

Improving passenger waste separation behaviour through design at Schiphol Airport

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Figure: Me writing my 'Special Thanks' chapter



Special thanks

Dear reader,

To realise that you are reading this thesis is very exciting, I have put a lot of love and effort into this report which I hope that you will enjoy. I hope that my work can be a source of inspiration for you so that in a way, we can create a sustainable future together.

A big thanks to my supervisors; Ruth, Stefan, and Elisabeth. Ruth, as a chair, thank you for your curious and critical view of my project, I appreciated this and your useful and quick responses. Stefan, as my mentor, thank you for helping me put my project into perspective, asking the right questions and for the endless generative dialogues. Elisabeth, as my client mentor, thank you for making time for me every week, to be available when I needed you and to always be very positive and excited about my work.

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Thank you all.

Abbreviations

| | |
|-----|-------------------------------|
| PSW | Passenger Solid Waste |
| SW | Solid Waste |
| RSG | Royal Schiphol Group |
| RSW | Residual Solid Waste |
| SUP | Single-Use Plastic |
| PMD | Plastic, Metal, Drink cartons |
| PD | Plastic & Drinkcartons |
| TPB | Theory of Planned Behaviour |
| FBM | Fogg Behaviour Model |
| IDE | Industrial Design Engineering |
| CDL | Circular Design Lab |

Abstract

This graduation project focuses on the problem of solid waste, specifically passenger waste at Schiphol Airport. The project aimed to enhance passenger separation behaviour to reduce the amount of residual waste that would be incinerated. Throughout the project, stakeholders' interactions with the FF3 bin and waste were considered, emphasising the importance of their needs to realize a design that resulted in a better solution for all stakeholders.

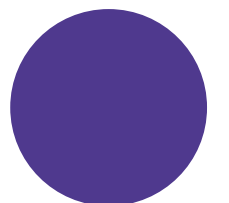
I started with exploring the context of the FF3 bin, covering its physical attributes, pilot tests, waste mapping, and user ecosystem. After this, design conclusions were drawn, including aligning bin elements with Dutch recycling standards, improving signage visibility, accommodating generated waste, prioritizing effective separation for specific streams, and considering users' influence. Several insights were gained from deepening exploration through interviews and observations with stakeholders and other relevant organizations such as other airports and bin manufacturers. The resulting design conclusions involved separating organic and liquid waste, accommodating diverse cultural backgrounds, and enhancing communication for proper disposal. Furthermore, behavioural aspects were analysed using the FOGG behaviour model, and strategies emerged to improve the ability and motivation for waste separation, accounting for cultural differences and emphasising design interventions.

The conclusions of the context, deepening exploration, and behavioural insights were combined into a problem statement: 'Passengers at Schiphol Airport do not separate waste correctly'. By creating a roadmap for Schiphol Airport, several steps that could be taken to address these issues were outlined, divided into improving the ability for passengers to separate waste and increasing the motivation for passengers to separate waste. An interaction vision was stated, highlighting the importance of passengers' pride in correct waste separation.

With the use of the problem statement, roadmap, and interaction vision, the iterative design process began. This process consisted of phases involving waste stream decisions, bin redesign, motivation ideation, campaign development, and co-creation sessions. Design iteration opportunities were identified for the final proposal. The final proposal, 'Time To Waste,' integrated an FF3 bin skin, a campaign, and projectors. Feasibility, desirability, and viability aspects were addressed. The graduation project also provided Schiphol with a more extensive view of the roadmap, outlining Schiphol's steps towards its zero waste and circular goals, and providing insights on how to approach these objectives. Finally, a strategic plan was developed to aid other organizations in achieving their goals of becoming zero waste or circular.

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1. Introduction

Content

This Chapter introduces the worldwide problem of solid waste and dives deeper into the problem of passenger waste at Schiphol Airport. The initiative of TULIPS and the problem for Schiphol will be introduced. The project goal will be determined, and the project approach will be discussed. Lastly, an overview of the stakeholders within this graduation project will be given.

1.1 Solid Waste Background

Solid Waste (SW) refers to any type of garbage, trash, refuse or discarded material (Guidance on Solid Waste and Health, n.d.). Every year, an estimated 11.2 billion tonnes of SW is collected worldwide from which the organic proportion's decay contributes to about 5% of global greenhouse gas emissions (United Nations, n.d.).

1.1.1 Environmental Effects

Inappropriate or irresponsible disposal of waste may affect environmental pollution and increase risks to public health. Improper waste management facilities are affecting the environment and future generations (Alam & Ahmade, 2013). Present methods of waste disposal entail hazards to human health and the environment, as they can contaminate groundwater, clog drains, create stagnant water and floods, and by incinerating waste, hazardous gases are discharged into the air. Additionally, the toxic residues produced by waste incineration may negatively impact both human and animal health (Tait et al., 2020).

1.1.2 Circular Economy

Our current global economy operates mainly on a linear model, where natural resources are extracted, processed into goods, transported, used, and eventually discarded (Pronk, n.d.). Unfortunately, this approach results in a significant loss of valuable materials and resources. Additionally, as the world's population continues to grow and living standards improve, the demand for natural resources will only increase. Given that these resources are finite, humanity must shift towards a circular economy, greater recycling and reuse are the main actions contributing to closing the loop (Luttenberger, 2020). By adopting a circular economy, we can conserve and even increase our natural resources and derived materials for future generations. Such an economy requires ongoing and efficient product cycles, such as up-cycling instead of down-cycling (Dieterle et al., 2018).

1.1.3 EU Legislation on SW

The European Union (EU) has implemented several legislative measures over the past 20 years to manage waste. The European Union is taking action to combat marine litter and plastic pollution by implementing rules to reduce the volume and impact of single-use plastic products (SUPs) on the environment. The Circular Economy Strategy from EU COM/2015/0614 supports waste management based on a waste hierarchy for the best overall environmental outcome and to get valuable materials back into the economy (EU Commission, 2015). In 2018, the EU created a plan for a circular economy for plastics to reduce the production and consumption of single-use plastics: promote recycling and reuse and improve the sustainability of plastic products (European Commission, 2018). The new strategy includes measures such as charging customers for disposable plastic cups and food packaging, as well as extended producer responsibility for SUP products such as beverage cups, food packaging and carrier bags (Kvk, 2023).

1.1.4 The SW Separation System in NL

The Netherlands produces about 60 million tons of SW per year, of which 48 million tons are separated and 7,6 million tons are incinerated (Afvolverwerking in Nederland in Cijfers, n.d.). Separation rates in the Netherlands are relatively high, about 60%, which is partly because of the extended waste separation system in the Netherlands (Milieu Centraal, n.d.-a). There are nine main solid waste separation streams: :

1. PMD (plastic, metal and drink cartons)
2. Paper
3. Glass
4. Textile
5. GFT (vegetables, fruit and garden)
6. Electronic waste
7. Liquid fats
8. Deposit PET bottles and cans
9. Residual waste

The nine primary waste streams targeted for separation from household waste by municipalities of which some can be seen in Figure 1.1.4, are different from the waste streams produced by public spaces or companies (Effecten Gescheiden Afvalinzameling Openbare Ruimte, n.d.). Public spaces and educational institutions often choose to separate the most common streams: PMD, paper, and residual waste.

In the Netherlands, from July 2023 onwards, the use of SUPs at food service outlets, festivals, supermarkets, and offices will be restricted because of the European guidelines discussed earlier (Ministerie van Infrastructuur en Waterstaat, 2022). The objective of these regulations is to reduce the amount of plastic waste that is generated by SUPs. Instead of disposable products, reusable plates, containers, and cups should become the norm, to prevent environmental pollution and the accumulation of plastic waste (Kvk, 2023). From July 2023 onwards, 'to go' locations, delivery locations or supermarkets can not provide customers with free SUPs, however, customers are allowed to bring their reusable substitute or can buy the SUP (Ministerie van Algemene Zaken, 2023). At the time of writing, there are no clear rules about what the price of an item should be and where the money goes. Starting from January 1st, 2024, single-use cups and containers containing plastic for on-site consumption will be entirely prohibited. This applies to sectors such as hospitality, events, offices, institutions, associations, and sports clubs.



Figure 1.1.4. Picture of underground waste containers in the Netherlands

1.2 Project Introduction

1.2.1 TULIPS

The TULIPS consortium has been formed to explore the adoption of sustainable and innovative technologies to reduce emissions at airports. From 2023 until 2027, the consortium will develop and implement novel solutions aimed at supporting the transition to low-carbon mobility and enhancing existing sustainability efforts at airports. The EU has granted €25 million in funding to the consortium as part of its commitment to the European Green Deal. (Home - TULIPS, 2022) This graduation project is part of one of TULIPS' twelve work packages, Work Package 6 is called 'Circular Airports'. which contains: Setting up a circular baseline for the airport and a circularity management system (Projects - TULIPS, 2022). One of the two goals of this TULIPS Work package is to eliminate operational consumer and passenger waste.

1.2.2 Schiphol Airport

Schiphol Airport, the main international airport in the Netherlands, is one of the lighthouse airports that is showcasing and implementing green innovations for TULIPS. Schiphol Airport is aiming to be zero-waste in 2030 and fully circular in 2050 (Schiphol Group, 2020). With zero waste, Schiphol means "that all raw materials, components, and products used by Royal Schiphol Group will be reused or recycled to the highest degree possible according to the waste hierarchy. This will be achieved preferably at Royal Schiphol Group's locations or as close to those airports as possible. The consequence of this vision is that what has been traditionally treated as waste will now be regarded as 'residuals' of the operation of value, rather than as useless waste." (Pronk, n.d.).

Over the past years, Schiphol has made several steps to realise this goal, by improving its recycling possibilities on both operational and infrastructural sides. They did this by for example adapting to 100% renewable energy from Dutch windfarms, their 'light as a service' concept, buildings made to disassemble, changing their airport transport to electronic vehicles, and improving PSW recycling opportunities (Moving towards a more sustainable airport, 2019).

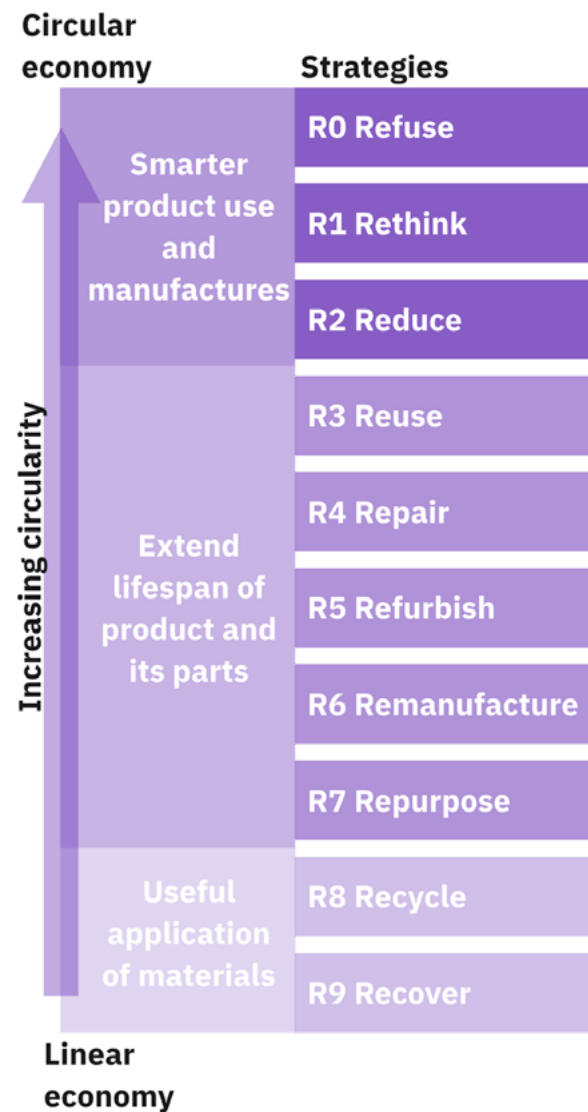


Figure 1.2.2. 9R Approach

To identify the optimal solution for residual waste usage Schiphol Group employs the "9Rs approach", which is shown in Figure 1.2.2 (Pronk, n.d.). This approach assists in identifying the most sustainable and valuable application of the material, thereby minimizing its environmental impact. This approach is also used by TULIPS to identify possible solution spaces.

1.3 Project Goal and Approach

1.3.1 Project Goal

Despite the waste separation facilities at Schiphol Airport, there is a lack of effective waste management practices among passengers resulting in a big amount of recyclable material being sent to incineration. Passengers at Schiphol can separate their waste into Paper, Plastic and Residual waste. The waste streams Paper and Plastic are according to Schiphol and TULIPS often too contaminated, which makes them unrecyclable. There is a need to improve passenger waste separation behaviour at Schiphol Airport by implementing effective waste management practices to enhance waste separation and reduce the amount of PSW being incinerated. The Project Brief that this graduation project started with, can be found in Appendix A.

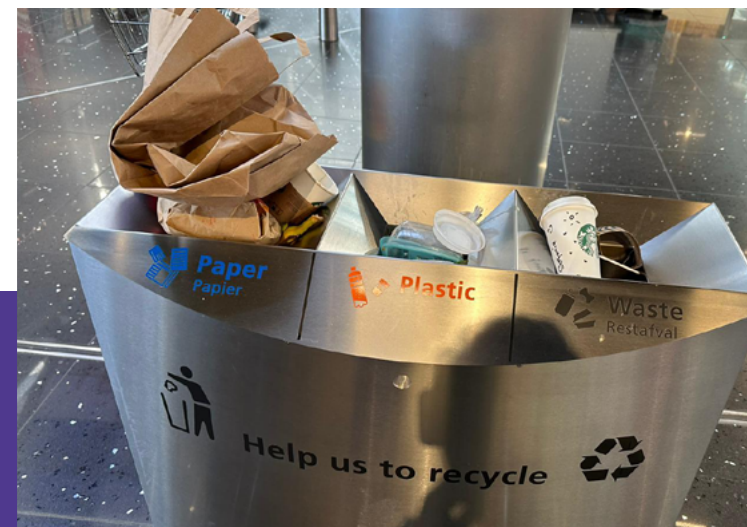


Figure 1.3.1 A picture of the problem taken at Schiphol Airport

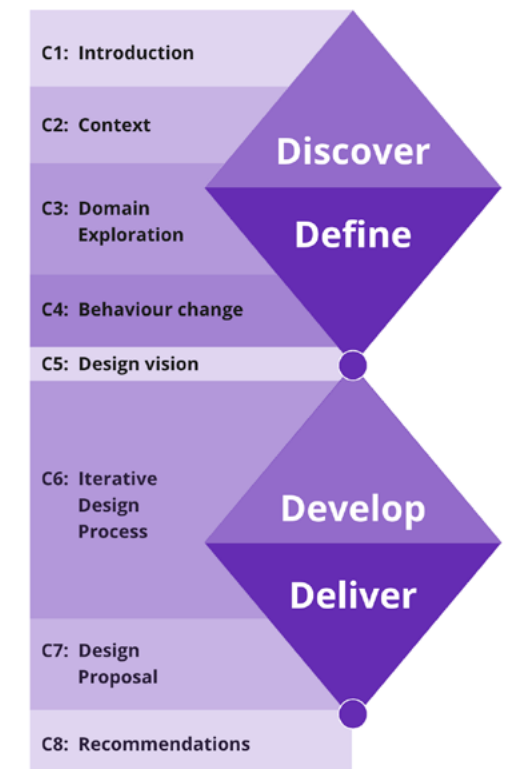
The goal of this graduation project:

Improving PSW separation behaviour at Schiphol Airport, to reduce the amount of residual waste being collected and incinerated.

1.3.2 Project Approach

The design approach for this graduation thesis will be using the double diamond method. The double diamond can be a useful framework (see Figure 1.3.2) which separates four phases; explore, define, develop, and deliver (Framework for Innovation - Design Council, n.d.). The first diamond can be used to explore and define the problem, understand the current waste management practices, and identify the pain points and opportunities for improvement. This will include observations at Schiphol, as well as other airports and organisations with benchmark strategies. From several interviews with stakeholders and by analysing behaviour models and the behaviour of passengers, insights can be gathered to define the problem definition which leads to design opportunities. These opportunities will be mapped on a design roadmap, after which a design vision for this project is created. All the insights from the first diamond can be used to generate ideas and potential solutions for an improved PSW separation system. This includes ideation sessions, co-creation and testing ideas in context. These ideas can evolve into concepts, which can be evaluated against criteria that are defined over time. The concepts will be tested and by iterating on these, a final design can be concluded, which will be prototyped, tested, evaluated, and added with recommendations.

Figure 1.3.2. Project Approach



1.4 Stakeholder overview

This graduation project is connected to various stakeholders involved in the current waste management process at Schiphol Airport. The current stakeholders (February 2023) involved in waste separation at Schiphol include Schiphol Group, business partners under which Catering Company A and B, cleaning companies A and B, and Waste Handler A. For this graduation project, the names of the direct stakeholders of Schiphol are made anonymous, a list of the names of the companies can be found in Confidential Appendix B. It should be noted that from June 2024 onwards, Waste Handler A's contract will end and Waste Handler B will become the new waste handler. For this graduation project, Waste Handler A is contacted to gain insights about waste handling at Schiphol. This switch in waste handlers results in a possible limitation for the result of this project

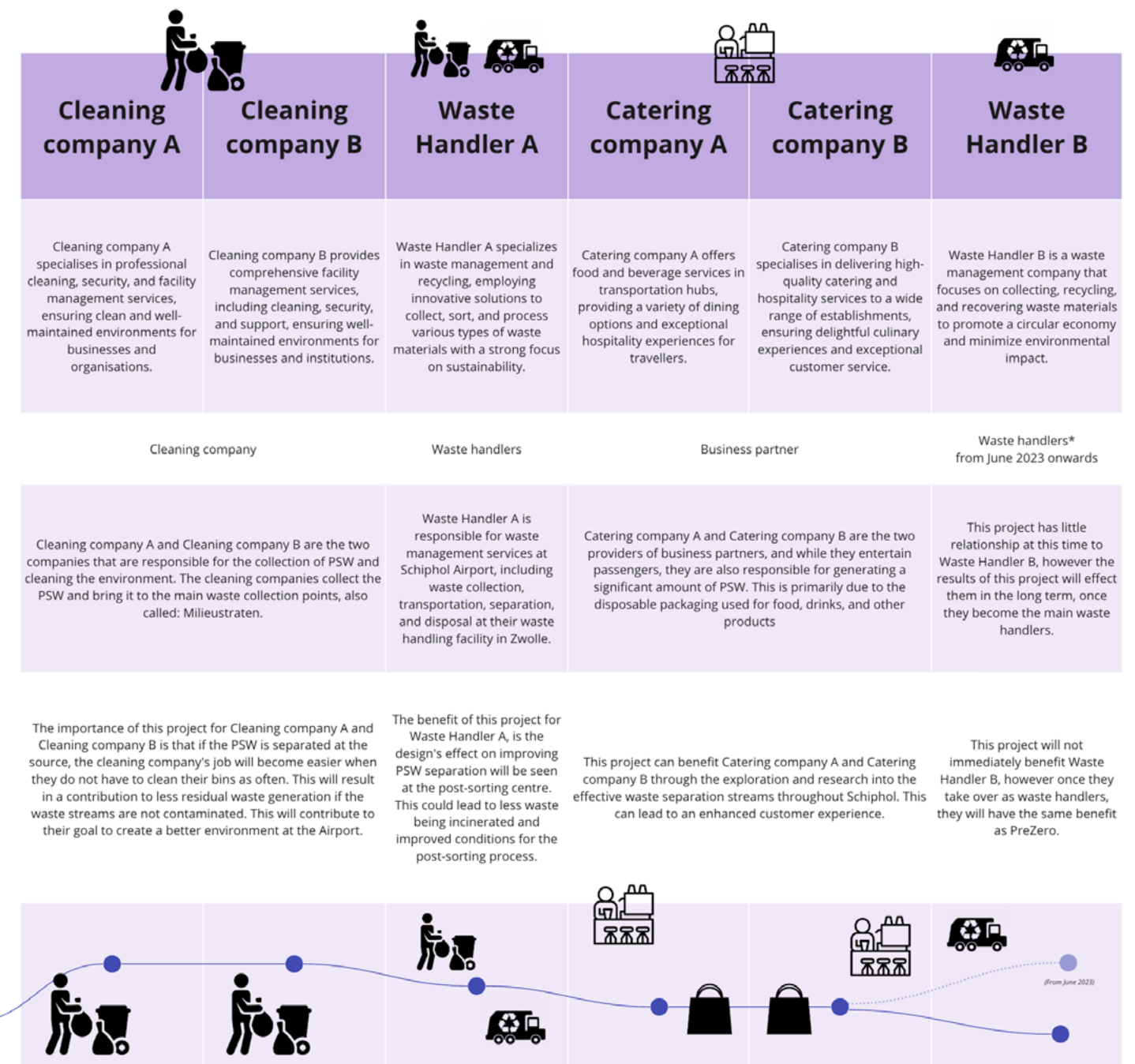
since Waste Handler Bs approach to waste handling can be different. This is why, for general information about waste separation, the 'Afvalscheidingswijzer' from Milieusentraal has been consulted, which is a platform that guides in the correct disposal of waste (Afvalscheidingswijzer | Milieu Centraal, n.d.). Figure 1.4 provides an overview of these stakeholders and their respective roles in the waste separation process at Schiphol Airport, the complete overview with names, logos and sources can also be found in Confidential Appendix B.

| | Schiphol |  |
|---|---|--|
| Company aim | Royal Schiphol Group operates and manages Amsterdam Airport Schiphol, providing excellent airport services and enhancing the travel experience for millions of passengers. <i>(Schiphol Royal Schiphol Group, n.d.)</i> | TULIPS is an EU-supported consortium focused on developing low-carbon mobility innovations and promoting sustainability at airports over the next four years. The aim is to accelerate the adoption of sustainable aviation technologies, working towards zero emissions and waste airports by 2030 and climate-neutral aviation by 2050. <i>(TULIPS, 2022)</i> |
| Function | Airport facilitation managers | EU funded consortium |
| The relation to the project | Schiphol Group oversees the collection, transportation, and disposal of waste. Schiphol Group is also responsible for coordinating with other stakeholders involved in waste management; including airlines, tenants, business partners, cleaners and waste management companies. | Tulips are heading up this project and carrying out this research in order to help facilitate Schiphol achieve their goal of zero waste by 2030. |
| Benefits of project for stakeholders | Schiphol's interest in this graduation project is to get closer to their goal to be zero waste in 2030 and to get insights into the PSW process that is currently going on. | Tulips interest is to help facilitate in getting Schiphol to their goal of zero waste in 2030. |
| Involvement in project |  High involvement Low involvement |  |

Main takeaways: This graduation project is connected to quite a few stakeholders, all having their own company goals and values. For this project, this means that the stakeholders should be considered when designing since they all have different interactions with

waste at Schiphol Airport. It is important to find out what the exact interaction is between the stakeholders and the FF3 bin and what they require for this project.

Figure 1.4 Stakeholder overview





2. Context

Content

In this Chapter, the context of the project will be discussed. The current FF3 bin that is situated throughout Schiphol will be examined in detail, including all elements of its physical appearance as well as the locations of the bins. It will also touch upon the pilot test that Schiphol is carrying out with the FF2 bin and what effect that can have on passenger waste separation and Schiphol's end goal. Furthermore, there will be discussed what items are considered PSW and the source that these items come from through waste journey mapping. Lastly, the user ecosystem of the bins will be determined, to gain information about who uses the bins, and therefore, who is affected by the use and alteration of the bins.

2.1 The Current FF3 Bins

Schiphol Airport has implemented PSW separation programs over time to reduce the amount of waste being incinerated and to increase its recycling rates. The airport has currently different ways for passengers to dispose their waste; residual waste bins or three-component waste bins (FF3 bins). Next to these two ways of disposing waste, passengers can also donate their PET bottles with a deposit to a charity in transparent cylindrical bins, see Figure 2.1.

2.1.1 The FF3 Bin

Figure 2.1.1a shows the current FF3 bin at Schiphol Airport, which features three holes for the disposal of Paper, Plastic, and Residual Waste. In and around Schiphol Airport, about 900 of these bins are placed. The bin uses a combination of icons, text, and colours to indicate the different waste streams, as can be seen graphically in Figure 2.1.1b.

The text indicating the different waste streams is written in English, with translations into Dutch provided for 'paper' and 'Other waste' as 'papier' and 'restafval,' respectively. Notably, the text for 'other waste' has been updated from the current FF3 bin label of 'waste', as seen in Figure 2.1.1b. Additionally, the bin includes the text "Help us to recycle" on both vertical planes of the bin. The text for the different waste streams is placed on an oblique plane. There should be noted that according to Waste Handler A, the Plastic waste stream was seen as the Dutch PMD stream, up to January 2023, which could include Plastic, Metal and Drink cartons. From January 2023 onwards, the PMD stream for companies is changed to Plastic and Drink cartons (PD 'Waste Handler B' Neemt Het Apart Mee!, n.d.), in which metal is seen as a contamination of the stream. To give the right information to the passenger, the text on the bin should include information about the disposal of drink cartons as well.



Figure 2.1.1a The FF3 bin at Schiphol Airport

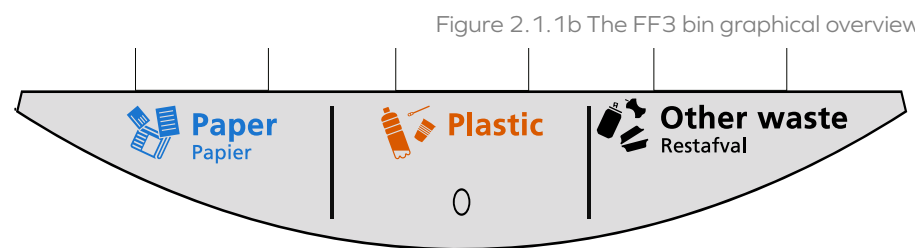


Figure 2.1.1b The FF3 bin graphical overview

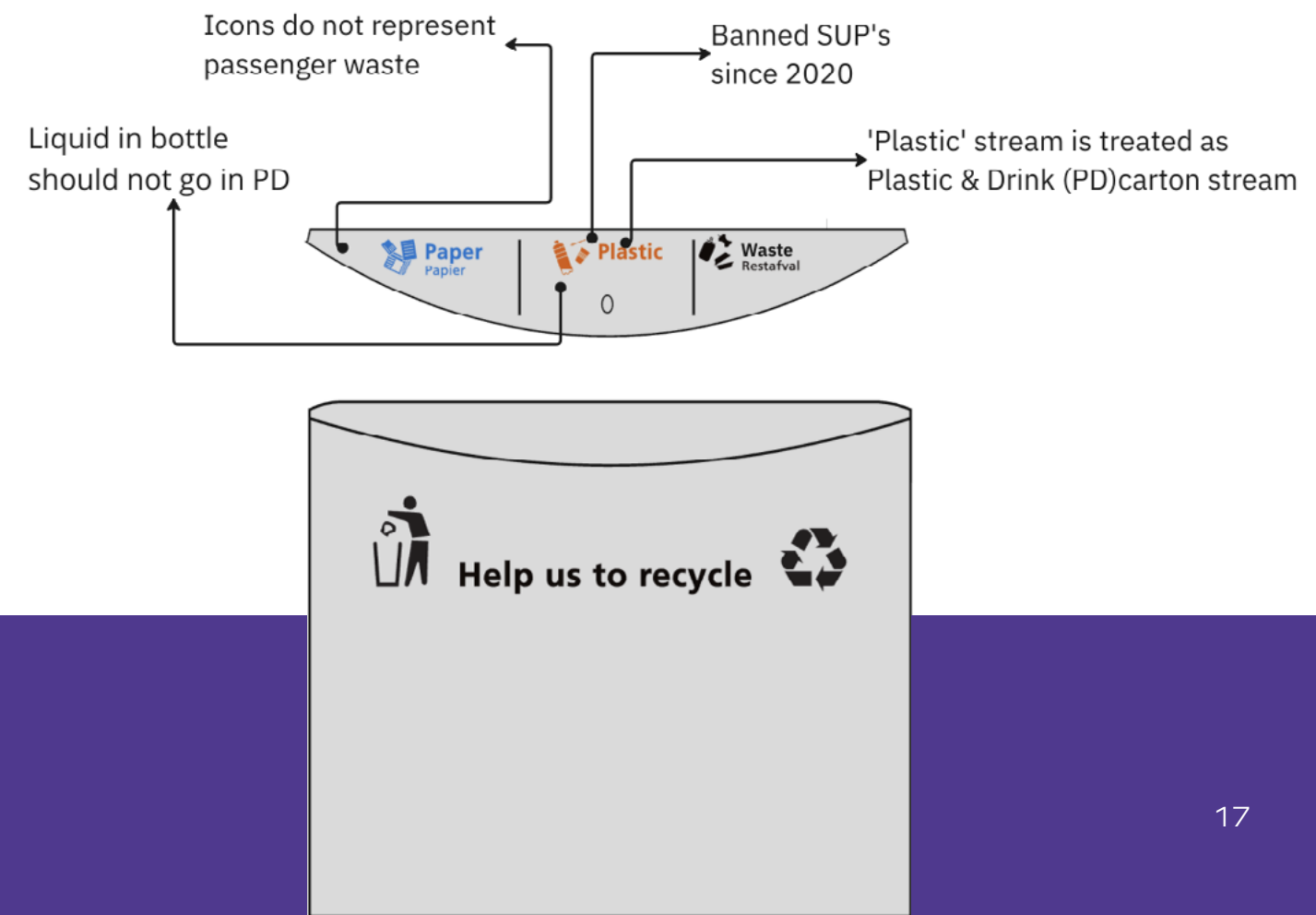


To improve understandability, icons are included for each waste stream. The paper waste stream is represented by a newspaper and two tickets. The plastic waste stream features an icon of a PET bottle with a small amount of liquid, a plastic beverage cup, and a plastic stirring spoon. Interestingly, liquid waste should not be disposed of in the plastic waste stream (Doe mee met PMD, n.d.). Furthermore, the plastic cups and the plastic stirring spoons that are displayed have already been banned since July 2021 (Ministerie van Algemene Zaken, 2022). Lastly, the 'Other waste' stream is indicated with a can, the core of an apple, and a food container. The icon of the can, used to be indicated wrong, since according to the Dutch separation system, cans should go in the PMD stream (Metalen Verpakking Weggoien | Afvalscheidingswijzer, n.d.). However, for company waste from January 2023 onwards, cans and other metal packaging should be disposed of in the residual waste.

Finally, each waste stream is associated with a specific colour; the paper waste stream is indicated with blue, the plastic waste stream with orange, and the residual waste stream with black. These colours are corresponding to the colours used by the Dutch government for waste separation of the different materials.

Main takeaways: The text and icons of the FF3 bin do not match the Dutch recycling system and some of the Plastic icons are outdated. Other insights can be seen in Figure 2.1.1c. This means that to improve the understandability of the bin, the text should be following the Dutch regulations and the icons should represent PSW items.

Figure 2.1.1c Insights analysis FF3 bin



2.1.2 Location of the FF3 Bin

FF3 bins are situated in various locations in and around Schiphol Airport, primarily in high-traffic areas such as at the main entrances, elevator lobbies, toilet entrances, hallways, and waiting areas at gates and arrival halls. The visual in Figure 2.1.2a, which is developed based on observations, provides an overview of the FF3 bin placement at each location.

When analysing Figure 2.1.2a, the business partners mostly have residual waste bins. In the toilets, Schiphol only provides residual waste bin since according to the Contract and Service Manager at Schiphol: "90% of the waste ending up in this bin are wet paper towels, these cannot be recycled, and therefore, it is unnecessary to place separation bins in this location." (Confidential Appendix C)

The FF3 bins are predominantly located in high-traffic areas such as hallways, crossings, and escalator access points. I conducted several observations before and after security during February 2023, which indicated that the convenience of disposing of PSW in the high-traffic hallways is low, considering the busy foot traffic and time constraints of passengers heading to their destinations. Additionally, the orientation of bins is often aligned with the direction of foot traffic (see Figure 2.1.2b), which decreases their identity as FF3 bins, since the signage is only visible on one long side of the bin. When looking at the placing of the FF3 bins at for example entrances the accessibility is higher, since people step out of the traffic to separate their waste and because they can see the difference between the 3 holes better.

This research project will focus on improving PSW separation in general areas so that it is feasible within the scope of this graduation project.

Main takeaways: The convenience for passengers to separate waste in the FF3 bins, which are located in high-traffic areas, is low due to the bad signage orientation in combination with the walking direction and the busy foot traffic passengers could be in. This means that the signage should be improved in such a way that passengers see the difference in waste streams from all directions.

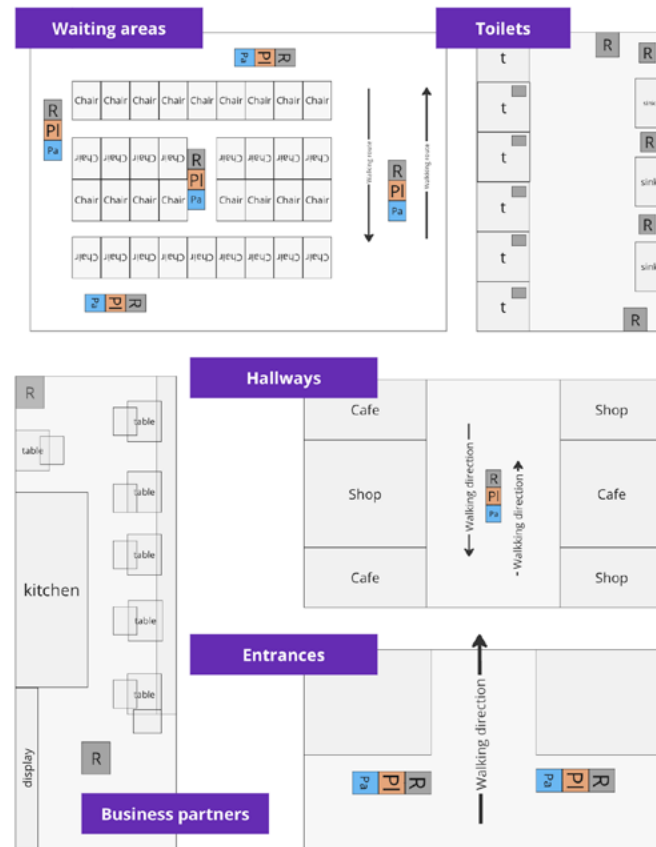


Figure 2.1.2a Overview of locations bins at Schiphol Airport



Figure 2.1.2b The FF3 bin located in a walking path

2.1.3 The FF2 Pilot Bin

From March 2023 onwards, Schiphol started a pilot with 15 FF2 bins, which separate PET bottles and Cans from Other waste (see Figure 2.1.3). This FF2 bin only gives the passenger two options to separate waste, which is according to Andrews et al. (2013) not enough: 'A two or three-compartment bin next to a residual bin may be the best bin type for recycling accuracy'. Besides this, there are currently over 900 FF3 bins located within Schiphol Airport. From a sustainable perspective, it is better to see how the FF3 bins can be improved or reused, than to replace all the FF3 bins with FF2 bins. Moreover, due to a lack of data and access to the bins within the frame of this project, the FF2 bins that are only placed in April 2023 could not be analysed to the fullest potential yet. Because of these arguments, this graduation project will focus mainly on improving PSW separation behaviour with the current FF3 bins, from which data is derived over the years and from which there is a potential to improve waste separation whilst using the current 900 FF3 bins.

Figure 2.1.3 The FF2 bin



2.2 Passenger Solid Waste

Passengers at Schiphol Airport generate a wide variety of SW. In this paragraph, the different types of PSW will be discussed, which are based on observations and the Waste Safari report of TULIPS. Furthermore, a visual representation of the waste journey illustrates how waste moves from, within, and beyond Schiphol Airport.

2.2.1 PSW Generated at Schiphol Airport

To examine the current PSW management at Schiphol, Elisabeth Tschavgora and Anne Rademaker from TULIPS did a 'Waste Safari' through SW FF3 bins at Schiphol Airport (Confidential Appendix D). The top five PSW items found were cups, PET bottles, food bags, food boxes, and cans, all related to the food and beverage consumption of passengers. The study found that mixed material items such as cups,

food bags, and food boxes were present in all waste streams, indicating a need for better communication and education on waste separation and disposal. An overview of the PSW, the generated location and the aimed disposal stream is shown in Figure 2.2.1. The waste classification is determined using the 'Waste separation guide' developed by Milieucentraal (Afvalscheidingswijzer | Milieu Centraal, n.d.), which outlines guidelines for effective waste separation. What should be highlighted is that the items visible in the paper stream should be dry and clean, if they are not, they should be disposed of in the residual waste stream.

Main takeaways: Most PSW is generated by business partners and generated for food or beverage consumption. Furthermore, the number of paper items, if disposed of correctly, is a small amount compared to the number of items the residual and plastic waste stream can include.

| | | | |
|---------------------------|--|---|--|
| Restaurants | | Coffee cups beverage cups Cup lids Pet bottles* Cans* | Dirty paper food containers Organic waste Biodegradable material Receipts |
| Cafes | Cup holders Clean napkins Clean paper bags | Drinking cartons Plastic or aluminium food containers | |
| Bars | | *without deposit | |
| Shops | Newspapers Paper bags Product packaging | Plastic shopping bags Product packaging | Receipts Product packaging |
| Toilets | | | (wet) paper towels |
| Service desks | Boarding passes | | Luggage labels |
| Location/ PSW disposal | Paper | Plastic | Waste |




Figure 2.2.1 Distribution of PSW over Airport facilities and the current FF3 bin waste streams

2.2.2 Waste Journey at Schiphol Airport

From observations, the Waste Safari report and the insights gained from joining one of Cleaning Company A's cleaners, the complexity of the waste journey is visualised in Figure 2.2.2. In this visual the journey of waste can be seen, which starts at the moment the waste is generated and then disposed of by the passenger. After this, the waste is collected by the cleaners and then they post-separated the waste streams at the milieustraat. Waste Handler A posts separate some PSW items at the milieustraat before the waste handlers pick up the waste and bring this to the main waste handling facility in Zwolle (NL).

From the waste journey can be concluded that the responsibility for PSW separation lies not only with the passengers but also with the Business Partners, cleaners, and waste handlers. They together influence the PSW being separated or not at the waste handlers in Zwolle. Specifically, the cleaners and some business partners are empowered to determine whether the content of a bin bag will be recycled or not. They do this by examining the collected bin bags and see if the bin bag contains the right items for the waste stream, if the bin bag contains the correct items for over 70%, the bin bags will go to the determined waste stream in the milieustraat. However, according to Cleaning Company A and Cleaning Company B, the separated streams are almost always too contaminated and since it is hard to determine exactly whether a waste stream is contaminated or not, a lot of bin bags end up in the residual stream. Upon collection, waste handlers undertake a post-separation process at the Milieustraat, in which they examine the waste streams to see if they can sort items such as PET bottles or paper bags. After this, the waste streams proceed to the waste handlers in Zwolle, where a post-separation machine carries out further separation.

Main takeaway: The responsibility for waste separation lies not only with passengers but also with business partners, cleaners, and waste handlers. They need to determine whether a bin bag is contaminated for the determined waste stream, so if this process can be improved, the amount of residual waste can be decreased.

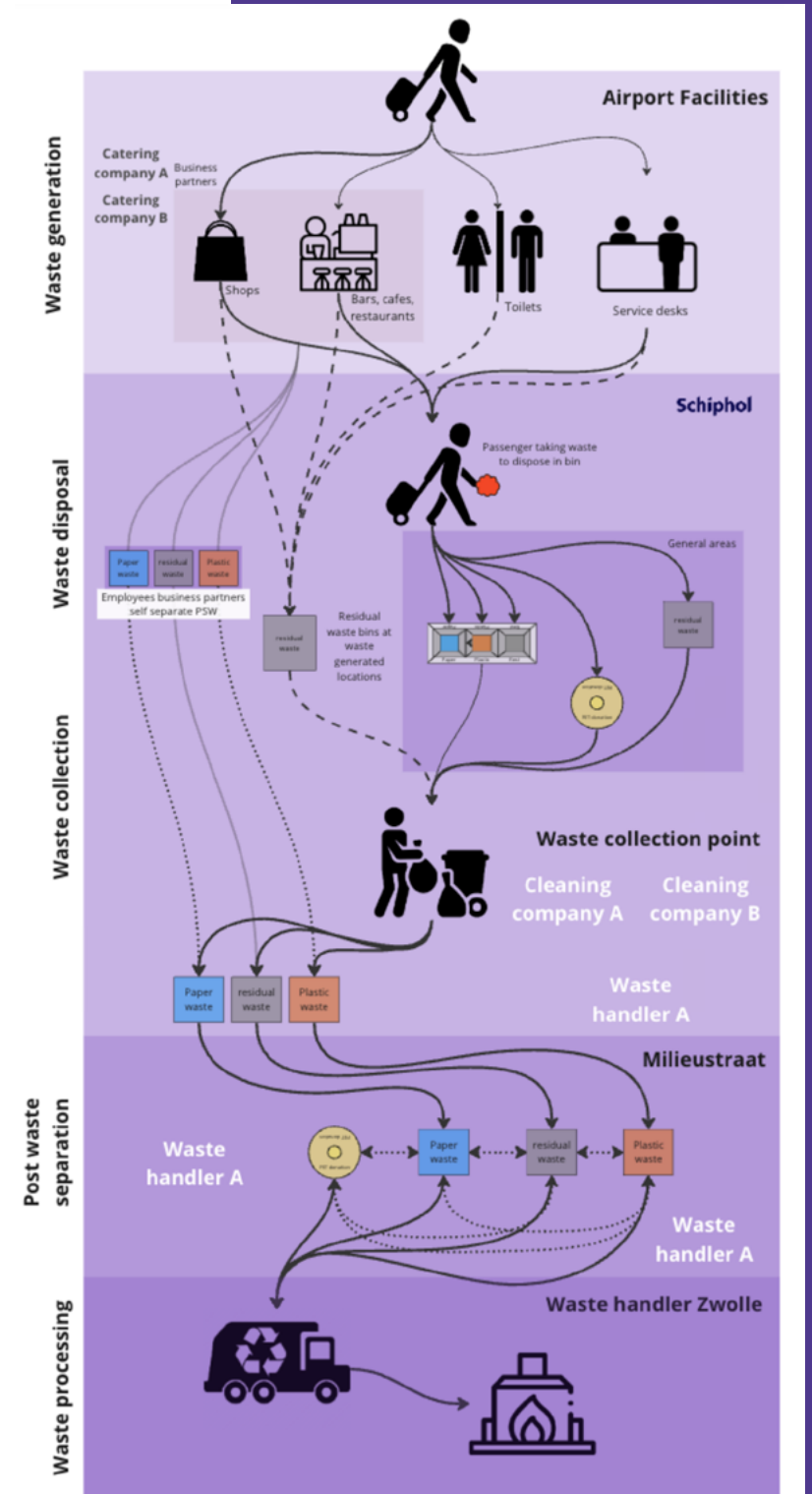


Figure 2.2.2 The waste journey

2.3 The Users of the FF3 Bin

Passengers are the primary users of the FF3 bins, however, as shown in the waste journey, passengers are not the only users of the FF3 bins. Youngblood and Chesluk (2020) have described different types of users that can be a part of a user ecosystem, in a book called: User Ecosystems. They describe how analysing the current user ecosystem, can help to envision ways to design more thoughtfully and strategically for the current PSW separation problem at Schiphol. In Figure 2.3 a visual of the current user eco-system of the FF3 bin at Schiphol Airport is visualised. This information is based on observations and created by following the Current User Ecosystem session of the book of Youngblood and Chesluk (2020). From the analysis of the user eco-system (Confidential Appendix E), several main takeaways could be concluded.

Main takeaways: Passengers are the primary direct and indirect users, and their behaviour can influence each other's behaviour, as well as the airport experience of ambient users. Cleaners are the second biggest user since they empty, clean, repair and maintain the FF3 bins. For this project, this means that if changes are made to improve the waste separation behaviour of passengers, this should be evaluated with the cleaners. The redesign can even be designed with the cleaners since they have the most knowledge about what ends up in the bins and what the problems are for PSW separation.

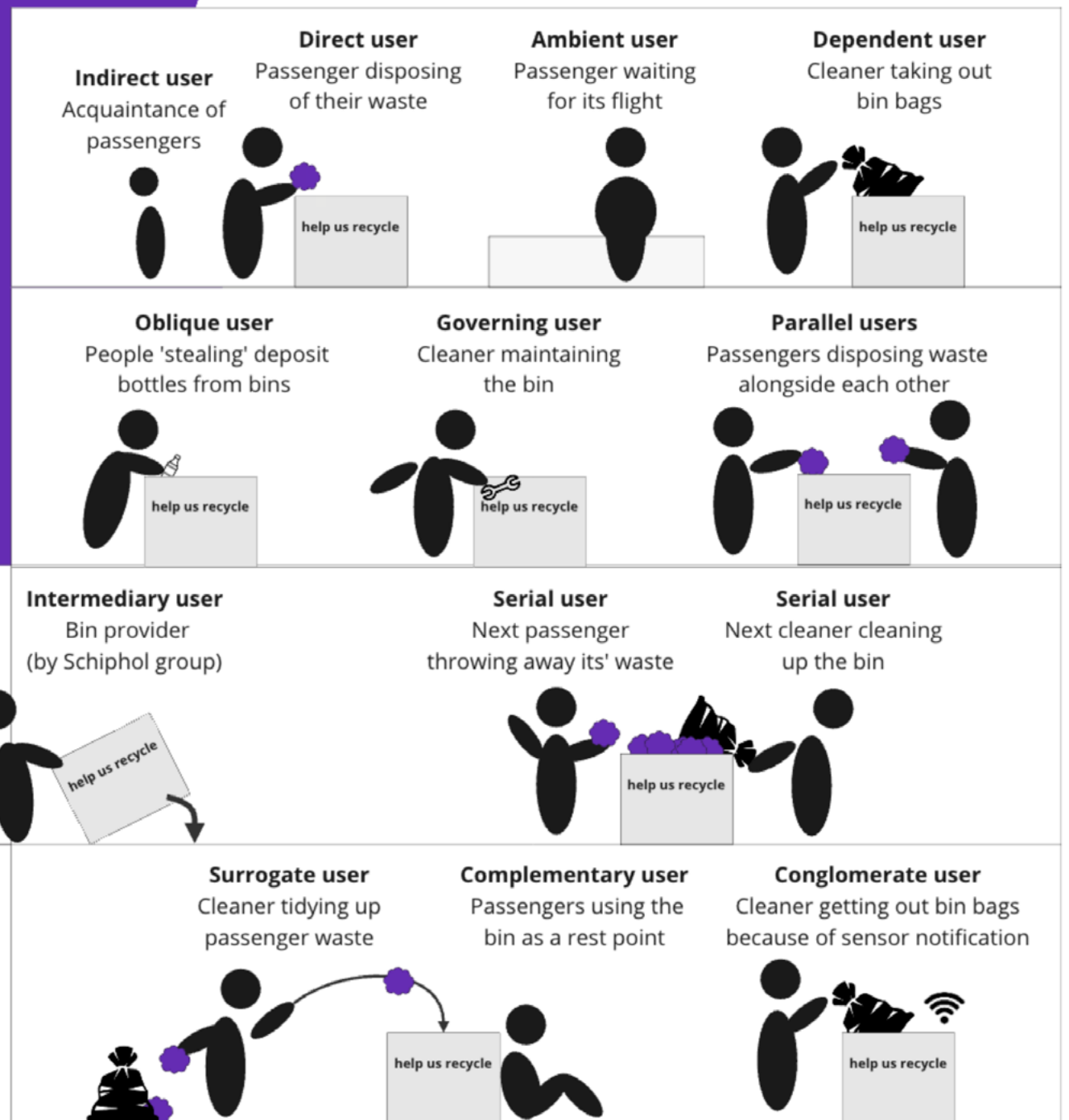
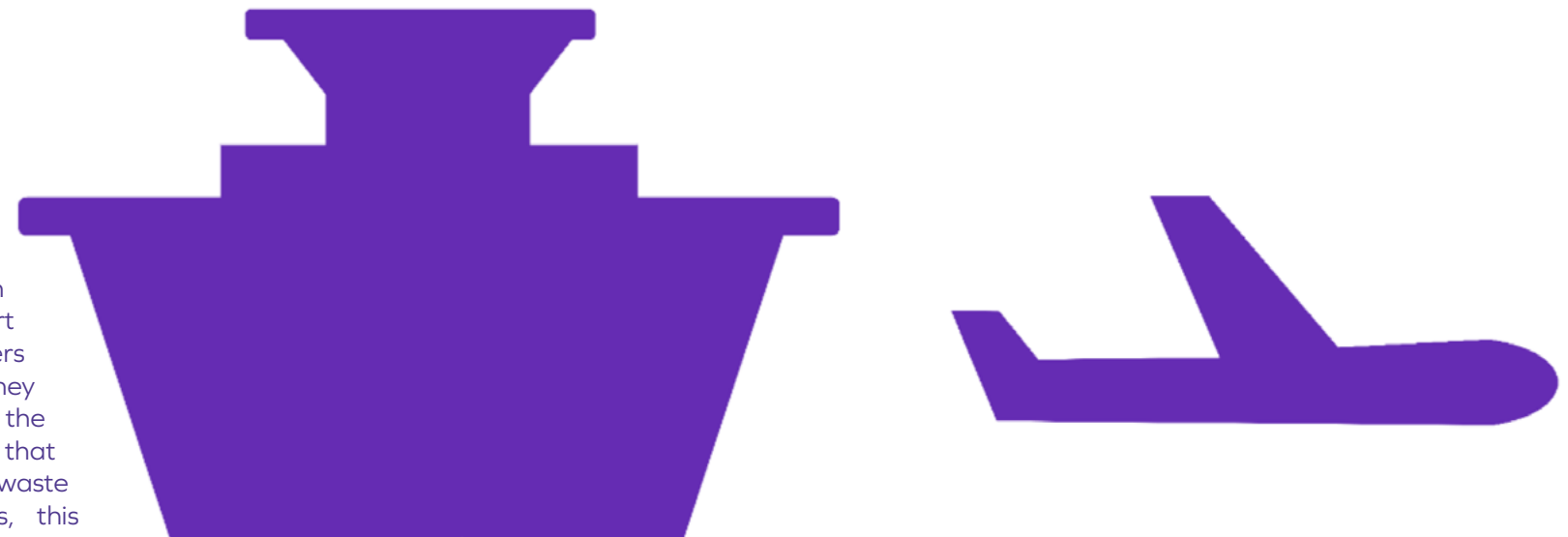


Figure 2.3 The User Eco System

2.4 Conclusion: Design Criteria

The context analysis reveals several key takeaways regarding the FF3 waste bins at the airport and its users, all the main takeaways are combined in Figure 2.4. Furthermore, the main takeaways of this chapter can be translated into several Design Criteria (DC).

DC 2.1 The design should be aligned with the Dutch recycling system and the waste handler

- The text and icons on the FF3 bin should align with the regulations of the Dutch recycling system.
- Icons should accurately represent PSW (plastic, residual, and paper waste) items and how these should be sorted according to the waste handler

DC 2.2 The design should have an enhanced signage visibility (T2.1.2)

- Signage should enhance visibility and legibility from all directions for passengers.
- Walking direction and busy foot traffic of passengers should be considered when positioning signage.

DC 2.3 The design should focus on generated PSW items (T2.1.2)

- The specific waste generated by business partners should be addressed, especially related to food and beverage consumption.
- Solutions that accommodate the volume and types of waste business partners generate should be created.

DC 2.4 The design should consist of a combination of waste streams that reduce contamination (T2.2.1)

- Paper waste, when disposed of correctly, contributes minimally compared to residual and plastic waste.
- Effective waste separation methods for residual and plastic waste streams should be prioritised.

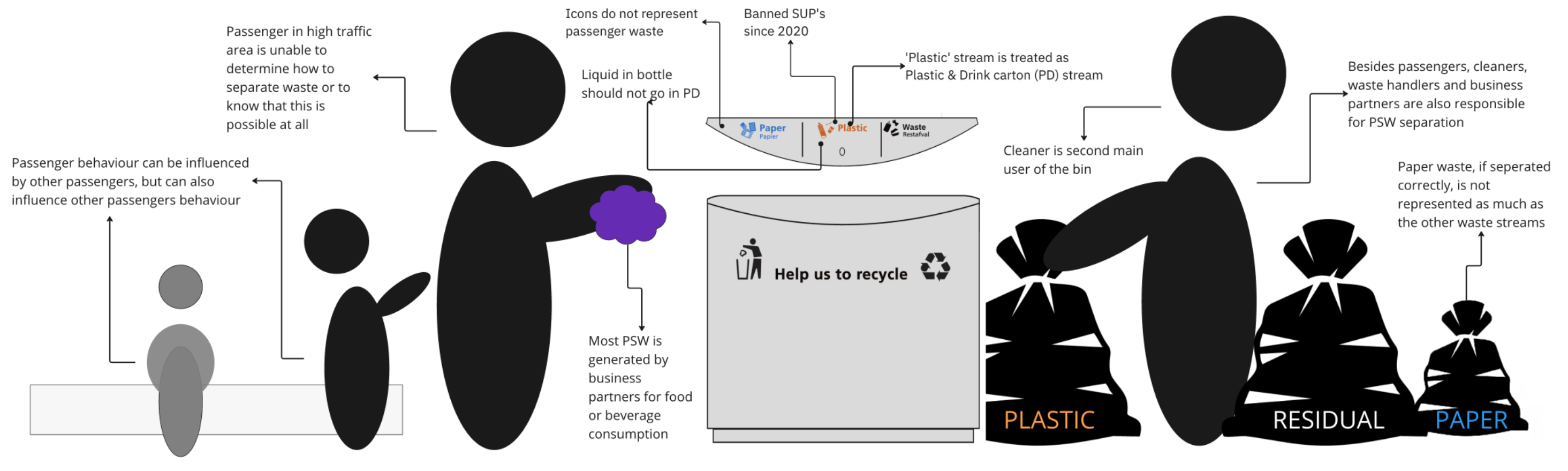
DC 2.5 The design should improve critical steps of the waste journey (T2.2.2)

- Improved waste separation by involving the needs of passengers, business partners, cleaners, and waste handlers should be facilitated.
- The process of determining contamination levels in bin bags by cleaners to reduce residual waste should be determined.

DC 2.6 The design should involve the users' influence (T2.3)

- The influence of passenger behaviour on other passengers and the overall airport experience should be considered.
- Solutions that encourage positive waste separation behaviour among passengers should be designed.
- There should be collaborated with cleaners to gather their knowledge and insights regarding waste management challenges.
- The expertise of cleaners in the design process to address problems and optimize waste separation in FF3 bins should be incorporated.

Figure 2.4 Main Takeaways Chapter 2: Context





3. Deepening Exploration

Content

This chapter deepens the understanding and insights of the stakeholders, which was gained via interviews with cleaners, waste management and passengers. It describes what was gained from the field trips to both neighbouring and international airports. Furthermore, other public organisations and what they are currently doing to recude the amount of residual PSW, will be explored.

3.1 Project Stakeholders

To get a better understanding of the stakeholders, deepening interviews were conducted with the cleaning companies and the waste handler to explore underlying problems and insights that improve passenger separation behaviour at Schiphol Airport in the general area.

3.1.1 Cleaning Company A and B

From an interview conducted with Cleaning Company A's Operational Manager Landside and Cleaning Company B's Innovation Manager, some interesting insights came to the surface (Confidential Appendix C and F). Cleaning Company A shed light on the challenges they face in managing the waste generated by passengers, particularly regarding the disposal of takeaway packaging. Despite previous efforts of Schiphol to implement initiatives such as adjustments in lids for the bins, the lack of cooperation from passengers continues to contribute to the waste problem. Cleaning Company B's cleaners notice that passengers face difficulties in determining which bin items should be sorted into, especially international passengers. Cleaning Company A's Operational Manager Landside acknowledged the difficulties faced by the cleaners in separating waste due to the dirty and confusing nature of the bins, highlighting the importance of separating waste at the source: 'Not only do we need to empty the bin a couple of times a day, but the biggest job is also to keep the bins clean, all the left-over bits of coffee, liquids and melted ice creams end up on the bin.' Cleaning Company B's Innovation Manager also raised concerns about liquid and leftover food that contaminates the waste stream and the bins, making them difficult to empty and necessitating frequent cleaning. They both acknowledge the challenges in incentivizing passengers to dispose of their waste properly, particularly with international guests and the importance of convenience for passengers who do not want to spend much time disposing of their waste.

Main takeaways: The cleaners' biggest problem regarding PSW is liquid and food waste, which is making the bins and environment dirty, and influences the recyclability of the waste streams due to contamination. Furthermore, the three waste streams collected by the cleaners are often determined as too contaminated, resulting in more waste ending up in the residual waste stream.

3.1.2 Waste Handler A

Waste Handler A is responsible for waste management services at Schiphol Airport, including waste collection, transportation, separation, and disposal at their waste handling facility in Zwolle. An interview with the Operational Manager and the Commercial Manager revealed and supported the problem that the current streams of PSW are poorly separated, which can be read in Confidential Appendix G. According to Waste Handler A's operational Manager, "The streams are mostly contaminated due to liquid and food waste. If those were not present in the PSW stream, it would be easy to separate the waste at our facility in Zwolle. However, if the paper, for example, is wet or creased, we cannot post-separate it at all." As concluded from Chapter 2.2 Passenger Solid Waste, even PSW that is collected separately ends up in the residual waste stream, due to contamination more PSW than necessary is being incinerated. Waste Handler A's Commercial Manager made an interesting point that passenger behaviour varies by country of origin, stating, "Passengers from countries known for their tidy public space, such as Japan and Singapore, show the same behaviour when sorting waste at Schiphol, the opposite is also clearly visible from other countries of origin" Furthermore, Waste Handler A's Operational Manager emphasised that bin liners make up about 9% of the total residual waste. Every time a bin is more than 60% full (Confidential Appendix H), all three bin bags are taken to the Milieustraat and these bin liners are currently made of virgin plastic (Waste Safari TULIPS, Confidential Appendix D).



Figure 3.1.2
Example of
contaminated
bin at
Schiphol Airport

Main takeaways: The waste handlers confirm that most waste streams are contaminated, mostly by wet and organic food waste, see figure 3.1.2. This indicates a need for exploring opportunities to separate wet waste from the other waste streams, to improve the recyclability and post-separation process. Furthermore, the behaviour of passengers separating waste could be related to their country of origin, which implies that researching how waste is separated in other countries might give insight into a better way to separate waste that more passengers will understand.

3.2 Other Airports

Exploring the waste management practices of other airports in the Netherlands can give insights into their waste management practices in a smaller but similar environment. The insights from Eindhoven Airport and Rotterdam Airport can be used as inspiration or design guidelines further on in this graduation project.

3.2.1 Eindhoven Airport

Eindhoven Airport, which is 51% owned by Schiphol Airport, is a relatively small airport with twelve gates, compared to Schiphol Airport's 220+ boarding gates (Schiphol | Regionale Luchthavens, n.d.). Upon conducting observations at Eindhoven Airport, attention was drawn to the different holes in the FF3 bins, which are designated for Residual, Paper, and Plastic Bottles, as depicted in Figure 3.2.1. An interview with the Environment Manager at Eindhoven Airport revealed some noteworthy insights. Firstly, the separate stream for plastic bottles does not work, a lot of other waste ends up in there contaminating the waste stream. Furthermore, Eindhoven Airports Environment Manager highlighted the problem of closed bags, which do not perform well in the post-separation machine at the waste handlers. This indicates that the bin bags should be opened before entering the machine and that passengers would dispose of their waste separately, without combining everything into one plastic bag for example. Lastly, also at Eindhoven, the paper waste stream is often contaminated with wet and food waste, making the paper waste stream non-recyclable, and causing it to end up in the residual waste stream.



Figure 3.2.1 The separation bins at Eindhoven Airport

Main takeaway: Having a separated waste stream for plastic bottles does not improve the separation ability of the stream, wet- and food waste contaminate the waste streams and waste that is gathered in bags together makes it hard for the post-separation process to separate.

3.2.2 Rotterdam The Hague Airport

Rotterdam The Hague Airport (RTHA), fully owned by Schiphol Group, has the same waste streams to separate PSW, see Figure 3.2.2. Their bins provide a Papier (paper), Plastic and Restafval (residual) waste stream. The bins provide information in Dutch and each waste stream has a colour and one icon. The information is minimum, which could be their problem of PSW not being separated accordingly. However, unlike Schiphol Airport, RTHA has a different approach to coffee cups, utilising a porcelain cup system at the main café/restaurant near the gates, resulting in a considerable decrease in disposable cup waste. In an interview with the sustainability Advisor at RTHA, was highlighted that only on rare occasions disposable cups are used, mainly provided by Specialty Coffee Retailer on the airside. F&B Director from Catering Company A also explained the reason for this in an interview: 'A generic cup will not fully cater for the need. Hospitality is all about creating an atmosphere, a set of minds to spend for a "luxury" need. Branded cups add to the total experience, which is covered in the branding of a strong consumer brand such as a Specialty Coffee Retailer.'



Figure 3.2.2 The separation bins at RTHA

Main takeaway: By replacing coffee cups with reusable cups, there is a significantly lower amount of coffee cups and spills contaminating the waste streams. However, in the case that passengers still need the takeaway cups at RTHA, the bins do not provide enough information on where to dispose of these. This indicates the need for better communication on how to dispose of the current PSW items.

3.3 Other Public Organisations

3.2.3 International Airports

Christchurch International Airport's Project Coffee Cup and San Francisco International Airport are interesting examples of successful waste management initiatives (ICAO, 2018). Project Coffee Cup at Christchurch Airport aimed to reduce the number of disposable coffee cups contaminating the PSW recycling streams. They did this partly by creating separate disposable coffee cup bins for passengers that were easy to recognise because of their form, shape, and consistency. This initiative resulted in terminal recycling rates increasing by 7%, this shows that by highlighting an item of PSW on a bin, the understandability of how to dispose of this PSW item can help.

At San Francisco Airport, the goal of achieving zero waste by 2021 has tried to be accomplished through various initiatives, including increasing recycling and composting efforts, implementing a waste-to-energy program, and partnering with stakeholders to reduce waste. For Schiphol, Zero Waste means no more incineration, so a waste-to-energy will not be a relevant option for Schiphol. However, San Francisco's Zero Waste Roadmap does present other relevant strategies that could be applied to Schiphol Airport (San Francisco International Airport, 2017). Expressly, the roadmap emphasises the importance of consistent waste separation bins, increased signage to inform passengers about waste separation, and the involvement of all stakeholders in achieving the zero-waste goal.

At Vancouver Airport they are trying to improve their waste management by implementing the Oscar AI bin (Oscar Sort, n.d.). The Oscar bin is an AI-powered bin that helps to guide passengers into sorting their waste, see Figure 3.2.3. The passenger shows the PSW item to the screen on which it will be shown how the passenger can dispose of this item. Interestingly is that in this case, technology is helping the passenger to understand how to dispose of their waste, whilst the experience for the passenger is seen as entertainment and education.

Main takeaways: Highlighting the most common PSW items can help the passenger determine how to dispose of these items. Consistency in colours, icons and text can improve the whole waste separation management at airports and waste that is translated into educative entertainment, can trigger passengers to separate waste.

Figure 3.2.3 The Oscar bin



Exploring waste management practices of other public organisations can provide valuable insights that can be utilised as design guidelines for this graduation project. An analysis of the Dutch government's guidelines on public waste separation will be conducted. In addition, there will be dived into the waste management system of the TU Delft Campus, as well as the designer bins from De Afvalbak, to explore different practices for PSW management.

3.3.1 Dutch Government

The document "Guidelines for the Use of Pictograms for Waste Separation" published by Rijkswaterstaat provides recommendations for the design and usage of standardised pictograms to enhance the clarity and effectiveness of waste separation systems (Pictogrammen, n.d.). The document guides effective waste sorting communication using colours, icons, and text, and emphasises the importance of consistency in colour coding for different waste streams, positioning elements suitably, and ensuring good readability. In Figure 3.3.1 an example of the use of colour, text and icons can be seen for Paper, PMD and Residual waste bins, derived from the guidelines document. The document "Stappenplan Herkenbare Afvalscheiding" (Step-by-Step Plan for Recognizable Waste Separation) offers useful inspiration for redesigning a waste separation system at Schiphol Airport. Furthermore, it also guides on assessing the current waste separation system and it suggests involving stakeholders in the design process to ensure the system meets their needs.

Main takeaways: It is important to include consistency and clarity in colour coding for different waste streams, well-positioned elements, and good readability. Moreover, the plan highlights the importance of designing a system that is recognizable and clear for all users.

Figure 3.3.1 The separation bins at TU Delft Library



3.3.2 TU Delft Campus

In 2020, the TUDelft Coordinator of Logistics and Environment started a pilot for the bins which can be seen in Figure 3.3.1. Initially, these separation bins were installed at three locations, but after the success observed during the pilot, there are plans to introduce these bins across all faculties and buildings on campus (Confidential Appendix I). Several noteworthy aspects can be highlighted regarding the waste separation system implemented at the campus of TU Delft. The decision-making process for these bins involved conducting a waste assessment and considering the identified waste streams. The bins use the text and icons from the waste stream guidelines set by the government. The bins are colour-coded on the top and front, providing a visual indication for users from different directions. Furthermore, the TUDelft Coordinator of Logistics and Environment emphasized the importance of convenience, aiming to keep the lids of the bins open to minimize the effort required for waste disposal. What is interesting is that the bins are equipped with shaped lids that guide the user into a certain decision. For instance, small circular holes are provided for coffee cups, while a longer slot is designed for paper waste. Moreover, the PMD bin contains a sticker that indicates that coffee cups should not be disposed of in this bin. The TUDelft Coordinator of Logistics and Environment raised the challenge they are facing with organic waste, which is relatively heavy, it contaminates the other waste streams and can attract animals and cause smells.

Main takeaways: Providing bins with clear and consistent indications for the disposal of different waste streams works. It is important to investigate the types of waste and design accordingly, furthermore, convenience for the user is crucial in designing separation waste bins. This can be done by indicating waste separation by giving clear cues with colour, shapes and text which can be visible from multiple directions, or by using additional information such as 'do not throw [item] in'.

3.3.3 Deafvalbak.nl

The Founder of De Afvalbak discussed in an interview his company's approach to sustainable waste management solutions (Confidential Appendix J). They aim to make recycling more attractive by incorporating stylish and hip designs into their products, see Figure 3.3.3a. The Founder of the Afvalbak emphasised the importance of signage and looks to encourage proper waste disposal. Furthermore, he pointed out the importance of conducting a recurring waste assessment, like the waste safari and designing according to the waste that is found in that assessment. The Founder of the Afvalbak also highlighted the possibilities of the bins, by making them more attractive to customers, for example by displaying different themes to motivate more people to use the bin.

De Afvalbak conducted a waste assessment in De Koffie Salon, a cafe located in the Up To Do Good shop in the general area of Schiphol Airport. They placed one of their bins in the cafe, which has three holes for different types of waste: PMD, coffee cups, and residual waste (see Figure 3.3.3b). In an interview

with De Koffie Salon, it was discovered that the cafe employees separate their waste at the Milieustraat at Schiphol itself (Confidential Appendix K). The Koffie Salon indicated that they experience still a lot of trouble with contaminated waste. Furthermore, Georgia highlighted that they dispose of their coffee cup stream in the PMD stream at the milieustraat, if not too contaminated. Meaning that having two holes in the bin, with PMD and residual waste, would also be enough. Furthermore, 'PMD' is understood by Dutch passengers, but for a lot of international travellers, this abbreviation will not mean anything, which can confuse and so the reason that passengers also do not separate properly in this bin.

Main takeaway: Clear communication, consistency, and recognisability are essential to improve waste separation behaviour. By making the bins attractive for the user, their motivation to separate waste accordingly can be increased. However, even though a bin looks visually appealing, it is still most important to do a recurring waste assessment, to see if waste streams are applicable and so if the users of the bin understand the given information.



Figure 3.3.3a The separation bins from Deafvalbak.nl



Figure 3.3.3b The separation at De Koffie Salon

3.4 Conclusion: Design Criteria

The deepening exploration of the project stakeholders, other airports and other public organisations resulted in several Takeaways (T) that can be translated into Design Criteria (DC).

DC 3.1 The design should separate organic and liquid waste (T3.1.1, T3.1.2)

- To enhance recyclability and post-separation processes. (T3.1.2)
- To effectively handle liquid and food waste, preventing contamination of bins and the surrounding environment. (T3.1.1)
- Incorporate features that facilitate easier cleaning and maintenance of the bins to mitigate the impact of dirty waste streams. (T3.1.1)
- Design specialized compartments or mechanisms within the bins to accommodate wet waste disposal. (T3.1.2)

DC 3.2 The design should accommodate users with different cultural backgrounds in waste separation (T3.1.2)

- Create an intuitive waste separation system for passengers from various cultural backgrounds.
- Ensure that the design of waste separation elements accounts for cultural differences and provides clear instructions for disposal.

DC 3.3 The design should conveniently communicate the disposal of PSW items (T3.2.1, T3.2.2 & T3.3.2)

- Improve communication to guide passengers on the proper disposal of PSW items.
- Include clear and visible instructions on the bins, such as designated compartments or signage, to direct passengers on how to dispose of specific PSW items.
- Design bins that are user-friendly and convenient, with clear cues and information visible from multiple directions.
- Consider the placement of waste separation elements to ensure easy access and visibility for passengers.
- Highlight the most common PSW items through visual cues, such as colours, icons, and text, to facilitate easier identification and proper disposal.



4. Behaviour

Content

This chapter focuses on behaviour, more specifically on what the current behaviour of the passengers is and on how to change certain behaviour. By analysing the FOGG behaviour model, it will be described how motivation and ability can trigger passengers to use the FF3 bin correctly. This chapter concludes by touching upon the cultural differences of passengers of an international airport and how this can affect behaviours, as well as diving into literature.

4.1 Current Passenger Behaviour

To find out how passengers of Schiphol Airport separate PSW, I handed out an online questionnaire. Simultaneously, I tested and interviewed different students of the TU Delft under time pressure to gain insights into how passengers might react to disposing of their waste when they are under time pressure.

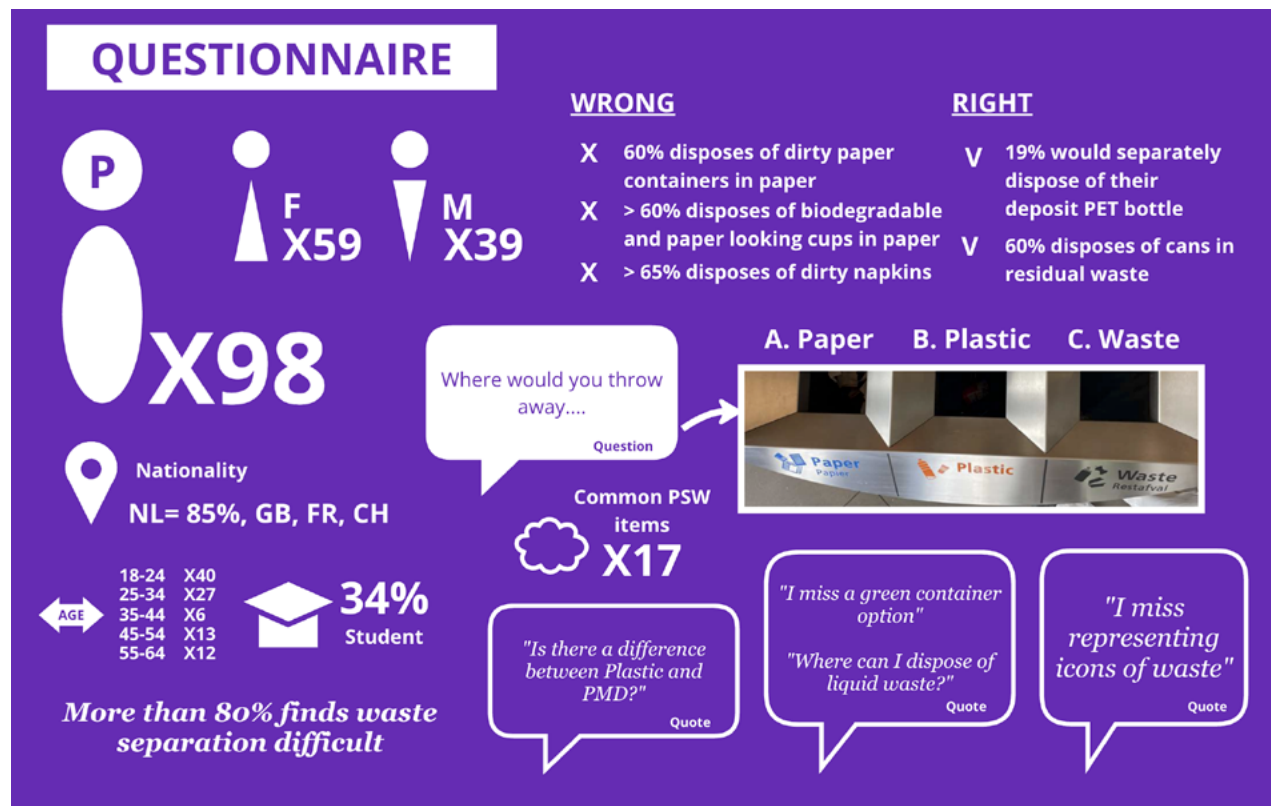
4.1.1 Baseline Questionnaire

To understand where the separation of PSW goes wrong, an online questionnaire is conducted (N=98) in which respondents had to decide in which bin they would dispose of a certain item of PSW. The sample was a Convenient Sample, of which respondents were found by sharing the Microsoft Form link via social media such as WhatsApp and Instagram, and some participants were recruited via Snowball Sampling. In total, the respondents had to 'separate' 17 items of PSW, by choosing in which hole of the FF3 bin they would dispose of it. The items that the participants had to separate are based on Chapter 2.2: Passenger Solid Waste. The questionnaire can be found in Appendix L, the results can be found in Appendix M, and an overview of the results can be seen in Figure 4.1.1.

Most interesting from these results is the confusion about paper waste, the respondents did not seem to be able to determine what is made from paper that can be recycled, resulting in the coffee cups and the soup containers, ending up for more than 60% of the time in the paper stream instead of the plastic stream. The paper stream is also wrongly used for biodegradable material, dirty napkins, dirty food wrapping and receipts, which should all be disposed of in the residual stream. Furthermore, the respondents did not understand the difference between the FF3 bins' Plastic stream and the Dutch PMD stream that 85% of the respondents are used to..

Main takeaways: Respondents find it hard how to dispose of paper-looking items, most end up in paper, whilst they should be disposed of in either the Plastic stream or residual stream. Furthermore, there should be made clear that the Plastic stream is equal to the Dutch PMD stream, to decrease the number of cans and drink cartons in the residual stream.

Figure 4.1.1 Overview of Questionnaire Results



4.1.2 Testing and Interviews: Separating PSW Under Time Pressure

To get a better understanding of the situation that passengers are in, a test in combination with an interview has been set up, in which participants were put under 'pressure' by sketching a scenario for the participant that they are in a hurry to catch their flight at Schiphol, whilst they still must dispose of two or three given PSW items in the current FF3 bin. The items were selected based on Chapter 2.2 Passenger Solid Waste and consisted for example of a coffee cup, paper containers, napkins, plastic bottles, and mixed plastic/paper waste. The participants have been asked questions afterwards to get insights into their thought processes, these questions were about their choice, their experience and their current waste separation behaviour. This test and interview have been conducted with an FF3 bin in the faculty of Industrial Design Engineering more information about the participants can be found in Figure 4.1.2a. The test setup and test results can be found in Appendix N, which includes a list of the PSW items that were

given, the questions that were asked after the test and an analysis of photos from the tests. A summary of the insights from the interviews can be found in Figure 4.1.2b.

Based on these interviews, it is evident that the existing text, colours, and icons on the FF3 bins do not effectively communicate the waste separation instructions to passengers. Time pressure often leads passengers to overlook the bin's labelling, causing them to dispose of their waste without proper separation. Additionally, the decision of where to dispose of becomes stressful in an already demanding environment. Furthermore, passengers frequently encounter difficulties in separating their waste due to full hands, for example, it is challenging to remove the carton holder from a coffee cup if someone is also holding a phone.

Main takeaways: There is a clear need for improved clarity and visibility in the labelling and design of the FF3 bins to alleviate confusion and facilitate proper waste disposal practices. Furthermore, there should be considered changing waste streams and giving additional information about waste separation practices at Schiphol Airport. Disposing of waste is mostly done with one hand because the other hand of the passenger is holding a phone or luggage, this results in bad waste separation behaviour.

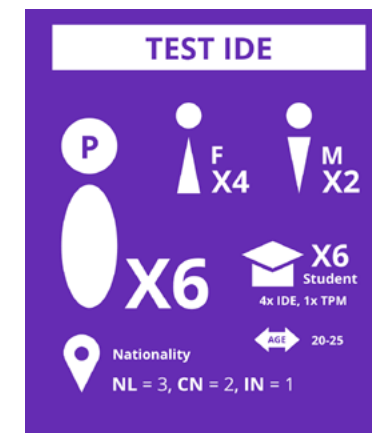


Figure 4.1.2a Participant information testing and interviews

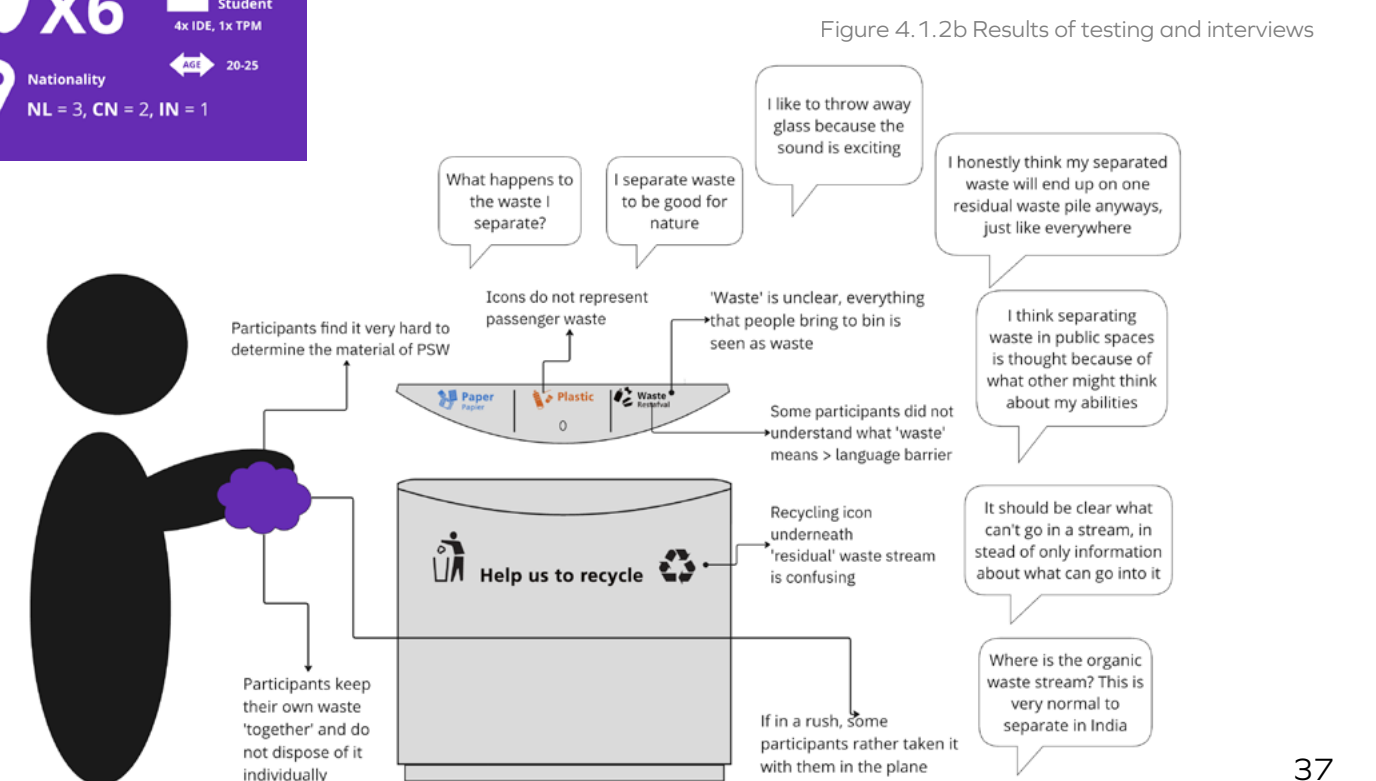


Figure 4.1.2b Results of testing and interviews

4.1.3 Sensitising booklets

To gather more insights into the passenger journey and their experiences during their whole trip, from leaving their houses until entering the plane, a sensitising booklet has been created, which can be seen in Figure 4.1.3a. A sensitising booklet is a way of gathering information that later can be used to gain deepening insights (Sanders & Stappers, 2012). This booklet aimed to discover potential design opportunities within the passenger journey, and to find out in which phase of the passenger journey the behaviour could be changed or adjusted. This booklet was created together with Annik Keijer, another graduate student at Schiphol and TULIPS who is working on improving collecting PET bottles and cans with a deposit. Since her context and users are the same as from this project, we could together set up this booklet and follow up on the filled-in booklets with questions, whilst separately drawing conclusions. In total, ten passengers conducted this research, in which they took the booklet and stickers on their trip and handed it back over to us afterwards. The participants consisted of six design students, of which three were Dutch and three were Chinese, more information can be seen in Figure 4.1.3b. The booklets and extra follow-up interviews can be found in Appendix O.

What could be concluded from analysing the booklets is that most passengers bought something on their outbound flight and consumed this at the gate. The passengers liked the restaurants and cafes the most, however, most of them still preferred to consume their bought goods at the gate. As one of the passengers stated in the follow-up interview: 'I prefer to buy something nice and take it to the gate so that I am sure I am at the right place and I do not have to stress

about being at the gate on time to board.' Multiple passengers indicated that at the gate they relax, watch a movie, or read a book.

Main takeaways: Passengers buy food, drinks and products after security and then quickly make their way to the gate, to feel secure in their time and to gain a relaxed feeling. For this project, this can be a good moment to motivate the passengers to separate their waste correctly, because the passengers have time to kill and since they take consumptions to the gate that generate waste, which they would want to dispose of before boarding.

Figure 4.1.3a Participant information sensitising booklets

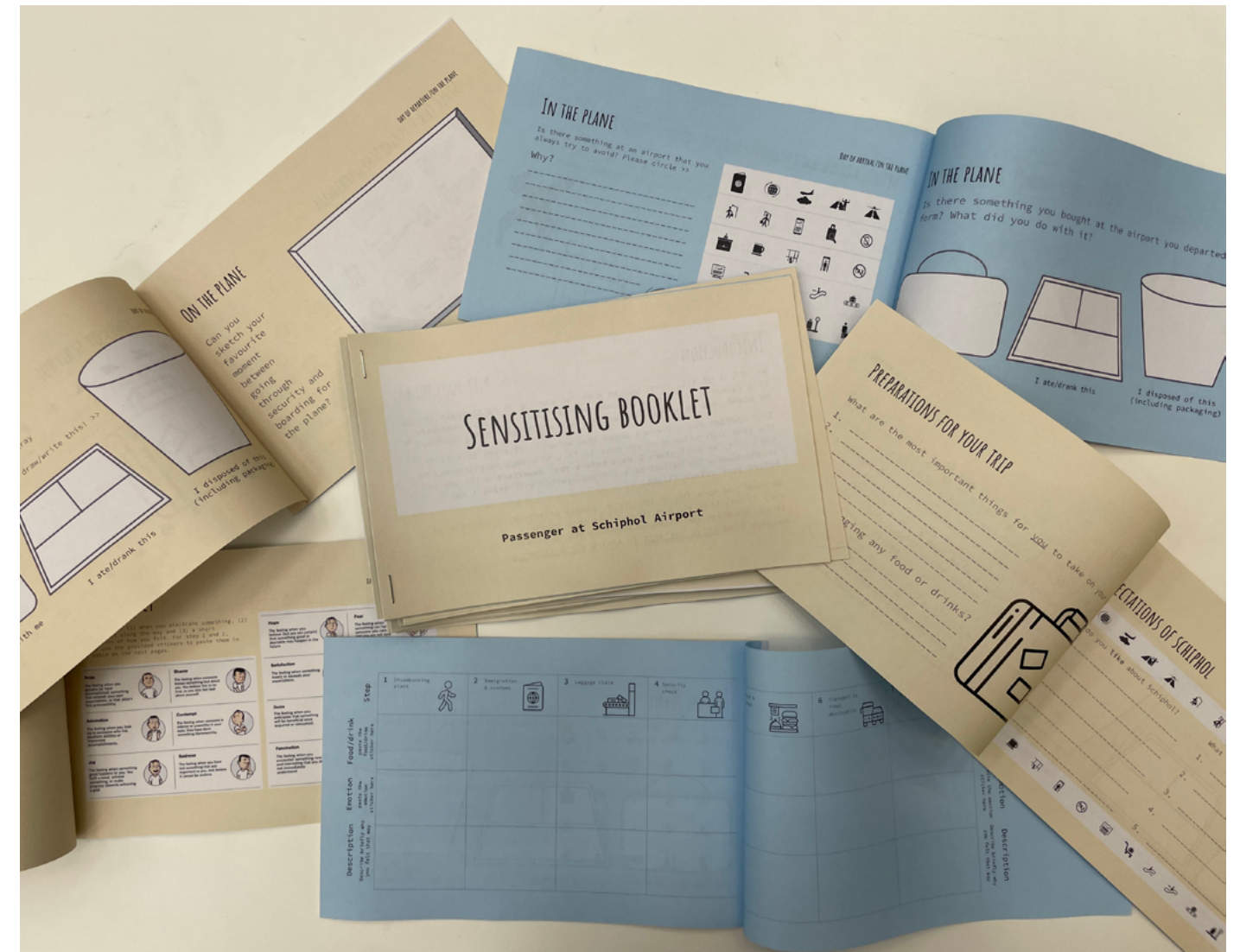
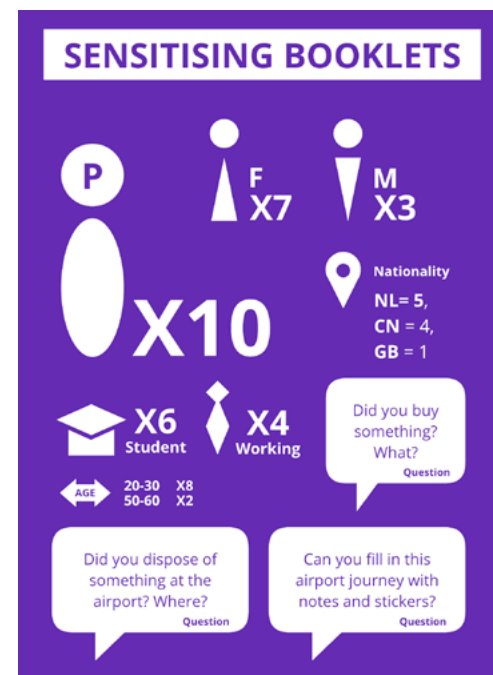
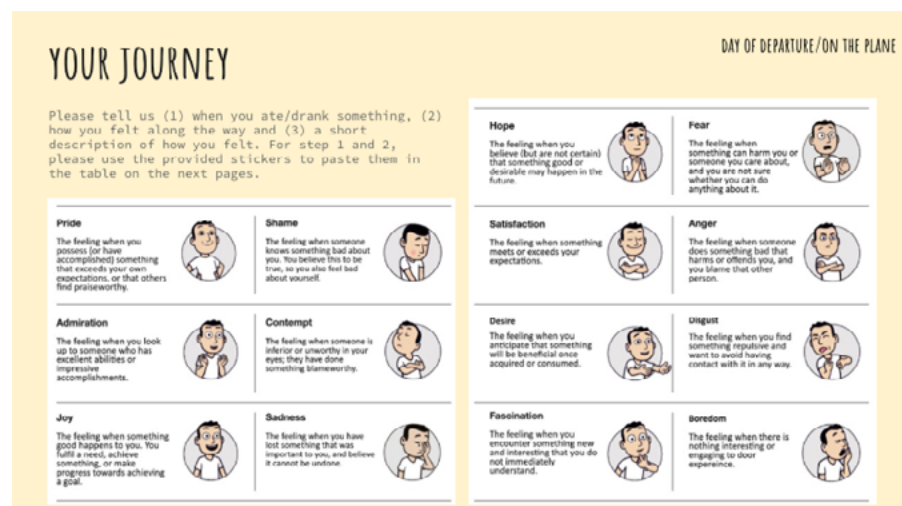


Figure 4.1.3 Sensitising booklets



| Step | 1 Transport to airport | 2 Check-in flight and/or bags | 3 Going through security | 4 Food & shops | 5 Walking to gate | 6 Waiting at gate to board | 7 Boarding | 8 Getting seated in plane | Step |
|-------------|------------------------|-------------------------------|--------------------------|----------------|-------------------|----------------------------|------------|---------------------------|-------------|
| Food/drink | | | | | | | | | Food/drink |
| Emotion | | | | | | | | | Emotion |
| Description | | | | | | | | | Description |

4.2 FOGG Behaviour Model

Analysing behaviour models can give guidance to what should be investigated to change the passengers' behaviour. For this project, the Fogg Behaviour Model (FBM) will be analysed in the project's context (Fogg, 2009). The reason this model is analysed is that the model is a clear visual overview that helped me indicate which factors, such as motivation or ability, influenced the performance of behaviour and how this can be improved.

The Fogg Behaviour Model, which can be seen in Figure 4.2, is a widely used model for understanding behaviour change. The FBM asserts that when people are persuaded to perform a behaviour, then three factors come together at once: motivation, ability, and trigger (BJ Fogg, 2009). As a person has increased motivation and increased ability, the more likely it is that the targeted behaviour will be performed.

The biggest problem that was found in the analysis of the context in Chapter 2, is that Schiphol does not provide passengers with the ability to understand how to properly separate PSW. If we look at the simplicity factors of FBM, the 'brain cycle' is the weakest link. If performing a target behaviour causes passengers to think hard, then the behaviour is not seen as simple, as it hurts our processing fluency. This indicates the need to improve the FF3 bins with clear and consistent signage to help passengers easily understand how to dispose of their waste correctly. Once this improvement has been made, the ability of the passengers will be high which will increase the occurrence of the preferred behaviour. However, the passenger should also be motivated to separate waste correctly. Currently, at Schiphol Airport, waste separation is not actively promoted or indicated. More about waste separation than the current FF3 bins that are in the general areas are not provided to the passengers. The passenger in this way is not triggered to separate waste and so, even if the passenger might be able to do it right, they do not get the motivation to do this.

Motivation can be increased by three core motivators: sensation (pleasure/pain), anticipation (hope/fear), and belonging (acceptance/rejection). Core motivators can trigger the behaviour of passengers to dispose of and separate their waste correctly. These core motivators can be used later in this project for the ideation phase. Moreover, for some passengers, waste separation behaviour is not a part of their routine, which can be overcome by simulating the right behaviour or by allowing the passengers to self-monitor their waste separation behaviour (Toxboe, 2019).

Main takeaway: Sustainable behaviour can be created by improving the ability of the passenger to be able to separate waste correctly, which can be done by improving the text, icons and information that is given on the bin. Furthermore, by improving the number of triggers that indicate the importance of waste separation, passengers can be motivated to act upon this and to separate their waste correctly. The core motivators sensation, anticipation and belonging can help by ideating motivational prompts, as well as simulating the right behaviour by providing the opportunity to self-monitor their waste separation behaviour.

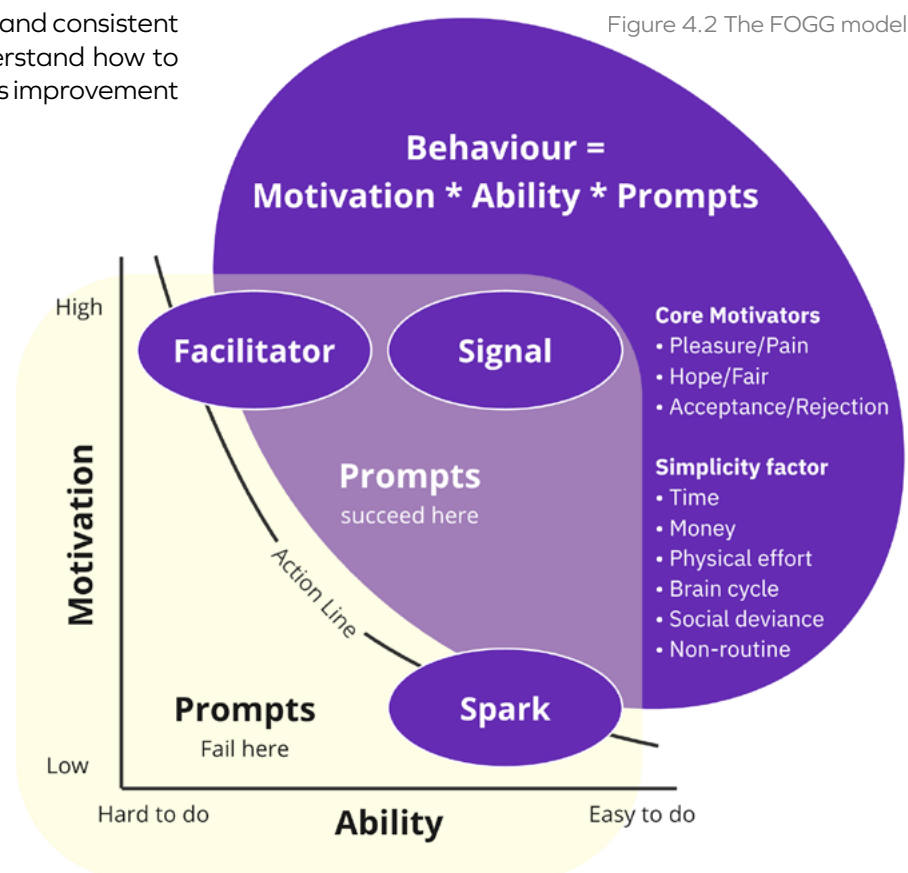


Figure 4.2 The FOGG model

4.3 Cultural differences in waste separation

It is important to note that cultural differences among passengers can affect SW separation behaviour at Schiphol Airport, where passengers from all over the world bring their habits and sorting systems. Furthermore, many passengers may not be able to read Dutch or English, which highlights the need for clear visual communication in the design to improve waste separation for most passengers, regardless of their knowledge of waste separation.

4.3.1 Cultural Waste Separation Differences

A study from Minelgaitė and Liobikienė (2019), showed that in the EU 3.3% of the participants did not sort waste at all. This indicates the importance for potential users of the FF3 bin who are not used to separating waste, within the EU but also assuming from outside of the EU. For the potential passenger that is not used to separating waste, I find it important that they are still able to understand how to separate their PSW at Schiphol Airport. Furthermore, potential passengers might be illiterate or might have trouble reading, who then might have difficulty reading the waste stream indications. In these circumstances, it is important to have visual cues to guide these potential users.

Main takeaway: The bin design should be able to guide potential users that are not used to separating waste, as well as potential users that might not be able to understand different aspects of the bin design, such as text or material indication. This indicates the need for a clear indication of waste streams by using icons representing the common PSW items, see Figure 4.3.

4.3.2 Culture and the Natural Environment

Milfont and Schultz's (2016) research examined the relationship between culture and the natural environment and reported that a significant proportion of the global population endorses environmental protection and recognizes the value of 'looking after the environment'. The study also found that there are shared attitudes towards environmental issues among people from different cultural backgrounds. Furthermore, it identified psychological processes that appear to be universal, such as future orientation, self-transcendent orientation, and psychological distance. The study suggested that individuals who have a future-thinking perspective, exhibit altruism, and perceive environmental problems as psychologically close, demonstrate a heightened concern for environmental issues and are more likely to act.

Main takeaways: Reducing the perceived distance between passengers and the global waste separation issue, particularly at Schiphol Airport, while fostering pro-sociality and future thinking can strengthen passengers' connection with the natural environment. This connection may lead them to make more environmentally conscious choices, like actively participating in waste separation efforts.

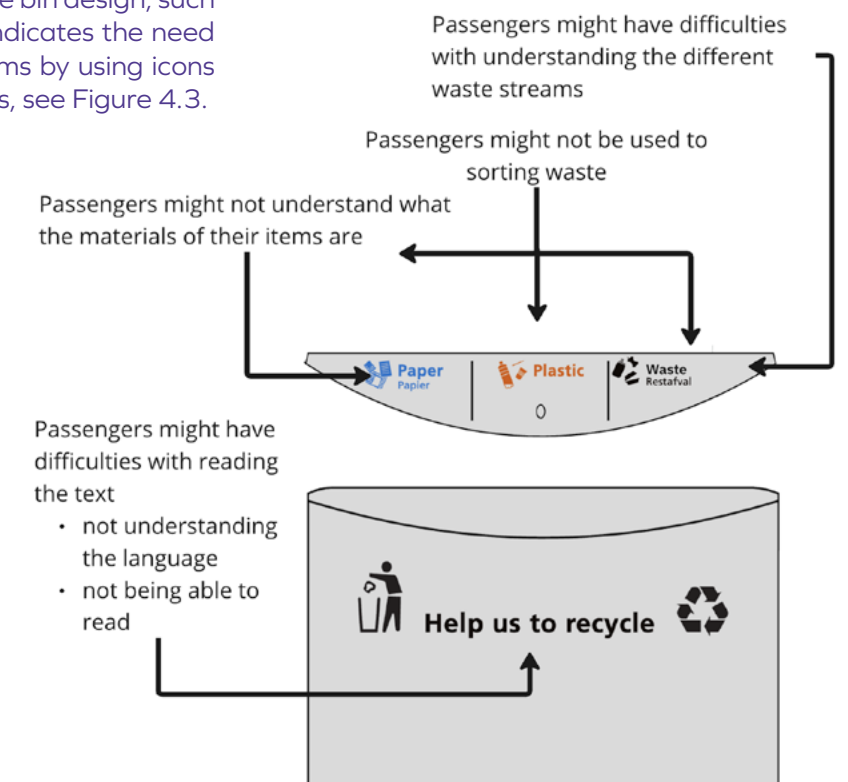


Figure 4.3.1 Potential cultural waste separation differences

4.4 Literature Review: Improving Waste Separation Behaviour

In the literature, different strategies to improve waste separation behaviour can be found. From Chapter 4.2 Fogg Behaviour Model, could be determined that by improving the ability and motivation to separate waste at Schiphol Airport, waste separation behaviour could improve. In this paragraph, I will dive into research that has been done on improving the ability to separate waste and on increasing the motivation the separate waste.

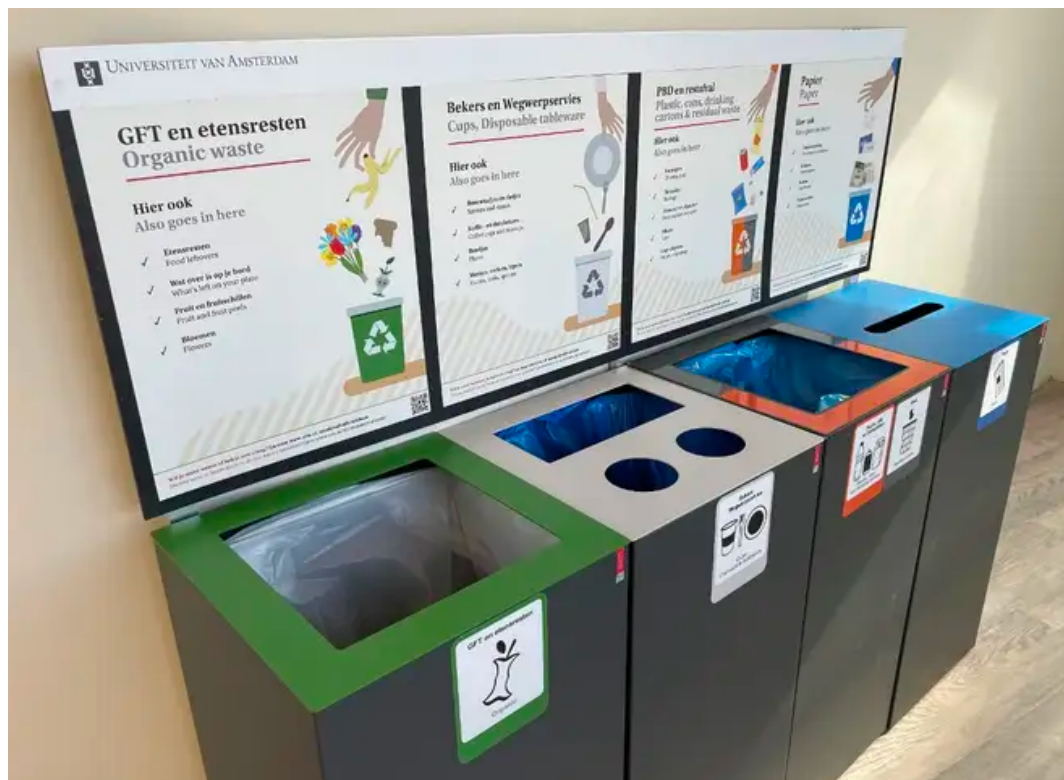
4.4.1 Improving the Ability to Separate Waste

According to Leebai et al. (2022) bin design significantly influenced the preference, waste collection performance, and waste separation behaviours of the public. The results suggested that the use of bins with different capacities, clear signage, and an attractive appearance could increase public participation in waste separation. Subsequently, Stoeva and Alriksson (2017) found that providing clear instructions further enhances waste separation behaviour. Both Kelly et al. (2006) and Ramayah et al. (2013) suggest that improving the ability of the separation facilities will result in improved waste separation behaviour, as also suggested in Chapter 4.2 Fogg Behaviour Model.

Furthermore, Leebai et al. (2021) showed that waste separation behaviour improved with bins with high noticeability. Jiang et al. (2019) found that the design and placement of recycling bins significantly impact separation behaviour. In a later study, Jiang et al. (2021) found that using colour design to differentiate recycling bins improved waste separation, particularly when the colour design was combined with clear labelling and the use of icons. Kelly et al. (2006) recommends the use of clear communication and education to overcome confusion about what materials can be recycled, of which an example can be seen in Figure 4.1.1.

Main takeaways: More information about the waste streams can improve the passengers' ability to separate waste. Information can be given by improving and adding text, but also by using icons that represent PSW items or by indicating the differences between waste streams with more colour. Additionally, more surfaces of the FF3 bin can be used to give the passenger information, for example, the front of the bin or the surfaces around the slots. In this way, passengers can be given information from far away as well as at the moment passengers are making a decision.

Figure 4.4.1 Bins at the University of Amsterdam, using colour, icons, extra information and shapes (Universiteit van Amsterdam, 2023)



4.4.2 Increasing Motivation to Separate Waste

According to Andrews et al. (2013), a signage change alone may not effectively increase recycling compliance and accuracy. Achieving sustainable behaviour means increasing the knowledge and understanding of the passengers as well as gaining their interest in waste (Boonrod et al., 2015). Several studies have explored the importance of motivation to improve waste separation behaviour. Tonglet et al. (2004) found that attitude, subjective norm, and perceived behavioural control (TPB) are significant predictors of recycling behaviour, emphasising the need to focus on improving positive attitudes towards recycling to promote recycling behaviour. Increasing awareness of the benefits of recycling has been suggested to improve solid waste separation behaviour by Ramayah et al. (2013). Additionally, Polyportis et al. (2022) emphasise the importance of knowledge and motivation through education and awareness-raising campaigns. According to Boonrod et al. (2015), 'the most effective schemes involve active enforcement, i.e., increased education, financial incentives and socio-economic factors conducive to law-abiding

behaviours.' Moreover, risk and uncertainty can influence passengers' behaviour (Janmaimool, 2017). When individuals face environmental or health risks, it can increase their motivation to act and reduce those risks. According to Dispensa and Brulle (2003), people do know about the effect of climate change but lack sufficient information to adequately participate in activities that mitigate climate change. Moreover, self-efficacy people, people who believe that they can make a difference, are more likely to engage in sustainable waste management behaviours (Janmaimool, 2017). If we combine these three insights, a passenger facing environmental risks whilst being given information on how to reduce this risk will be more motivated to act.

Main takeaways: Interventions aimed at increasing motivation to separate waste can be developed with a focus on improving attitudes towards recycling, clear communication and education, and awareness of benefits for the environment. Furthermore, passengers can become more motivated if awareness is raised about the risks of bad waste separation. Simultaneously, the passengers should be given information that shows how to reduce these risks, which will trigger participation in sustainable behaviour.

Figure 4.4.2 Advertisement to raise awareness (Moneim + Gado, n.d.)



4.5 Conclusion: Design Opportunities

By analysing the current behaviour, FBM, and several strategies to improve the ability and motivation of the passengers to separate PSW, several main takeaways arose. These Takeaways (T) can be translated into Design Opportunities (DO).

DO 4.5.1 Improving the ability for passengers to separate waste

- Improve the text, icons, and information displayed on the bins to enhance passengers' ability and perceived behaviour control to separate waste correctly. (T4.2, T4.1.2, T4.3.1)
- Provide opportunities for self-monitoring of the waste separation per passenger and feedback to simulate the desired behaviour. (T4.2)
- Indicate the correct disposal method for paper-looking items, reducing confusion and ensuring they are correctly separated into the appropriate waste stream. (T4.1.1)
- Communicate that the Plastic stream is equivalent to the Plastic and Drink carton stream to minimize the presence of drink cartons in the residual waste stream. (T4.1.1)
- Enhance the labelling and design of FF3 bins to provide clear instructions and facilitate proper waste disposal practices. (T4.1.2)
- Consider changing waste streams and provide additional information about waste separation practices at Schiphol Airport to alleviate confusion. (T4.1.2)
- Utilize various surfaces of the bins, such as the front or surfaces around the slots, to provide information to passengers from a distance and at decision-making moments. (T4.1.2)
- Provide the bin with a clear indication of waste streams by using icons representing the common PSW items, to guide potential users who are not used to separating waste or who do not understand the text provided on the bin. (T4.3.1)

DO 4.5.2 Improving passenger motivation to separate waste

- Incorporate visual triggers and motivational prompts on the bins to emphasize the importance of waste separation. (T4.2)
- Provide additional information about waste separation practices at Schiphol Airport to alleviate confusion. (T4.1.2)
- Design interventions and prompts to motivate passengers to separate waste correctly during the pre-boarding period. Utilize this time to educate passengers about waste separation and provide convenient disposal options near the gate area. (T4.1.3)

- Develop interventions that improve attitudes towards recycling, raise awareness of environmental benefits, and communicate the risks of improper waste separation. Provide information on how passengers can actively contribute to reducing these risks, fostering their participation in sustainable behaviour. (T4.3.2)
- Reduce the perceived distance between passengers and the natural environment through design elements that evoke a sense of connection and proximity. Promote pro-sociality and future thinking to encourage passengers to make environmentally conscious choices, such as separating waste. (T4.4.1)

In Figure 4.5, the current situation (a) and the desired situation (b) is sketched, where the desired situation includes several options for the listed design opportunities.

Figure 4.5a Current situation

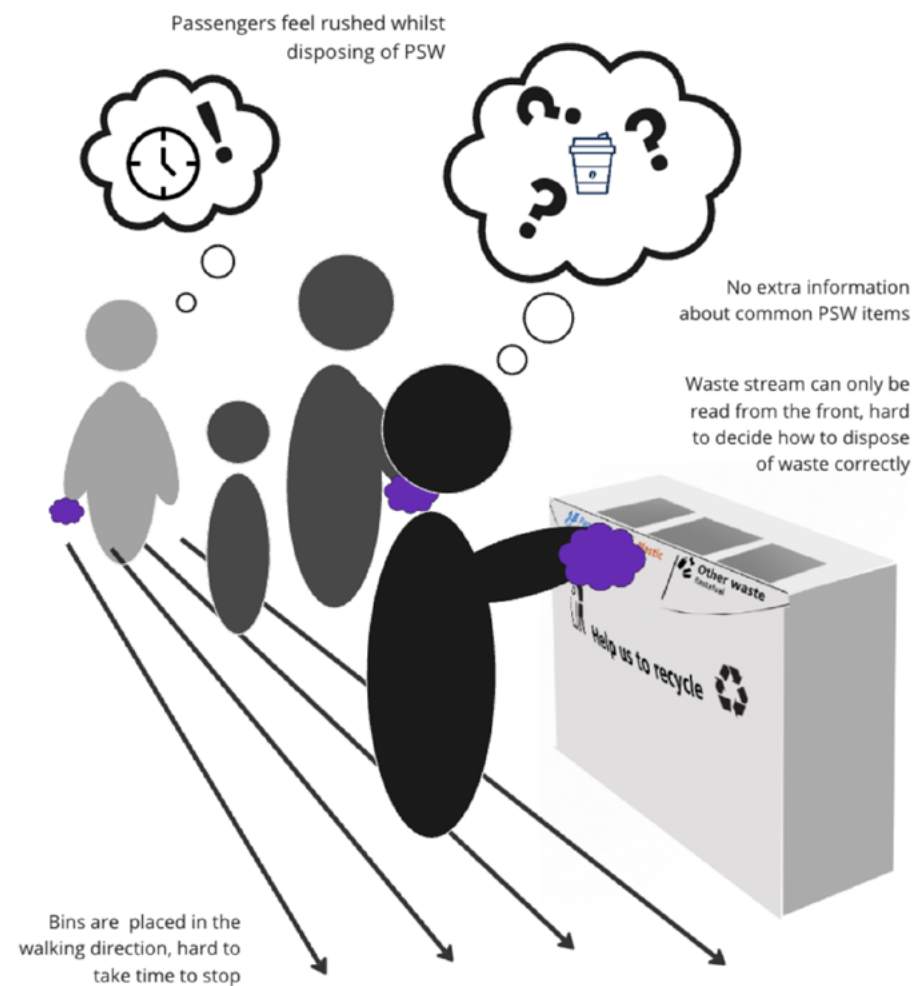
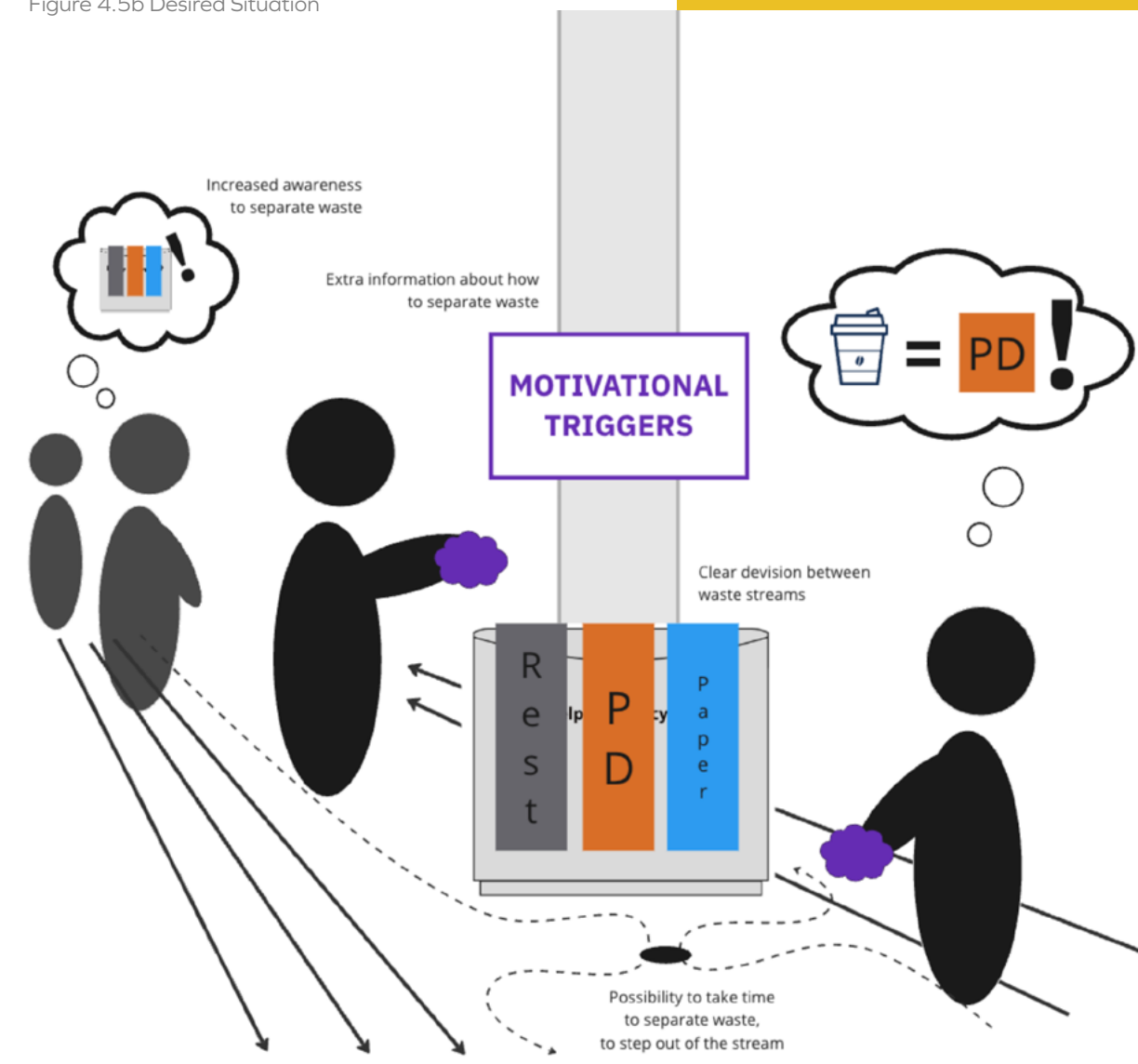


Figure 4.5b Desired Situation





5. Design Vision

Content

This chapter goes into detail about the overarching problem statement for this project and displays a roadmap that is created to achieve Schiphol's goal of zero-waste 2030 for PSW. This is accompanied by the design statement which will guide the design and concepts as well as the interaction vision aimed to shape the experience of using the new FF3 bin.

5.1 Problem Overview

The overarching problem statement for this graduation project is: 'Passengers at Schiphol Airport do not separate waste correctly'. After discovering and defining this problem, subproblems could be defined; passengers do not have the ability to separate PSW and passengers are not motivated to separate PSW. These subproblems can again be divided into further subproblems. The overview of these problems can be seen in Figure 5.1. This overview is created by summarizing the main takeaways from previous chapters.

Figure 5.1 Problem overview



5.2 Design Roadmap

Together with TULIPS, Schiphol is working towards the zero-waste goal in 2030 and the goal to be a fully circular airport in 2050. These goals can be set as horizons in a roadmap (Simonse, 2018), on which the solution spaces can be mapped, see Figure 5.2. The solution spaces are derived from Chapter 5.1 Problem Overview. The Roadmap is created together with Elisabeth Tschavogova, who is a TULIPS WP6 PhD candidate at TU Delft. In this overview, the horizons can be seen with the goals of Schiphol such as becoming Zero Waste in 2030 and Circular in 2050, the horizons are aligned with the horizon of TULIPS. Underneath, passenger values are visualised, these values are based on the current behaviour of the passengers as well as the values for passengers that

should develop over time by implementing changes. The changes Schiphol Airport can implement are divided into changes to improve the FF3 bin and to increase the triggers for passengers to indicate waste separation.

For this design project for Schiphol Airport, I focussed mostly on the first Horizon: Reducing Residual Waste. However, the insights for the other horizons gained throughout my research will be discussed in Chapter 8 Horizon Recommendations. Furthermore, in Chapter 8, the strategy for these horizons will be further discussed as well as ideas to perform this strategy at other companies.

Figure 5.2 Design roadmap

| Horizon | H1: Reducing Residual Waste | | H2: Road to Zero Waste | | H2: Road to Circular Airport | |
|---|---|-------------|--|--|--|--|
| | 2023 | 2023 - 2025 | 2025 - 2030 | | 2030 - 2050 | |
| Goal | Goal of this horizon is reduce waste, where it is possible and feasible at the airport. | | Goal of this horizon is to archive a zero waste airport. | | Goal of this horizon is to archive a circular airport. | |
| Passenger values that should develop | | | | | | |
| Change FF3 bins | Improve the understanding and use of FF3 bin Change waste streams according to governmental regulations and according to most prominent PSW items Improving accessibility of the FF3 bins | | Recurring waste safaris Redefining bin use in a circular airport | | | |
| Triggers to use FF3 bins correctly | Motivate passengers to use FF3 bins at gate Aligning stakeholders with Horizons | | Create interactive experience that educates passengers about waste separation at Schiphol/NL Refining PSW items for improved disposal adherence | | | |

5.3 Design Statement

The design statement for this project covers the aspects I want passengers to experience with the design. The different aspects are motivation to act sustainably, confidence to do it right, and contribution to a bigger cause.

Confidence to do it right;

Giving the passenger the ability to separate waste accordingly, by giving them information on how to do it correctly, will give the passenger the confidence that they did it right.

Eager to act sustainably;

The passengers will more likely be triggered to separate their waste accordingly if they know they are contributing sustainably. Educate passengers about the importance of waste separation.

Contribute to a bigger cause;

By making it clear how important it is for Schiphol that the passengers separate their waste, it will give the passenger the feeling of being part of a bigger cause.

Therefore, the design statement is as follows:

“I want passengers to feel proud of being able to correctly separate PSW at Schiphol Airport, by enhancing a feeling of contribution to the airports’ sustainability.”

5.4 Interaction Vision

The proud feeling of passengers and the feeling of contributing to the airports’ sustainability should not be forced upon the passengers. The interaction between the design and the passenger should be the connection that results in the desired behaviour.

5.4.1 Analogy

An analogy is stated, which describes how the desired interaction should feel:

Like taking part in a walk for charity.

This analogy is chosen because the participant of the charity walk is motivated to contribute to the walk to be part of a bigger cause, see Figure 5.4.1. Moreover, this participant can already walk, so this participant does not need to gain any skills. The participant will feel confident whilst walking since they know the route of the walk. Furthermore, other participants joining the walk will enhance the social norm for the participant, giving the feeling that together an even bigger amount will be raised. The moment that the participant walks over to the finish, the participant will feel proud and have a sense of accomplishment.

5.4.1 Analogy

The interaction qualities that can be taken from the interaction vision are:

- Energising
- Rewarding
- Encouraging
- Proud
- Intuitive

The design statement and the interaction vision with the interaction qualities will be used as focus and inspiration for the iterative design process in the next chapter.

Figure 5.4.1 Taking part in a walk for charity





6. Iterative design process

Content

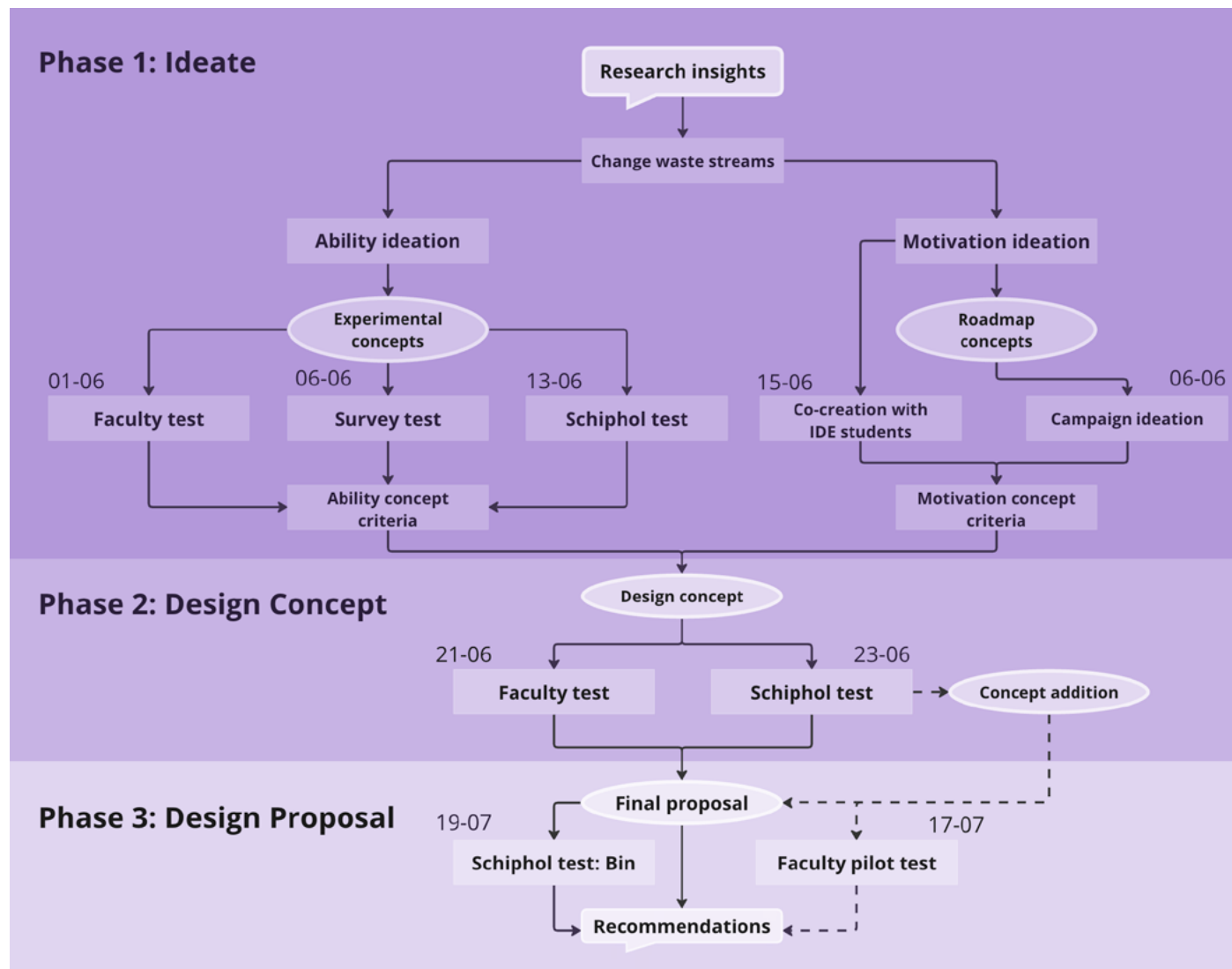
This chapter describes the first two phases of the design process, which starts with deciding on the waste streams. Then, the FF3 bin is redesigned to increase the ability of the bin. After testing this, the motivation ideation started, of which several concepts were created that fit the roadmap. From the insights of a co-creation session, a campaign was developed and tested. The results of both ability as motivation concepts were analysed and these insights were used to create a design concept. This concept is tested together at the IDE faculty and Schiphol Airport. The results are written down in design iteration opportunities, which will be used for the final design in Chapter 7.

6.1 Design Phases

The iterative design process is divided into three phases. The first phase, Ideate, focuses on ideation and conceptualising to improve ability and motivation separately. The second phase, Design Concept, focuses on combining these two concepts, which will be tested and with the results of this test, a final proposal will be created for the next chapter in phase 3, Design Proposal. Firstly, Phase One starts with the waste streams that will be changed or substituted. Secondly, the ability of the FF3 bin will be improved, tested,

and evaluated. Lastly, an ideation and a co-creation session result in a concept to improve passenger motivation to separate waste. An overview of the full iterative phase can be seen in Figure 6.1. The insights from the ability and motivation ideation will be used to create a design concept, which is detailed, expanded, and tested in Phase Two. The results from this test will be taken to the next chapter, presenting the final Design Proposal.

Figure 6.1 Design Phases overview



6.2 Phase One: Changing Waste Streams

The names of the FF3 bins need to be changed to give clear information to the passenger. Furthermore, the paper stream should be substituted to reduce the amount of contaminated waste.

6.2.1 Names of Waste Streams

The 'waste/restafval' stream should be changed into 'Other waste' so that the passenger understands that this is the option for waste if it does not belong in the other streams. Moreover, the name 'Plastic' is not in line with the waste handling system for companies in the Netherlands, since the first of January 2023 the name of this stream should be 'Plastic and Drink Cartons'. Both these names should be changed and according to these streams, icons should give a clear indication for the passenger to dispose of their waste right. The waste stream names will be only provided in English, to give more space for the words and to follow the same guidelines as the famous signage that is already present in Schiphol (Mijksenaar, 2008).

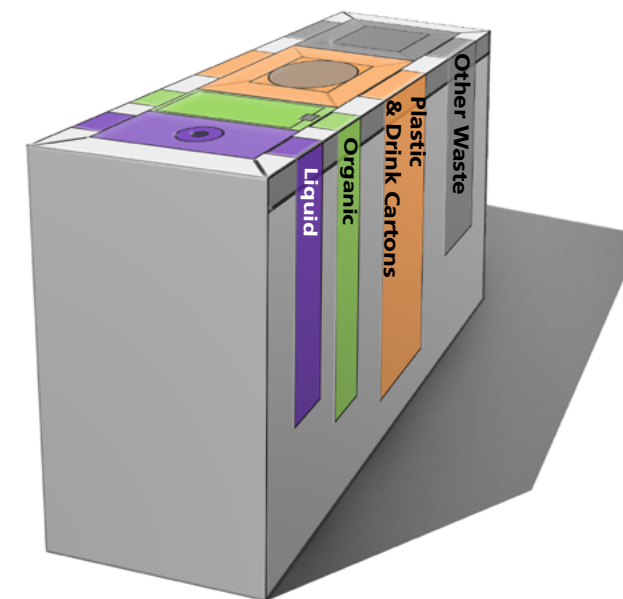
6.2.2 Substitution of Paper

The paper waste stream in the current FF3 bin has several problems:

1. Clean paper that can be recycled is under-represented in PSW items.
2. Paper gets contaminated quickly, from organic and liquid waste.
3. The material of PSW items is hard to identify for passengers, some paper-looking items, such as coffee cups, include a plastic layer which passengers find hard to detect.

According to this, the substitution of the paper waste stream with an alternative waste stream is recommended. Looking into the possible waste streams, in combination with the present PSW items and the problems the cleaners encountered with organic and liquid waste, I found that the separation of organic and liquid waste would be a suitable solution. Furthermore, separating organic and liquid waste complies with the circular economy, bio-waste can form a resource for organic soil improvers, fertilisers, growing media components and bio-based products, as indicated by European Compost Network (2020) and Ghani et al. (2013). To validate this idea, deepening interviews were conducted with Waste Handler A and Deafvalbak.nl, whilst Figure 6.2.2 was shown. From these interviews could be concluded that the separation of organic and liquid waste has the potential to separate PSW better and enhance the post-separation process of the residual waste stream. By extracting organic and liquid waste from the residual waste stream, the resulting residual stream becomes lighter and contains fewer contaminated items (interview Waste Handler A, Confidential Appendix P). Combining the Liquid and Organic streams was advised, to avoid the difficulty of multiple messy bins. Furthermore, there was advised against the use of covers for the bins, since the users would not like to use these due to hygiene reasons in such an anonymous surrounding as Schiphol Airport. However, this change implies that clean paper should be disposed of in the residual waste stream. Nevertheless, the presence of clean paper in a residual stream with reduced organic or liquid waste facilitates more efficient post-separation at waste handling facilities, as the clean paper has minimal contact with moisture (Milieu Centraal, n.d.-b).

Figure 6.2.2. Suggestion bin for the change of waste streams



6.3 Phase One: Improving the Ability

6.2.3 Evaluation

To evaluate these changes in waste streams, an overview of the most common PSW items for the new concept is visualised next to the current FF3 bin. This overview is shown to the cleaners of Cleaning Company A and Cleaning Company B since they will collect the bins and will have to deal with problems that might occur. The overview can be seen in Figure 6.2.3a.

A point that should be considered is that according to the cleaners from Cleaning Company A, organic and liquid waste are currently causing a problem for them with the spills on and around the FF3 bins. By collecting all organic waste in one container, this problem can increase. I asked The Afvalbak's Founder from Deafvalbak.nl for advice, who suggested using a separate bucket that fits into the current 50L container of the FF3 bins (Confidential Appendix Q). Furthermore, according to The Founder of Afvalbak, the bucket should be waterproof and smaller in size, about twice as small, since organic waste is heavier and smaller than the other PSW items, see Figure 6.2.3b. Making the bucket smaller will prevent the containers from being too heavy for the cleaners. To empty the bin, the buckets can either be replaced with a new bucket, or the cleaners can use biodegradable binliners, both options will reduce the amount of virgin material binliners used. Nevertheless, according to cleaners of Cleaning Company A, taking apart just organic and liquid waste will result in the other two streams filling up quicker, due to bigger PSW items such as paper shopping bags and food containers, this means the FF3 bin has too probably emptied more often. However, the new ban on SUPs in the Netherlands should reduce this amount again (Ministerie van Algemene Zaken, 2023).

Main takeaways:

- The waste streams will be named Organic & liquid, Plastic & Drink cartons, and Other waste.
- Separating Organic & Liquid waste is in line with the circular economy and this will make the other waste streams less heavy and moist, which improves the post-separation process.
- Clean paper that is disposed of in the residual waste bin is easier to post-separate at the waste handlers because it does not get moist.
- To improve the conditions for the cleaners, separate inlay buckets should be made, that cleaners take out and switch for a clean bucket. This will decrease the number of spills, reduce the weight of the bins, and will reduce the amount of binliners used.



Figure 6.2.3b
Bucket inside
FF3 bin

Figure 6.2.3a Waste stream overview

| | | | |
|---------------------------|---|--|-------|
| Restaurants | Coffee cups beverage cups Cup lids Pet bottles* Cans* Drinking cartons | Dirty paper food containers Organic waste Biodegradable material Receipts Food waste | |
| Cafes | Cup holders Clean napkins Clean paper bags | Plastic or aluminium food containers | |
| Bars | *without deposit | | |
| Shops | Newspapers Paper bags Product packaging | Receipts Product packaging Product packaging | |
| Toilets | | (wet) paper towels | |
| Service desks | Boarding passes | Luggage labels | |
| Location/ PSW disposal | Paper | Plastic | Waste |

| | | | |
|---------------------------|---|---|--|
| Restaurants | Napkins Food waste | Coffee cups beverage cups Cup lids Pet bottles* Cans* Drinking cartons | Dirty paper food containers Organic waste Biodegradable material Receipts |
| Cafes | Biodegradable food packaging Clean paper bags | Plastic or aluminium food containers | |
| Bars | | *without deposit | |
| Shops | | Plastic shopping bags Product packaging | Receipts Product packaging Newspapers Paper bags Product packaging |
| Toilets | | | (wet) paper towels |
| Service desks | | | Luggage labels Boarding passes |
| Location/ PSW disposal | Organic & Liquid | Plastic & Drink cartons | Other Waste |



After deciding to change the waste streams, I started ideating the new appearance of the FF3 bin. The ideation phase of the FF3 bin started with inspiration from the bins from De Afvalbak, bins from TU Delft, the guidelines from the government as well as bins I found in my surroundings throughout my graduation project, the pictures of these bins can be found in Appendix R. Besides this, I made a morphological chart (Appendix S) with options and an ideation sheet, of which I choose a combination to start testing.

Whilst defining the concept I made design choices. I choose to use Schiphol's font for the text: Schiphol Bold. Schiphol Bold is based on the font Frutiger, which is designed to be clear, easy to read at a distance and in small sizes (NHS Identity Guidelines | Fonts, n.d.). In the first ideation phase, I used green for organic waste and orange for the plastic & drink carton stream, like the colours of the Dutch government. For the final concept of this phase, I decided to use the exact colours of the Dutch government, since this improves the consistency throughout the Netherlands and acts as a reference for passengers throughout their stay in the Netherlands. I decided to use the colour around the surfaces of the holes and give a colour indication next to the text indication. In this way, it is highlighted that the three holes are a different waste stream from different perspectives. For the ideation phase, I used icons from the internet that represent the PSW items discussed in Chapter 2.2.1 PSW generated at Schiphol Airport. Furthermore, I decided to focus on the top and the tilted surface mainly, to see how this influences passengers' behaviour in this first phase. The concept iterations of this first phase can be seen in Figure 6.3

6.3.1 Testing at the IDE Faculty

At the faculty, I experimented with different names of waste streams and the placement of icons. I pilot-tested three different concepts, the test setup can be seen in Figure 6.3.1a, each test was done with two different students, see Figure 6.3.1b. The test set-up was similar to the test set-up in Appendix N, the results of these tests can be found in Appendix X.

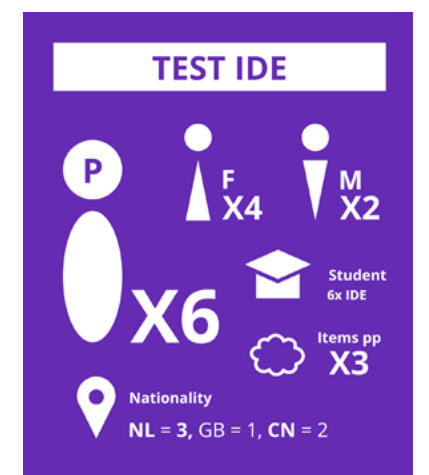
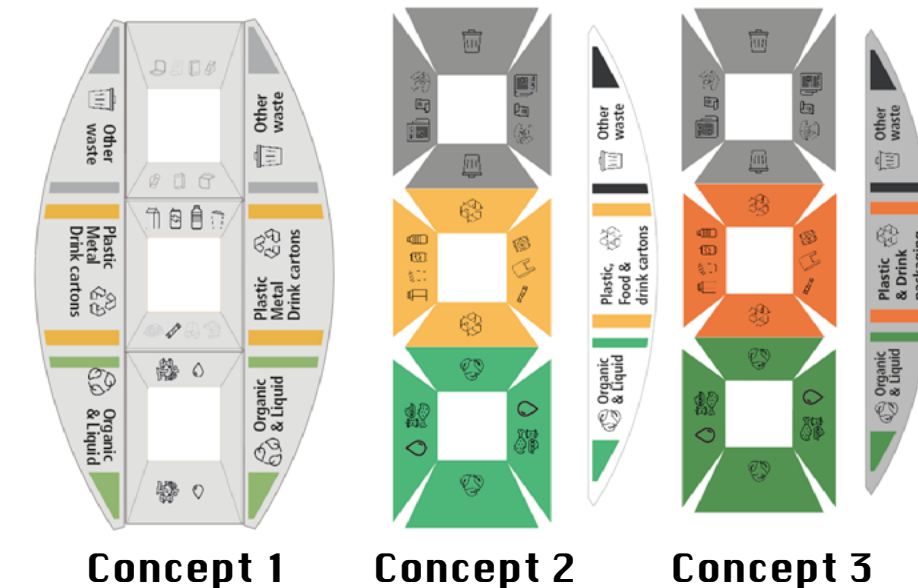
Main takeaways: The name Plastic & Drink packaging is confusing if cans are not allowed in. Icons and names are not clear enough if disposing of PSW in a hurry or from a distance. This indicates the need for visual guidance on the front of the bin.

Figure 6.3.1a Testing at the IDE faculty



Figure 6.3.1b Participation information

Figure 6.3 Ability concept iterations

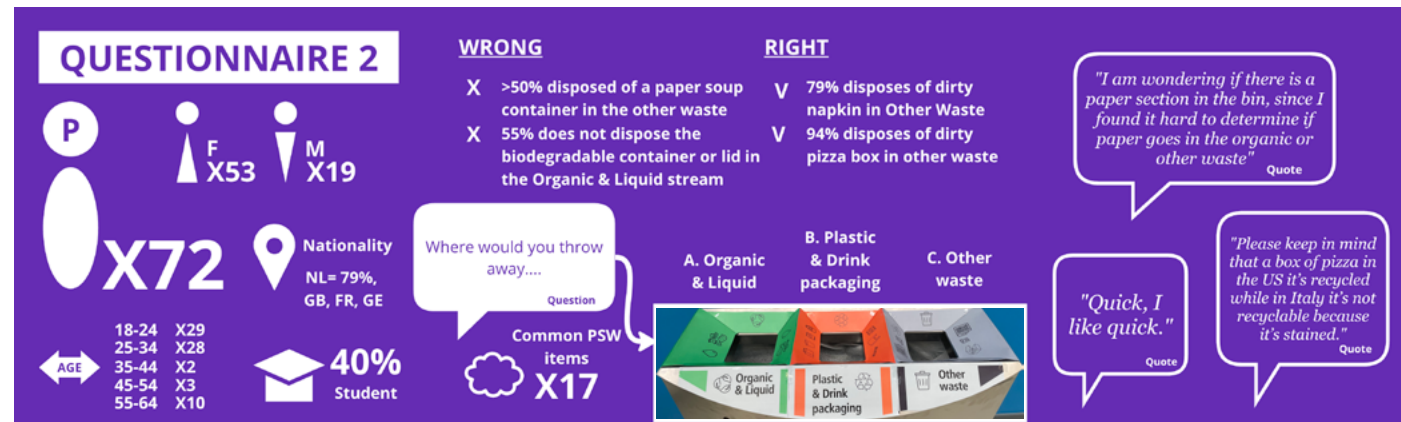


6.3.2 Concept Questionnaire

To quantify the concept further, a similar questionnaire (N=70) has been sent out to a similar group as the questionnaire from Chapter 4.2.1, see Figure 6.3.2a. Again, Convenient Sampling as well as Snowball Sampling through WhatsApp and Instagram was used. This time, instead of using photos from the current FF3 bin, I used photos of the concept bin, which can be seen in Figure 6.3.2b. Participants had to answer the same questions as in the baseline questionnaire, the questions and results can be found in Appendix U. An overview of the compared questionnaire results can be seen in Table 6.3.2. This overview shows that there is a big improvement in the number of correct answers the participants gave. By analysing the answers there could be concluded that some PSW items could have also been disposed of in another waste stream, which would not be wrong; for example; dirty napkins should be in the Other Waste stream but can also be disposed of in the organic waste stream (Afvalscheidingswijzer | Milieu Centraal, n.d.).

Main takeaways: From the questionnaire could be concluded that the participants answered on average 80% of the questions right, which is a 30% increase compared to the current FF3 bins. The PSW items that the respondents had the most trouble with were cans, soup containers and biodegradable materials, which can be solved by indicating this clearly on the bin. Furthermore, besides the passengers that might not know which PSW item can be disposed of in which waste stream, the cleaners and waste handlers might also struggle with this. This indicates a need for a list of the most common PSW items and their correct, incorrect, and acceptable way of disposal, to give the cleaners the ability to determine how contaminated waste streams are.

Figure 6.3.2 Questionnaire participation information



| PSW Item | Paper | Plastic | Waste | Other | % correct | O&L | P&Dp | OW | Other | % correct |
|----------------------------------|-------|---------|-------|-------|------------|-----|------|----|-------|------------|
| Dirty Aluminium | 0 | 19 | 76 | 3 | 80% | 0 | 19 | 50 | 0 | 72% |
| Biodegradable food container | 63 | 1 | 29 | 6 | 31% | 36 | 9 | 23 | 1 | 53% |
| Coffee cup | 62 | 8 | 27 | 1 | 8% | 4 | 48 | 17 | 0 | 70% |
| Deposit bottle | 0 | 79 | 1 | 19 | 99% | 0 | 52 | 1 | 16 | 98% |
| Coffee lid bio | 59 | 19 | 21 | 0 | 21% | 38 | 20 | 10 | 1 | 56% |
| Dirty napkin | 62 | 0 | 37 | 0 | 37% | 9 | 5 | 54 | 1 | 79% |
| Airpod box | 22 | 9 | 42 | 24 | 58% | 0 | 13 | 47 | 9 | 78% |
| Receipt | 77 | 2 | 19 | 1 | 19% | 4 | 0 | 62 | 3 | 94% |
| Paper bag | 94 | 0 | 3 | 1 | 97% | 6 | 5 | 53 | 5 | 83% |
| Subway packaging | 46 | 3 | 44 | 5 | 47% | 3 | 5 | 58 | 3 | 88% |
| Soup cup | 52 | 6 | 40 | 1 | 6% | 8 | 32 | 28 | 1 | 47% |
| Banana peel | 0 | 0 | 79 | 19 | 100% | 69 | 0 | 0 | 0 | 100% |
| Starbucks cup + cardboard holder | 56 | 6 | 32 | 4 | 34% | 2 | 44 | 20 | 3 | 67% |
| Plastic coffee lid | 2 | 94 | 3 | 0 | 95% | 0 | 66 | 3 | 0 | 96% |
| Dirty pizza box | 51 | 0 | 48 | 0 | 48% | 1 | 3 | 65 | 0 | 94% |
| Pet bottle | 0 | 92 | 0 | 7 | 100% | 0 | 63 | 1 | 5 | 98% |
| Total | | | | | 55% | | | | | 80% |

Table 6.3.2 Overview of Questionnaire Results

right way of disposal
Take back for deposit
Also correct way of disposal
More than 70% correct

6.3.3 Test at Schiphol Airport

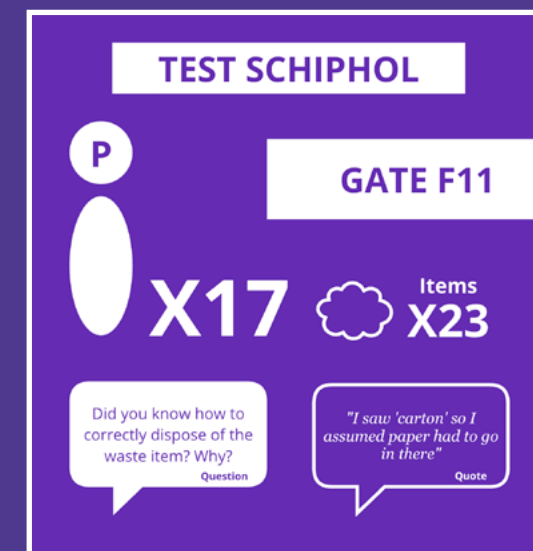
The concept was revised for the test at Schiphol Airport, as can be seen in Figure 6.3.3a. The test was conducted at Gate F11, where a prototype was placed on a selected bin near the gate. The Schiphol test primarily involved the observation of passenger behaviour in waste disposal. I positioned myself close to the bin, to monitor the items being discarded by passengers. Whenever passengers made noteworthy choices, I approached them and asked about their actions. An overview of the test can be found in Figure 6.3.3b. The detailed findings from these observations and subsequent interviews are documented in Appendix V.

Main takeaways: From the test at Schiphol could be concluded that the name for the 'Plastic & Drink cartons' stream is confusing. This is due to the name 'carton' which passengers indicated to associate with paper. However, paper is not allowed to go in this stream. Furthermore, passengers do rarely separate waste that is attached, this is an extra action that the passenger must do, which is not indicated by the bin. The passenger decided which bin the combined waste will go on the biggest item, such as food packaging in the Plastic & Drink carton stream, with still food in.

Figure 6.3.3a Test at Schiphol Airport



Figure 6.3.3b Participant information



6.4 Phase One: Increasing Motivation

To generate ideas for the motivation concept, an ideation session was set up to generate as many ideas as possible whilst using the core motivators of the FBM as starting points: sensation (pleasure/pain), anticipation (hope/fear), and belonging (acceptance/rejection). Furthermore, a visual overview of motivational practices is used to stimulate ideas (See Appendix R). The idea generation session was with several IDE students, who gave me input for ideas that would motivate passengers at Schiphol to separate waste, see Figure 6.4ab. After ideating over 50 ideas, I spread the ideas over a C-box, see Figure 6.4c (Heijne & Van Der Meer, 2019). With the guidance of the roadmap, described in Chapter 5.2, five concept ideas were created (see Figure 6.4d), which are presented in order from easiest to implement to hardest to implement.

- **Concept 1:** Showing a route on the floor to guide passengers to the closest bin with PSW item disposal indication
- **Concept 2:** An app that passengers can download and that would give them information to learn more about PSW and how to separate this
- **Concept 3:** A bin with a screen that shows videos of celebrities disposing of common PSW items correctly
- **Concept 4:** A bin with a screen that shows videos of celebrities disposing of common PSW items correctly
- **Concept 5:** An interactive bin that tells the passengers how to dispose of waste and indicating this via screen that are on the front of the bin.

This graduation project focuses on the first horizon of the roadmap, which means that the motivation concept that will be detailed further, should be easy to implement. To make the concept easy to implement, it is important to focus on a certain part of the passenger journey where it is possible to interfere with the passenger and to motivate them to separate their waste. According to the sensitising booklets and observations, I found that there is an opportunity to interfere with the passengers' journey whilst the passengers are waiting at the gate to board.

Main takeaways: There is most time to interfere with the passengers' journey whilst the passengers are waiting at the gate to board, which is why the motivation concept should be focussed on this part of the passenger journey.

Figure 6.4a Motivaiton ideation; 50 ideas

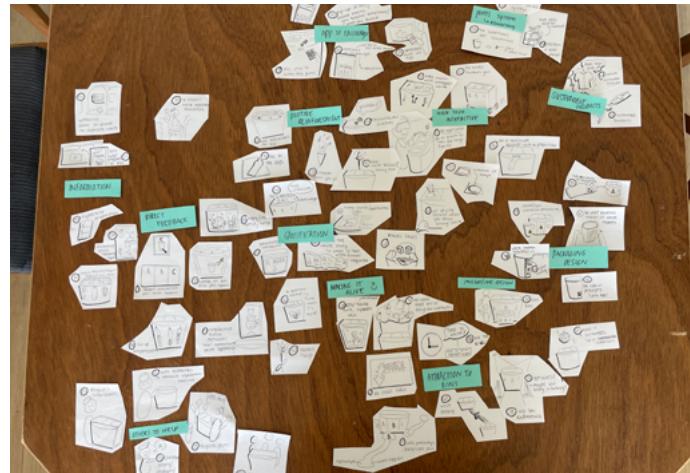


Figure 6.4b Motivaiton ideation; clusters of ideas

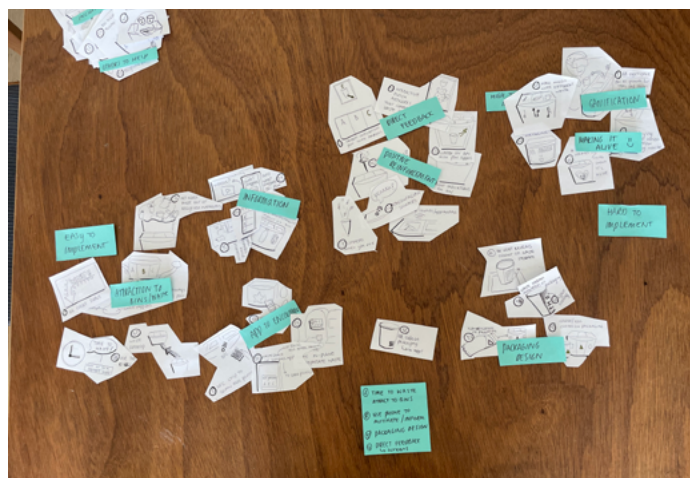
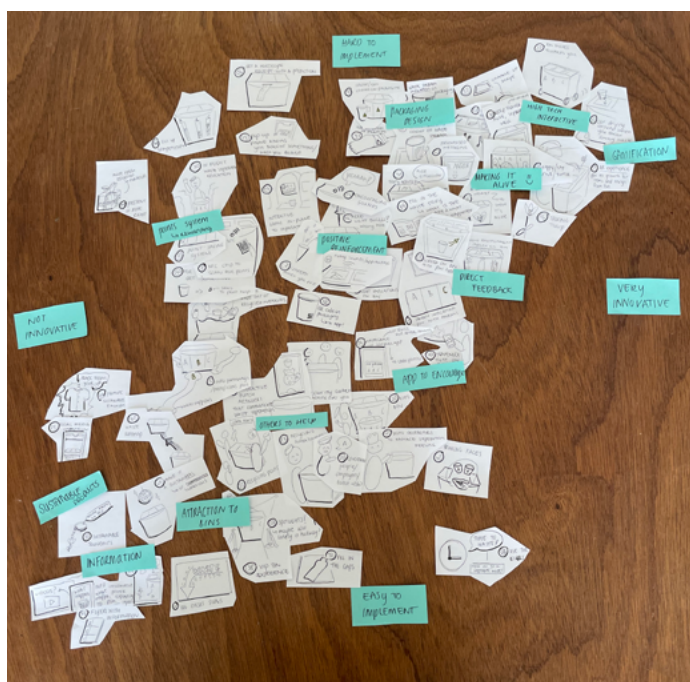


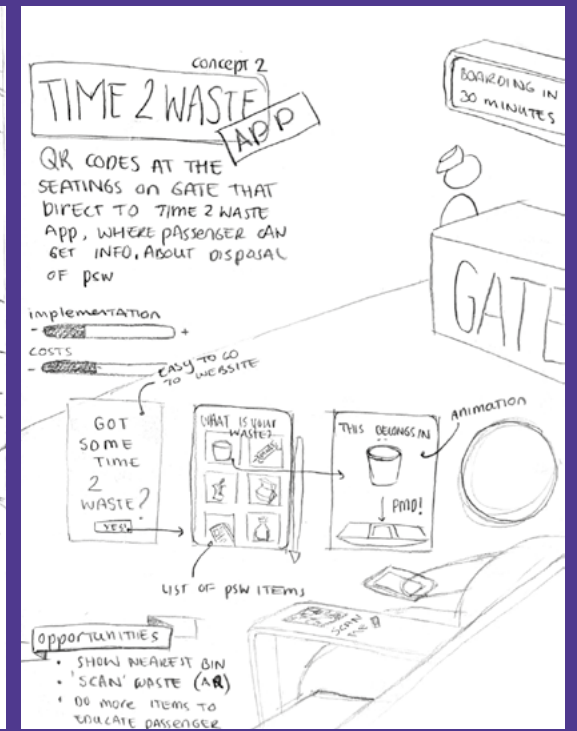
Figure 6.4c Motivaiton ideation; ideas placed in C-box



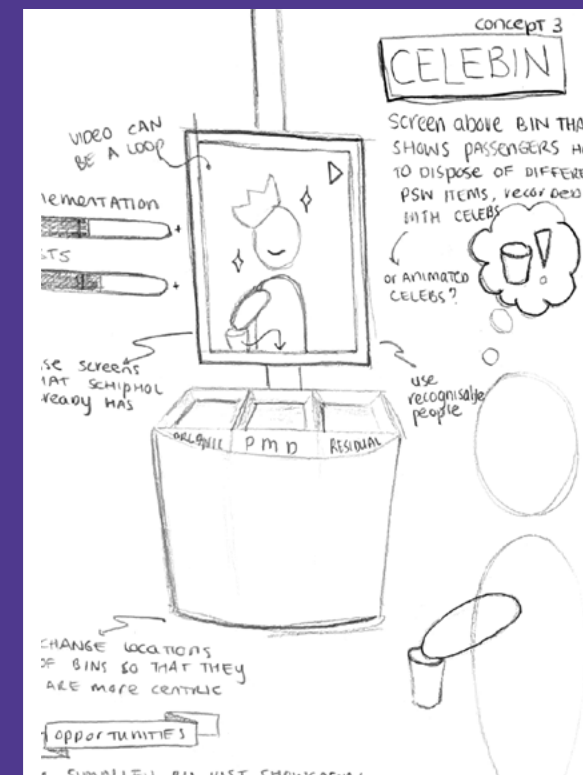
Concept 1



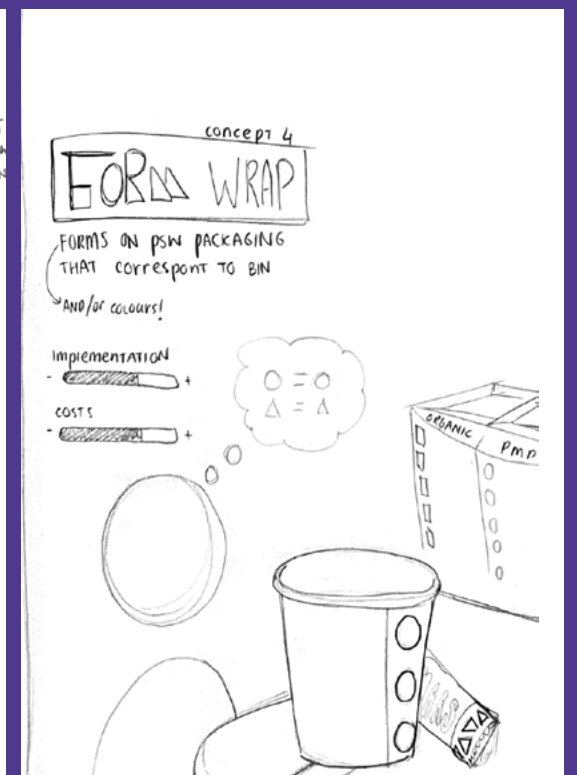
Concept 2



Concept 3



Concept 4



Concept 5

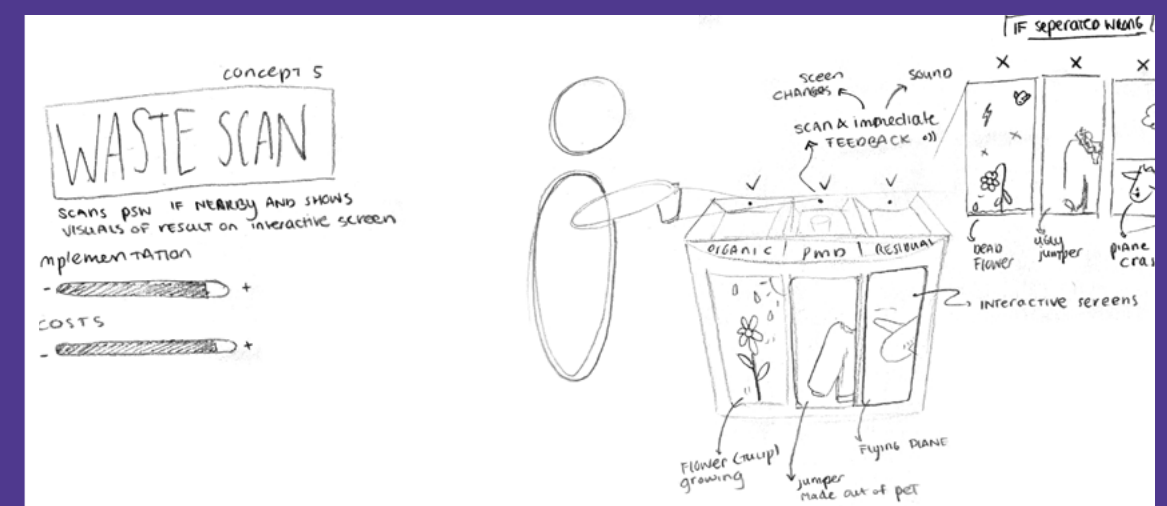


Figure 6.4d Five motivational concepts

6.4.1 Campaign ideation

The passengers can be best interfered with in and around the gate, where the passengers have time to kill or time to waste. I decided to go with the campaign that fits this location and purpose, which was already shown in Figure 6.4: concepts 1 and 2: a 'Time To Waste' campaign. The concept campaign 'Time to Waste' can consist of stickers, posters, or other signage that gives the passenger indication about waste separation in and around the gates.

With this 'Time to waste' campaign as a concept, different ideas were generated to trigger the different types of passengers. The ideas I generated could be divided into 5 groups;

- C1** > Fun facts about the waste at Schiphol Airport, such as: 'Did you know that passenger waste per day at Schiphol is equal to the weight of 10 hippopotami?'
- C2** > An indication about how to dispose of PSW items, such as: 'Did you know that biodegradable material can be disposed of in the organic & liquid bin?'
- C3** > Extra information about the disposal of PSW items, such as: 'Did you know that over 60% of coffee cups are disposed of in the wrong bin?'
- C4** > An indication of where to dispose of PSW items, such as: 'Did you know that the closest bin is 5 steps in that direction?'
- C5** > Monsters that represent the waste streams, such as an orange waste monster eating items made of plastic.

The visuals of these ideas can be seen in Figure 6.4.1a. Within the online questionnaire described in 6.3.2, two questions were added. The first question asked the participant to choose between the 5 options, giving them a name, description and an example of the concept. The second question asked them to explain why they choose that concept, the results of this can be found in Appendix U. The responses (N=70), see Figure 6.4.1b, were almost equally divided among the 5 concept ideas, except for the extra information on waste streams. The monsters were voted more often but also indicated as childish by some other participants. The division in these answers indicates that each participant would be motivated differently, which should be considered in the next iteration.

Main takeaways From the campaign ideation and validation of this through the questionnaire could be concluded that the campaign should include the needs of different passengers, to gain the biggest amount of motivation by addressing them all. However, since the Aware Disposer is already conscious of its' separation behaviour and is mostly stimulated by the ability to dispose of its waste correctly, the motivation campaign should mainly focus on the Intuitive and the Unaware Disposer.

6.4.2 Motivating Different Passengers

During testing at Schiphol on the 13th of June, Anniek Keijer and I found that there seem to be three types of passengers that behave differently when disposing of their waste. I described these as the following three personas: the Aware Disposer, the Intuitive Disposer, and the Unaware Disposer. The characteristics of these Disposers can be found in Figure 6.4.2a.

To discover what the motivators for the different Disposers would be to separate their waste correctly, a co-creation session was set up with the Circular Design Lab graduation students at the IDE faculty (Figure 6.4.2b), an overview of the participants in the session can be seen in Figure 6.4.2c. Each participant got assigned a certain Disposer to be able to address the needs of different passengers. The agenda and the exact results of the session can be found in Appendix W. In Figure 6.4.2a the determined motivators per Disposer can be seen.

Main takeaways The motivation ideation sessions revealed that various types of Disposers require different forms of motivation. Specifically, the Intuitive and Unaware Disposers benefit from motivation strategies that emphasise enjoyable facts about waste separation at Schiphol Airport and increase awareness of its significance. In contrast, the Aware Disposer, already conscious of proper waste separation, is driven by the convenience of correct disposal. Because of this, I decided that the motivation efforts should primarily target the Intuitive and Unaware Disposers.

Figure 6.4.2c Participant information

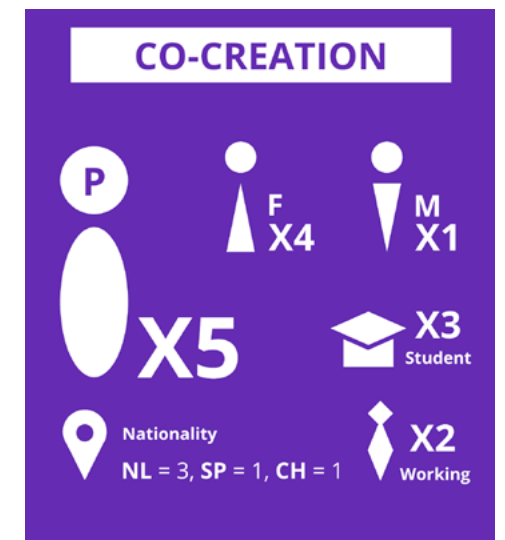
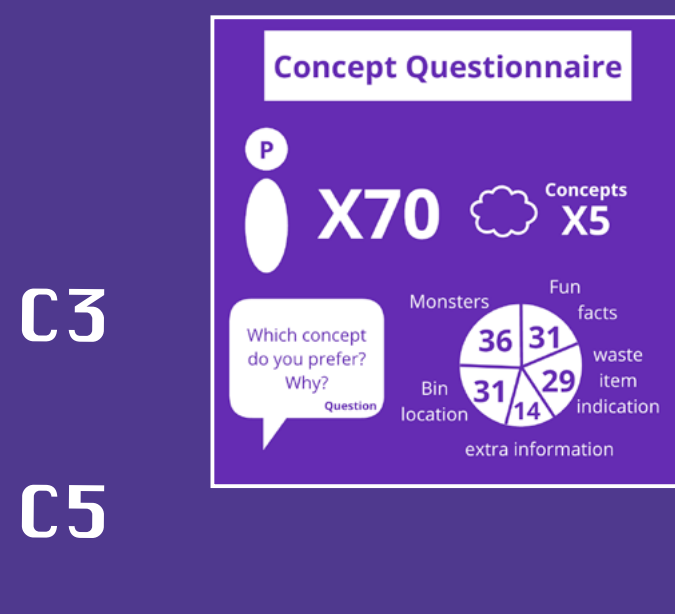


Figure 6.4.1a Campaign Ideation



Figure 6.4.1b Concept questionnaire participants results



| | A | I | U |
|------------------------|---|--|---|
| | The aware disposer | The intuitive disposer | The unaware disposer |
| Characteristics | Looks for cues on correct waste disposal. Aware of waste separation importance. | Decides on the disposal approach before reaching the bin. Confident in their waste disposal choices. | Disposes of waste without considering separation. Lacks awareness of waste separation. |
| Motivators | Seeks information to confirm correctness. Values clear justification of actions. | Responds to easily readable information. Engages with awareness initiatives. Interested in fun facts for longer decision-making. | Requires clear guidance for disposal. Benefits from indications of separation importance. Responds best to subtle reminders to avoid overwhelming feelings. |

Figure 6.4.2a Disposers, their characteristics and motivators

Figure 6.4.2b Co-creation session



6.5 Phase Two: Design Concept

In this Phase, the ability concept will be merged with the motivational concept, in which we first iterate on the evaluation of the first phase, and then test the concepts together.

For the concept of the bin, several disposal cues were added to the stickers, which can be seen in Figure 6.5a. First, an indication for the different waste streams is added on the front, to allow the passengers walking towards the bin to choose without having to be close by. Secondly, all the PSW items icons are placed towards the passenger and can be seen on one side of the angled surfaces. Lastly, underneath the icons, extra guidance is provided in words, to guide the passengers further if they need more confirmation.

The concept ideas that were derived from the motivation ideation session led to the insight that different Disposers need different ways of motivation. Mostly the Intuitive and the Unaware Disposer need motivation to do it correctly, which can be done by focusing on fun facts about waste separation at Schiphol Airport as well as by raising awareness of the importance of waste separation. With these insights, the concepts can be integrated into one campaign, see Figure 6.5b. The campaign concept is created based on the three waste streams, in which the colours of the separate motivators represent the waste stream that the information is about. Furthermore, a fourth colour is added for the general information about waste at Schiphol Airport, the colour that is used is purple, which is Schiphol's brand colour. On the top of each visual, the posters state the name of the campaign: 'Got some time to waste?'. The hints and facts are based

on mistakes or common misunderstandings to give passengers direction about waste disposal or to raise awareness about the importance of waste separation. With each fact or hint, a simple visual is added to give more guidance, with the same icons that are present on the FF3 concept bin. The small stickers, which are business card sized, are meant to stick on the armrests of the chairs at the gate or on the tables. On these smaller stickers, a QR code is shown, which can lead the passenger to more information about waste separation online. The bigger posters are A5 sized and are meant to be placed on flat surfaces in and around the waiting areas of the gate, for example, pillars or walls. Each signage includes a graphical display of the bin at the bottom, to inform the reader it is about the bins that are present around them. For the design style of the posters, the book Wayfinding at Schiphol Airport is used as a guideline (Mijksenaar, 2008). One colour is used as the background and Schiphol's font is used to keep consistency.

Figure 6.5b Campaign concept



Figure 6.5a FF3 bin concept



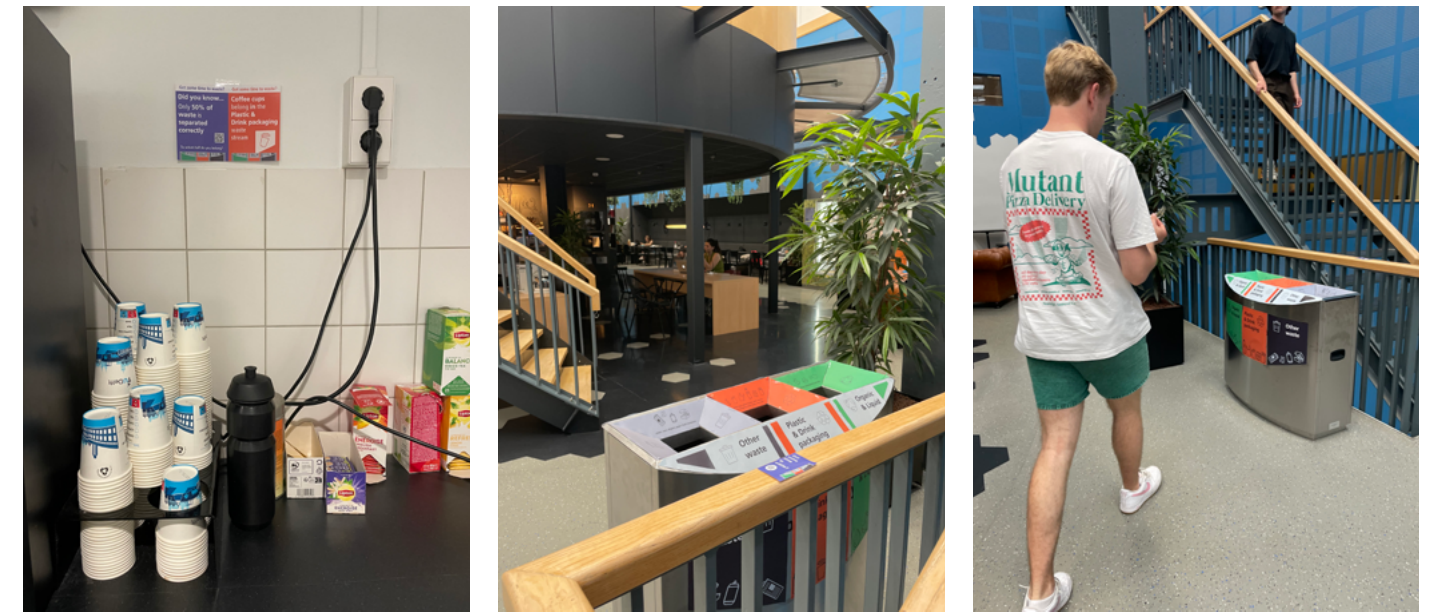
6.6 Phase Two: Testing

6.6.1 Testing at the IDE Faculty

The Phase Two concept was first pilot tested at the IDE faculty, in which I placed the FF3 bin with the new concept in the hallway and next to the canteen. Around the bin, I placed the campaign posters and stickers, so that users could read the facts and hints. The binliners were empty when the test started, at the end of the day the content of each bin liner was analysed to see whether the users used the bin right.

From observations around the test set-up, interviews with two students who looked at the posters and an anonymous online questionnaire that I distributed around the test area (see Figure 6.6.1) I summarised the most interesting insights in Table 6.6.1. These insights are based on a comparison with observations from the IDE test of Chapter 4.1.

Figure 6.6.1 Testing the concepts at the IDE faculty



| Observation | Interviews | Questionnaire |
|---|---|---|
| <ul style="list-style-type: none"> + Users looked twice before disposing of waste, they took more time + Users compared their waste to the icons displayed on the bin | <ul style="list-style-type: none"> + The interviewees indicated that they liked the posters and found the information fascinating* + The posters raise their awareness for the importance of waste separation* | <ul style="list-style-type: none"> + the participants were fascinated by the hint and facts + they would like to know more about waste separation |
| <ul style="list-style-type: none"> -Users looked confused (could be because the bin is new to the faculty) -Users did not seem to immediately be triggered to dispose of waste - There were some little mistakes such as cutlery and aluminium foil in Plastic & Drink packaging | <ul style="list-style-type: none"> - the interviewees would not directly act upon the posters because they did not need to at that moment <p>*this information could have been biased, because of the steering situation</p> | <ul style="list-style-type: none"> -Some participants did not immediately link the questions to the bin |

Table 6.6.1 Results testing the concepts at the IDE faculty

6.7 Phase Two: Interactive Addition to the Design

6.6.2 Testing at Schiphol Airport

For the test at Schiphol Airport, I assembled the paper prototypes in the bin and around this bin I hang up or put down some campaign posters, see Pictures 6.6.2abc. The testing at Schiphol Airport was done together with Aniek Keijer. At the Airport, I mainly observed passengers disposing of their waste (Figure 6.6.2), however, I did have some small conversations with some of the Schiphol staff and passengers, the insights can be seen in Table 6.6.2. These insights are based on a comparison with the baseline observation, of which the full test setup can be found in Appendix X.

Main takeaways: The concept of the bin is working, the items thrown in the bin corresponded to the waste streams. Minor design changes could be made to enhance the visibility: change the black lettering on the green and orange stream also to white, from a distance, it was hard to read due to the dark environment of Schiphol. These Design Opportunities are summarised in Figure 6.6.2d. There should be noted that the campaign was hard to validate because it did not provide immediate interaction, which can be translated into new design opportunities.

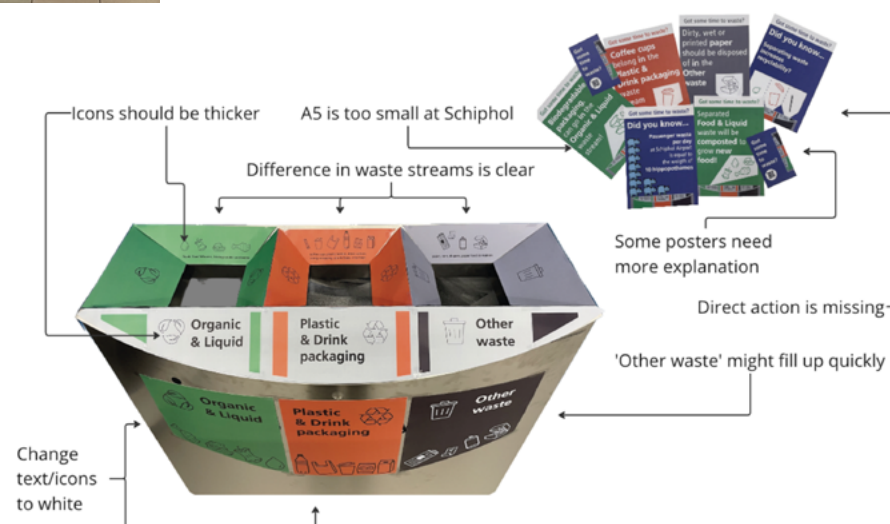
Figure 6.6.2abc Testing the concepts at Schiphol Airport



Table 6.6.2 Insights testing

| Observation | Interviews |
|---|--|
| + The passengers did try to dispose of their waste correctly, by taking their time to compare waste | + 'It would be hard to still put the coffee cups in the wrong bin' (Military police) |
| + Passengers did stop more often than the baseline test to see what type of waste they had and compared it to the icons | + 'Wow, that bin really stands out' (security) |
| -The A5-sized posters were too small in the big airport. | - 'Waste is not alive enough yet' (Cleaning Company A cleaner) |
| - In the busy environment, it was very hard to see which passengers read the campaign posters | - 'Some of the icons are too tiny and the words are hard to read' (Passenger) |
| -The black letters on the green and orange surfaces do not stand out in the environment | |

Figure 6.6.2d Design Opportunities

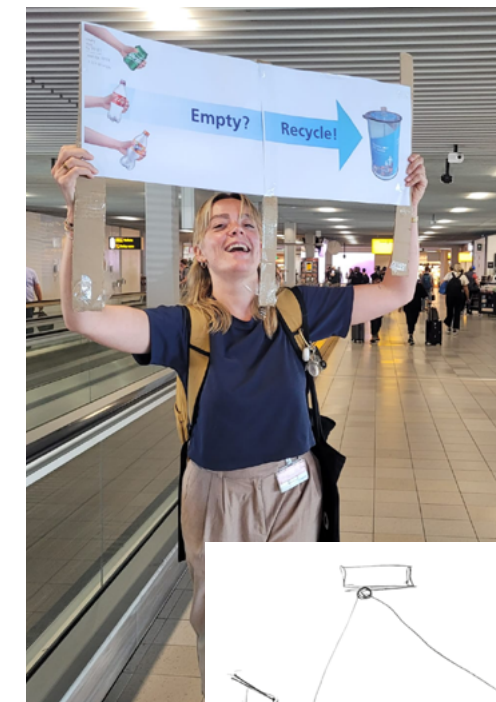


The campaign was hard to validate because campaigns do not provide immediate interaction. The purpose of the campaign was to raise awareness and give more information. Nevertheless, the campaign does not draw enough attention to go to action. On the testing day at Schiphol, after taking down the prototypes, Aniek and I walked with the prototype down the hallways past the gate. At that moment, I was playing with Aniek's sign (see Figure 6.7a) and I noticed people were trying to read my sign because they were curious about what it said. The observation indicated the integration of active elements in the design to enhance passenger engagement.

A list was made with criteria that I found are missing so far, which are:

- C6.1:** The concept provides an **active experience** at the gate to activate passengers to separate waste
- C6.2:** The concept realises an **innovative experience**, it catches the attention
- C6.3:** The concept is flexible, so it can **address different Disposers** described in Chapter 6.4.2

Figure 6.7a Me walking around Schiphol with Aniek's prototype

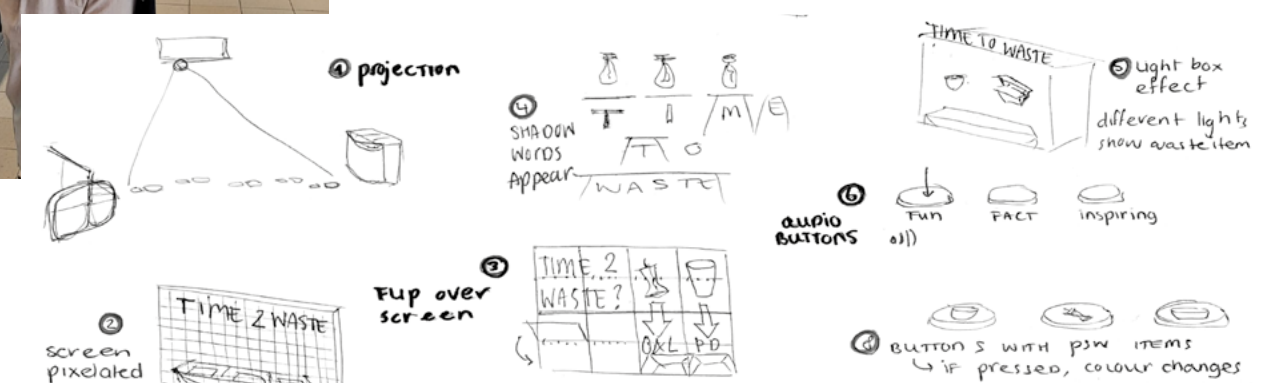


Consequently, several ideas were generated and clustered into concepts. A selection of the concepts that I liked most were: different audio buttons with information about waste separation (6), projectors at the gate that indicated separating waste towards the nearest bin (1) and analogue flip-over signs at the gate about waste disposal (3), see Figure 6.7b. Whilst ideating these ideas, I realised another important aspect that should be included in this addition to the concept, which is based on Takeaway 6.4: There is most time to interfere with the passengers' journey whilst the passengers are waiting at the gate to board. Important here is that, passengers that are seated at the gate mostly look towards the floor, either engaged with personal devices, reading materials, or items on their laps. This led to another criteria:

- C6.4:** The concept is **visible to the passengers whose attention is aimed at the floor** whilst waiting to board.

Subsequently, I revisited the concepts, focusing on the seating area near the gate. For the short timeframe of this project, I decided to go forward with the projection concept, because it is more innovative and can be adjusted in multiple ways. Furthermore, these projections are aimed on the floor, which is the interesting part of the design. Nevertheless, it should be acknowledged that projectors are not the most sustainable solution. However, the projectors can be leased from Philips, as Schiphol already does with their lights currently. In this way, this can be experimented with and reviewed for a couple of years to see how passengers react and then the ownership is still in Philips hands. Also, the projectors do not have to be placed at every gate, I would propose to place them at the gates that need most attention towards waste separation, as mentioned in the interview with Waste Handler A in Chapter 3.1.2.

Figure 6.7b Active ideas





7. Final Design

Content

This chapter summarises the testing and design process from the previous chapter and combines it into a final design. The proposal and requirements are clearly laid out, as well as how it would be implemented at Schiphol. The effects that this design could and will have on passenger behaviour, and the achieving of Schiphol's zero waste goal will be described and the findings of final testing at both IDE faculty and Schiphol can be summarised into the design recommendations.

7.1 Design proposal

The final design proposal is called 'Time To Waste' and is designed to improve passenger waste separation behaviour at Schiphol Airport. The design proposal consists of three elements, a new skin for the already existing FF3 bins that are in Schiphol Airport, a campaign containing 'Time To Waste' posters that will be displayed throughout Schiphol Airport to gain awareness and projectors that display the indication for waste disposal at the gates where passengers are waiting to board. The 'Time To Waste' proposal can be seen in Figure 7.1.

Figure 7.1 Time To Waste



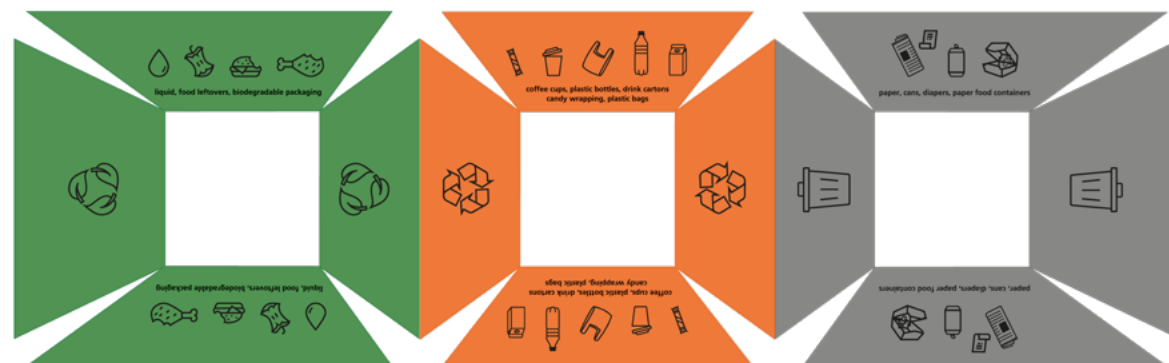
7.1.1 The new FF3 Bin

The new skin on the existing FF3 bins shows the users how to dispose of their waste using different aspects. First, the difference in waste streams can be read from a distance, from up close and in more detail from the top. Furthermore, the difference between the waste streams is made visually strong by using the colours of the Dutch Government for the waste streams, which can be seen from multiple directions. The text that indicates the waste streams are written in English using the Schiphol font and to make it even clearer which PSW items can be disposed of in this, icons of the PSW items are presented on the FF3 bins in icons. A detailed overview of the new skin can be seen in Figure 7.1.1ab.



Figure 7.1.1a Close-up of icons and text top

Figure 7.1.1b Graphical overview new FF3 bin skin



7.1.2 The Campaign

To gain awareness among passengers of the importance of waste separation for Schiphol Airport a campaign is designed. The campaign will give the passenger information about how to separate PSW, what happens with the PSW and how to improve PSW separation. These posters should be spread in and around Schiphol Airport, from parking to arrivals and departures. An overview of the different posters that are designed can be seen in Figure 7.1.2.

Figure 7.1.2 The campaign posters



7.1.3 The Projections

To actively engage the passengers at the gate to separate waste, the 'Time To Waste' projectors will be installed. These projectors will project different projections to catch passengers' attention whilst they are waiting at the gate to board. The important aspect of these projectors is that they are aimed at the floor, so that the passengers that mostly look downwards whilst they are seated at the gate, will be distracted by an interactive experience. The projections can



show different indications, such as how to dispose of different PSW items, as well as the route to the bin. The projections and their different functionalities can be found in Figure 7.1.3.

Figure 7.1.3 Figma screenshot of projections for projector videos



7.2 Final testing

Elements of 'Time To Waste' have been tested a final time, to evaluate the design and to find possible recommendations. The projections have been pilot tested at the IDE faculty, whilst the bin is tested at Schiphol Airport. The campaign is not tested again, because the influence a campaign has can only be tested on a larger scale and over a long time, which did not fit within the project time limitations.

7.2.1 Final testing the new FF3 Bin

To evaluate the new skin of the FF3 bin, a comparative study was conducted at Schiphol Airport. For this study, I went to Schiphol Airport two mornings, where I observed a gate of passengers going to Los Angeles, departing at 12:50. I observed the same flight at the same gate, however, one time I put my design on the FF3 bin at the gate. I observed passengers (see Figure 7.2.1a) throwing away PSW, I noted this in an Excel sheet together with in which bin they disposed of it. The test set-up can be found in Appendix Y and the Excel sheets can be found in Appendix Z. Afterwards, I compared the two sets of results, and the conclusions I drew from this are summarised in Figure 7.2.1b.

Main takeaways: The confusion in the design test persisted with items like paper bags and candy wrapping (foil). However, the design test showcased more instances of correct disposal, with 77% correctly disposed of compared to 40% in the baseline test. Moreover, it was clear in passengers' behaviour that they took more time to dispose of their waste, indicating that the design improvements helped passengers better understand waste separation.

Figure 7.2.1a The FF3 bin I observed with 'after' photos of observation

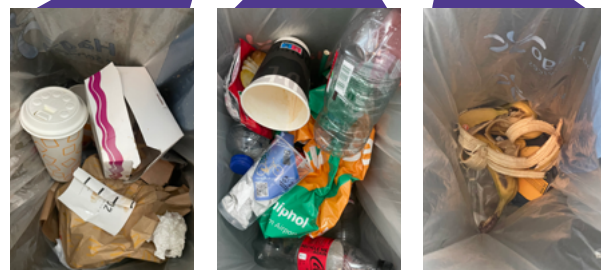
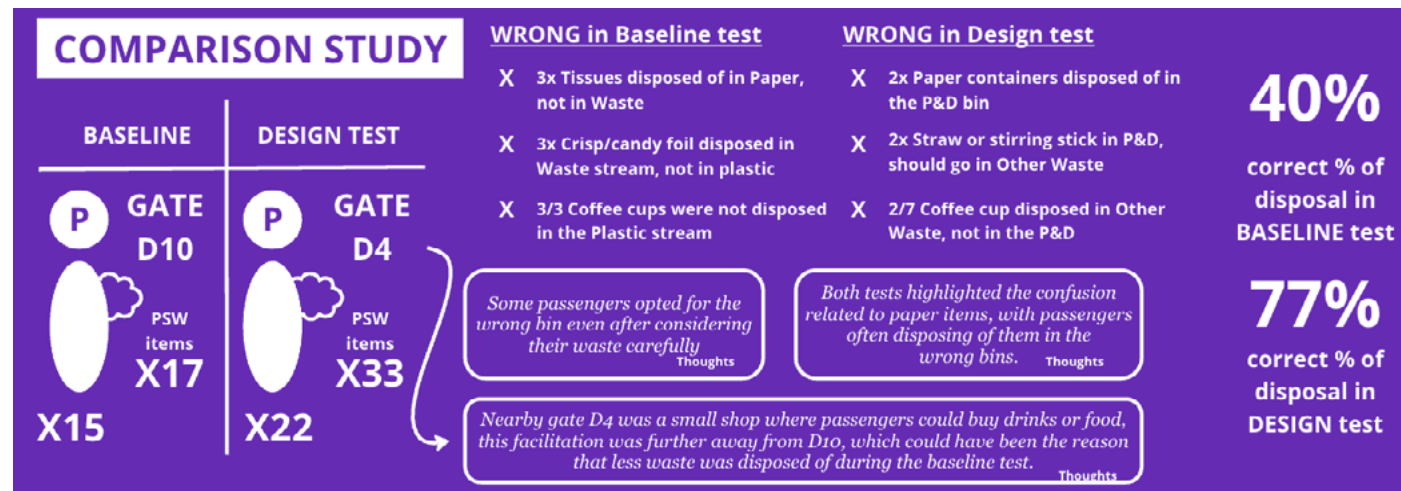


Figure 7.2.1b Summary comparative study



7.2.2 Pilot testing the Projections

Several ideas for the projections were prototyped in Figma, which can be seen in Figure 7.2.2a. The ideas are made into concepts by making different videos to display on a 'gate'. Within the faculty of IDE, I realised a gate-looking seating situation, above which a projector could be placed that could project the different videos on the floor, which is shown in Figure 7.2.2b. The participants were students of TU Delft and employees of the service point (Figure 7.2.2c), and I asked them to imagine they just arrived at the gate at Schiphol and would take a seat before their gates opened in 10 minutes. Before they took a seat, I gave them a disposable coffee cup (plastic) with a paper straw in it (residual waste) and I asked them to do something on their phone that they would normally do at a gate. They sat down and then after some time I turned on the projections and observed their reactions.

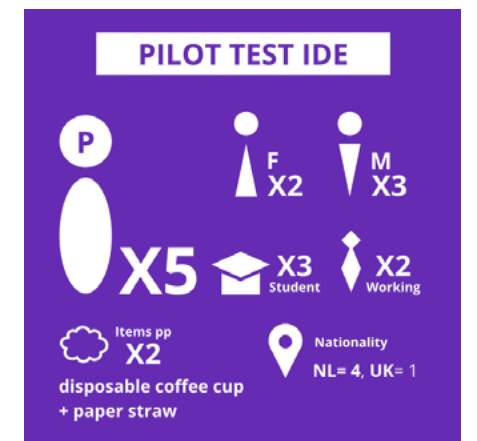
Main takeaways: From the test could be concluded that the attention was almost directly drawn to the projections on the floor. However, it should be noted that their attention to this could be slightly biased because I stood above them with a projector. It was hard to tell which projection the participants liked most and the projection was sometimes hard to see, but this is mainly because the light in the hall of IDE comes mostly from above, whilst in Schiphol this comes from the side. Overall, the participants did seem to like the motion of the different projections and that they were guided toward the bin.

Figure 7.2.2a Testing projections in IDE hall



Figure 7.2.2b Test set-up IDE hall

Figure 7.2.2c Participants information



7.3 Evaluation of Time To Waste

The design criteria that were set up as the conclusion of Chapter 2 and Chapter 3, and the added criteria from Chapter 6.7, could be used to evaluate the design. In Table 7.3, each design criterion is shown, and the part of Time to Waste that matches this criterion is marked with a V, the part that matches the strongest is highlighted.

| | FF3 bin | Campaign | Projections |
|--|---------|----------|-------------|
| DC 2.1 Align design with the Dutch recycling system and the waste handler | V | V | V |
| DC 2.2 Enhanced signage visibility | V | | |
| DC 2.3 Focus on generated PSW items | V | V | V |
| DC 2.4 Reduce contamination through waste streams | V | | |
| DC 2.5 Improve steps of the waste journey | V | | |
| DC 2.6 Involve the users' influence | | V | V |
| DC 3.1 Separate organic and liquid waste | V | | |
| DC 3.2 Accommodate users with different cultural backgrounds | V | V | |
| DC 3.3 Conveniently communicate the disposal of PSW | V | V | V |
| DC6.1 Provides an active experience | | | V |
| DC6.2 Realises an innovative experience | | | V |
| DC6.3 Addresses different Disposers | | V | V |
| DC6.4 Visible to the passengers whilst looking towards the floor at the gate | | | V |

7.3.1 Evaluation of the new FF3 bin

DC 2.1: The new skin of the FF3 bin is aligned with the Dutch recycling system, since the separation of PSW items that are indicated on the bin is determined by using the 'Afvalscheidingswijzer' from Milieucentraal, from the Dutch Government. However, since Schiphol switched waste handlers throughout this project, this still needs to be aligned with them.

DC 2.2: The waste streams, text and icons can be seen from different perspectives, from far away, and close by. The text is only written in English, to give more space for bigger text. Furthermore, the signage of indication is shown on different surfaces and the colours guide the passenger in the right direction.

DC 2.3: The skin shows icons of PSW items that are disposed of most; however, this can be improved by doing more Waste Safaris.

DC 2.4 By substituting the paper waste stream with an Organic and Liquid waste stream, the amount of waste that is contaminated will be reduced. Furthermore, the post-separation process will be enhanced.

DC 2.5 Separating Organic and Liquid waste and including a separate waterproof bucket in this bin to avoid spills, the cleaner will have to spend less time cleaning the bins and surroundings.

DC 3.1 Organic and Liquid waste is separated; however, the bucket should still be designed and a system to clean, empty and/or collect these should be created.

DC 3.3 Due to the bright colours and the easier-to-understand waste streams, it is easier and more convenient for passengers to dispose of their waste. Furthermore, passengers get more information whilst getting closer to the bin to know better how to dispose of their waste.

7.3.2 Evaluation of the campaign

DC 2.3 A part of the campaign focuses on the most common PSW items, giving an indication to the passenger about how to dispose of these.

DC 2.6 The campaign should communicate to the passenger the importance of correctly separating PSW. However, more facts or information could be generated to include a broader audience.

DC6.3 The campaign is made to address the different Disposers, by showing fun facts, direct disposal information or hints to separate waste. The campaign can be made flexible, by re-evaluating the campaign with more information from more Waste Safaris, which can guide the passengers more towards the right disposal of most common PSW. The concept is flexible, so it can address different Disposers described in Chapter 6.4.2

7.3.3 Evaluation of the projections

DC6.1 The projections give the passengers a sudden indication that motivates them to dispose of their waste. The projection is made playful and appears suddenly, so that it reminds passengers to stand up and make time to waste.

DC6.2 The projections would be new to the passenger and is not a very common way to promote PSW separation, however, the projections do require more money, labour, and time to be implemented correctly.

DC6.3 The projections can motivate the different Disposers by showing common PSW items and how to dispose of them or by footsteps towards the closest bin. These projections can be further developed to gain the desired interaction.

DC6.4 The projections are aimed on the floor in between passengers, so that passengers can see the projections appear whilst they are facing down. What should be noted it that the brightness of the projections should be high enough, otherwise the passengers would not see the projections.

7.4 'Time To Waste' Recommendations

Throughout evaluations and reflection, each part of 'Time To Waste' has several recommendations that should be noted if future steps will be taken. Furthermore, I defined a timeline for implementation, which is based on the first two Horizons of the Roadmap of Chapter 5.2.

7.4.1 Design Recommendations for Schiphol Airport

FF3 Bin:

- Adjust the design to align with Waste Handler B's waste processing for accurate PSW categorisation. Engage in discussions with Waste Handler B concerning PSW items and appropriate waste streams.
- Given the recurring confusion with paper items, reinforcing proper disposal of paper waste, like trays, cups, and containers, is essential in the campaign and projection messages. Address the inclusion of paper in the 'Other Waste' stream, 'Time To Waste' does not optimally separate this at the source.
- Conduct recurring waste assessments, or Waste Safaris, to evaluate the effectiveness of the bins and ensure user understanding of the provided information.
- Periodically monitor and update the design if required based on waste assessments to optimise waste separation behaviour and improve user experience.
- Besides using icons of items that can be disposed of in the bin, it might be interesting to conduct research into using icons of items that can not be disposed of in the bin, such as a 'no cans' icon on the Plastic and Drink packaging bin.
- Further design and test the waterproof buckets that should be placed within the FF3 bin to avoid contamination of the environment, these also need to be easy to remove and easy to clean.
- Explore the possibility of managing Organic & Liquid Waste through composting or conversion to fertilizer.

Campaign:

- Re-evaluate the campaign regularly by using the results of Waste Safari, the most common mistakes can be highlighted through the campaign.
- Develop an online version of the campaign, possibly integrating it into emails or websites to enhance passenger exposure.
- Extend the campaign's reach to include information about passenger waste separation at Schiphol and in the Netherlands.
- Passengers combining mixed waste items in one disposal stream suggests the need for clear communication on keeping waste separated, such as separating paper straws from plastic cups.

Projections:

- Test several projectors first before implementing, especially to check the amount of Lumen that is needed to see the projections on the floor in daylight. It might be that this differs per gate.
- Customise projections according to traveller demographics or flight destination, incorporating language and waste type, aligning with regular waste assessments.
- Explore interactive projection options where feasible, possibly enhancing passenger engagement. However, deploy these within lounges rather than gates to target the appropriate audience.
- Collaborate with design studios or artists to refine the projection content.

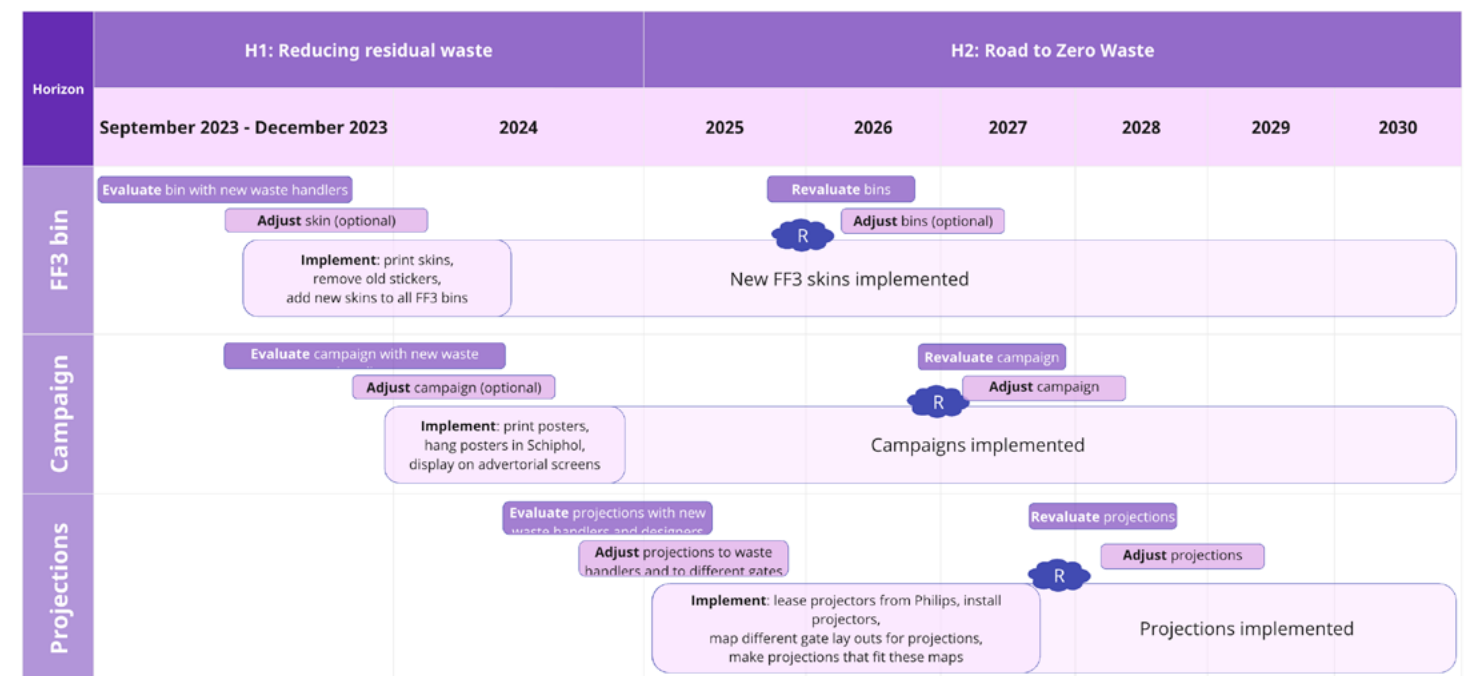
7.4.2 Timeline for Implementation

To guide the implementation of the different aspects of 'Time To Waste', a recommended timeline is set up, which can be seen in Figure 7.4.2.

The overview indicates to start with the implementation of the bin, after which the implementation of the campaign can follow and lastly the implementation of the projection. It is important to evaluate the full design at the beginning because of the recent change in waste handlers. This is because, this project's findings are based on information from Milieucentraal and old insights from Waste Handler A, which could differ from Waste Handler B's waste handling system. From my experience, it is best to start with refining the bin design and then base the campaign on this evaluation. To apply the skins on the FF3 bins, I would recommend asking the cleaning companies and their employees since they have the tools to clean the bins before applying the skin. The 'Time To Waste' projection project will be harder to implement because more steps should be taken. However, by starting this after the implementation of the skins and campaign, there can be full focus on the final part of the design.

To implement 'Time To Waste', it is advised to employ an (external) design team for the implementation, evaluations, and adjustments of the design. This is especially needed to align the design to go from Horizon 1: Reducing residual waste, towards Horizon 2: Road to Zero Waste. For the projections, this team is needed most, to map the gates and to find a way to easily adjust the projections on these maps. The overview is also indicated when the team needs to re-evaluate the designs. The re-evaluations are divided over the end of 2025 to 2029, to give Schiphol Airport time and options to prepare and adapt 'Time To Waste' for their goal to be Zero Waste in 2030. For 'Time To Waste', this would mean that there should be almost no residual waste, which can result in re-evaluating the 'Other Waste' stream on the bin and replacing this with a different stream.

Figure 7.4.2 Timeline for implementation of Time To Waste



7.5 Conclusion: 'Time To Waste'

To conclude the results of the 'Time To Waste' design, see Figure 7.5, three aspects of the design are analysed: feasibility, desirability, and viability.

7.5.1 Feasibility

Can it be done?

The feasibility of the 'Time To Waste' initiative is addressed through the creation of a design that aligns with the first two horizons of the roadmap. The proposed design involves applying stickers as the new bin skin, accompanied by a campaign utilizing physical or digital posters and projections which can be acquired by using leased Philips projectors. Both the FF3 bin skin and the campaign implementation have a short turnaround time, as the design only needs reassessment with Waste Handler B before printing and installation. However, a subsequent evaluation for these parts over time is recommended, due to the dynamic shifts in waste streams. Conversely, the projections' implementation requires a lengthier timeframe and encounters higher costs towards technological considerations and the involvement of a design team. Nonetheless, this approach offers increased adaptability to accommodate evolving PSW separation guidelines or address specific items at Schiphol Airport.

7.5.2 Desirability

Does it address the stakeholders' values and needs?

The main aim of this project was to decrease the amount of residual PSW. Passengers better understand how to correctly separate their waste, due to the enhanced communication on the FF3 bins, which results in less waste stream contamination. Furthermore, the project considered the needs of other stakeholders, such as cleaners and waste handlers. By separating organic waste, the time required by cleaners to clean the bins will be reduced, and the waste sorting process after collection will also improve due to reduced waste contamination. Additionally, through the implementation of the campaign and projections, waste separation becomes an integral part of the airport environment, raising awareness about its importance and offering information and guidance to passengers in a fun and easy manner.

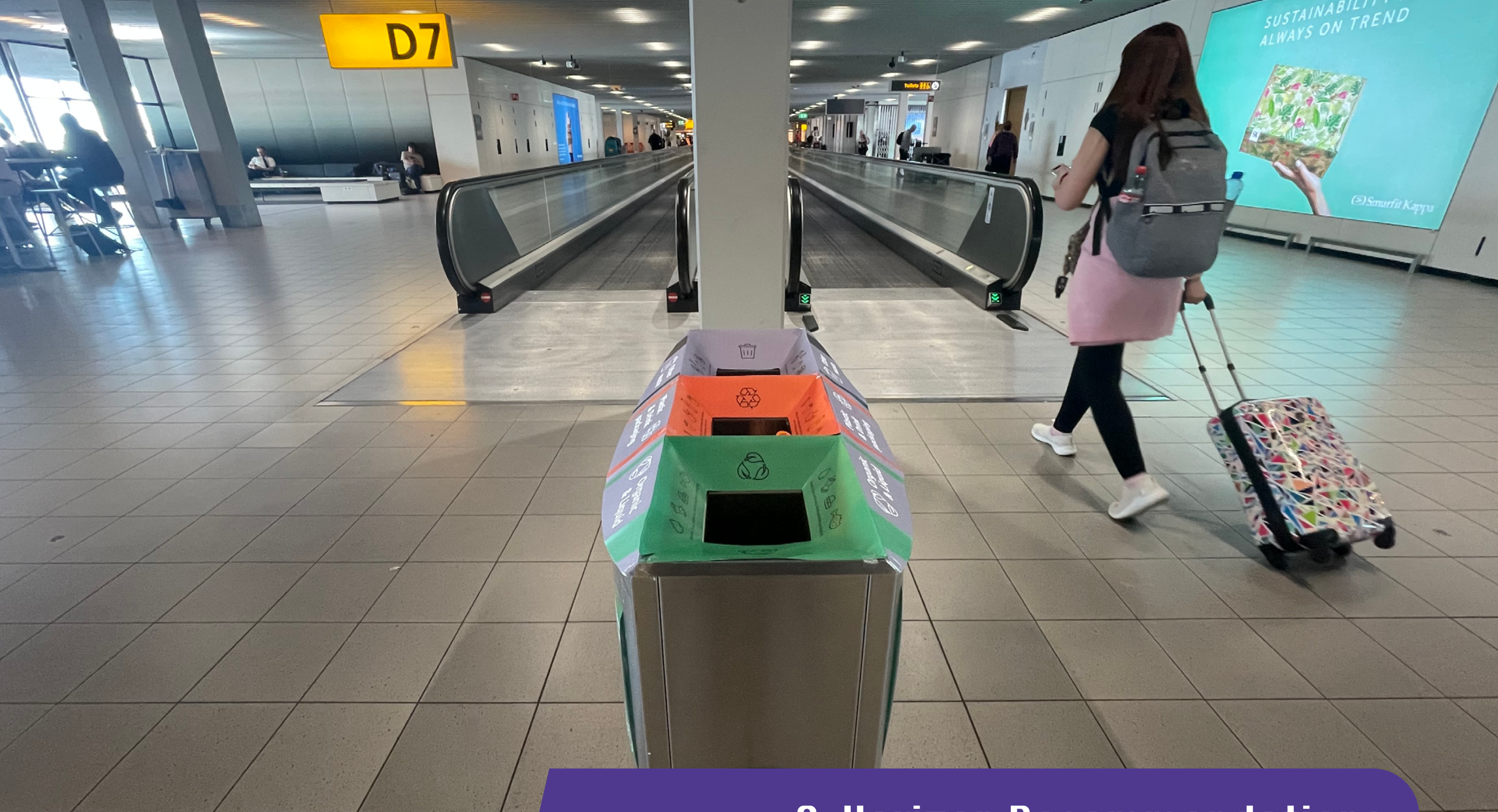
7.5.3 Viability

Will it survive in the long term?

The design proposal was initially based on the waste management process of the previous waste handler, Waste Handler A. However, Schiphol Airport switched waste handlers in June 2023, potentially leading to changes in waste management procedures. To make the design a better fit for the future, it is highly recommended to reassess 'Time To Waste' with Waste Handler B. This reassessment will determine if the waste streams and associated indicators remain accurate or need modification. Nevertheless, 'Time To Waste' is created to guide Schiphol Airport through the first two Horizons of the Roadmap, in which it makes a start in reducing their residual PSW and the first steps to becoming Zero Waste in 2030. It is foreseeable that an alternative for 'Time To Waste' will be adopted during Horizon 3: Road to a Circular Airport, because for this goal, waste should not only become non-existent, but the view on waste should shift to resources for new materials.

Figure 7.5 Time To Waste





8. Horizon Recommendations

Content

This Chapter dives deeper into the Roadmap that is introduced in Chapter 5, which described the steps for Schiphol to take to reach its 2030 Zero Waste goal and its 2050 Circular goal. The steps will be explained and elaborated with ideas on how Schiphol Airport can tackle this. Furthermore, a strategic plan is formed to help other organisations to reach their zero waste or eventually circular goal.

8.1 Roadmap Recommendations for Schiphol Airport

Chapter 5.2 introduced the Design Roadmap, which is created to pinpoint when and how the design of this graduation project will help Schiphol towards its goal to become Zero Waste, see Figure 8.1. However, the Roadmap includes additional aspects beyond my project's scope, which remain unaddressed and that are important aspects to elaborate on. These aspects encompass enhancing FF3 bin accessibility, implementing Recurring Waste Safaris, redefining bin use in a circular airport, aligning stakeholders with horizons, and refining PSW items for improved disposal adherence. These points will be explained and substantiated with recommendations and ideas that I gathered throughout my research.

Figure 8.1 Roadmap

| Horizon | H1: Reducing Residual Waste | | H2: Road to Zero Waste | | H2: Road to Circular Airport | |
|--------------------------------------|---|-------------|--|-------------|--|-------------|
| | 2023 | 2023 - 2025 | 2025 - 2030 | 2025 - 2030 | 2030 - 2050 | 2030 - 2050 |
| Goal | Goal of this horizon is reduce waste, where it is possible and feasible at the airport. | | Goal of this horizon is to archive a zero waste airport. | | Goal of this horizon is to archive a circular airport. | |
| Passenger values that should develop | Information, Transparency, Efficiency, Connection, Accomplishment | | Change, Empowerment, Future | | Sustainability, Impact, Experience | |
| Change FF3 bins | Improve the understanding and use of FF3 bin Change waste streams according to governmental regulations and according to most prominent PSW items Improving accessibility of the FF3 bins | | Recurring waste safaris | | Redefining bin use in a circular airport | |
| Triggers to use FF3 bins correctly | Motivate passengers to use FF3 bins at gate Aligning stakeholders with Horizons | | Create interactive experience that educates passengers about waste separation at Schiphol/NL | | Refining PSW items for improved disposal adherence | |

8.1.1 The FF3 Bins

Improving accessibility of the FF3 bins

Baxter et al.'s (2018) study at Kansai Airport underscores the value of airport-business collaboration for efficient waste sorting. Currently, the FF3 bins are only available in the main hallways, entrances and waiting areas whilst toilets and business partners do not provide the passengers with the opportunity to separate waste. In addition to changing the bin appearance at Schiphol, there's potential to enhance waste separation accessibility across the entire airport. Essential is a uniform PSW separation system aligned with stakeholder needs, extending airport-wide from parking to gates, toilets, and partnerships. This unified approach communicates waste separation's importance to passengers, sharing responsibility among stakeholders and lessening Schiphol's load.

Recurring waste safaris

To enhance Passenger Solid Waste (PSW) separation, recurring Waste Safaris are crucial. This research will identify the PSW items that the waste consists of. These analyses offer insights into PSW origins, facilitating discussions with partners to drive changes. For instance, interviews with Schiphol showed that over 80% of toilet waste is non-recyclable wet paper towels, signalling the potential for environmental improvement through altered hand-drying methods. Regular waste safaris empower Schiphol to reduce residual waste by adapting the bin or campaign towards the items that are mostly contaminated. The findings can inspire innovative waste treatment approaches, identifying waste reduction, reuse, and recycling prospects at Schiphol Airport.

Redefining bin use in a circular airport

For the third horizon, the concept of a bin in which passengers dispose of waste might not be necessary anymore. This is the reason that the concept needs to be re-imagined if Schiphol wants to become a circular airport because it must switch from waste to resource.

8.1.2 Motivation

Aligning stakeholders with Horizons

Research by Thomas and Sharp (2013) emphasizes the need to normalize recycling behaviour throughout the chain. The goal to become Zero Waste in 2030 and Circular in 2050 should not only be aimed by Schiphol and be dependent on the passengers. All parties that have a stake in the waste production of Schiphol Airport should have these horizons as goals. To achieve this, Schiphol should take charge by establishing clear collaborative guidelines that are determined based on the needs of the stakeholders. When all stakeholders consistently emphasize the importance of PSW separation, it encourages passengers to follow suit.

Refining PSW items for improved disposal adherence

Changing the packaging of products that passengers buy at Schiphol Airport is another possibility to encourage passengers to dispose of their waste correctly. Packaging serves as a clear cue for users, which can influence their disposal decisions. By adopting innovative packaging designs that communicate proper disposal methods and highlight recyclable components, Schiphol Airport can empower passengers even more to make correct choices. Ultimately, redesigning packaging to align with efficient waste separation raises a sustainable mindset.

8.2 Implementation of the Roadmap for Other Organisations

The steps that I executed throughout this graduation project led to a design to improve passenger waste separation at Schiphol Airport. Nevertheless, these steps can also be applied to other organisations which want to improve their waste separation behaviour. This is why, I combined all the steps I took into a 'No Time To Waste' Brochure, which can help other organisations and companies to reduce their residual waste. This Brochure can be seen in Figure 8.2.



Scan the QR code to download a PDF of the physical or online brochure.



Figure 8.2a Physical Brochure on A4

Figure 8.2b Online pdf version Brochure

NO TIME TO WASTE

A guide to reducing the amount of residual waste by improving waste separation behaviour through design

By Nika den Ouden

1 Analyse

Understand your waste management system

Efficient waste separation begins with a thorough analysis of your current system. This evaluation provides a clear understanding of where improvements can be made.

Bins: Consider the appearance and placement of bins. Are they consistent throughout your premises, or do variations confuse users? Assess the ease of use and visibility of bins to ensure their effectiveness.

Waste: Conduct a Waste Safari to delve into your waste composition. Identify the items present and their sources. Quantify how much of each item contributes to waste, pinpointing accurate insights into (in)correct separation.

Users: Understand your users beyond the ones directly disposing of waste. Consider cleaners, bystanders, and waste handlers as terminal users. Recognize their roles and needs within the waste separation process for a comprehensive perspective.

2 Research

Examine user behaviour, their needs, and external regulations

To improve waste separation behaviour, research and insights are vital. Delve into several aspects:

Behaviour Analysis: Examine current user behaviour to identify patterns and shortcomings. Utilize the Fogg Behaviour Model (2009) to uncover whether users need more motivation or ability for proper waste separation.

User Needs: Uncover what users require for successful waste separation. Do they grasp the current system? Are the bins conveniently located? Evaluate the needs of indirect users (cleaners) and dependent users (waste handlers) for a holistic approach.

Government Regulations: Stay compliant with government regulations by understanding national and international waste separation guidelines. Utilize these regulations as a foundation for improvements, ensuring alignment and consistency.

3 Design

The practical implementation of improvements

The design phase is pivotal in translating insights into tangible improvements. Utilize the gathered data to drive your design:

Identifying Weak Spots: Combine your insights from analysis and research to identify weak points in your waste separation process. Develop a comprehensive list of requirements that guide your design improvements.

Enhancing Ability: According to the Fogg Behaviour Model, enhancing ability drives behaviour change. If redesigning, engage an (external) designer for a fresh perspective. For smaller companies, test systems with printouts before committing to larger changes.

Boosting Motivation: Motivation plays a pivotal role in waste separation. Depending on your company's size and user base, consider campaigns with posters, infographics, or newsletters. Enrich the experience with interactive elements like games or apps to educate users in a futuristic and engaging way.

This brochure is made for companies eager to reduce residual waste production by enhancing waste separation behaviour. Insights were derived from a TU Delft graduation project for Schiphol Airport, where design improvements were explored to decrease residual passenger waste. This guide extends the knowledge gained from this project, offering companies a roadmap to create meaningful change within their own contexts.

This guide offers a comprehensive framework for improving waste separation, but individual steps might not apply to every company's specific circumstances. Adjustments should be made based on your company's waste handler, local regulations, and unique operational constraints. Utilize this guide to cultivate a culture of responsible waste separation, benefitting your company, the environment, and future generations.

Re-evaluating the steps is crucial to ensure continuous improvement and alignment with evolving waste separation goals and strategies.

Incorporating sustainability into your waste separation process goes beyond significant changes. Small, impactful steps, such as enhancing the appearance of bins with designed stickers or opting for digital motivation campaigns, can yield remarkable results. By embracing sustainability, you align your efforts with global environmental goals and minimize waste generation.

Effective waste separation is a journey that demands a comprehensive understanding of your system, user behaviour, and regulatory landscape. By strategically analysing, researching, and re-evaluating, you pave the way for a more sustainable and responsible waste separation process within your company.



9. Reflection

The journey through this project proved to be quite challenging, particularly due to the diverse range of stakeholders involved. However, engaging with these stakeholders was an enriching experience which gave me a lot of motivation. The process of interacting with them not only provided insights into their perspectives but also allowed me to feel valued and recognized as someone significant to their company. This experience that I gained in contacting and engaging stakeholders will undoubtedly prove useful in the future.

More efficient testing

The project involved a multitude of tests, which turned out to be enjoyable due to the different participants and useful insights I gained. Collaborating with others and seeking their input was a crucial aspect, which gave me a lot of direction for the rest of my project. However, sifting through the diverse inputs to determine what was truly important posed a challenge. In hindsight, I wonder if a more efficient approach could have been adopted so that it would have been easier to filter the important point. This could mean, spending more time at Schiphol for in-depth observations and testing, instead of multiple brief visits, allowing for a deeper immersion in the environment under study.

Preparation of tests

The on-location testing was valuable, although I acknowledge that better preparation was needed in certain moments. In retrospect, involving stakeholders more extensively during the preparation stage could have provided clarity on what aspects were critical and for example what locations were most suitable for testing. Furthermore, validating results with stakeholders could have enhanced the overall reliability of the findings. Perhaps with more time, this validation process could have been even more comprehensive.

Flexibility and planning

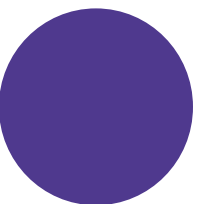
Collaborating with others throughout the project was very motivating, and being able to share struggles and pain points helped me a lot go through the process. However, it was essential to find a balance in accommodating each other's planning. There were moments when challenges demotivated me, yet these experiences highlighted the importance of flexibility in planning and execution.

'What do I find?' decisions

Decision-making was a central aspect, given the multitude of solutions within the project scope. However, I tried to base my decisions more on what stakeholders thought or what I could justify with other sources than I used my own opinion. In future projects, I would use this more, since that is what would make it 'my' project in the end.

Waste expert

The realisation that I can now consider myself a waste expert is pretty cool. I am very happy with the knowledge that I have gained throughout the project, which made me have a lot of fun assisting those with questions related to waste management, even if the questions were completely out of my project scope.



References

- Afvalscheidingswijzer | Milieu Centraal | Afvalscheidingswijzer. (n.d.). <https://www.afvalscheidingswijzer.nl/>
- Afvalverwerking in Nederland in cijfers: composteren en verbranden toegenomen, storten opnieuw afgenomen. (n.d.). Kenniscentrum InfoMil. <https://www.infomil.nl/@256377/afvalverwerking-nederland-cijfers-2020/#:~:text=De%20cijfers%20over%202020%20laten,opzichte%20van%20het%20jaar%20ervoor.>
- Alam, P., & Ahmade, K. (2013). IMPACT OF SOLID WASTE ON HEALTH AND THE ENVIRONMENT. Special Issue of International Journal of Sustainable Development and Green Economics (IJSJGE).
- Andrews, A., Gregoire, M. B., Rasmussen, H. E., & Witowich, G. (2013). Comparison of recycling outcomes in three types of recycling collection units. *Waste Management*, 33(3), 530-535. <https://doi.org/10.1016/j.wasman.2012.08.018>
- Baxter, G., Srisaeng, P., & Wild, G. (2018). Sustainable Airport Waste Management: The Case of Kansai International Airport. *Recycling*, 3(1), 6. <https://doi.org/10.3390/recycling3010006>
- Boonrod, K., Towprayoon, S., Bonnet, S., & Tripetchkul, S. (2015). Enhancing organic waste separation at the source behavior: A case study of the application of motivation mechanisms in communities in Thailand. *Resources Conservation and Recycling*, 95, 77-90. <https://doi.org/10.1016/j.resconrec.2014.12.002>
- Doe mee met PMD. (n.d.). Doe mee met PMD. Prova Reiniging. <https://doemeemetpmd.nl/#:~:text=Wat%20wel%20bij%20PMD%20mag&text=Flessen%20voor%20frisdrank%2C%20water%2C%20melk,voor%20sauzen%2C%20olie%2C%20etc.>
- Effecten gescheiden afvalinzameling openbare ruimte. (n.d.). Zwerfafval. <https://zwerfafval.rijkswaterstaat.nl/actueel/artikelen/artikelen/effecten-gescheiden-afvalinzameling-openbare/>
- EUROPEAN COMMISSION. (2018). COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS. Eur-lex. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2018:28:FIN>
- European Compost Network. (2020, August 13). Circular Bioeconomy - European Compost Network. <https://www.compostnetwork.info/policy/circular-economy/>
- Fogg, B. J. (2009). A behavior model for persuasive design. *International Conference on Persuasive Technology*. <https://doi.org/10.1145/1541948.1541999>
- Framework for Innovation - Design Council. (n.d.). <https://www.designcouncil.org.uk/our-resources/framework-for-innovation/>
- Ghani, W. a. W. a. K., Rusli, I. S., Biak, D. R. A., & Idris, A. (2013). An application of the theory of planned behaviour to study the influencing factors of participation in source separation of food waste. *Waste Management*, 33(5), 1276-1281. <https://doi.org/10.1016/j.wasman.2012.09.019>
- Guidance on solid waste and health. (n.d.). <https://www.who.int/tools/compendium-on-health-and-environment/solid-waste#:~:text=Solid%20waste%20refers%20to%20any,solid%20waste%20are%20produced%20annually.>
- Heijne, K., & Van Der Meer, H. (2019). Road map for creative problem solving techniques: organizing and facilitating group sessions.
- Janmaimool, P. (2017). Application of Protection Motivation Theory to Investigate Sustainable Waste Management Behaviors. *Sustainability*, 9(7), 1079. <https://doi.org/10.3390/su9071079>

References

- Jiang, Q., Izumi, T., Yoshida, H., Dilixiati, D., Leeabai, N., Suzuki, S., & Takahashi, F. (2019). The effect of recycling bin design on PET bottle collection performance. *Waste Management*, 95, 32-42. <https://doi.org/10.1016/j.wasman.2019.05.054>
- Jiang, Q., Leeabai, N., Dilixiati, D., & Takahashi, F. (2021). Perceptive preference toward recycling bin designs: Influential design item depending on waste type, the impact of past perception experiences on design preference, and the effect of color design on waste separation. *Waste Management*, 127, 130-140. <https://doi.org/10.1016/j.wasman.2021.04.037>
- Kelly, T. C., Mason, I., Leiss, M., & Ganesh, S. (2006). University community responses to on-campus resource recycling. *Resources Conservation and Recycling*, 47(1), 42-55. <https://doi.org/10.1016/j.resconrec.2005.10.002>
- Kvk, N. C. O. C. (2023). Ban on plastic straws, plates, and other single-use plastics. [business.gov.nl. https://business.gov.nl/running-your-business/environmental-impact/making-your-business-sustainable/ban-on-plastic-straws-plates-and-other-single-use-plastics/](https://business.gov.nl/running-your-business/environmental-impact/making-your-business-sustainable/ban-on-plastic-straws-plates-and-other-single-use-plastics/)
- Luttenberger, L. R. (2020). Waste management challenges in transition to circular economy - Case of Croatia. *Journal of Cleaner Production*, 256, 120495. <https://doi.org/10.1016/j.jclepro.2020.120495>
- Metalen verpakking weggoeien | Afvalscheidingswijzer. (n.d.). <https://www.afvalscheidingswijzer.nl/producten/metalen-verpakking/>
- Mijksenaar, P. (2008). Wayfinding at Schiphol.
- Milfont, T. L., & Schultz, P. H. (2016). Culture and the natural environment. *Current Opinion in Psychology*, 8, 194-199. <https://doi.org/10.1016/j.copsyc.2015.09.009>
- Milieu Centraal. (n.d.-a). Afval scheiden en recycelen. <https://www.milieucentraal.nl/minder-afval/afval-scheiden/>
- Milieu Centraal. (n.d.-b). Papier en karton inleveren. <https://www.milieucentraal.nl/minder-afval/afval-scheiden/papier-en-karton/#:~:text=Papier%20en%20karton%20wordt%20in,goed%20meer%20overwerkt%20kan%20worden.>
- Minelgaitè, A., & Liobikienè, G. (2019). The problem of not waste sorting behaviour, comparison of waste sorters and non-sorters in European Union: Cross-cultural analysis. *Science of the Total Environment*, 672, 174-182. <https://doi.org/10.1016/j.scitotenv.2019.03.342>
- Ministerie van Algemene Zaken. (2022, January 19). Welke producten van wegwerpplastic kan ik niet meer kopen? Rijksoverheid.nl. <https://www.rijksoverheid.nl/onderwerpen/afval/vraag-en-antwoord/verbod-producten-van-wegwerpplastic#:~:text=Plastic%20bordjes%2C%20bestek%2C%20roerstaafjes%2C,medisch%20gebruik%20zijn%20wel%20verkrijgbaar.>
- Ministerie van Algemene Zaken. (2023, May 31). Regels over wegwerpplastic. Afval | Rijksoverheid.nl. <https://www.rijksoverheid.nl/onderwerpen/afval/regels-voor-wegwerpplastic>
- Ministerie van Infrastructuur en Waterstaat. (2022, March 29). Minder wegwerpplastic voor een schoner milieu. Nieuwsbericht | Rijksoverheid.nl. <https://www.rijksoverheid.nl/actueel/nieuws/2022/03/29/minder-wegwerpplastic-voor-een-schoner-milieu>
- Moneim + Gado. (n.d.). Your future seafood meal: Your future seafood meal. Ads of the WorldTM. <https://www.adsoftheworld.com/campaigns/your-future-seafood-meal#comment-form>

References

- NHS Identity Guidelines | Fonts. (n.d.). <https://www.england.nhs.uk/nhsidentity/identity-guidelines/fonts/#:~:text=Frutiger%20is%20a%20contemporary%20and,people%20associate%20with%20the%20NHS>.
- Oscar Sort: Zero-Touch Zero-Waste Stations — Intuitive AI. (n.d.). Intuitive AI. <https://intuitiveai.ca/oscar-sort>
- PD Waste Handler B Neemt Het Apart Mee! (n.d.). > Confidential Appendix A
- Pictogrammen. (n.d.). AfvalCirculair. <https://www.afvalcirculair.nl/onderwerpen/afvalscheiding/pictogrammen-0/>
- Polyportis, A., Mugge, R., & Magnier, L. (2022). Understanding householders' perspectives on sorting plastic waste. TU Delft Repositories. https://pure.tudelft.nl/ws/portalfiles/portal/146835276/AP_Understanding_household_perspectives_on_sorting_plastic_waste.pdf
- Pronk, D. (n.d.). Circular Economy at Amsterdam Airport Schiphol. https://www.icao.int/environmental-protection/Documents/EnvironmentalReports/2019/ENVReport2019_pg294-299.pdf
- Ramayah, T., Lee, J. T., & Lim, S. (2013). Sustaining the environment through recycling: An empirical study. *Journal of Environmental Management*, 102, 141–147. <https://doi.org/10.1016/j.jenvman.2012.02.025>
- San Francisco International Airport. (2017). Zero Waste Plan. [flysfo.com. https://www.flysfo.com/sites/default/files/media/sfo/community-environment/13259_Zero_Waste_Roadmap.pdf](https://www.flysfo.com/sites/default/files/media/sfo/community-environment/13259_Zero_Waste_Roadmap.pdf)
- Sanders, E. B., & Stappers, P. J. (2012). *Convivial Toolbox: Generative Research for the Front End of Design*. BIS Pub.
- Schiphol | Regionale luchthavens. (n.d.). Schiphol. <https://www.schiphol.nl/nl/schiphol-group/pagina/regionale-luchthavens/>
- Schiphol | Royal Schiphol Group. (n.d.). Schiphol. <https://www.schiphol.nl/en/schiphol-group/>
- Schiphol Group. (2020). Moving towards a more sustainable airport: Figures and data over 2019. In <https://www.schiphol.nl/en/download/b2b/1595320986/1BKyULSQcE2G4qGw4wmYm8.pdf>.
- Simonse, L. (2018). *Design Roadmapping: Guidebook for Future Foresight Techniques*. BIS Publishers.
- Stoeva, K., & Alriksson, S. (2017). Influence of recycling programmes on waste separation behaviour. *Waste Management*, 68, 732–741. <https://doi.org/10.1016/j.wasman.2017.06.005>
- Tait, P. R., Brew, J., Che, A., Costanzo, A., Danyluk, A., Davis, M., Khalaf, A., McMahon, K., Watson, A., Rowcliff, K., & Bowles, D. C. (2020). The health impacts of waste incineration: a systematic review. *Australian and New Zealand Journal of Public Health*, 44(1), 40–48. <https://doi.org/10.1111/1753-6405.12939>
- Thomas, C., & Sharp, V. (2013). Understanding the normalisation of recycling behaviour and its implications for other pro-environmental behaviours: A review of social norms and recycling. *Resources Conservation and Recycling*, 79, 11–20. <https://doi.org/10.1016/j.resconrec.2013.04.010>
- Tonglet, M., Phillips, P. S., & Read, A. D. (2004). Using the Theory of Planned Behaviour to investigate the determinants of recycling behaviour: a case study from Brixworth, UK. *Resources Conservation and Recycling*, 41(3), 191–214. <https://doi.org/10.1016/j.resconrec.2003.11.001>

References

- Toxboe, A. (2019, April 8). Making the Fogg Behavior Model actionable. Copyright (C) 2007-2023 Anders Toxboe. <https://ui-patterns.com/blog/making-the-fogg-behavior-model-actionable>
- TULIPS. (2022, November 4). TULIPS. <https://tulips-greenairports.eu/>
- United Nations. (n.d.). Facts and Figures | United Nations. <https://www.un.org/en/actnow/facts-and-figures>
- Universiteit van Amsterdam. (2023, April 13). Sustainable waste separation. University of Amsterdam. <https://www.uva.nl/en/about-the-uva/about-the-university/sustainability/sustainable-operations/sustainable-waste-separation/sustainable-waste-separation.html?cb>
- Youngblood, M., & Chesluk, B. (2020). *Rethinking Users: The Design Guide to User Ecosystem Thinking*.