Designing, Developing, and Deploying a Platform for Sharing Economy

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Abstract:

As the climate crisis continues to worsen, we argue that sharing economy could support a mitigation of the effects. In this report, we present the further development of a sharing economy platform, consisting of an Android application and a backend. We continue an older report made by us, the authors, in which the backend of the platform was missing, as well as some changes discovered through user feedback. We present the changes made to the application design, whereafter we explain the architectural design of the platform. We introduce a field study and a lab study, in order to evaluate the functioning of the platform. Lastly, we discuss our findings and thoughts regarding changes and future plans for the platform, based on feedback from the studies. Our primary contributions is the design of platform, the process of developing it, and the feedback from users. This can assist in future development and research of similar platforms.

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We would like to thank our supervisor, Florian Echtler for the guidance related to this report and project. Additionally, we would like to thank the users who participated in the field study and the interviewees who gave us feedback on our platform.

The content of this report is freely available, but publication (with reference) may only be pursued due to agreement with the author.

Resume

This report presents our process of designing, developing, and deploying a platform that assists private individuals in participating in the sharing economy. The initial phase of the project was presented in our previous report [1], in which we explored existing platforms, made the initial design, and developed two high fidelity prototypes. A user study was conducted on the last prototype, that served as a starting point for this report.

Sharing economy is the concept of private individuals sharing their items, that they already own but might not use all the time. An example of this could be a drill or some kitchen appliance. A large focus in research is placed on for-profit companies, specifically Airbnb and Uber, and theoretical areas of sharing economy. This leads to a gap in the study of sharing economy as a practical tool to improve society. Instead we argue, that sharing economy could be utilized to allow private individuals to help each other and mitigate the climate crisis. Most real-world solutions, e.g. DBA and GoMore, does not focus on sustainability or is too narrow in their target domain. This lead us to developing a platform, that could close both the gap in research and real-world solutions.

Throughout this report, the final design choices are presented, including the design of the platform architecture, as well as the UI design changes made to the Android application. The Android application is developed in React Native, and the majority of the source code can be reused for an iOS version. Parts of the code can also be used for a web version, which would further increase the availability of the platform. The backend was developed in the Nest.js framework. By developing both parts in Typescript, we argue that we eased the process of developing the complete platform.

A field study was conducted after developing the backend, and implementing it in the Android application. The amount of participants that signed up and participated in the study was very low, and as such a lab study was conducted. The lab study emulated some interactions that users would go through if they were using the platform in the field. When the users had completed a list of tasks, they were asked a few questions about their experience through a semi-structured interview. The overall feedback of the lab study was very positive, with a list of suggestions for improvement.

Based on the feedback from the user study, as well as our own experience of designing, developing and deploying the platform, we present some future directions for the project. The direction we recommend, is giving the public access to the platform, as it is in a fully usable state. This would entail creating a posting on the Google Play Store, that follows Google's requirements. It would also be reasonable to fix some minor errors and bugs in the application.

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1 Introduction

Considering that the climate crisis continues to worsen and consumption skyrockets [2], actions must clearly be taken. As a singular individual it would be seemingly impossible to have any effect on these global problems. But we, the authors, argue that sharing economy could be a means to lessen the impact of consumption on the climate, by allowing private individuals to cooperate and help each other. We present a potential software implementation that can assist in this fashion. Sharing economy is the practice of sharing one's possessions with other people, instead of buying something new when it is needed [1]. We further argue that sharing economy could assist in fulfilling goal 12 and 13 of the United Nations' 17 Sustainable Development Goals, as both are closely related in regards to consumption.



E-waste generated and recycled, 2010–2019, projected e-waste generated and required growth in recycling, 2020–2030 (kilograms per capita)

Figure 1.1: An overview of e-waste recycling presented by the United Nations [2]

Goal 13 concerns combating climate change and according to the UN, the COVID-19 pandemic has not slowed down the climate crisis, even if the economy has been slowed. Goal 12 is to ensure sustainable consumption and production patterns, which is closely related to the climate crisis. A large focus of goal 12 is e-waste and the UN projects that the amount of e-waste generated will only increase towards 2030. In 2019, we only recycled about 25 percent of everything generated, meaning we will have to increase our recycling by a significant amount to ensure recycling of all e-waste. [2]

Figure 1.1 shows the dramatic difference in recycling and generation of e-waste. As the increase in recycling has been minuscule compared to the increase of generation, it might be too difficult closing the gap solely by increasing recycling. Perhaps, it could instead be possible to lower the generation of e-waste, by limiting the production of new electronics through sharing already existing electronic products. In addition to not recycling properly, the global material footprint increased by 70 percent from 2000 to 2017, meaning our consumption has heavily increased in this time frame. Thus, the UN describes a need to keep products and materials in use, which also aligns with the concept of sharing economy.

Logically, private individuals could have an effect on their own generation of e-waste and material consumption, which in turn could lessen the impact of climate change, by abstaining from buying new items. Of course, people would still need some amount of items to get by, but instead of buying something new, they could borrow something already existing from each other. Borrowing from others could thus help lower emissions, in addition to not producing a new item. Especially if the involved individuals does not borrow from too far away, compared to a product shipped from outside their country. Sharing economy thus fits well as a way of reaching both goal 12 and 13.

We continue our work from Andresen et al. [1] in order to create a platform for supporting sharing economy between private individuals. Even though most points and details presented are explained as they are drawn forward, it might be necessary for the reader to also read some parts of our previous report [1], as this report is heavily based on it. In our previous report [1], we present a problem statement that reads the following:

How can an accessible and flexible platform for supporting sustainable sharing economy be constructed, while involving users, not motivating primarily through monetary compensation? [1]

As the previous work succeeded in parts of the the problem statement, this report will present an overview of the finalized platform and a two user studies. The first study is a field study in which the platform was deployed as real application, open to select participants. The second study is a lab study performed with one user at a time, emulate real-world interactions through the platform.

As we identified in our previous report [1], research presents a gap in the area of sharing economy, but also calls for new implementations, instead of theory. Furthermore, another gap is identified in real-world solutions for supporting sharing economy, as most platforms focus on profits instead of trying to combat climate change. This report contributes a potential software solution to help fulfill goals 12 and 13 of the UN's Sustainable Development Goals, bridge the gap in research, as well as real-world solutions.

2 Related Work

This chapter explores a paper that has been published since the writing of Andresen et al. [1], regarding the sharing economy, that provides insight into how retention rates can be upheld. Additionally, an introduction is made of Andresen et al. [1], our previous report, which the current report bases its foundation on.

2.1 How Users are Retained on Sharing Economy Platforms

Mojtaba et al. [3] presents a business model with three main actors, which shows how the actors are affected by multiple factors that can affect retention and loyalty to a platform. The three actors are the customer, the service provider, and the platform. The service provider delivers the underutilized resources for costumers to gain access to over a period of time, and the platform is the intermediary that makes the exchange between the service provider and customer possible. The factors that affect the actors are either inhibitors or motivators, and we focus primarily on the customer actor and service provider actor.

The main motivators for a customer are the utilitarian, hedonic, social and environmental values. The utilitarian and hedonic values are the benefits that customers expect during interaction with the platform. The utilitarian value is the economic aspect that is included in the exchange while the hedonic value focuses on the fun or pleasure gain from using the platform. These benefits are presented by Mojtaba et al. [3] as essential motivators for customers, in order for platforms to retain them.

The main inhibitor for a customer is the probability of suffering a loss, while using the platform. As the service providers are independent actors, there is a higher risk for the customer in a sharing economy setting, compared to the traditional market.

The motivators for a service provider is split into 3 parts by Mojtaba et al. [3]: economic value, work flexibility, and social value. The primary and initial motivator is usually the economic value of becoming a service provider, as you gain a second income. The second motivator for being a service provider is the work flexibility, such as being able to change the volume, location, and time of the services provided. Lastly, the service provider gains a network by meeting other people. This benefits the service provider as they can build a network of trusted customers and have social interactions.

The inhibitors for the service provider, mainly lies in the risk of damage of their property, whether it is a car, an object, or a location, resulting in economic loss.

The customer loyalty to a platform depends on multiple factors according to Mojtaba et al. [3]. The more trustworthy service providers that are on the platform and the higher satisfaction the customer gains from the service providers, the more the customers will be loyal to the platform. It is therefore essential to keep service providers on the platform as that leads to more customers as well. The retention of service providers has been studied to be mainly affected by the quality of their relations with customers. Thus, it is also essential to create a platform that creates an environment where both the customer and service provider can build a strong relationship.

To be able to motivate the individual actors Mojtaba et al. [3] suggests to focus on the utilitarian and hedonic values in regards to the customer, as they have the highest impact. The economic value has the highest impact on the service providers satisfaction and should therefore likewise be in focus.

2.2 How to Design a Sharing Economy Platform

In Andresen et al. [1], we present a possible way to design a platform for supporting the sharing economy without primarily motivating through monetary compensation. The report presents multiple factors that should be considered while designing such a platform, based on research and existing platforms.

We also argue for a gap in research: that most of the existing research is focused on theory instead of practical solutions and their impacts [1]. Calls for practical implementations is also called for by research directly. Furthermore, in Andresen et al. [1], we argue that another gap exists in real-world solutions, as multiple other solutions from larger companies is explored and found to focus mostly on profits, instead of the potential positive impact on the climate. The solutions from larger companies are explored and compared to highlight what features are key components of a sharing economy platform.

An initial prototype was constructed based on the findings in related research and existing platforms, and a user study was carried out with multiple users who were interviewed after trying the initial prototype. The report then presents a final prototype, based on the findings, that is ready for a backend to be implemented. Lastly, it presents a number of challenges related to getting a sharing economy platform operational, some of which we will further discuss in Chapter 6.

3 | Design

This chapter presents the architecture and design of the platform based on the work in Andresen et al. [1], presented in Chapter 2. It consists of an Android application and a backend that handles all data related to the platform. The application makes use of a custom library to facilitate communication between the application and the backend.

The design of the application, including changes from the final prototype in Andresen et al. [1], is presented in Section 3.1, while Section 3.2 explains the architecture of the platform and some basic details about the deployment of the backend. An overview of most pages in the application can be found in Appendix A.

3.1 User Interface

Following the design presented in Andresen et al. [1], the app consists of 5 main sections: Discover, Groups, My Page, Favorites, and Conversations. Additionally, a login/register page exists as a barrier requiring authentication to access the rest of the app. The Discover section is the main entry point point of the application, after the user has logged in or signed up, and it is from here users can discover and search for postings. The Groups section contains all group related functionality, such as joining, creating, and inspecting groups. In My Page users can see their currently requested, borrowed, and reserved postings. They can also see their own postings, incoming requests, reservations, and create new postings. From the Favorites page, users can see the postings they have marked as favorite, and from the Conversations page, they can see all their active conversations with other users.

Since our last report [1], there has been a number of changes to the design, most of which are additions. There has been some small changes and refinements, but overall the design has not changed dramatically. In Table 3.1 the most noticeable changes are summarized.

Feature	Design in last prototype	Changes in the final platform
Login/Register Screen		Login screen that shows logoRegister screen that allows users to create an account
Onboarding		 Onboarding flow that introduces users to the platform when they sign up Allows them to join groups pre-made for field study
Discover	 Cards with title, price, description, image, favorite icon, and group tags Group tags a little rounded, and displayed in primary color 	 Added link to FAQ page Group tags fully rounded, and displayed in more desaturated green color
My Page	 Simple cards with small image, description and price Shows a badge with time information displayed in primary color 	Also shows requested reservations, both incoming and outgoingBadges have been colorized according to their status
$\overline{\text{My Page} \rightarrow \text{My postings}}$	Simple cards with small image, description and price	Smaller cards, pricing removed
Posting with reservation	Only posting details	 Shows reservation status above posting details Includes time frame, status, requested-at time, requesting user, buttons to interact with reservation
Profile Page	• Displays avatar, rating, verifications, badges, and join date	 Colorized ratings with green as provider and blue as consumer Added an info button to badges to see their descriptions Added contact button to create a conversation Added clickable stars to rate user

Table 3.1: The changes in the design. The first column specifies the specific feature or page that has changed, the second column specifies how the design was in the last prototype, and the last column specifies what has changed in the final platform. If a row in the first column is empty, the feature or page did not exist in the last prototype.

	Register	welcome to
	Profile picture*	₹®↓
Sharing Economy Platform	Name* Last name	Sharing Economy Platform
Welcome	Email*	Thanks a lot for participating in our test of the platform. Should you run into any problems with the platform, please contact os on sharingeconomynlatform@gmail.com
🖾 Email	Email	Please follow the instructions on the following pages.
Password 🗞	Password*	
	Password 🗞	
Register	Confirm password	
	Must be between 8 and 128 characters.	Have you already completed first time setup? Skip
	Cancel Sign up	Next
(a) Login page	(b) Registration page	(c) A page of the onboarding process

Figure 3.1: Screenshots of the login, registration, and onboarding page

The first thing a user sees when they open the application is the login/register page, seen in Figure 3.1. This page is new compared to the last prototype, and is shown to the user if they are not logged in. From here, the user can log in to an existing account, as well as create a new account. The logo is placed in the background, with the content to log in and create an account placed in a sliding card

in front, that scrolls up above the logo to reveal the rest of the content. After a user has created an account, they are taken to the onboarding page, seen in Figure 3.1c, which will introduce the user to the application, and guide them through first time setup, such as email verification and joining groups.



Figure 3.2: Screenshots showing the Discover page, "My Page", and a posting with a reservation

A subtle change, that might be less noticeable, is that some colors has been changed from the primary color to the more desaturated version, that is already used for the header and navigation bar. An example of this is the group tags on the discover page seen in Figure 3.2a. This was done to not make the elements stand out as much, as they were too attention attracting compared to the other elements on the page.

A more prominent change is the overhaul of the "My Page" section. The "My Items" page was renamed to "My Postings" to accommodate other types of postings, such as services. The cards on the "My Postings" page has been made smaller, and the price has been removed from the cards, based on the assertion that the provider cares less about being able to see the price on their own postings and more about seeing more postings at once. Incoming requests has also been added to this page, meaning that the page now contains incoming requests, reserved items, currently lent out items, and items at home. Likewise, outgoing requests has also been added to the "Borrowed" page. The badges has been colorized based on the status of the reservation, allowing the user to easily distinguish the different entries on the page. A screenshot of the "Borrowed" part of the "My Page" section can be seen in Figure 3.2b. In order for users to be able to go back and see old reservations, a reservation archive has been added that shows all reservations with the "done" or "cancelled" status.

Whenever a user clicks on a posting with a related reservation, a block displaying the status of the reservation, shown in Figure 3.2c, is displayed above the rest of the information, as well as buttons to deny, accept, cancel, or complete the reservation depending on its status. After completing a reservation, the user will be asked to give the other user a review, which is done through the profile page.

Besides having a section for reviewing the user, the profile page has also had some other changes. The colors of the rating stars has been colorized, in a similar fashion as the first prototype presented in Andresen et al. [1], in order to easily differentiate the provider and consumer rating. A contact button has been added, to make it easier for users to send messages to each other. Lastly, an information button has been added to the badges, in order for the user to read the description of each badge.



Figure 3.3: Screenshots of the badges found on a user's profile page

In order to help users get an understanding of the system, the test, and give them a place to get help, an FAQ page has been added, that can be accessed through the discover page by pressing the circled question mark in the upper right corner, as shown in Figure 3.2a.

3.2 System Architecture

The architecture of the platform is split into three main parts: the backend, the Android application, and the cloud. An overview, presented as a diagram, can be seen in Figure 3.4.



Figure 3.4: An overview of the system architecture visualizing the data flow of the platform

Backend

The backend itself is further split into two main parts, a server and a database. Both the server and the database is hosted on a single VPS instance, with Docker Compose. The server communicates with the database through a Docker network, meaning that the database is not exposed directly to the public network. The server is a REST API written in Nest.js meaning both the server and the clients is written in Typescript, which has eased the development. In order to encrypt data sent to and from the API, an Nginx reverse proxy handles all traffic into the network, with an SSL certificate from Let's Encrypt, thus securing communication between the server and the application.

Android Application

The Android application also consists of two parts: the React Native application and the API Library. The API Library is a self-contained library with the necessary API to communicate with the backend. This means that to build another client, such as a website, the API library could be used again, as long as the new client is written in JavaScript or TypeScript. Another benefit of the modularized API library, is that it abstracts away details of the API implementation, such as attaching access tokens to the requests and refreshing them. The access tokens are automatically attached to each request and they are refreshed whenever an "expired token" response is received from the backend, letting the developer abstract all this into a single line.

The Cloud

To send notifications to users, Firebase Cloud Messaging (FCM) is used. The notification system works by the Android application sending its tokens to the server which then stores them. Whenever an event that triggers a notification happens, the server sends the notification data to FCM along with the appropriate token, after which FCM will send a notification, based on the data from the server, to the Android application. Besides notifications, a third-party service, called SendGrid, is used to send verification emails to the users. The reason for using SendGrid is that it is easy to use and has a free tier with 100 emails per day. It also promises to be stable, scalable, and provides features to ensure that emails are delivered [4]. Much like FCM, the server sends a message to SendGrid with the email content, along with the email address of the recipient, and then SendGrid sends the email to the user.

4 | Field Study

This chapter presents a field study conducted based on the changes and deployment details described in Chapter 3. The study was intended as a live beta test of the platform, in order to collect feedback from users stemming from real-world usage. Due to low participant response and interaction in the field study, Chapter 5 presents a lab study that emulates the real-world usage of the platform.

4.1 Methodology

Participants were recruited from a dormitory in Aalborg and a residental area in Aarhus. Recruiting was done through posts on each recruiting area's private Facebook groups, as well as posters in common areas of the dormitory. The two areas were chosen as two of the authors were already living there and thus had access to the internal Facebook groups. Another consideration was that participants must have some level of trust, as discussed in Andresen et al. [1], and the hypothesis was that people living close together would trust each other more than complete strangers. This would allow them to get to use the platform quicker. The first 30 participants who registered would be compensated with a gift card of 50 DKK, while 5 participants among the users who created a posting would be compensated with a gift card of 100 DKK.

Google provides "internal testing" as part of their Play Store services. This allows developers to distribute their app to 100 users, without fulfilling all of Google's requirements for fully published apps. [5] The internal test process from Google allowed the app to be available from the Play Store through a link, when participants were added to the internal test. This would be similar to how users would download the application, were it fully published. In order to provide participants with ideas of what to post on the platform, we created a number of postings with items they could borrow or services they could utilize.

After the field study, all eligible respondents from the recruitment questionnaire received a concluding questionnaire to gather more feedback about the platform. This included questions about why people did or did not participate in the study.

4.2 Results

The participation and interaction for the field study was very low. During initial recruitment, a questionnaire was posted on the internal Facebook groups, which in total collected answers from 16 different respondents. Of those 16 respondents, 7 did not have an Android device, which is approximately 44% of all respondents who could not participate in the study. Of the remaining 9 respondents, only 2 actually created an account in the application, with 1 of them creating a posting. None of the created posting received any reservation requests.

The concluding questionnaire received a single answer from one of the participants who had registered in the application. The participant answered that they liked the application and the concept of groups, and had considered creating a posting but did not state why they did not. Due to the focus shifting to the lab study, we chose not to pursue getting more answers to the questionnaire.

5 | Lab Study

Because of the low participation in the field study presented in Chapter 4, we designed a lab study to gather more feedback, which is presented in this chapter. The lab study collects a similar form of feedback, by putting participants through the same processes as if they had used the application in the real world. By utilizing a lab study, an appropriate number of participants was ensured and a deeper level of feedback was possible.

5.1 Methodology

The lab study is designed to emulate the situation users will be in, and the interactions they will have with others, when borrowing items through the platform. In order to accomplish this, tests were conducted where participants interacted through the application with one of the authors. In this test, each user would act as both consumer and provider and their experiences were collected through a semi-structured interview. Participants were recruited through the dormitory used in Chapter 4, again by using their internal Facebook group. As compensation, participants received a gift card of 100 DKK.

Participants were handed an Android phone with the app open and asked to create an account. They were provided an example email, in order to not get sent a verification email, and a code for a group used for this test, so they would be able to see the correct postings. After creating an account, they had access to the same backend as the initial field study described in Chapter 4. This allowed them to see a number of postings created by other users, that were created in the group covering all of Denmark.

After creating an account, the participants were asked to make a reservation request for a posting already created by an account controlled by the authors. They would then go through the flow of a reservation. Participants were then told that the borrowing time was up, and the item was returned to the provider, who marked it as such. After going through the process of making a reservation, they were asked to give the provider a rating.

After the provider had been given a rating, the participants were asked to create a posting of an item they were provided with. When the posting had been created, they received a reservation request. We then asked the participants what they would do if they wanted to contact the consumer in order to agree upon a time and place to pick up the item. Again, they were told that the borrowing time was up and asked to mark the reservation as done. Afterwards, they were again asked to review the user.

Lastly, when participants had acted as both consumer and provider, they were asked questions related to their experiences of the process as a semi-structured interview. The questions and answers are presented in Section 5.2.

5.2 Results

This section presents the feedback from all participants, with its structure following the processes examined in the application, followed by the questions. The overall feedback from the participants was positive, with some comments and ideas for improvements. In Table 5.1 an overview of the participants can be seen.

Participant ID	Age	Gender	Study
P1	27	Male	Computer Science
P2	23	Male	Medicine
P3	20	Male	Computer Science
P4	25	Female	Biotechnology
P5	23	Female	Biologi
P6	22	Female	Chemistry Technology

Table 5.1: The participants of the lab study, along with their age, gender, and field of study

Signing Up and Onboarding

All participants, except P1 who had also participated in the field study, would try to sign up using the login field when handed the phone, instead of pressing the register button below the input fields. When creating their account, both P2 and P5 questioned why a profile picture was required, as they were concerned about their privacy. Most participants would also miss that they should add a profile picture, but be reminded by the application when trying to proceed from account creation.

With regards to onboarding, most participants recognized the process but would skip battery optimization, while P1 was confused of how exactly it worked in the Android system settings. P3 tried pressing a card when joining a group that did not have function, other than showing the name of the group they had joined. Otherwise, most users seemed to expect this form of onboarding.

Borrowing

The participants were familiar with how they should find an item and while some of them used the search bar by themselves, P5 expected to find it at the top instead of bottom. Most users would use the dedicated reserve button, but both P2 and P4 tried using the contact button at first. When P4 saw the dedicated reserve button and the related process, they liked that they did not have to talk to someone, in order to create a reservation.

When the participants reached the calendar to choose their reservation period, it was mostly understood how it worked, after trying to use it. P4 expected the calendar to show an overview and be able to enter the dates through a keyboard, while P5 wanted to be able to set the time they would pick it up. P6 initially thought they could only pick two days, as they tried to mark each day they wanted to borrow an item, instead of selecting a start and end date.

With the reservation requested, the application navigates back to the posting's detail page and shows a reservation card with a status at the top. Multiple participants tried pressing the card, expecting it to do something. Some participants were mildly confused when the status did not change while they were on the posting's details page, but overall the various statuses were understood. P1 however, wished the statuses were more visible.

When asked to rate the provider they had borrowed the item from, participants found it cumbersome that they had to navigate to the user's profile, in order to give them a rating. P5 explicitly stated they wanted to be able to find ratings on the posting page directly. Furthermore, P5 stated that they had difficulty in discerning which role they had just acted as and proposed locking the rating type, depending on the user's role in a reservation.

When participants looked at the "My Page" tab to check the status of their reservation, it was generally well understood, but P3 expected their old reservations to also appear here, which corresponded with other participants having difficulty finding their old reservation. P5 had trouble navigating and discerning between "Discover" and "My Page", due to the posting details page being shown on both.

Creating a Posting

The participants seemed to be familiar with filling out forms of information to create a posting. When P1 tried to create a posting, they noted that they would like to be able to add multiple pictures to a posting. P1 accidentally pressed the back button while creating a posting and lost the progress in creating a posting, and they suggested to have a confirmation message pop up when trying to leave the page.

Multiple participants seemed to have troubles understanding the price input field. Half the participants only input a number as the price, P6 entered both the price and currency, and only P1 and P4 fully entered the price, currency, and time frame.

P3 seemed to have trouble finding the page where they could create a new posting, but the rest of the participants had no trouble finding the page. Both P3, P4, and P5 found it difficult to understand the location input. P3 and P4 both thought that the placeholder text meant that the field was already filled out, and P5 suggested that the default location should be based on the phones current location.

P5 did not understand how the posting features should be used as the description was already informative enough, while P4 understood the purpose of features but did not find it suitable for them posting the hammer provided to them as an example item.

Lending to Someone Else

In general, there were no significant problems related to the lending process. All participants accepted the request without problems. P6 mentioned that it did not automatically start the reservation when the time was right, but also said that it made sense that they had to control it themselves. When asked to send the requesting consumer a message, P5 had troubles figuring out how. They wanted to use the contact button on the posting page, but was confused that it was disabled. When participants were asked to complete the reservation, some were confused about the wording of the complete button, with P3 looking for a button that said "Delivered", and P5 suggested the word "Finish". ¹

Questions

As described in Section 5.1, participants were asked a number of questions when they had used the application. Both the questions and a summary of the participants answers are presented in this section, with each heading presenting a question.

What was the most confusing part of the process, when using the application?

In general, the feedback to this question was positive with a number of minor problems. P3 noted that there were some problems with the correctness of the application's state. As an example, the status of the reservation would show differently on the posting's details page and "My Page". P4 mentioned that they would like to see some form of notification indicators in the navigation bar, since they said that they were more likely to spot that compared to native notifications from the Android system.

What worked well, and what did not?

The feedback to these questions was notably positive. Both P1 and P6 explicitly mentioned that the interface was familiar, and P6 also mentioned that the icons were familiar. P4 liked that interactable items were easy to distinguish, and liked the floating action buttons, such as the reserve button, not

¹The suggested words have been translated from Danish, and were originally "Afleveret" and "Afslut".

being in the way of other UI elements. Multiple steps related to the general reservation flow were mentioned as working well. Both P1 and P3 said that the overall process of renting and lending was good. P4 thought that it was easy as the provider to see what people wanted to loan, and P5 liked that it was easy to make a reservation.

In general, the participants pointed out errors and bugs that interfered with the use of the application. Examples include P1 who wanted the forms to accept input better; P3 and P6 who had difficulty finding their old reservations; and P4 who wanted a notification when they received a message, or a reservation status changed. The feedback collected during this question was mostly about specific elements in the UI and not about the process of using the application. However, P5 expressed how they thought the location of a posting should be an approximate location, so they did not give away their precise location, but still allowed potential renters to see how far they had to travel.

Would you use the application if it was available from the Play Store and lend your items to others?

Most participants answered that they could see themselves using the platform, except for P2 who had misgivings related to insurance of their items and taxes on income from using the application. However, all participants had some apprehension to letting others borrow their items. P3, P4, and P5 all stated that a deposit would decrease their apprehension, as it would provide them with some security that they could recover their item. Some also stated that looking at a profile's ratings could improve their trust in the user.

Most would use the platform in closed groups, and P1, P5, and P6 explicitly mentioned they thought it would be smart to use at their dormitory. Most participants also expressed they liked the group functionality, as it would allow them to control who can borrow their items. When asked why they would use the platform, most would do it in order to help others at their dormitory, not to earn money. P4 mentioned that they could want to use it with sustainability in mind. Some participants also stated it would allow them to borrow items they would not want to buy.

Would you rather do it through an application on a phone or on a computer?

All participants answered that an application on a phone would be preferred. P4 mentioned that they had previously used Airbnb, which has a website, but they always used the app. They also pointed out that having an app allows them to get notified whenever anyone contacts them. P1 noted that when creating postings, it makes the most sense to do it through an app since it allows them to take pictures directly from the phone. P6 also preferred using an application, but though it would be convenient with a website in addition.

Did you like a defined process or would you rather have more freedom to organize as you please?

The participants seemed to be generally satisfied with the current flexibility of the platform. P3 suggested adding the ability to ask for a specific item using the platform, akin to being able to ask in a Facebook group. They suggested that it could disappear after a set amount of time. P5 mentioned

that in the case of using a Facebook group for sharing economy, people might not take down their posts, so posts found there might not be as relevant as they would expect from the platform. Both P1 and P4 would prefer the price input being more strict, such as having an input for price, and a selector for time frame, which would ensure that prices adhere to the same standard.

Summary

In summary, the majority of feedback was positive. Multiple participants expressed that they found the UI familiar and that they could see themselves using the application in the real world. They had no trouble exploring the application and made sense of most elements on their own. If they did not immediately understand an element, they would often gain an understanding by interacting with it. In relation to the overall process of using the application, participants had minor comments and seemed to expect how borrowing should take place.

Of course, some areas were slightly troublesome to the participants, in particular the "My Page" tab and the process of contacting another user. Multiple participants had feedback of how they thought these areas should work differently. Other areas also received smaller remarks or ideas for improvement, but were often understood by participants nonetheless.

6 Discussion

In Andresen et al. [1], the goal was to design and construct a prototype for a sharing economy platform, ready for integration with a real backend for deployment. The backend of the platform has now been developed, and the platform is nearly ready for deployment, meaning that users would be able to participate in the sharing economy. This could help the fulfilment of goal 12 and 13 of the United Nations' 17 Sustainable Development Goals. There is still work to be done in order to fully realize the aspirations of the project, some of which will be explored in Section 6.1.

This chapter discusses the results gathered from both studies and reflects upon the methods utilized in the studies, as well as the design choices of the platform. The chapter also relates this report to Andresen et al. [1], our previous and closely connected report. Lastly, a number of future directions are presented; some being new directions and others stemming from Andresen et al. [1] that were not implemented in this version of the platform.

Field Study

As presented in Chapter 4, the results of the field study did not contribute much valuable information, because of the low participation. By comparing the data of the registration form, with the data from the platform, it is seen that only 2 out of the 9 people who said they wanted to participate, actually created an account within the two weeks of the study. This indicates that either more time is needed, more reminders need to be sent out, or the study needs to be easier to participate in. It is also possible that better compensation also could have a positive effect on engagement. With a platform as ours, which is of course driven by the need to loan specific items, it could be argued that two weeks is a fairly short time to collect behavioural data, since it is not certain that users will have that specific need in that time frame. We had however hoped, that more users would at least join the platform and create a posting with some item they were willing to lend out.

The long development time of the platform, meant that the user studies were executed late in the process. This in turn meant that it took place in a period of high intensity in educational workload for many of the potential participants, possibly leading to lower participation. In support of this claim, P5 of the lab study mentioned that they had originally signed up for joining the field study, but ended up forgetting because of having work to do themselves. Section 6.1 presents an alternative method to recruit participants.

Another likely substantial shortage of our study, is the exclusion of iOS users. In the responses to our registration form, 7 out of 17 respondents answered that they could not participate because of not owning an Android phone. One could also presume, that some non-Android users would abstain from answering the form, because they knew from the beginning that they could not participate. This means that developing the application for iOS as well, could potentially have almost doubled the number of people who answered that they wanted to participate. Many of the features that were implemented during development, was prioritized over the ability to use the application on iOS devices. To be able to publish an application to iOS, a license and adherence to a set of guidelines defined by Apple is required.[6] [7] To have as many features as possible present on the platform, we estimated that a port to iOS would take too long.

Lab Study

The lab study was much more successful than the field study, in terms of the amount of useful feedback. Of course, a lab study is not completely accurate in the case of how users would behave in a field setting. As described in Section 5.1, participants were recruited from the dormitory of one of the authors. This could of course impact the validity of the results gathered through the study. However, based on the results gathered, and the feedback we received, we argue that the impact was minimal. By looking at the feedback, there is no apparent pattern to the feedback between participants with a personal relation to the authors and participants without.

Multiple participants expressed concern about uploading a profile picture being required while registering for the platform. This was a choice made during development on the presumption that having a profile picture would benefit the relationship between users. As noted in Section 2.1, one of the ways to retain providers on the platform is to increase the quality of their relations. It was however noted by some participants, that having to upload a profile picture before entering the platform could be a high barrier of entry. A partial solution to this problem could be to have some form of avatar generator, and then allowing users to upload a profile picture later in the process.

An issue that confused multiple participants, was problems with the correctness of the reservation states, leading to different states in different parts of the application. This could be solved in different ways, such as using Firebase Cloud Messaging (FCM) to notify the app of state changes, but some areas could also simply be fixed by invalidating data in the application, causing it to be fetched again. The leading cause of this was that the participant was viewing the reservation details while it was changed from the other account.

One of the factors discussed a lot in Andresen et al. [1], and a part of the problem statement, is the flexibility of the platform. Based on the feedback of the lab study it seems that users like the platform being more strict rather than flexible, in the sense of following a specific process. As an example, the price input field was confusing for a lot of participants. Changing the price input field to a set of predefined currencies, and time frames would make it easier for providers to create new postings, and would insure conformity of pricing, thus making it easier for consumers. A solution for still having flexibility, is to still make it possible to enter a custom value into the field. In general, participants liked the flexibility of the application, and had few things they wanted to change.

Project Outcome

As explained in Section 2.1, one of the main motivators for consumers on a sharing economy platform is the hedonic value. One of the features of the platform that tries to increase this, is the badge system. This features has a lot of room for improvement, both in the case of adding more badges, but also adding more features. An idea is to allow users to share their badges, thus also increasing the awareness of the platform. Another idea is to let users see a list of potential badges or let users showcase a badge on their avatar.

For both the service providers and consumers the main inhibitors were related to economic loss. The platform tries to minimize this risk by increasing trust, through features such as reviews and verifications. Multiple participants mentioned that they liked the NemID verification feature of DBA, which we explored in Andresen et al. [1], and see that as the most trustworthy form of verification. This is a potential feature for the future but is out of scope for this project since it requires an agreement with Nets, along with a registered company [8]. Some participants mentioned that it would be preferable if they could add text to reviews, since it would allow users to explain if they have had an awful experience with another, instead of just being part of an aggregated rating. This is already supported in the backend but has not been implemented in the app yet since we focused on getting more features implemented, rather than expanding existing features.

When looking at the final platform in relation to the last prototype presented in Andresen et al. [1], it can be difficult to see a substantial difference. Most of the work of this project has been in implementing a backend for the platform, including security, stability, and performance. A lot of work has been put into making sure that the platform was ready for a field study, so the low participation was unfortunate, but we argue that the time spent on implementation was not in vain. Once fully deployed, a platform exists that allow users to participate in the sharing economy. This can help users save money, and lower the need to produce new products, thus helping the environment.

6.1 Future Work

As evident throughout Chapter 3, Chapter 4, and Chapter 5 the platform is in a state where it is fully usable as an Android application and the backend can be deployed on most hardware, due to it running on Docker Compose. Both the Android application and backend has some bugs, errors, and performance issues, such as incorrect UI navigation or data display, or slowly updating UI elements. These are the most obvious areas to fix first. But when these areas are fixed, we present two contexts the platform can be utilized in: practical and research.

As the platform is fully usable, it might make sense to deploy it in a real-world setting where it is available from the Play Store on Android. This will require some work to create a store page for the application and get it reviewed by Google [9]. Releasing the application to the public is thus not too far away and would allow an agile development process, as it would be possible to gather feedback from users as it is in use. As we have not explored the question of how to get funding since discussing it in our previous report [1], the problem is still standing. Furthermore, the field study presented in Chapter 4 was not very extensive and did not indicate the amount of resources the backend would

require in a real deployment. An alternative to releasing the platform to the public, could be to increase the accessibility of the platform, by making another application for iOS. This would present an even larger amount of work, as Apple also requires review of all apps [10]. However, much of the code from the Android application should be reusable, as a result of using React Native. Developing the app for iOS would not require any changes to the backend.

In order to utilize the platform in a research context, an obvious direction to continue along, would be to perform larger user studies to increase the validity of the results presented in this report. Another possibility is to utilize the platform to explore how specific interface elements works with the users, such as badges, ratings, or the process of borrowing items. This could improve the overall platform and experience of using it, which could improve a future real-world deployment. The platform could also be utilized for other research directions, for example with a heavier focus on interactions between users or the cold start problem presented in Andresen et al. [1]. But we argue that research could benefit greatly from utilizing the platform in a practical context.

As evident of the field study, it can be difficult to recruit enough participants to get proper validity. However, if the platform is deployed to the public, it is possible it will become populated by itself, providing participants for a research study without any recruiting needed. With a large enough user base it could also be possible to perform A/B testing and test different interface designs, since current research does not focus on this very much [1]. Therefore, we recommend utilizing the platform in a practical context and focus further development on publishing it to the public. This will allow people to actually use it and give it a chance to have a positive impact on the environment, as discussed in Chapter 1. If research is the initial focus people will not be able to use it and as argued, research can potentially benefit more at a later point in time, while the platform assists people at the same time. In Andresen et al. [1], we explored existing research and found that Ntourus et al. [11] argues to take a human centered approach, instead of what makes the most money. We agree with this argument and by allowing public use, a platform without focus on monetary compensation will exist, as the purpose of the platform is not to make money for either the users or creators. It can then later be studied in contrast to Uber and Airbnb, that are large for-profit companies.

In addition to our recommendation for the overall direction of future development for the platform, we briefly present some smaller areas of the platform that can be improved, and we argue these are the most ideal related to the direction recommended earlier. The areas are based on ideas that appeared along the implementation and the future directions from our previous report [1]. The platforms current design is mostly aimed at physical items, but we would have liked it to be able to handle services, and were suggested to add events as a concept as well. This could be implemented by allowing user to specifically create a service or event, that would then be presented differently in the application. As mentioned in Section 5.2, a participant from the lab study suggested the idea of allowing users to request items. This would allow consumers to request instead of wait, allow providers to see what consumers find useful, and allow more flexibility in the use of the platform. These improvements would potentially increase the usefulness of the platform, by allowing more flexibility in the use of the platform.

In Andresen et al. [1], we discuss the challenges revolving around funding. But we argue that before the platform becomes too large, in terms of users, the requirement for funding will not be too large either. This means that it could be possible as a private individual to run the platform as a service to the public, with little money required. However, at some unknown point it will become too

expensive to host the backend as a charity service and funding must be secured in some way. This is only relevant in the practical context, as a research context could easily limit the number of users.

Another relevant area for the practical context, is the moderation of groups. As discussed in our previous report [1], there are multiple implementations to choose from, such as having the group creator be an administrator or a democratic vote to choose administrators. We argue that this is more pressing than funding, as moderation quickly can become needed on a public platform, but also could be managed by platform maintainers, as long as the user base is not too large. As a side note, this could also be relevant to explore in a research context.

7 Conclusion

Throughout this report we have continued the work of our previous report, Andresen et al. [1], primarily by developing and implementing a backend for the application that was presented. Additionally, we have made improvements to the application which are presented in Chapter 3 together with details of the backend. Lastly, we have conducted two user studies in order to gather user feedback.

In our previous report, we presented the following problem statement:

How can an accessible and flexible platform for supporting sustainable sharing economy be constructed, while involving users, not motivating primarily through monetary compensation?[1]

As this report is a continuation of our previous report [1], we argue that we have still fulfilled the problem statement, based on the arguments presented in Andresen et al. [1]. We further argue that the problem statement is fulfilled to an even higher degree in this report. The involvement of users is answered by the two user studies conducted, and as the platform is now fully usable, the aspect of constructing a platform is now more comprehensively answered.

Chapter 4 and Chapter 5 presents the two user studies we have performed, in a field and lab setting respectively. The field study was not successful due to various reasons, a large one being that of the 17 people who were interested, approximately 44% could not participate, as the application was only available on Android. This led to the addition of the lab study in which 6 participants to a great degree provided positive feedback. Some areas were critiqued, which resulted in clear directions for the future of the platform. This is presented in Chapter 6, which also discusses and reflects upon the outcome of the user studies, but also the overall project.

The platform's final state means that not much work is needed in order for it to benefit to society and potentially help mitigate the climate crisis by aiding in fulfilling goal 12 and 13 of the UN's Sustainable Development Goals, as argued in Chapter 1. In conjunction with Andresen et al. [1], this report also contributes to research by presenting a list of design choices evaluated through user feedback, as well as a practical implementation, thereby helping close the gap presented in our previous report [1].

The project was successful in showing how an accessible and flexible platform could be constructed to support a sustainable sharing economy, without motivating the users primarily through monetary compensation.

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Appendices

A | Application Screenshots

The following figures shows most of the pages and features found in the application. Some of them are shown and explained in Chapter 3 but are presented here to provide an overview and additional context if needed.

	Register	Welcome to
	Profile picture*	ب ()
Sharing Economy Platform	Name* first name Last name	Sharing Economy Platform
Welcome	Email*	Thanks a lot for participating in our test of the platform. Should you run into any problems with the platform, please contact os on
🖀 Email	Email	sharingeconomyplatform@gmail.com Please follow the instructions on the following pages.
Password 🗞	Password*	
	Password 🗞	
Register	Confirm password	
	Must be between 8 and 128 characters.	Have you already completed first time setup? Skip
	Cancel Sign up	Next
(a) The Login page	(b) The Register Page	(c) First Onboarding Page

Figure A.1: Screenshots the login, register and first onboarding page



(a) Onboarding Battery Optimization

(b) Onboarding Email Verification

Figure A.2: Screenshots the onboarding page

(c) Onboarding Join Groups

Discover			0	÷	Example I	Posting			÷	Requ	est Re	servati	ion		
Folding Table A folding table 74x180 cm			EXAMPLE				← June 2			lune 202	2022 →				
IV no					LA.				Mo	n Tue	Wed	Thu	Fri	Sat	Sun
AA											1	2	3	4	5
		100) kr. / day						6	7	8	9	10	11	12
Aalborg Dormitory	Aalborg			🖄 Dan	imark Aalborg	Aalborg Dormitory			1:	3 14	15	16	17	18	19
Spikeball Pro Se	A Spikeball pro set. If anything is please just write to me since Spil replace the broken part	et. If anything is broken.	5 k • Aalbo	r. / day ^{rg East}	/			20) 21	22	23	24	25	26	
		pikeball will			Contact			2	7 28	29	30				
				This is an example of how a posting could look. Here you can write a bit about the thing you want to lend out, whether there			Reservation period								
50 kr. / day				is a deposit, or if you only want to lend it out for a specific timeframe.			From 15/06/2022		To 18/06/2022		I	Days 4			
Soundboks			\neg	Text C Backg	olor round	Red White			Prie	ce					
Rent my Soundboks for playing music				Hugo Stone			5 kr. / day								
									Cancel				Request Reservation		
Q Search	d		Ŧ				E R	Reserve							
Aalborg Dormitory	Aalborg Denmark	\heartsuit	9	Ø	40a	@	\heartsuit	R	Ø) ;	0,	2	C	2	
(a) Discover Page				Discove	• (b) Post	ing Detail	s Page		Disco	(c) Rec	uest]	Reserv	vation	Page	

Figure A.3: Screenshots the Discover section



Figure A.4: Screenshots the My Page section

÷	Groups +	← Aalborg Dormitory						
John Doe mail@example.com View profile Edit	Aalborg Dormitory A group for all residents of the Aalborg Dormitory							
Reservation archive		Invite						
to: Settings	Aalborg A group for all members of	A group for all residents of the Aalborg Dormitory Members (11)						
	Sharing Economy Platform in Aalborg	Q Search						
About Sharing Economy Platform		Vaughn Parisian 😌						
Log out	Denmark	Simon Thomsen						
	2 104 R and a members of Denmark	Davin Zemlak						
Version: 0.1.9-prototype2 (build 12)	Join group	Agustin Steuber						
⊘ 🙁 🙆 ♡ 🖳	🖉 🏩 🙁 🏹 🖳	🖉 🤽 🕲 🎔 🖳						
(a) Meta Page	(b) Groups Page	(c) Group Details Page						

Figure A.5: Screenshots the Meta page and Groups Section



Figure A.6: Screenshots the Profile page



Figure A.7: Screenshots the Conversations section