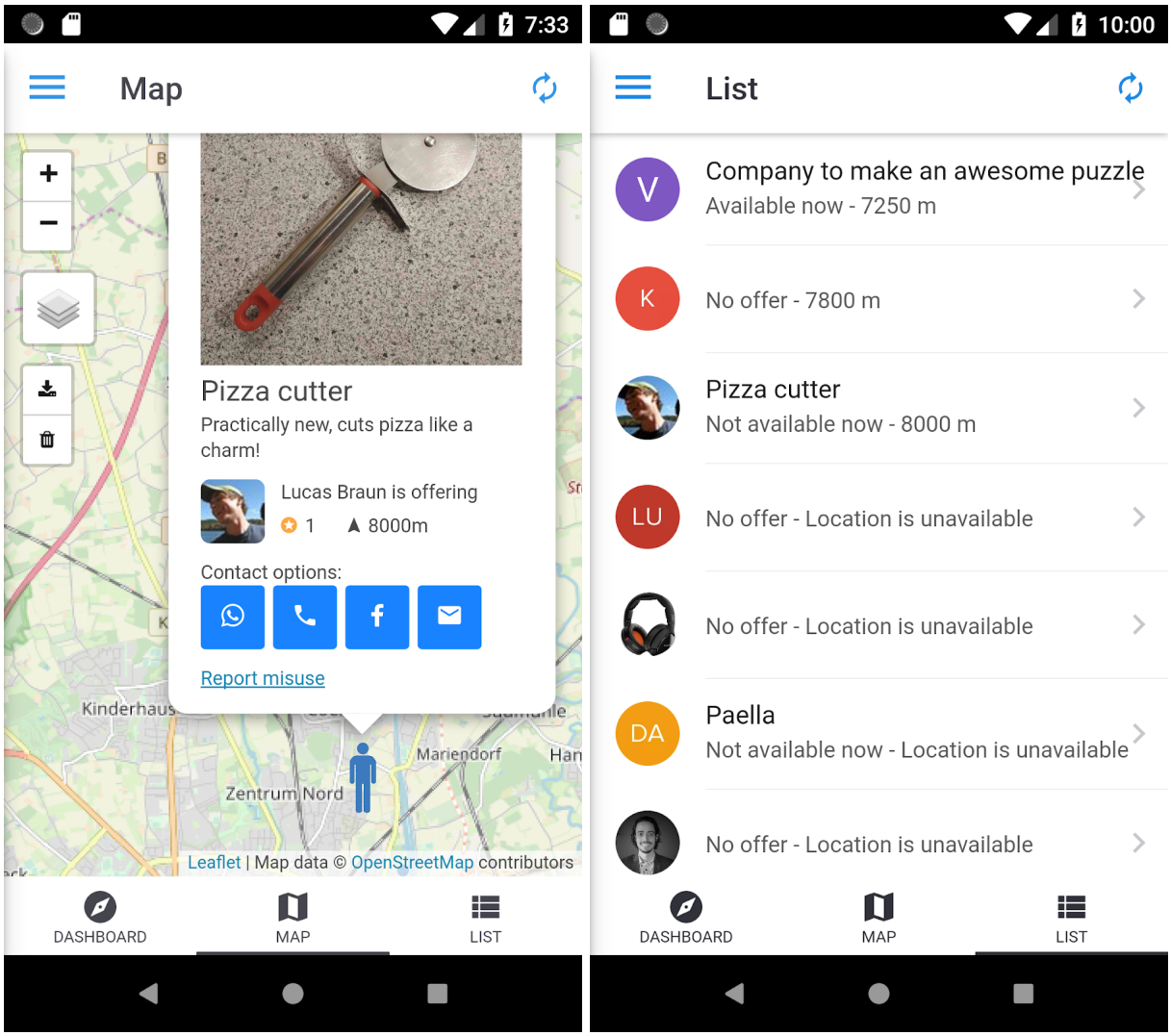

Figure 7.3: Prototype map and list views

Help

Offering help and technical support is important in any digital service. In digital services for vulnerable populations, we found it becomes especially important. These services must not only explain the functionality of the app but also address concerns about safety and privacy, all in a way that is easily understandable by users with a diversity of language abilities. Our help page includes five sections: help, rules, contact,

privacy, and consent.

Back button

One major cause of distress during pilot testing of the prototype was the back-button functionality on Android phones. Users are accustomed to being taken backwards one screen when they tap the back button, yet the default behavior in cordova apps is to exit the application entirely. This was quite frustrating to testers who were trying to reverse a mistaken navigation action, and instead got booted out of the system completely.

While not a revolutionary observation, the importance of respecting user expectations about basic UI functions is not to be overlooked. We updated the back button functionality to keep users in the app.

Reload button

Pilot testing also revealed the need for a refresh button. Mobile users often do not trust their network connection and want to be sure that they have the latest version of shared data. Such a button gives them control to see the latest data when they want it, not at the standard interval when the app refreshes data automatically. We added a refresh button to the top right corner in the navigation bar, as can be seen in figure 7.3.

7.3 Discussion of Evaluation

Usability

A SUS score of 82 falls into the top quartile of the 206 studies analyzed in one meta study about SUS scores, and correlates with an adjective rating of “excellent” (Bangor et al., 2008). Although a high SUS score does not guarantee acceptability in the field, it does suggest promise and a lack of major usability issues.

More interestingly, both user groups gave close to the same average SUS score. This

suggests that we successfully tailored the design solutions to both user groups through the human-centered design process.

Potential Usefulness

Our initial two-week trial of the prototype was not long enough to evaluate the full usefulness of the service. The relatively short duration of the trial was limiting for three reasons. First, building up a large user community takes time. Freecycling systems work best when there are a lot of users. The more users that are actively posting and browsing for offers, the higher the chance that someone will offer something that another user actually needs.

Second, as we identified in our needs assessment, both freecycling and making social contacts as a newcomer require good luck and patience. The longer someone is a member of a freecycling system, the more likely they are to find something they would like to offer or see an offer of interest.

Third, building relationships takes time. Even when people contact someone through a freecycling service, it takes time to arrange an in-person meetup. If this meetup is the first of repeated meetups, it may be a week or more before the next meetup takes place. In our model where the system is the "introducer," extra time is also required for the users to build a relationship of trust with the system.

For these reasons we could only evaluate the potential of the prototype system for creating social contacts. The in-app sampling results showed high feasibility and success compared to other freecycling systems. The results of the usefulness survey were also promising. Here we discuss these results in terms of their potential.

Creation of new instances of social contact

One participant reported having made a new social contact because of the app and described the interaction as positive and potentially leading to future repeat interactions. While this single result is not a significant indicator of the service's overall value in

regards to generating new social contact between strangers, it does show the potential and feasibility of the idea.

Participants' generally disagreed with the statements "I think using this system increased my contact with others during the last two weeks," "I made contact with people outside of my normal circles through this system," and "I think this app increased the size of my social network in Münster" because they did not successfully complete any freecycling exchanges. Half of the forced migrants did think that the app increased the size of their social network, however. This may be due to the modern understanding that a social network can also be virtual. For this reason, we recommend that future services do more to foster this virtual community. One limitation of the prototype, for example, was that participants' contact information only became visible when they had posted an offer. Users should have the possibility to make themselves open to contact even if they do not have something to offer in the moment.

Creation of a trusting community

Participants' general agreement with the statements "I feel like part of a community while using this system" and "I think the contacts made through this app are likely to lead to new friendships" also shows potential for reducing social isolation. Furthermore, only one participant disagreed with the statement "I think I can trust the other users of this system." Feeling like part of a community, optimism about making new friendships, and contact with trustworthy people are all indicators of low social isolation (Cornwell & Waite, 2009).

7.4 Limitations

There are several limitations to the results of this study. The number of participants and duration of the evaluation did not allow for a full assessment of the usefulness of the prototype service.

Furthermore, our recruitment strategies were biased towards forced migrant partic-

ipants who were already social enough to be out meeting strangers, meaning less social people were underrepresented. Women and older forced migrants were also underrepresented, so our results may not fully reflect their needs and contexts.

Another limitation is our assumption that contact through a freecycling service does indeed reduce social isolation. Meeting another individual in person does not guarantee a positive social interaction.

Chapter 8

Conclusion

8.1 Contributions

This work contributes to the greater understanding of challenges facing forced migrants today. We identified the context, core tasks, and specific needs of this vulnerable yet creative group in regards to creating social contacts in their new city and thus reducing their risk of social isolation.

We developed design solutions for a location-based service that supports forced migrant resettlement by helping them build their social network. We implemented some of these solutions and published them as open source software to allow adaptation and continued development.

Through the design and implementation of this freecycling app, we developed novel solutions to fill the gaps left by current freecycling services. These included independence from proprietary platforms, use of geospatial and location-based features, the ability to give feedback about other users, and recognition of inclusion and community-building as key goals when working towards the more commonly stated freecycling goal of sustainability.

Finally, we hope to have contributed insights that are useful for future development of location-based freecycling services for forced migrants, based on our prototype evaluation.

We have demonstrated how to design an LBS that is considered usable by both forced migrants and German locals when they use it in their everyday lives. We have shown the potential of such a service to reduce social isolation in a real world scenario.

8.2 Lessons Learned

The first lesson we would like to share with future researchers is that working with forced migrants is not just the best way to address their needs, but also rewarding in its own right. The forced migrants we worked with were generous with their time and ideas. They were aware of the challenges and needs of newcomers and patiently kind as they explained these in the interviews.

Another important lesson was that recruiting participants from a Facebook group can be challenging and unfruitful. For example, we posted one request for interviews in the largest and most active freecycling group, with more than 27,900 members and on average 17 posts per day. Only 10 members responded to this call and all but 1 of those backed out before meeting up to talk.

Finally, we learned that our choice of technologies for the prototype app created development friction when combined. Based on the relatively small amount of documentation and support for native Cordova apps implemented in React, we believe this is one of the less common web framework choices for Cordova developers. Leaflet and Auth0 provide powerful libraries for vanilla JavaScript, but not for React. The adaptations that we implemented came with limitations and the general technical support one finds in question-and-answer forums was lacking, probably due to the lack of other developers trying to do the same thing.

8.3 Future Work

There is great opportunity to continue the work started in the research conducted for this thesis.

Many of the user requirements developed in phase one of this work remain unimplemented in the prototype we built, and these could be added to the Geofreebie app. Further needs and user requirements came to light during the evaluation phase and these could also be addressed through additional development and implementation. This kind of iteration in the human-centered design process is expected and would produce higher-quality design solutions.

The prototype would benefit from further evaluation on a larger scale. Not just with more participants, but also with more time and perhaps with trials in other cities, the degree of usefulness of the app would become clearer.

Our analysis highlights the need for more research on technology that addresses the social isolation of forced migrants, especially those who are the most isolated. We only reached forced migrants who appeared to already have strong social networks. While their insights on the development of these networks was key to our research, those who have not succeeded in overcoming social isolation will be deprived even further of opportunities if their needs are not also considered in such services.

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Appendix A

Context Interviews

A.1 Interview Script

Preparation

- Put signed consent form, recorder, notebook, and two pens on the table
- Welcome and thank participant
- Explain what we are studying and why
  - Illustrate technical possibilities of a location-based service
- Explain focus on tasks, not systems
- Explain that interviewer won't be judging, there is no wrong answer
- Assure confidentiality and that interviewee can check facts
  - Will record audio to remember what is said, but won't share it with anyone
  - May include unidentifiable quotes in final work
- Explain consent form
- Ask participant to read and sign
- Ask if there are any questions
- Explain that recording will start now and interviewer will begin by asking for name, age, and verbal consent

Interview

- Start recorder
- Request consent statement
  - Please state your name and age.
  - Could you please say again, do you agree to have me record this interview?
- Perform interview
- Stop recorder

Conclusion

- Thank participant again
- Ask if they are interested in the results, and if so, note their preferred contact information
- Ask if they want to test the app in the second part of the study, and if so, make a note
- Ask if they know anyone else who might be interested in participating in the study

A.2 Interview Questions (Forced Migrants)

1. **Opening:** Please introduce yourself and describe your life in Münster. What do you do on a normal day?
2. **Introduction by the researcher:** Describe the issue of social isolation and its opposite: social contact
3. **Involvement:** Please describe your contact with people outside of your extended family in Münster.
   - Probe: How often do you have contact with such people? When was the last time?
   - Probe: Where do you have contact with people outside of your extended family?
   - Probe: What motivates you to do this?
   - Probe: How do you feel when you make contact with people outside of your

extended family?

- Probe: What are your main methods for making contact with people here?
- Probe: Which of these should be supported by a system?
- Probe: Which tools are necessary to make social contact as a newcomer? Which tools are missing? What tools do you wish existed?

4. **Prerequisites:** What is necessary for successfully making contacts here?
   - Probe: Do you need any specific knowledge? Are you lacking any knowledge?
   - Probe: Which skills do you need? Are you lacking any skills?
   - Probe: What does making contacts require of you (physically and mentally)?
5. **Execution:** When you want to meet someone here, how do you proceed?
   - Probe: What are the steps you take when making first contact?
   - Probe: Can things go wrong? If so, how do you become aware of that?
   - Probe: Are there any safety-critical aspects?
6. **Closing:** Based on this conversation, do you have any ideas for new ways people in Münster can come together to address the social isolation of newcomers?
   - Probe: What could be better here?
   - Probe: What already works well?

A.3 Interview Questions (Freecyclers)

1. **Opening:** Please introduce yourself and describe your life in Münster. What do you do on a normal day?
2. **Introduction by the researcher:** Explain the concept of freecycling and how it relates to the user's platform of choice.
3. **Involvement:** Please describe your experience with freecycling.
   - Probe: How often do you freecycle? When was the last time you freecycled?
   - Probe: Where do you freecycle?
   - Probe: What motivates you to freecycle?
   - Probe: How do you feel when you freecycle?
4. **Execution:** When you want to freecycle successfully, what do you have to do?
   - Probe: What are the specific steps you take?

- Probe: Which of these steps should be supported by a system?
- Probe: Can you make mistakes? If so, how do you become aware of them?

5. **Prerequisites:** What are the necessary qualifications for freecycling?
   - Probe: Do you need specific knowledge? Are you lacking any knowledge?
   - Probe: Which skills do you need? Are you lacking any skills?
   - Probe: What do the steps demand of you (physically and mentally)?
6. **Closing:** Based on this conversation, do you have any ideas for ways to improve existing freecycling systems in Münster?
   - Probe: Which tools are necessary?
   - Probe: Which are missing?
   - Probe: Which are desired in addition?

A.4 Interview Questions (Freecycling Moderators)

1. **Opening:** Please introduce yourself and describe your life in Münster. What do you do on a normal day?
2. **Introduction by the researcher:** Explain the concept of freecycling and how it relates to the moderator's system.
3. **Involvement:** What do you do as a moderator of a freecycling system?
   - Probe: How often do you actively moderate?
   - Probe: Where do you do this?
   - Probe: What motivates you to do this?
   - Probe: How do you feel when you do this?
4. **Execution:** What tasks are involved in moderating?
   - Probe: What are the specific steps you take [tasks]?
   - Probe: Which of these tasks should be supported by a system?
   - Probe: Can you make mistakes? If so, how do you become aware of them?
5. **Prerequisites:** What are the necessary qualifications for moderating?
   - Probe: Do you need specific knowledge? Are you lacking any knowledge?
   - Probe: Which skills do you need? Are you lacking any skills?
   - Probe: What do the tasks demand of you (physically and mentally)?

6. **Closing:** Based on this conversation, do you have any ideas for ways to improve existing freecycling systems in Münster?
    - Probe: Which tools are necessary?
    - Probe: Which are missing?
    - Probe: Which are desired in addition?

Appendix B

Context Analysis

B.1 Example Context Scenario

Bio	Participant came to Münster from Iran three years ago
Age	28
Gender	M
Date	Nov. 21, 2018
Duration	0:58:37

Question	**Answer**
[00:00:34] Please introduce yourself and describe your life in Münster. What do you do on a normal day?	Participant met many nice people after arriving in Münster. He meets up with his friends almost every weekend and goes out. He used to work for a German company but registered for disability one month ago because he has to have an operation. At the same time, he attends a C1 level German class.

	On a normal day, he used to work during the day and go to German class at night. He now doesn't work and does a lot of homework. On the weekends he goes out. He lives in an apartment by himself in a suburb of Münster and always rides his bike (hasn't bought a bus ticket for two years).
	He lived for one month in another city in Germany before he came to Münster. He feels particularly good in Münster because the people who live here are all in his generation, fresh and young.
[00:06:31] Please describe your contact with people outside of your extended family in Münster.	Participant has contact with his family still but is totally alone in Germany. He has friends with whom he goes out on the weekends, drinking, going to bars. He also has friends with whom he just learns languages.
	Participant has one friend who was a teacher at his language school (although not his teacher) and comes from an Asian country. Participant teaches him Persian in exchange for little lessons in his native language. He met him when the teacher greeted him in Persian (because a classmate found out the teacher was learning Persian) and they by chance rode the bus together. They got connected over Facebook, started doing a language tandem, have stayed in touch for a long time.
	Participant fled Iran with 3 others. One disappeared on the border with Austria but turned up later in Hamburg. The two others were placed in Bielefeld when he was placed in Münster. So he came to Münster all alone and was placed in a house with people of many different nationalities. This was difficult because he couldn't communicate well with his roommates. He can only speak a little English and Arabic. So he decided he had to learn German.

	They had social workers in the accommodation facility. He had practical skills and time (he was only doing a German course) and wanted to meet people and learn about German culture. So he went to the accommodation facility where they were renovating and he volunteered to help. He learned the German word "Kollege" from this experience, for example. The head of maintenance "Joe" saw him helping for two weeks and offered to give him a "one Euro job," a position with a very low wage, which allowed him to keep receiving the refugee money. He worked there for 6 or 7 months and met new people. When he had trouble with German homework, people there helped him. He helped "Joe" (who is about the same age) with whatever he needed, and "Joe" invited him to concerts, introducing him to Western culture. He was always with "Joe" and met many people through "Joe" until "Joe" moved away. He met his driving instructor "John" through "Joe" when they were out drinking together one time. "John" told him to come and convert his driver's license at his place. Participant used guessing tricks and logical deduction to pass the written test, since he didn't understand the questions. Failed the practical test two times because of language issues before passing on the third try.
[00:10:52] Probe: How often do you have contact with such people? When was the last time?	He goes out almost every weekend or every other weekend.
[00:25:09] Probe: What motivates you to do this?	Learning the language was the most important goal in his life.

	Second was to get to know the culture. Curiosity about food, traditions, etc. Also to be able to ask questions, and sometimes get the right answer, to improve his life.
[00:27:02] Probe: How do you feel when you make contact with people outside of your extended family?	He feels very excited when he makes new contacts and can talk about his life with them. He feels like a kid. He is always learning new things, it's like reading an exciting novel. He doesn't feel how the time is going by. For other people, everything is routine, but for forced migrants, everything is new. For example, he had never done an interview or had contact with an American before this interview.
[00:29:17] Probe: What are your main methods for making contact with people here?	For every contact he has a goal. He asks himself, why should I stay in contact with this person? What are the pros and cons? Every friend is different. For friends who come from other countries, he can help them. He learns languages from other friends. "Joe" is a good man, and helped him practice his German. He also could meet many people through "Joe".
[00:32:00] Probe: Which of these should be supported by a system?	Apps have pros and cons. Through an app, you can't tell what thoughts a person has. Through personal contact you can understand people better, but through an app you can save time. You can break off contacts that aren't going well more easily. You can make contact with people who are far away. Language tandems could be supported by an app, so that you could talk with someone in other countries.

[00:37:14] Probe: Which tools are necessary to make social contact as a newcomer? Which tools are missing? What tools do you wish existed?	Bars and beer are his tool. He wants to try living without a cellphone though. Using Facebook too much actually made him sad, reading news in Persian. On the other hand, all of his friends use WhatsApp and Facebook, so they are necessary in order to stay in contact. He can't think of any tools that are missing.
[00:42:14] What is necessary for successfully making contacts here?	The ability to act nice, to make a nice impression. To think about how to get along with people. He always tries to remain polite and kind.
[00:43:25] Probe: Do you need any specific knowledge to successfully make contacts here? Are you lacking any knowledge?	He has to act cool and relaxed, even if he is tired or upset. Even with someone who is his opponent, he has to act modest (bescheiden). That's something that works well in Germany: people even respect their opponents and are not arrogant.
[00:45:26] When you want to meet up with someone in Münster, how do you proceed?	He invites them for a coffee or cooks some Persian food at home and invites them to his place. On the second meeting he takes something with him, like gum or a chocolate, something! He always has gum in his bag and he often offers it to start a conversation. Also makes small talk about the weather when he's waiting in a doctor's office or something because he knows everyone is bored and might want to talk. He has made friends this way at the language school. But even if he doesn't make friends, it makes the moment better. He isn't trying to make long-term contacts every time.

	He sees his neighbors very seldom. He is considering inviting them to a meal at his place though, because he thinks neighborly contact is important.
[00:51:11] Probe: Can things go wrong? If so, how do you become aware of that?	When one always talks about one's self. Then people don't answer your messages anymore and then they don't meet you anymore. Also when you are too stingy. It helps friendship when you pay for each other from time to time.
[00:52:28] Probe: Are there any safety-critical aspects?	When people make fun of him, it bothers him. Even if it isn't really serious, so he tries to just avoid it.
[00:54:30] Based on this conversation, do you have any ideas for new ways people in Münster can come together to address the social isolation of newcomers?	One should found clubs for different subjects that don't cost very much (medicine, technical things, etc.). Clubs just for newcomers. And there should be possibilities in every language. It shouldn't be a club for refugees, but for all newcomers.

B.2 Context Elements

The following five tables show the various context elements we extracted from the interviews in phase one of the study (see chapter 4), along with the percentage of the interviews in which they appeared. The sixth table lists ideas that we collected from participants during the interviews about how to support forced migrant resettlement in regards to social isolation.

User Characteristics

Code	**% of Participants**
limited language ability	100%
politeness and respect	60%

bravery	40%
concern that you can't know who strangers really are	40%
friendliness	40%
adaptability	20%
concern about reliance on Facebook	20%
empathy	20%
humility	20%
knowledge of the community rules	20%
neutrality (no prejudices)	20%
older people are more isolated	20%
positive energy	20%
some forced migrants are illiterate	20%
time	20%

Goals

Code	**% of Participants**
learn something new	80%
learn language	60%
curiosity	40%
fun	40%
healthy	40%
help making decisions	40%
increase happiness	40%
break down prejudices	20%
broaden your perspective	20%
express oneself	20%
feel good	20%
find a romantic relationship	20%
get to know neighbors	20%

Tasks

Code	% of Participants
Find people with common interests	100%
Invite others to your home	100%
Meet an “introducer”	100%
Plan spontaneous meetups	100%
Be patient and open to chance	80%
Share your talents and abilities	80%
Find out about open/safe social opportunities	60%
Go regularly to work or school	60%
Improve communication ability	60%
Join a course or club	60%
Join organization that puts you in contact with many people	60%
Learn about host culture	60%
Match schedule with social opportunities	60%
Solicit help	60%
Start conversation	60%
Add other as a friend on Facebook	40%
Ask others questions	40%
Ask people about social opportunities	40%
Block people who are bothering you	40%
Connect with people from different generations	40%
Contact family/friends via WhatsApp	40%
Exchange contact information	40%
Exercise with others	40%
Go out with friends	40%
Go to open/safe social opportunities	40%
Learn languages with others	40%
Look for social spaces while walking around town	40%
Maintain financial stability	40%
Meet in a cafe	40%
Offer help	40%

Share your culture	40%
Spontaneously join an ongoing activity	40%
Answer people when they greet you	20%
Be understanding and tolerant	20%
Become an organizer	20%
Browse for interesting offers	20%
Choose meet-up place together	20%
Clarify details of meet-up	20%
Consider others' safety before your own	20%
Evaluate potential contacts	20%
Exchange skills	20%
Find commonalities with others	20%
Give conflict time and space	20%
Help others make decisions	20%
Introduce yourself	20%
Join a study program	20%
Learn about the city	20%
Meet in a public place	20%
Meet up in person	20%
Offer food	20%
Pay the bill for someone else	20%
Read promotions of social opportunities	20%
Set a goal	20%
Talk about common interests	20%
Use an app to meet new people	20%
Visit others at home	20%
Visit public events and attractions with others	20%
Volunteer	20%

Risks

Code	**% of Participants**

getting overwhelmed by too much technology	40%
newcomers act based on prejudices about Germans	40%
people isolate themselves	40%
socializing takes up too much time	40%
being made fun of	20%
conflicting interests or beliefs	20%
forced interaction may be bad	20%
forced migrants have to start life all over	20%
interaction is awkward or uncomfortable	20%
language skills lacking	20%
not enough energy to give and give	20%
not enough people using the service, so needs aren't met	20%
other members don't want personal contact	20%
people have fear of other people	20%
people only interested in themselves	20%
people stereotype newcomers	20%

Environment

Code	**% of Participants**
communication tool (Facebook/WhatsApp/Email/Phone)	60%
internet	40%
cellphone	20%

Ideas

Code	**% of Participants**
meet-ups for people with common interests	40%
app for promotions (events/discounts)	20%
clubs designed for newcomers	20%
contact through housing search	20%
contact through online personal ads	20%

enable long-distance language exchanges	20%
more advertising of social opportunities in foreign languages	20%
multiple language possibilities	20%
visit the people who are most isolated	20%

B.3 Implied Needs

We identified 6 core tasks when making social contacts as a newcomer, and analyzed the interviews to determine what forced migrants need in order to complete those tasks. For this reason, here we list the needs under the header of the core task to which they relate.

Formula: Purpose + necessary prerequisite to fulfill this purpose efficiently

Template: In order to ... , ... must ... .

Core task 1: find time to be social

In order to find time to be social, a newcomer must

Need	**N**
...match their schedule with social opportunities.	3
...maintain financial stability.	2

Core task 2: find potential contacts

In order to find potential contacts, a newcomer must...

Need	**N**
...meet an “introducer”.	5

...be patient and open to chance.	4
...join an organization that puts them in contact with many people.	3
...find out about open and safe social opportunities.	3
...go regularly to a place of responsibility like work or school.	3
...go to open and safe social opportunities.	2
...have the ability to spontaneously join ongoing activities.	2
...learn about the city.	1
...answer people when they greet them.	1

In order to find out about open and safe social opportunities, a newcomer must...

...ask other people about social opportunities.	2
...look for social spaces while walking around town.	2
...read promotions of social opportunities.	1

In order to go regularly to a place of responsibility like work or school, a newcomer must...

...volunteer.	1

In order to go to open and safe social opportunities, a newcomer must...

...know how to get there.	2

Core task 3: find a reason to initiate contact with potential contacts

In order to find a reason to initiate contact with potential contacts, a newcomer must...

Need	**N**
...find people with common interests.	5
...share their talents and abilities.	4
...learn about the host culture.	3
...join a course or club.	3
...solicit help.	3

...exercise with others.	2
...ask others questions.	2
...connect with people from different generations.	2
...learn languages with others.	2
...offer help.	2
...share their culture.	2
...be understanding and tolerant.	1
...exchange skills.	1
...find commonalities with others.	1
...help others make decisions.	1
...offer food.	1
...talk about common interests.	1
...pay the bill for someone else.	1
...set a goal.	1

Core task 4: communicate with potential contacts

In order to communicate with potential contacts, a newcomer must...

Need	**N**
...have accommodation of low language abilities.	5
...improve communication ability.	3
...start conversation.	3
...add other as a friend on Facebook.	2
...contact people via WhatsApp.	2
...exchange contact information.	2
...introduce themselves.	1

Core task 5: plan and execute meetups with potential contacts

In order to plan and execute meetups with potential contacts, a newcomer must...

Need	N
...invite others to their home.	5
...plan spontaneous meetups.	5
...go out with friends.	2
...meet in a cafe.	2
...choose meet-up place together.	1
...clarify details of meet-up.	1
...meet in a public place.	1
...meet up in person.	1
...visit others at home.	1
...visit public events and attractions with others.	1

Core task 6: avoid bad interactions with potential contacts

In order to avoid bad interactions with potential contacts, a newcomer must...

Need	N
...block people who are bothering them.	2
...evaluate potential contacts.	1
...give conflict time and space.	1

B.4 User Requirements

The following is a list of all the user requirements that came out of the context interviews with our forced migrant participants. User requirements marked with an asterisk

(*) are identical or nearly identical to user requirements that emerged from the interviews with freecyclers.

User requirements are actions that a user must be able to perform with the system in order to fulfill one of the implied needs efficiently. For this reason, they are basically the implied needs rephrased in terms of a system. It should be noted that while the requirements mention the system, they do not mention any specific technical solutions.

Template: The user must be able to ... the system ...

The user must be able to...

see when a social opportunity is happening in the system
see who is an introducer in the system
tell the system that they want to join an organization *
see social opportunities in the system
see if a social opportunity is open and safe in the system
see currently ongoing activities in the system
tell the system that they want to join a currently ongoing activity
see information about the city in the system
see when people greet them in the system *
tell the system to say something to another user *
see nearby social spaces in the system
see promotions of social opportunities in the system
see volunteer opportunities in the system
tell the system that they want to volunteer
see how to get to social opportunities in the system
see the interests of other users in the system
tell the system about their talents and abilities
see the talents and abilities of others in the system
see information about the host culture in the system
see courses and clubs in the system
tell the system that they want to join a course or club

tell the system that they would like help

see opportunities to exercise with others in the system

see questions that others have asked in the system *

tell the system that they want to ask a question

see users from other generations in the system

tell the system to say something to a user of another generation

see opportunities to learn language skills in the system

tell the system how they can help others

see offers of help in the system

tell the system about their culture

see what other users have shared about their culture in the system

tell the system about their skills

see the skills of others in the system

tell the system that they want to exchange skills with another user

see that another user wants to exchange skills

see information about other users in the system *

tell the system about food they have to offer *

choose the language of the system

see the system in languages other than their own

tell the system they want to add another user as a friend on Facebook

be directed to the Facebook profile of other users in the system

tell the system that they want to contact another user via WhatsApp

be directed to a WhatsApp message thread of other users in the system

tell the system their contact information *

see the contact information of other users in the system *

tell the system introductory information about themselves *

see introductory information about other users in the system *

tell the system to invite other users to their home *

tell the system the location of their home *

tell the system that they are available to meet up spontaneously

see other users in the system that are available to meet up spontaneously

tell the system to tell something to other users that are available to meet up spontaneously

choose a place to meet other users in the system *

tell the system a suggested place to meet up *

tell the system to confirm or reject a suggested place to meet up *

tell the system details about a meetup *

see the location of the homes of other users in the system *

see public events and attractions in the system

tell the system about interest in a public event or attraction

see the interest of other users in the system in a public event or attraction

tell the system to block another user *

see information about other users in the system before contacting them *

tell the system to block another user temporarily *

tell the system to hide another user temporarily

Appendix C

Prototype Evaluation Questionnaires

C.1 Demographic Questionnaire

1. What is your age?
   (Under 18, 18 to 25, 26 to 35, 36 to 45, 46 to 55, Over 55)
2. What is your gender?
   (Male, Female, Other)
3. In which city or cities did you grow up?
   (Open question)
4. Are you an asylum seeker or refugee?
   (Yes, No)
5. Have you ever used Verschenk's Münster, Foodsharing, Freecycling.org, or any other "freecycling" system?
   (Yes, No)

C.2 Lubben Social Network Scale Questionnaire

This questionnaire is the result of an effort to develop a quick measure of social isolation to help identify suicide candidates among seniors from mainland China (Chang et al., 2018). For all questions, the answer possibilities are "none," "one," "two," "three

or four," "five to eight," or "nine or more".

FAMILY: Considering the people to whom you are related by birth, marriage, adoption, etc...

1. How many relatives do you see or hear from at least once a month?
2. How many relatives do you feel at ease with that you can talk about private matters?
3. How many relatives do you feel close to such that you could call on them for help?

FRIENDSHIPS: Considering all of your friends including those who live in your neighborhood...

4. How many of your friends do you see or hear from at least once a month?
5. How many friends do you feel at ease with that you can talk about private matters?
6. How many friends do you feel close to such that you could call on them for help?

C.3 Offer Review Questionnaire

This questionnaire appeared to participants of the prototype evaluation study as soon as they tapped a button in the app to say that they had given their offer to another user.

1. To whom did you give your offer?
   (Select user from a dropdown)
2. How did you get in contact?
   (Phone or SMS, WhatsApp, Email, Facebook)
3. Where did you meet up?
   (At my home, At their home, At someone else's home, At my work, At their work, In another public place, We didn't meet in person)
4. How satisfied were you with the interaction?
   (Very satisfied, Satisfied, Slightly dissatisfied, Very dissatisfied)
5. How likely are you to contact this person again?
   (Very likely, Likely, Unlikely, Very unlikely)

C.4 Usability Questionnaire

We used the System Usability Scale (SUS) to measure the usability of our prototype. This scale and the associated questions were originally developed by (Brooke, 1996) and has become the industry standard for measuring usability (Bangor et al., 2008). Participants were asked to answer all questions on a scale from one to five, where one meant "strongly agree" and five meant "strongly disagree".

1. I think that I would like to use this system frequently.
2. I found the system unnecessarily complex.
3. I thought the system was easy to use.
4. I think that I would need the support of a technical person to be able to use this system.
5. I found the various functions in this system were well integrated.
6. I thought there was too much inconsistency in this system.
7. I would imagine that most people would learn to use this system very quickly.
8. I found the system very cumbersome to use.
9. I felt very confident using the system.
10. I needed to learn a lot of things before I could get going with this system.

C.5 Usefulness Questionnaire

We developed the following nine questions in attempt to quickly assess changes in the indicators of social isolation established by Cornwell and Waite (2009). As with the usability questionnaire, participants were asked to answer all questions on a scale from one to five, where one meant "strongly agree" and five meant "strongly disagree".

1. I think this app increased the size of my social network in Münster.
2. I made contact with people outside of my normal circles through this system.
3. I think using this system increased my contact with others during the last two weeks.
4. I feel like I have a lot in common with other people using this system.
5. I think the contacts made through this app are likely to lead to new friendships.

6. I feel like part of a community while using this system.
7. I think I can trust the other users of this system.
8. I found I could rely on the other users of this system.
9. I think this app made me feel less isolated from others in Münster.