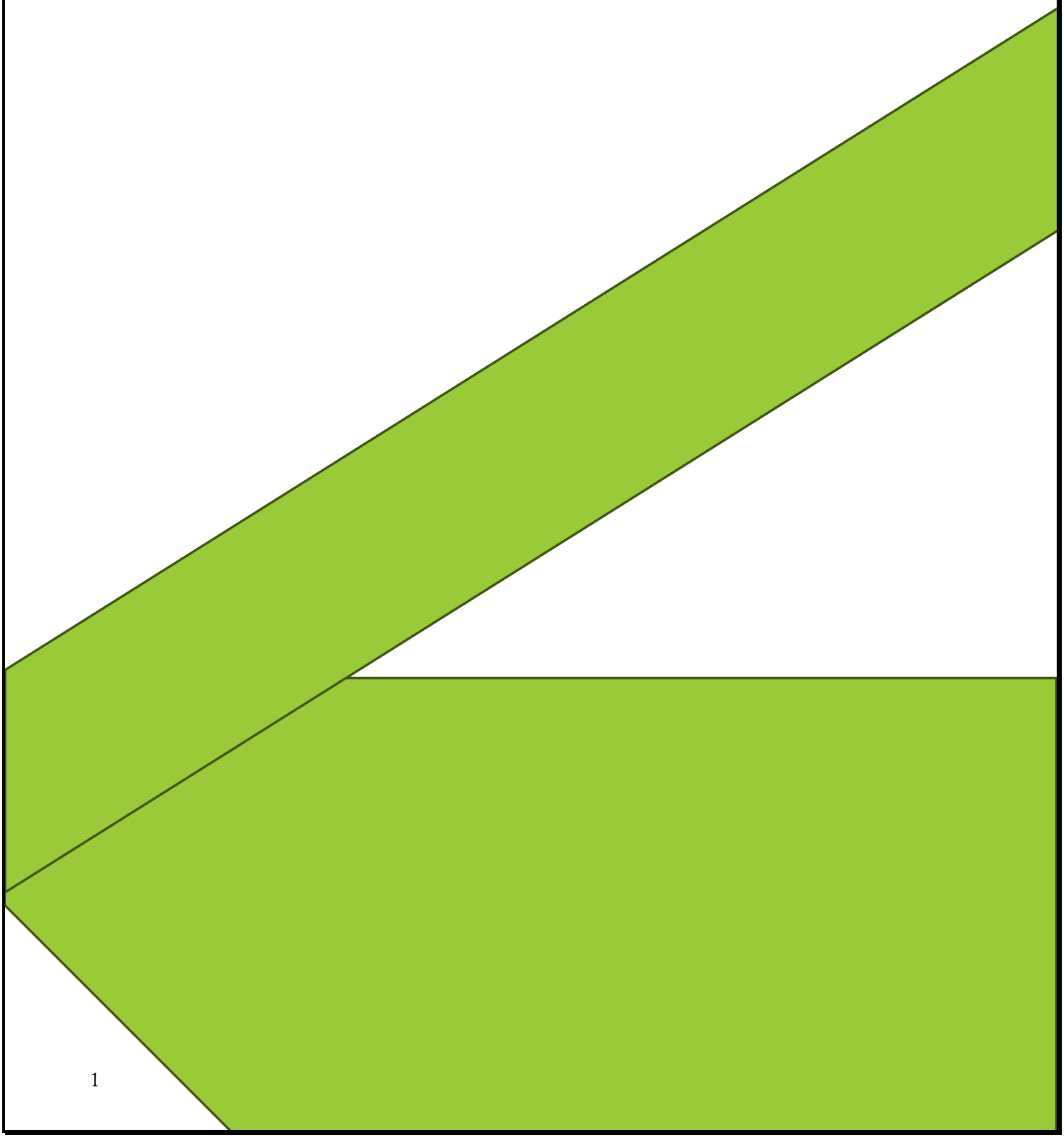
CASE STUDY: WASTE REDUCTION

STUDENT NAME: THIMO VAN DER VLIES

SMART MOBILE, SEMESTER 4

STUDENT NUMBER: 4553071

DATE: 17-12-2023



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PROJECT OVERVIEW

INTRODUCTION

The case that we are going to be working on is duo case 23, Waste Reduction.

The global waste crisis continues to grow, with individuals and businesses often lacking clear guidance on waste reduction and recycling. How can we create a mobile app that encourages waste reduction, promotes recycling, and provides comprehensive waste management information?

Our team will exist of;

- Andrei
- Thimo van der Vlies

The project will take place from 13.11.2023 till 17.12.2023.

PROBLEM STATEMENT

Recycling is a very important activity that is widely practiced in some European countries should perform in order to help reduce pollution and pointless filling of landfills. The current challenge foreign students that just have moved to the Netherlands are facing is correctly separating trash in the trash bins at their residence because they do not understand the recycling system and they don't really know where the trash they want to throw fits. This leads to not getting your trash picked up by the garbage truck or to getting a fine which especially for students can be hard to handle financially.

MAIN RESEARCH QUESTION

How can we make the local recycling system easier and better understandable for foreign students?

OBJECTIVES

Our objective for this project is to develop a progressive web application that can help the target audience recycle correctly and reduce waste pollution by sorting out their trash before throwing it out in the trash bins at their residence. This way our users will not get fines for improper waste disposal or not recycling correctly and furthermore their trash will be picked up, improving their quality of life.

STAKEHOLDERS

Foreign students that just have moved to the Netherlands and want to sort out and recycle their waste correctly.

SUBQUESTIONS

1. How do companies handle waste reduction? (Answered in the secondary research)
2. What types of waste are there? (Answered in the secondary research)
3. Is a persona helpful in the process of empathizing?
4. How can the app be more personalized for the user?

RESEARCH

USER RESEARCH

SURVEY

We conducted 1 survey about (we got 9 responses). The survey exists of 10 questions tackling both general questions about usage and application usage. This survey did it a bit better than the last one but the number of responses is still a bit low. This time the survey is not too specific, so that we could send it to more people but I do not really know why the number is not high. This is the LINK to the survey.

I will show the most interesting results of the survey, that we thought that is useful for the topic waste reduction.

SURVEY RESULTS

This question shows more or less how people participate in waste reduction. As you can see is the is biggest group (55,6%) moderately making an effort to reduce waste and recycle

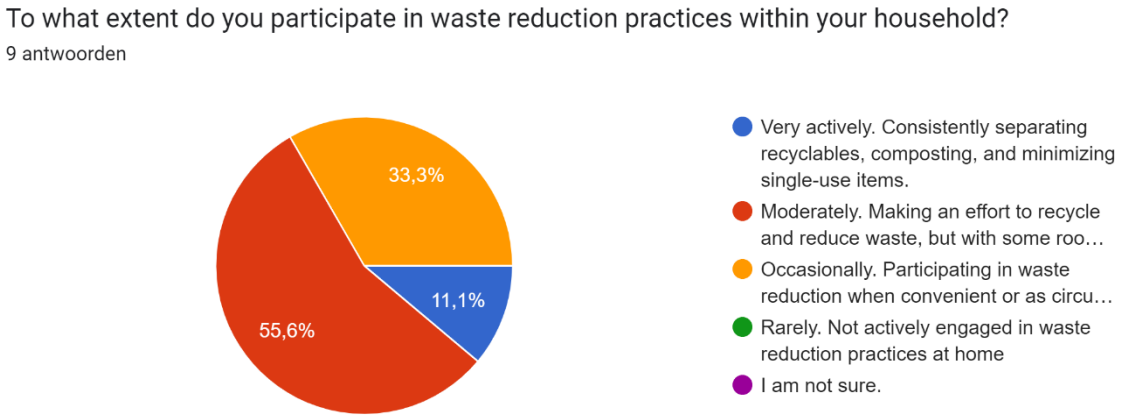

Figure 1.0: reduction practices in households.

But if you look at what factors influence their decision to recycle or reduce waste. You can mostly see that people do the things because it is a rule (77,8%) and after that the convenience (66,7%). It is because they have to or they are in a convenience that influence their decision. As you can see in the image below.

Figure 1.1: factors that influences decision to recycle or reduce waste.

We also asked if their were any barriers when trying to reduce waste in their daily life or workplace. Something I can already conclude from those answers is that it is mostly convenience or either they don't know where to throw their trash in. Here are some answers:

- At my workplace in healthcare, no waste is separated. I often find this a shame to see because it can be improved
- In the train everything goes in the same bin, so there's no recycling in the train. But in the station they do separate bins so one for plastic and another one for paper.
- Having no nearby trashcans whenever i take a walk, or when the trash is becoming huge that im too lazy to sort them out
- Often no trashcan etc. Nearby.

CONCLUSION

I can conclude that people say that they are actively participating to reduce their waste, but the data days something different. It is mostly convenience, if they have to put effort in throwing their trash away they are too lazy or it is something they don't have to do at work. It is the rules and fines that keeps the people actively recycle, or if the trash bin is nearby (the convenience) otherwise they are too lazy. So we have to try to break trough this barrier and try to get people engaged more so that they don't become lazy.

INTERVIEW

INTERVIEW QUESTIONS

Hello my name is (own name)

We are conducting an interview about dog owners and have some questions about what their view on the weather is.

Would you like to introduce yourself?

1. What motivates you to reduce waste in your daily life, and how do you think a mobile app could support these motivations?
2. In your opinion, what are the key challenges or barriers that prevent you or people you know from effectively recycling waste?
3. Are you currently using any apps or tools to manage waste reduction and recycling? If so, what features do you find most useful?
4. On the other hand, what aspects of these apps do you find frustrating or inconvenient?
5. What information do you think is essential for you to make informed recycling decisions?
6. What privacy concerns would you like the app to take into account?
7. What specific features or improvements do you think would make the app more compelling and enjoyable for you to continue using over time?
8. How important would it be for you to have a customizable experience within the app where you can learn about recycling correctly?
9. Do you have any routines or habits related to waste management that a mobile app could support or enhance? If yes, could you give some examples?
10. How do various factors, including environmental considerations, regulatory influences, and organizational priorities, shape and guide your approach to waste management practices?
11. Is there anything else you'd like to share or any tips you think would be valuable for an application / app?

INTERVIEWS + EMPATHY MAPS

I have conducted 3 interviews, one interview was a special one because I conducted an interview with an AI. I researched that a bit and trained the AI, so that I would be able to get some related answers to the topic. In that document you can see step by step how I went to work.

CONCLUSION

The interviews gave me some new insights in how handle recycling. From one of the interviews I got an interesting answer in what motivates them to reduce waste in their daily life: “I try to buy food in a way that I don't have too much at home, and whatever leftovers I have, I either eat again or turn into something else tasty.” this way of thinking can be used later in the project to maybe give some tips or advice on their waste usages. So that they can manage their waste better and improve from that. The interview with the AI was very interesting, because I gave the AI an persona and let him personate that persona with the research that was done, to help him to give me answers that are more in line with the project. The answers that the AI gave where very good and it really felt like I had an interview with a real person. The AI said as an answer that features like educational content, tracking progress, and a product scanner for recyclability info would be most useful for him. The product scanner was something that we already had in mind to do as a feature in our project. So in that way you can really see that the AI gives some good answers.

PERSONA

The persona is based on the research, survey and interviews. From all this data I created a persona that was in line with the answers I got from the empathizing phase. After the workshop with Erik I got some advice

on what to do and what to show not. The personalizing with how many precent the persona is extrovert etc is not worth mentioning in the project because it has nothing to do with the data that we researched. What he told me what was very important is the experience he had with the problem. So after looking through the presentation and the data I came up with this persona. His name is Steven Kools, he is 51 years old and is software developer. The persona is something we can always use for references during the different phases of the project.

So to answer the subquestion: "Is a persona helpful in the process of empathizing?" I would answer this answer as yes because as I just said before "The persona is something we can always use for references during the different phases of the project." the persona can be taken in account of everything that you research/design because you can always ask a question and look trough the eyes of that persona, because this persona is an answer from everything from what we have researched before.

Figure 1.3: Persona (Steven Kools)

TECH RESEARCH

I have researched on how to make things PWA. Luckily we received workshops on how to get to that point. I have followed the workshops that were given by Maikel, on how to make a PWA.

The workshops were very good and self-explanatory, I could do the workshop by myself if I missed some information. I did manage to make a PWA with the requirements that we were going for. I used the already pre build homepage that Maikel made to get that page to a PWA. The most important thing was to get that website also offline working. You had to make a service-worker for that and make a cache so that the website doesn't need to stay connected to the internet to be working.

I was the one that made our duocase project into a PWA, with ofcourse some help from Andrei (mostly when we had to get the website online).

SECONDARY RESEARCH

To fully understand the problem statement we have done a secondary research. To get a better understanding on the subject waste reduction.

My subquestions where:

1. How do companies handle waste reduction?
2. What types of waste are there? Conclusion on the subquestions “How do companies handle waste reduction?” and “What types of waste are there?”

How do companies handle waste reduction?:
Companies handle waste reduction through various strategies, including waste audits, measurement of waste, elimination of single-use plastics, going paperless, forming waste reduction teams, and implementing recycling and composting programs. Engaging employees, setting tangible targets, and fostering a culture of sustainability are key elements in these efforts.

What types of waste are there?:

The types of waste include Municipal Solid Waste (MSW), Industrial Waste, Hazardous Waste, Construction and Demolition (C&D) Waste, Electronic Waste (e-waste), Biodegradable Waste, and Plastic Waste. Each type poses unique challenges and requires specific management approaches to address environmental concerns effectively.

IDEATION

MINDMAP

In the ideation phase we had to come up with an idea of what kind of approach we want to take on. We started with ideating our idea, but to come up with an idea that is unique in its way we started with a combined mindmap to come up with as much ideas as possible. In the picture below you can see the mindmap with all kinds of different ideas that we came up with together.

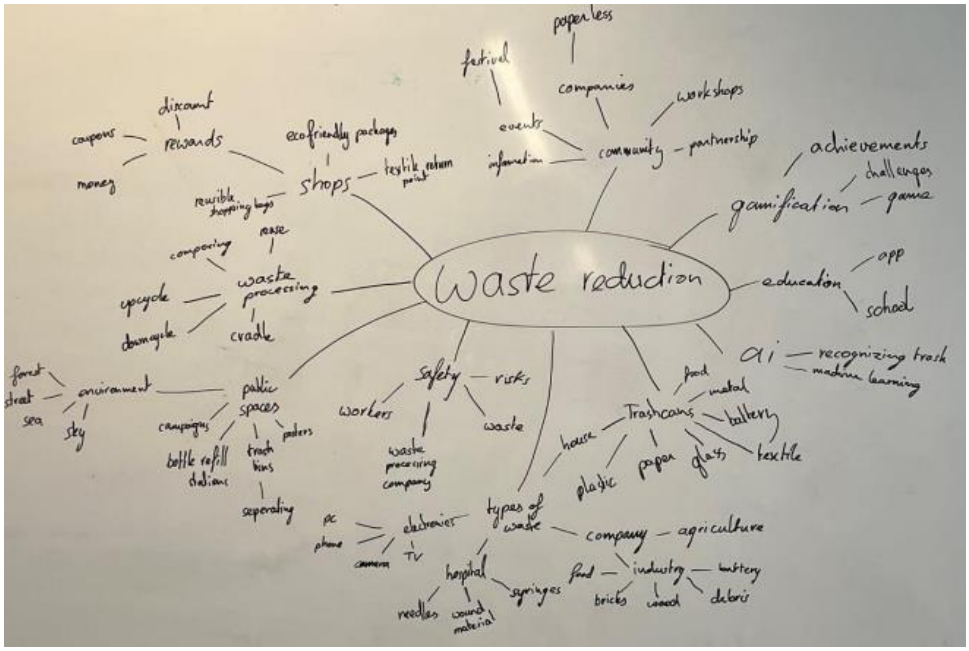

Figure 2.0: Mindmap waste reduction.

BRAINSTORMING

After we put all our ideas into a mindmap we started to come up with some ideas. Those ideas could go as crazy as you want, if it just keeps our core subject in its value. We used the method 50 rapid ideas, so we had to come up with 50 different and unique ideas.

The method was a good way to generate many ideas at ones, this way we could have some ideas that would be very fun to implement.

THE IDEA

After discussing all the ideas we picked one idea that we both found unique and fun, the one we picked is:

- Trash recognizer: Make an Ai that recognizes what thrash belongs in what trash can.

BUNDLE IDEAS

Now that we have all of our ideas written down and have chosen which idea would be our red line throughout our case. We want to elevate the current idea even further by bundling the best of the other ideas into one which is going to be our final idea.

The ideas we will be using are:

- Waste Sorting Guide: A guide to help users sort their waste correctly (AI).
- Waste Reduction Tips: Tip of the day kinda thing to help users reduce waste in their daily lives.
- Carbon Footprint Calculator: Estimate your carbon footprint based on your waste production.
- Achievements: Rewards for reaching waste reduction goals.
- Trash recognizer: Make an Ai that recognizes what thrash belongs in what trash can.
- Recycling Reminders: Set reminders for recycling collection days.
- Product Scanner: Scan product barcodes to learn about their recyclability.

Trash recognizer: The user scans a product / trash and the app will tell you the material it is made of and where to throw it away in (bin). The app would also have recycling reminders that tells the user when the next collection happens and at what time. We would also use a stats page that shows what you have scanned so far, and also would give you a notification if there is something strange with your waste behaviour. There would also be an information page where the user gets in-depth information about trash related topics (mostly focussed on the city Eindhoven).

FINAL IDEA

After looking at all the ideas we wanted to have some elements come back in our main idea, so we came up with this revised version of the idea that is also more detailed in its description and explanation:

Foreign students struggle to understand the local recycling system, they do not know how to sort their trash, leave alone what the material of the trash is. For that purpose we could offer a nice solution.

Even though our main focus would be the scanning of the trash, we also wanted to have some elements of the other ideas come back into our main idea.

Features would include:

- Waste Sorting Guide: A guide to help users sort their waste correctly (AI).
- Waste Reduction Tips: Tip of the day kinda thing to help users reduce waste in their daily lives.
- Trash recognizer: Make an Ai that recognizes what thrash belongs in what trash can.
- Recycling Reminders: Set reminders for recycling collection days.

DESIGN PROCES

PROTOTYPING

SKETCH / LOW-FIDELITY PROTOTYPE

To visualize our idea we made some sketches. The sketches represent a low fidelity prototype. We made a list of features that we want to see back in our prototypes, because of the survey and interviews that we have conducted to take in account that people don't become lazy and stay active. That is why we have chosen that the main selling point for our app would be the scanner, let people scan the trash so that they can throw it in the right bin. These sketches will provide the main guideline for the prototypes in the future.

We started with going through the survey and the interview results. After reading we came up with some ideas as to how we wanted to start with the sketch. I made a homescreen where you scan already start with scanning a product, underneath you get to see the result of that scan and in what it has to go in. The collecting page shows the bins and at what day they get picked up. This is an easy overview for the user. The performance page shows the performance of your waste behaviour and how that makes an impact on the environment. The info page shows all kind of information for the user to know, things like fines in Eindhoven, how to compose waste etc. In the picture below you can see how I made it look like:

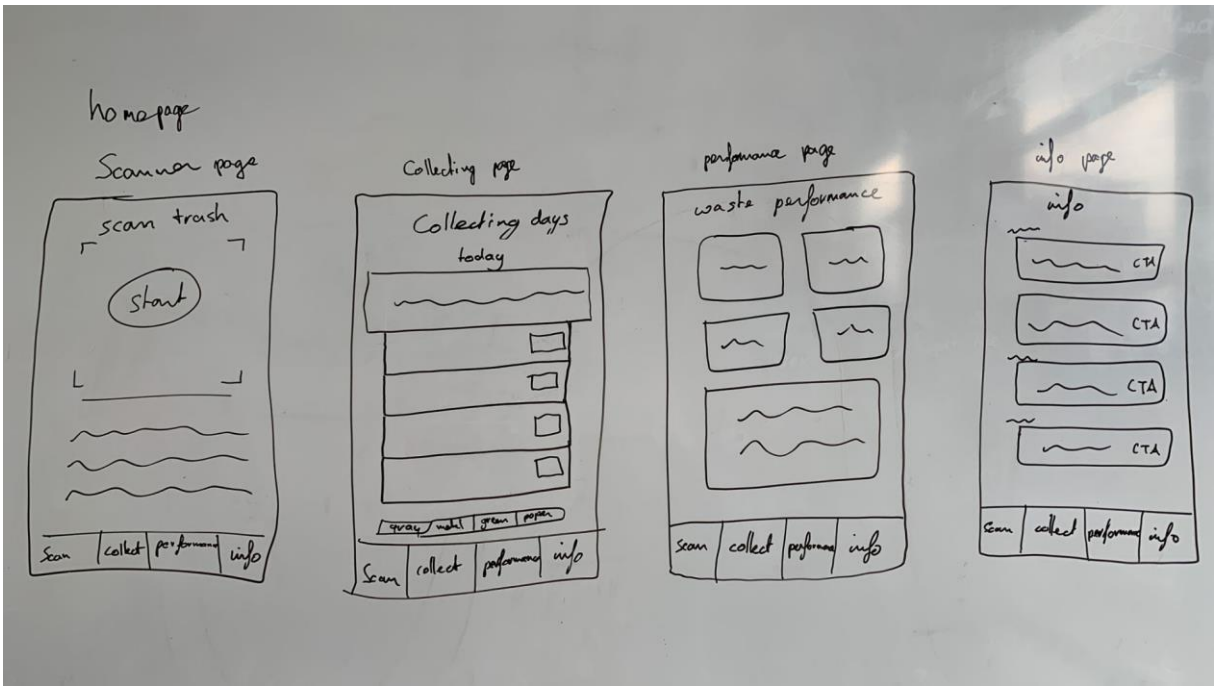

Figure 3.0: Sketch / low fidelity prototype

PAPER PROTOTYPE

We wanted to make a paper prototype to see if sketches we made have any logic, see if people understand our intentions and if this is intuitive. We conducted in total 3 tests, from these test we got to see how

people interacted with our prototype. We put the results of these interviews in a different document. In the picture below you can see a picture of the paper prototype.

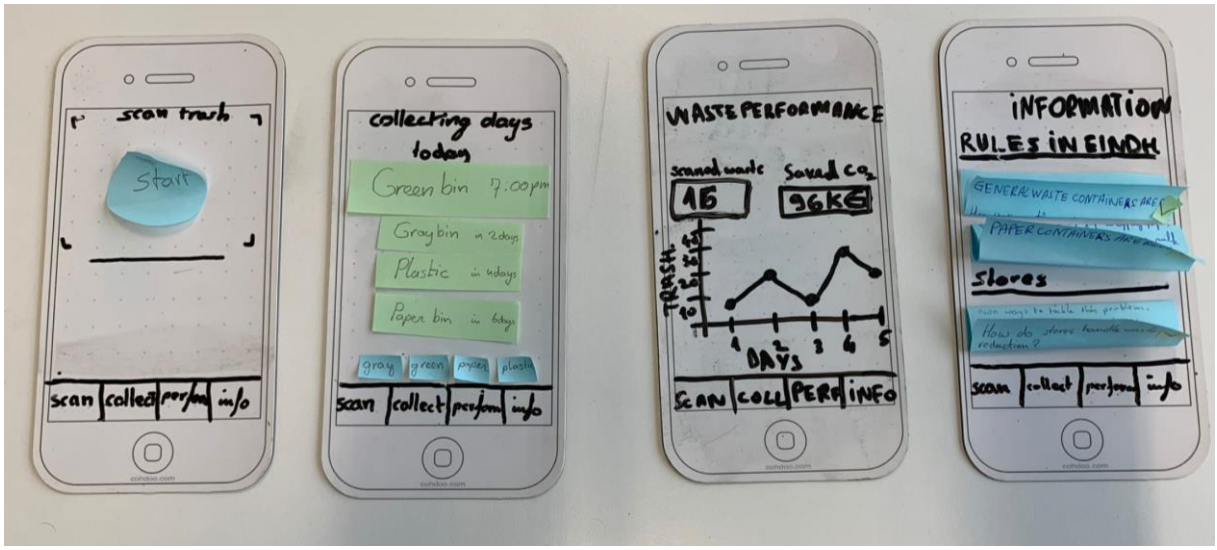

Figure 3.1: Paper prototype

CONCLUSION

After the feedback we received from the paper prototype, we noted the things that we find very important for our future, higher fidelity prototypes. Below there are some of the most important points out of the feedback sessions.

- Make use of images or icons to make certain information more clear.
- Make a button or give the user information after you scanned an item.
- Remove the filter system.
- Improve the waste performance screen, so people understand the data (and don't think the data is a button they can click) and is more connected to our home screen.
- Improve the graph and make it better to understand.
- There is no specific time for other bin collection days.
- Improve the information we provide the user in the information page.
- Make use of some gamification in the app.
- The scanner screen and the performance screen have to be connected to each other.

We will try to integrate these feedback points into the future versions of the prototype.

MID-FIDELITY PROTOTYPE

It was now time to design the idea in Figma where I worked on a Mid-fidelity prototype. During this process I was fully in charge of the design, because he said that it is not something that he is good at. In the image, you can see the first 2 image on the top left, those are the first two designs that I made but that weren't good enough for me. In the other images you can see the ones that were good enough, these standards were needed because we had 2 weeks to finish everything. I followed the previous design and with all the feedback I remade the design. I wanted to make a new index page where the user gets to see their data of products that they have scanned. There is also a small stroke of information about their upcoming collection. People can go quickly to the scan page by a button. In the setting page the user can select if they live in a house or apartment, so that the bins change because an apartment has often 1 big dump place for trash. The scan page did not change very much the only difference is that the results are shown on a different page (scan information page) where they can see what they scanned and in what bin they have to throw their trash in. The collection page didn't change very much the only thing that is removed is the filter for the bins and I added icons for what bin is for what day. The performance page is

fully transformed to show only data that is necessary for the user. I also added a stroke that gives the user advice depending on their waste behaviour from everything that they have scanned. The information page has stayed the same.

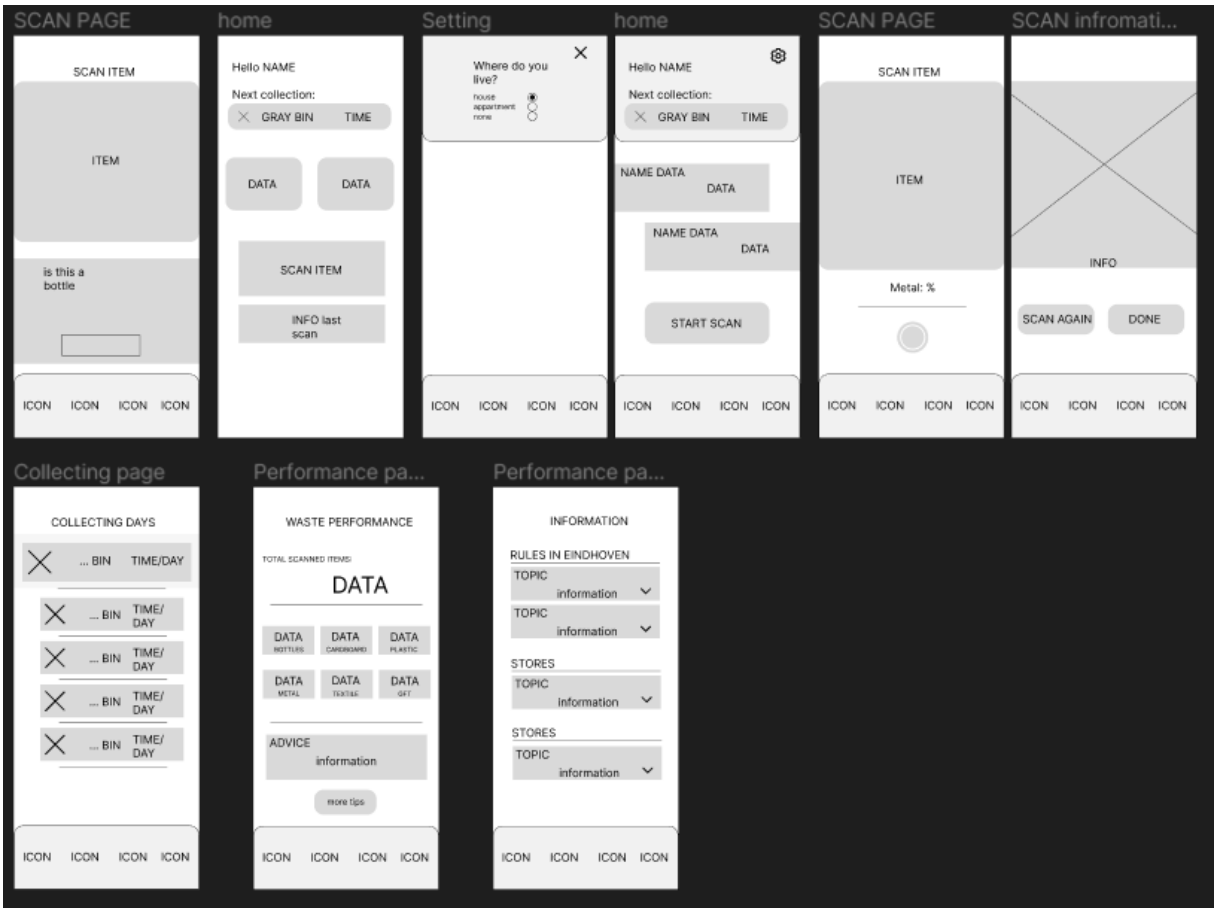

Figure 3.2: Midfidelity prototype.

MOODBOARD

To get some inspiration for the design I decided to make a moodboard to get started with the design, because I was a bit stuck at this phase. I had not that much inspiration, so that was the reason to make a moodboard. The mood board shows the colours I wanted to go with and inspiration for the design.

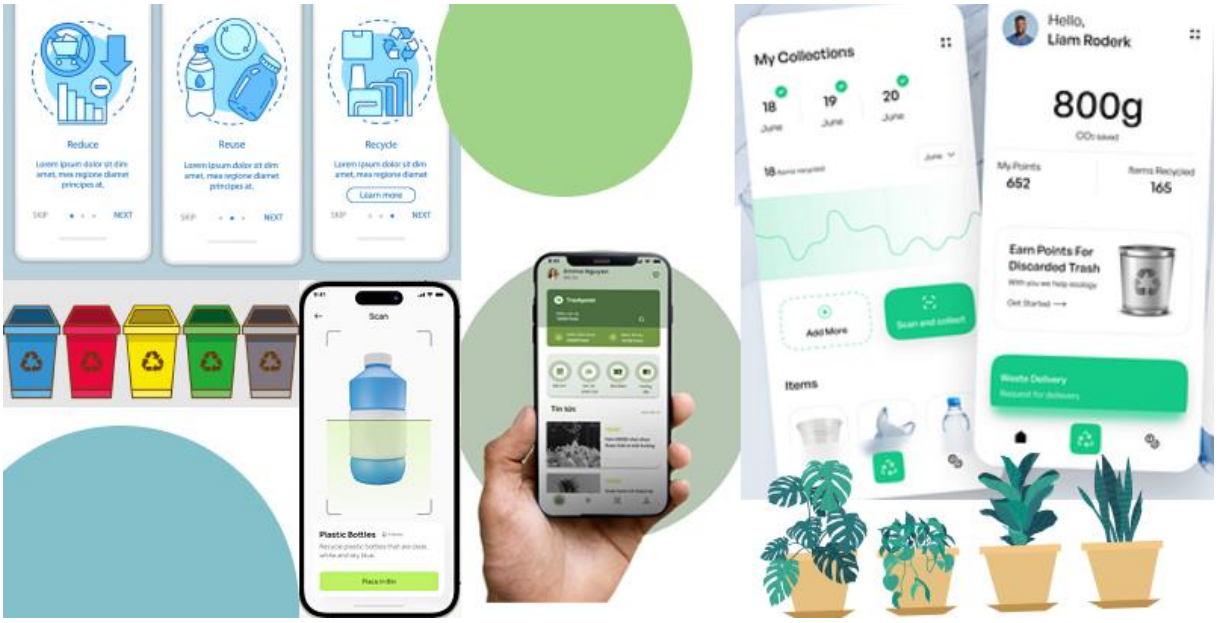

Figure 3.3: Moodboard.

HI-FIDELTITY PROTOTYPE (ITERATIONS) + USER TESTS

FIRST ITERATION

Now it is time to make the prototype even more beautiful with adding colours and giving it a nice design. Everything that you see in the first iteration is made in 1 day that was very hard working because of our tide deadline of finishing the prototyping.

I started with the colours that I want to use for the design:

Light colours:

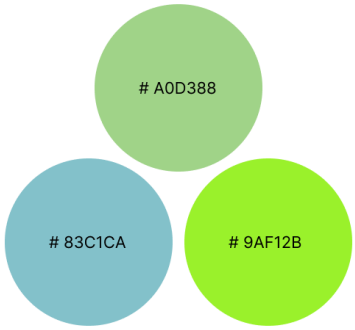

Figure 3.4: Light colours.

Dark colours:

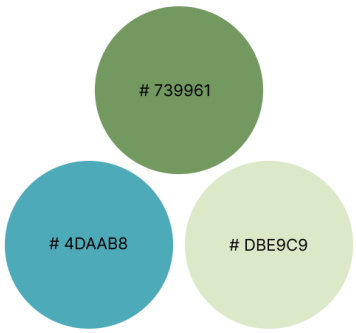

Figure 3.5: Dark colours.

After that I got started on designing the page to a higher level. The content is not changed from the previous prototype. I used mainly 3 colours, the colours are blue: #83C1CA, dark green: #739961, light green: # DBE9C9. I chose those colours because the green stands for the green carbon dioxide that you would be making of recycling. The blue colour is to get make it more interesting looking and because I stayed with my guideline of using that colour only for buttons, I think the design looks more professional in that way than using it randomly in the page. The font that we used is Inter. We used bins and gave them a specific colour depending on the purpose of that bin.

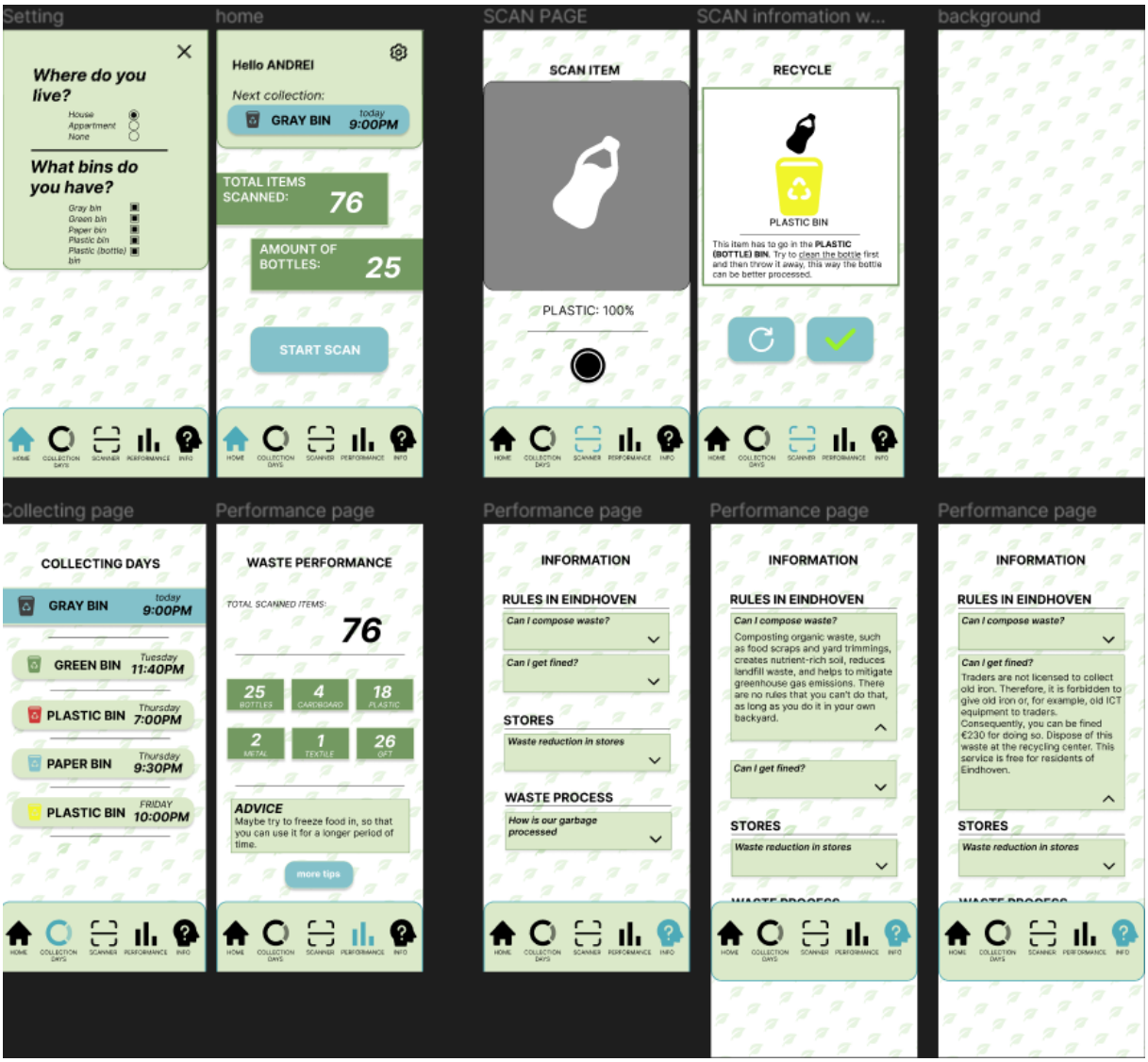

Figure 3.6: hi-fidelity prototype first iteration.

While designing the background I accidently made the logo for our app. I was twisting the leaves and it gave me the inspiration to make it look like the recycling logo. My teammate loved the design and we came up with the name WeLeafWaste. You can implement the name in different ways, like we are leaving the waste in the bins or like a leaf that is seen as waste.

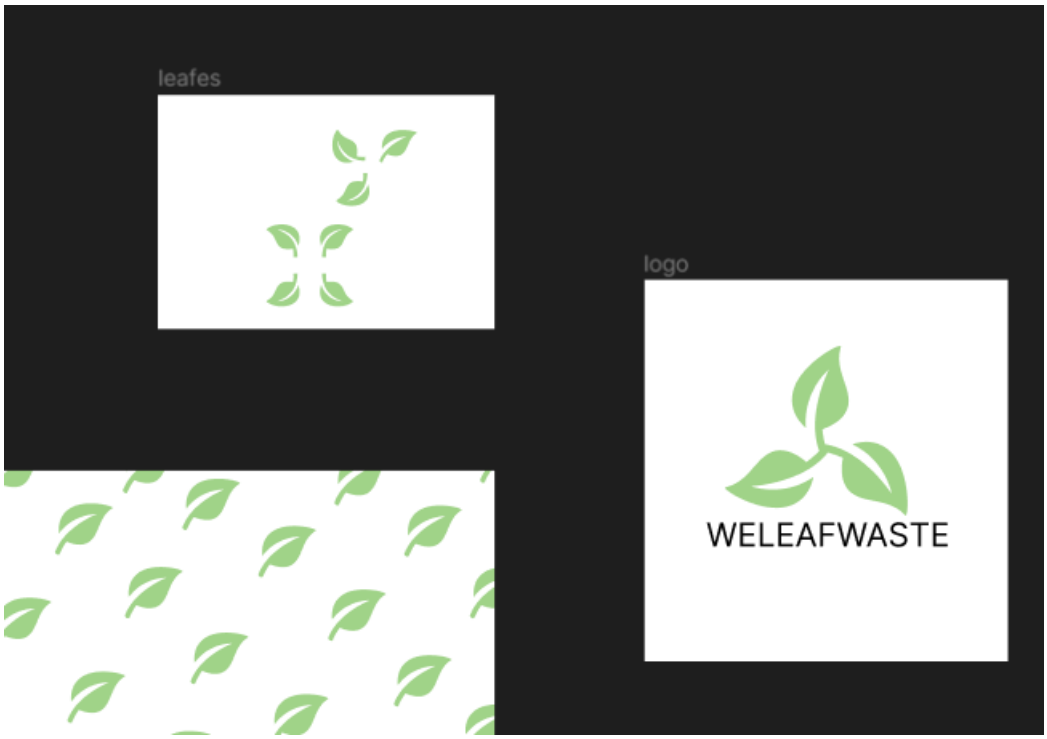

Figure 3.7: Logo design.

TESTING PROTOTYPE

After making the prototype interactive we emulated and tested the prototype on a phone and Maikel gave his feedback on our current prototypes. I wrote the feedback in bullet points so that we can easier see what needs to be done or changed. Of course I also validate with my teammate if we would implement these changes into our design. These are the points:

- Homescreen is more informative
- Nice that he sees the collection on home screen
- Scan result screen could be more clear on the actions that are possible
- No point in confirming the scan results
- Give more info on the scan results screen
- The collection bins are not intuitive
- Weekdays should be consistent
- Waste performance sounds weird/ waste stats
- More tips could be like more info or idk
- Info screen icon is not clear(user thought it was a profile)
- He missed the settings button
- Bins should be consistent in the settings

SECOND ITERATION

The settings button is now on all pages, this is so that the user gets more opportunities to go to the settings that way and is the settings button more visible. We edited the text of the to give more informative information on important actions. The confirmation button is removed because it is not necessary for the user to check it, we instead clarified the text of the scan again button even more. We edited the text of the

collection page to make it more understandable for the user what time and day it will be collected. We also added stroke that says for what week the collection is. We changed the name of waste performance to waste stats, because the content given in that page fit the name waste stats better than performance. The icon of the information page is changed to a more clear icon. I have created a onboard page that tells the user what the app is for and to ask his preferences right in the start so that we can make the app more personal. The onboarding page 2 tells the user how to make his first scan with some extra information about the other pages. The settings page and the onboarding page now look a lot like each other because we wanted the user to change its preferences if their situation changes, like moving to another house or that he wants to change its bins. To give an answer on the sub question: "How can the app be more personalized for the user?" we let the user set their on preferences on the bins and situation so that they can change that any time they want. Also the scanned items that you can see back is something that personalize the app even more.

Figure 3.6 hi-fidelity prototype second iteration.

THIRD ITERATION

After changing the design, we showed to Maikel and Petra what we have done so far for our duocase and they gave some minor things as feedback like the icon on the collection page was not clear that it was for that purpose, so we changed it to a more fitting icon. The onboard page and the settings page have the NONE answer removed because it is not worth mentioning as a possible answer, so we removed that answer. Also added some icons to the stats to make the items more clear for the user.

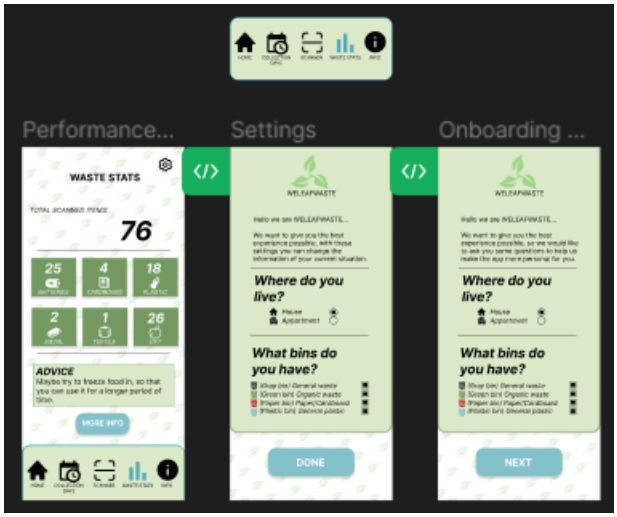

Figure 3.7: hi-fidelity prototype third iteration.

FINAL SOLUTIONS

FINAL DESIGN

Our final design looks nice in the browser but when put on a phone the placing is a little bit weird. But on the browser it looks like this which I am going to hold on to. All the pages looks identical to the last iteration of the hi-fidelity prototype. This is the home page and all the other ones:

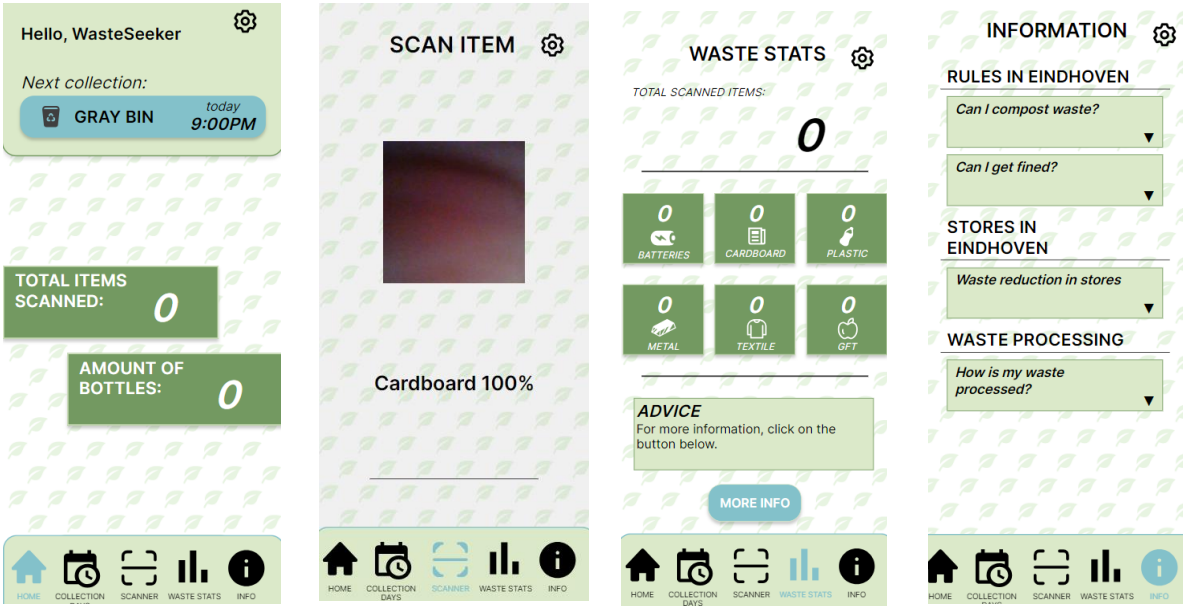

Figure 4.0: Final prototype.

FINAL CODE

The coding went better than I thought, my task was to make the stats page (getting data from the scan page), the onboard page, onboard 2 page and the settings page. Finally I also got the task to go over Andrei his code and try to make it look like the actual final design of the prototype, because it thar was not something he did. As an additional task I got the task to make a beginning of the PWA, I followed the workshop guidelines and manage to make it PWA (of course with some help from Andrei but I did the most work on it.

For the JS work I had to get the items that are in the scanprocessing.js to the local Storage and see if they are in there, if not is was not do nothing if it was in there increment the specific item with 1 per scan.

```
//This piece of code is to get the data for the the stats.html.
// Check if the scanned item is already in localStorage
if (localStorage.getItem(materialType) === null) {
    // If not, initialize the count to 1
    localStorage.setItem(materialType, 1);
} else {
    // If yes, increment the count
    let count = parseInt(localStorage.getItem(materialType));
    count++;
    localStorage.setItem(materialType, count);
}
```

In the stats.js I created a function to update the page with the new stats each time from the local Storage you go to this page. In this function you see that the SubCategory also gets updated. I also let the text of the advice change at certain numbers so that, you can get personal advise if you scanned a category to much.

```
// Function to update the statistics on the page
function updateStatistics() {
    // Update the total scanned items count
    document.querySelector(".total-scanned-data").innerText =
getTotalScannedItems();

    // Update each sub-category count
```

```
    updateSubCategory("Battery");
    updateSubCategory("Paper");
    updateSubCategory("Plastic");
    updateSubCategory("Metal");
    updateSubCategory("Clothes");
    updateSubCategory("Biological");

    // Check conditions and update advice text
    updateAdviceText();
}

// Function to get the total scanned items count
function getTotalScannedItems() {
    let total = 0;
    // Loop through each item in localStorage and sum up the counts
    for (let key in localStorage) {
        if (localStorage.hasOwnProperty(key) && key !== "predictionResult"
&& key !== "bin") {
            total += parseInt(localStorage.getItem(key)) || 0;
        }
    }
    return total;
}

// Function to update a specific sub-category count
function updateSubCategory(subCategory) {
    let count = parseInt(localStorage.getItem(subCategory)) || 0;
    // Update the corresponding element on the page
    document.querySelector(`#${subCategory}`).innerText = count;
}

// Function to update advice text based on conditions and sub-category
counts
function updateAdviceText() {
    let infoAdviceElement = document.getElementById("info-advice");
    let plasticCount = parseInt(localStorage.getItem("Plastic")) || 0;
    let batteryCount = parseInt(localStorage.getItem("Battery")) || 0;
    let paperCount = parseInt(localStorage.getItem("Paper")) || 0;
    let metalCount = parseInt(localStorage.getItem("Metal")) || 0;
    let textileCount = parseInt(localStorage.getItem("Clothes")) || 0;
    let gftCount = parseInt(localStorage.getItem("Biological")) || 0;

    // Example condition: If the count of Plastic items is greater than a
certain threshold
    if (plasticCount > 4) {
        infoAdviceElement.innerText = "You've scanned a lot of plastic
items! Consider reducing plastic usage.";
    } else if (batteryCount > 3) {
        infoAdviceElement.innerText = "You've scanned a lot of battery
items! Consider reducing battery usage.";
    } else if (paperCount > 4) {
        infoAdviceElement.innerText = "You've scanned a lot of paper items!
Consider reducing paper usage.";
    } else if (metalCount > 2) {
        infoAdviceElement.innerText = "You've scanned a lot of metal items!
Consider reducing metal usage.";
    } else if (textileCount > 2) {
        infoAdviceElement.innerText = "You've scanned a lot of textile
items! Consider reducing textile usage.";
    } else if (gftCount > 5) {
```

```
        infoAdviceElement.innerText = "You've scanned a lot of GFT items!
Consider reducing GFT usage.";
    } else {
        // Reset the advice text to a default message or leave it unchanged
        infoAdviceElement.innerText = "For more information, click on the
button below.";
    }
}


// Call the updateStatistics function when the page loads
updateStatistics();
```

We also made clear commits in git to let each other know what is changed. Because we worked together in the main it was very important that we knew who did what. In the picture below you can see all the commits that were made during the coding process:

Figure 4.1: Git commits.

FEATURES

Our problem statement was: Recycling is a very important activity that is widely practiced in some European countries should perform in order to help reduce pollution and pointless filling of landfills. The current challenge foreign students that just have moved to the Netherlands are facing is correctly separating trash in the trash bins at their residence because they do not understand the recycling system and they don’t

really know where the trash they want to throw fits. This leads to not getting your trash picked up by the garbage truck or to getting a fine which especially for students can be hard to handle financially.

Our key features:

- Information
- Collection schedule
- Performances from scan (stats)
- How to improve yourself (waste wise), tracks waste and advices you.
- Scanner

The features give the user a lot of important information that are useful for the topic waste reduction. It helps the foreign students to better understand the rules and the collection system in Eindhoven, so that they won't get in trouble.

RESULTS

SUCCESSES AND LEARNINGS

I found the actionplan not in-line if my new situation, of course I still have done some of the things of my action plan but I wanted to focus this time more on what my teammate and I want to do and followed a path that was more fitting with my current situation. I learned a lot especially with making it a PWA. I liked the workshops about PWA a lot, but maybe for a next time complete the full workshop and not stop halfway. I liked working with Andrei, he gave me a different view on how to proceed certain processes. Maybe for a next time first check if the FileZilla link of our project works before we go and code.

NEXT STEPS

For future iterations we wanted to implement a notification system for when the bins have to go outside. Make more stats, because the scanner also picks up other materials from the ones we now currently have. Maybe let the app also do other cities for trash, then we have to work with GPS to get the user location so that we know in what city he lives. Maybe use more gamification to unlock some stats. And fix the css on some pages. Not on all phones is the camera supported, we tried to look for a solution but didn't find any. Those are some future steps that could be made to make the app even better.