Behaviour change strategies for higher return of PET bottles and cans at Schiphol

Graduation report

Anniek Keijer
Design for Interaction

Master Thesis
Delft, October 2023

Author
Anniek Keijer
Design for Interaction (MSc.)

Supervisory Chair
Dr. ir. Koning, J.I.J.C. de (Jotte)
Assistant Professor
Design for Sustainability Transitions

Supervisory Mentor
Dr. ir. Dam, S.S. van (Sonja)
Assistant Professor
Circular Product Design and Energy Consumption & Transitions

Company Mentor
MSc. Tschavgova, E. (Elisabeth)
PhD candidate

Delft University of Technology
Faculty of Industrial Design Engineering
Landbergstraat 15
2628 CE, Delft
The Netherlands

Preface

Dear reader,

This is it! My final project for my master's Design for Interaction. I would have never thought that my study time would come to an end, but it is truly nearly there now. The past few months have been very intense, but I am proud to finalize it with this project, with this report, on this amazing topic.

At first, I would like to thank my supervisory team; Jotte, Sonja and Elisabeth. Jotte, thank you for your feedback and expertise on this topic when I needed it. Sonja, thank you for all your knowledge that has enriched my project so much. Both of you, thank you for guiding me towards graduation! Elisabeth, thank you for all the effort and time you have put in my project, and for all your positivity.

Thank you, stakeholders Schiphol and TULIPS for creating this opportunity, and shaping the project with your insights.

Waste handler A, and catering company B, thank you for your time to have interviews with you. Thank you cleaning company B and catering company A for your insights during the interviews and the visits you have realised for us.

Cleaning company A and Rotterdam The Hague Airport, my gratitude is great for you, without your efforts and help, my project would not have felt as satisfactory as it does now.

Thank you Eindhoven Airport, for your insights and visit opportunity. Thank you De Afvalbak, Avinor Airport, TU Delft waste manager, Statiegeld Nederland, NS. You all have provided me with great knowledge during our interviews and email communication.
I would also like to thank all the participants in my interviews and creative sessions with passengers and students, you have helped me out a lot!

Lastly I want to thank the people who stood closest by me during the last months.
First I would like to thank you, Nika. I am very grateful that we were able to graduate together, it was great to have team NIEK and being able to share our graduation struggles.
Second I would like to thank Thomas and Teska, you have been great graduation buddies of mine.
Third, my friends and family. You have been invaluable with helping me during the past months. In particular Pepijn, you are a true SolidWorks magician, thank you for your invaluable help!
Last but not least, thank you Sjoerd. For proof reading my report. Next to that, thank you for just being there. I would not have managed without your hugs and love.

For anyone who I might have forgotten, this was not on purpose, but do know I value you too: thank you!

All the best,

Anniek

Abstract

This report delves into the intricacies of sustainable consumer behavior, in the context of Schiphol airport. Schiphol airport is a large airport with large numbers of passengers. These passengers also create waste, which is discarded of. Schiphol has the aim to be zero-waste by 2030.
PET bottles and cans could be seen as a big contributor in the waste streams of Schiphol. This was concluded from research that was executed by TULIPS.
An opportunity for this project was found, as PET bottles and cans are a great option for recycling. This means that ideally these beverage containers should have their separate waste stream.
Drawing upon Fogg's behavior model (2009) as a foundational framework, design opportunities could be found. The model proposes that behaviour is a combination of three key factors: motivation, ability and triggers. In this context, motivation is explored in terms of environmental concerns, while capability is divided into components such as time, money and physical effort, among others. Triggers, on the other hand, are categorised as sparks, facilitators and signals, each playing a different role in influencing behaviour.
The research further delves into practical applications, with a focus on Schiphol and the challenges of PET bottle and can collection. Through a series of brainstorming sessions and idea generation exercises, participants created visual ideas and potential solutions.
A final design is proposed which consists of an add-on at the current waste bins at Schiphol, and a campaign proposal.
The report concludes with a series of recommendations and insights into what the final design could offer Schiphol as it moves towards a more sustainable future.

Glossary

Contamination: pollution of a waste stream with anything that is not supposed to be there.

Deposit: an amount of money you pay for the packaging when buying a drink, that is returned to you when delivered at an RVM (see below). This stimulates returning the packaging in order to let it be recycled.

Environmental Concern (EC): the degree to which people are aware of problems regarding the environment and support efforts to solve them (Dunlap & Jones, 2002)

Pro- environmental behaviour (PEB): actions taken by individuals or groups that contribute to the protection and preservation of the environment.

PET: refers to a drink packaging made of PET (polyethylene terephthalate) which is recyclable plastic.

Can: a drink packaging made of aluminium which is recyclable.

Collection: the initial step where consumers deposit their empty bottles and cans in designated bins.

Recollection: the ratio between the amount of sold PET beverage bottles in a certain region and the amount of recollected PET bottles in the same region.

RVM: Reverse Vending Machine, a machine where a person can insert a recyclable product in, like PET bottles or cans, in order to receive a reward (like the deposit) back.

FBM: Fogg Behaviour model.

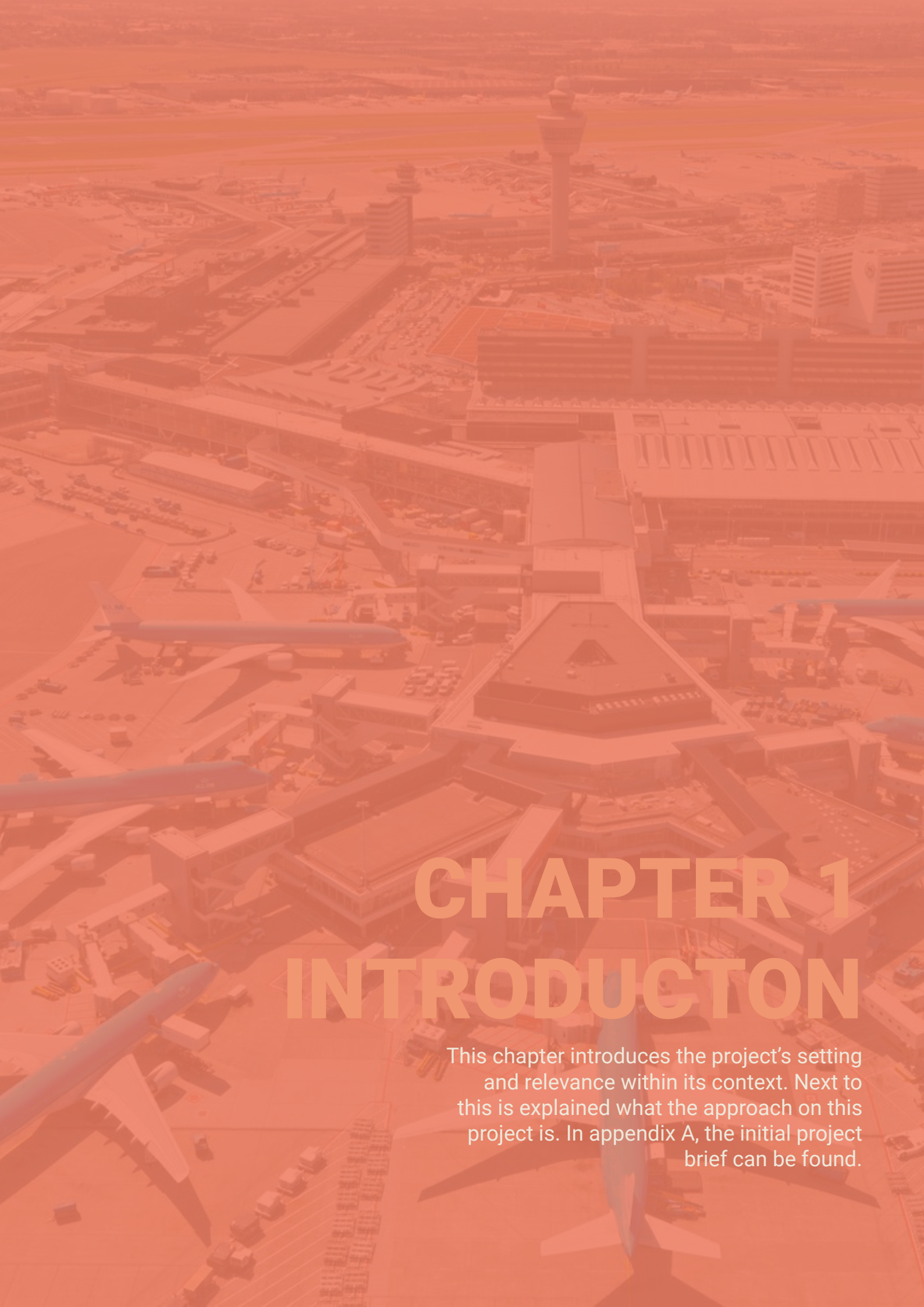
FF3 waste bin: Schiphol's waste bin with the holes 'paper, plastic and residual'. See figure 1.

Donation box: Schiphol's current PET bottle collection system. See figure 2.

Figure 1, FF3 bin at Schiphol

Figure 2, PET bottle donation box at Schiphol

Table of contents



CHAPTER 1
INTRODUCTON

This chapter introduces the project's setting and relevance within its context. Next to this is explained what the approach on this project is. In appendix A, the initial project brief can be found.

1.1 Project introduction

1.1.1 Sustainability

We are facing the biggest threat that humanity has ever faced, as climate change is happening and the climate crisis is real (UNEP, n.d.). A part of the solution to addressing the climate crisis could be to shift to a circular economy. Stahel (2016) states that 'A shift to a circular economy would reduce each nation's greenhouse-gas emissions by up to 70% and grow its workforce by 4%'. See figure 3 for a visualisation of closing loops aiming for a circular economy. In this project, the aim is to make sure the recycling stream is higher than before, reducing the amount of extracted virgin PET plastics and aluminium.

Conventional waste management minimises the expenses associated with collecting and disposing of waste (Stahel, 2016). It is therefore key to understand and create opportunities for sustainable waste management in order to close the loop.

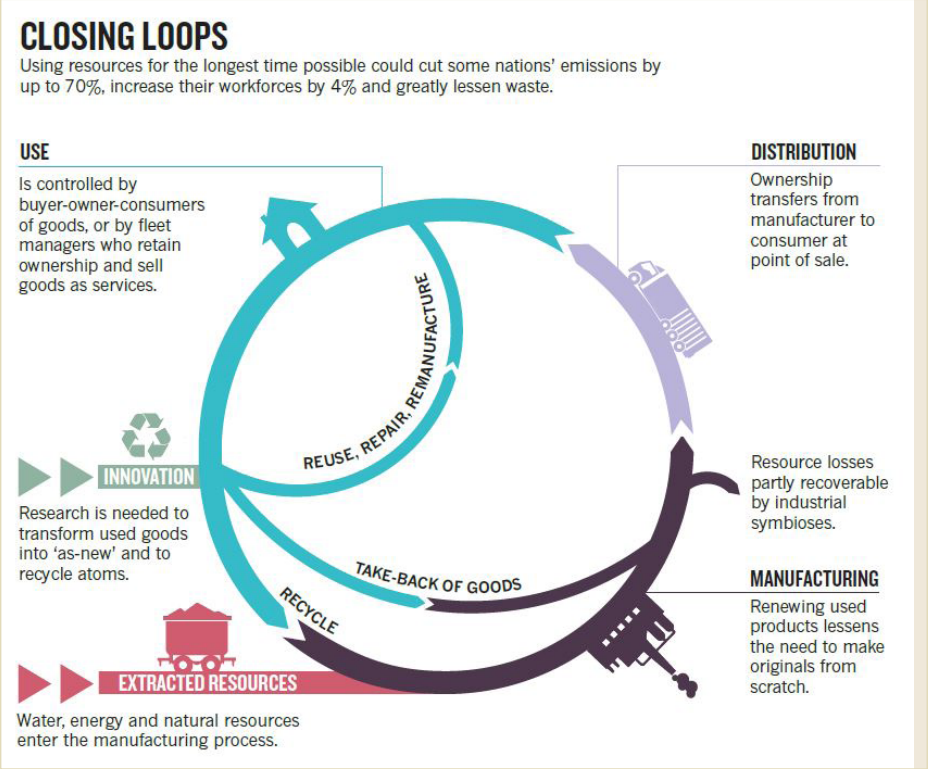


Figure 3, Closing loops (Stahel, 2016)

1.1.2 Schiphol

Schiphol is a large airport, situated in The Netherlands. Schiphol had 52,2 million passengers traveling through the airport (Verdubbeling Aantal Reizigers Schiphol in 2022, 2023). See figure 4 for passenger amounts of other airports. Schiphol has the goal to be zero-waste by 2030, which means that "all raw materials, components and products will be reused or recycled to the maximum extent possible according to the waste hierarchy" (Royal Schiphol Group, 2022).
The airport hosts 95 food and beverage selling points (Schiphol | Plattegronden, n.d.), which suggests a large portion of the waste stream is food and beverage related. Returning PET bottles and aluminium cans, helps to reuse the materials used for bottles and cans. Next to this, recycling bottles is more sustainable than making new ones: it uses less virgin materials, less energy, and creates less carbon dioxide (Dearmitt, 2020).

1.1.3 TULIPS

This thesis is part of TULIPS, a project funded under the European Union's Horizon 2020 research and innovation program. It responds to the European Green Deal and aims to reduce (and even eliminate) emissions at airports. Schiphol is the facilitator of this project, in which capacity it facilitates the (making and) testing of prototypes in the context of an airport (TULIPS, 2022).

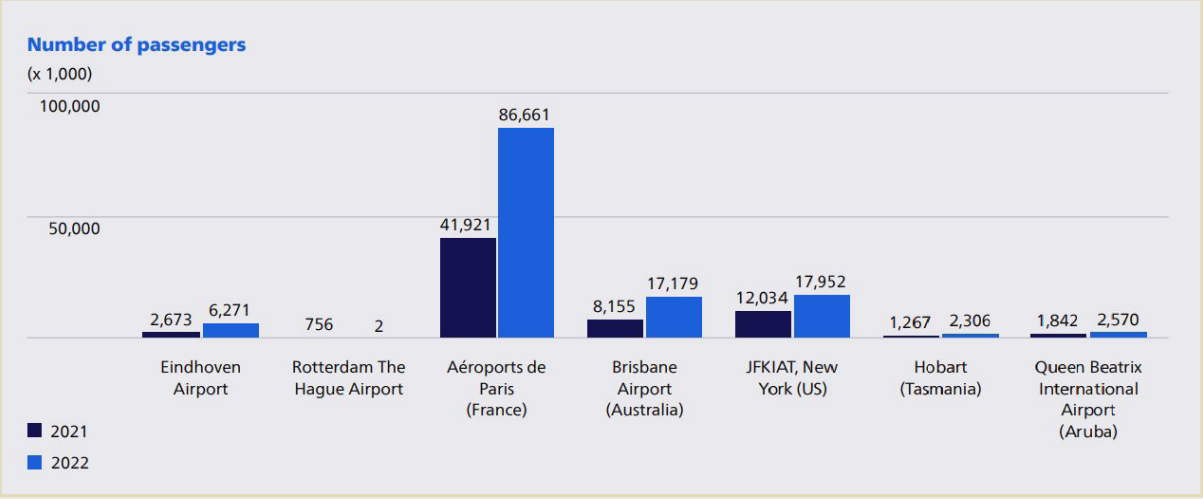


Figure 4, number of passengers for different airports worldwide (Royal Schiphol Group, 2022)

1.2 Design brief

1.2.1 Problem Definition

The previous years have shown that climate change is happening and we need to decrease our environmental footprint (UNEP, n.d.). Humanity needs to be more conscious about its waste creation and disposal. This is also relevant for airports such as Schiphol, where consumption is high, because of its 52,2 million passengers per year (Verdubbeling Aantal Reizigers Schiphol in 2022, 2023). These passengers buy and consume food and beverages at airside for an average of €6,17 per person in 2022, see figure 5.
Airside is the area of an airport that is beyond the security checkpoint (and passport and customs control), and includes the airfield and other areas where aircraft operate.
These 52,2 million passengers generate waste, as for example buying a drink in a single use bottle/can is often part of the travel journey of these passengers. Schiphol aims for zero waste by 2030. To meet the goal of zero waste, the number of returned PET bottles and cans needs to increase. This number is currently very low (catering company A). Therefore, this project aims to create a design towards higher return of PET bottles/cans.

Spend per departing passenger at Schiphol (in EUR)

	2022	2021
Airside retail	12.67	14.02
Airside catering	6.17	5.97
Total	18.84	19.98

Figure 5, average spent per departing passenger at Schiphol (Royal Schiphol Group, 2023)

1.2.2 Current barriers for Returning PET bottles and aluminium cans

Some barriers can be seen at Schiphol that make returning a PET bottle/can less likely. Firstly, Schiphol has donation boxes, but there are not many of them. See figure 2 for a donation box. They are not placed uniformly throughout the airport, which makes it hard to find one, and makes it less likely that people know of them and go looking for them. Secondly, there are no Reverse Vending Machines (RVM), where the deposit can be received back. Thirdly, there are many different cultures and passengers that have different practices regarding recycling their waste. Therefore they might not know of the deposit on PET bottles and cans in The Netherlands.

1.2.3 Project scope

To scope the project, decisions were made to determine the project's area at Schiphol. Schiphol is a very large airport which consists of multiple terminals and many gates, as well as a pre-security area and a post security area for passengers. An important aspect for this project is the difference in these areas. This difference is mostly about the mindset of passengers. At the landside area (before security), passengers are in general a bit more stressed than at the airside, as this is the last time where there could be a stressful activity and there might be a time consuming queue. After that, passengers go to the gate and try to relax there. For this project the focus will be on the area behind security as these passengers are more likely to consume a drink in a PET bottle or can, and will thereafter dispose of it along their journey at the airport.
Also, the project will focus on passenger terminal waste after security, rather than waste from the airplane or other waste generated backstage of Schiphol. See the orange highlighted part in figure 6.

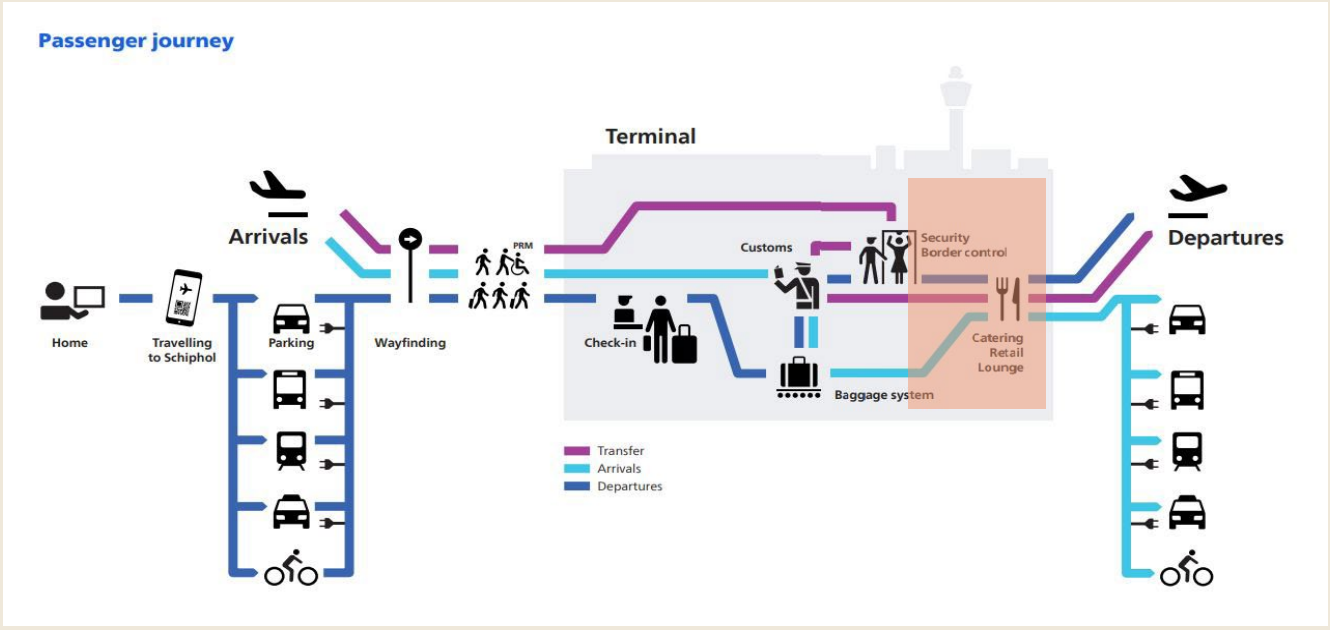
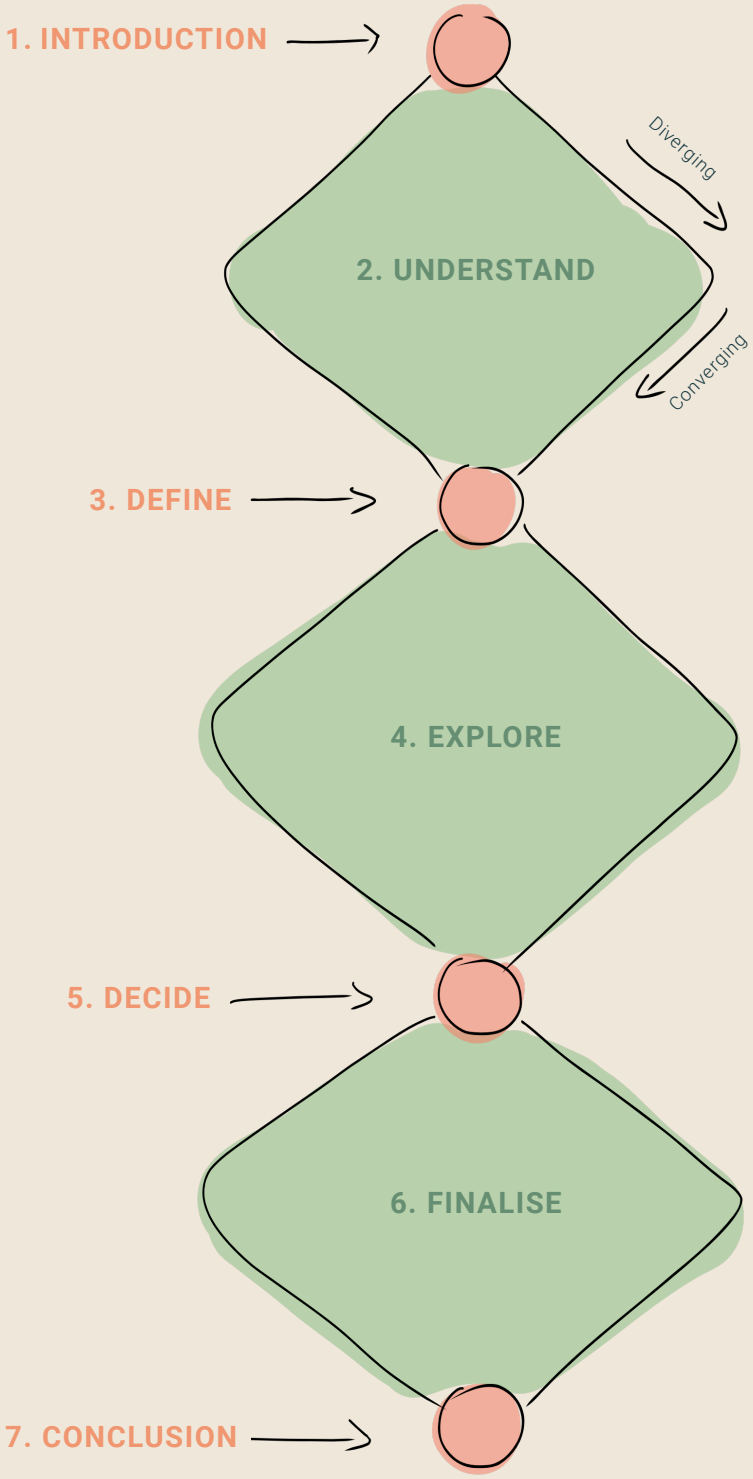


Figure 6, passenger journey (Royal Schiphol Group, 2023)

1.3 Project approach

This project follows the triple diamond model (The Double Diamond - Design Council, 2005) for the graduation process. This model helps the design process. This project is done in 100 working days. A visual of the double diamond model is shown in figure 7. The visual explains what chapter will be discussed in which phase of the project.



The introduction phase will dive into the project's context and relevance. The design brief is discussed and the project approach is discussed.

The understand phase shows more elaborate research outcomes of the context and relevance of PET bottles and cans. Next to this, Schiphol and its practices are explained. The last paragraph explains how sustainable consumer behaviour can be achieved.

The define chapter concludes the analysis phase.

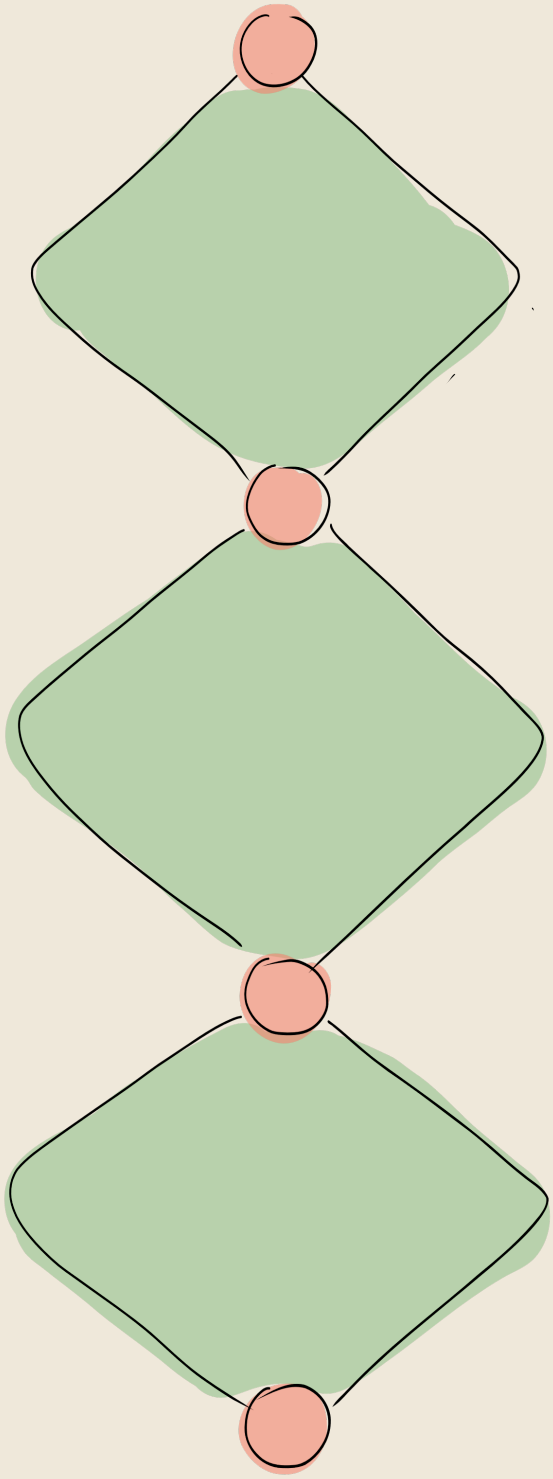
The explore phase shows the ideation, conceptualisation and concept testing outcomes.

The decide phase explains which concept was worked out as the final design.

In the finalise phase, the final product is introduced, and the validation tests are discussed.

The conclusion phase explains what recommendations can be made, and what the final design could bring Schiphol.

Figure 7, Triple diamond



1.4 Research activities

Stakeholder interviews
Semi structured interviews with Schiphol stakeholders were conducted to gain knowledge on their view on the topic.
- Schiphol
- Catering company A
- Waste handler A
- Cleaning company A & B

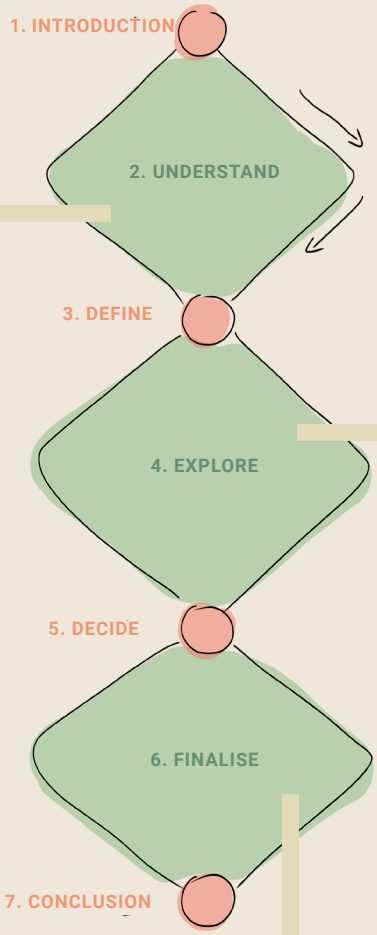
Interviews external parties
To gain knowledge about the topic outside of Schiphol.
- TU Delft
- Statiegeld Nederland
- NS
- Rotterdam The Hague airport
- Avinor airport
- Eindhoven airport
- DeAfvalbak

Desk research
Gaining knowledge about sustainability, deposit systems, different practices, sustainable consumer behaviour.
- Literature study
- Podcast Alledaagse vragen

Visits
- Observational study Schiphol
- Informational visit catering company A
- Rotterdam The Hague airport
- Eindhoven airport

Passenger interviews
To gather insights in passengers at the airport
- Informal talks in own environment
- 2 TU Delft students
- 5 passengers at Schiphol

Sensitising booklets + interview
- 8 - 10 people sensitising booklets
- interviewed for more in depth information



Desk research
Desk research for inspirational examples in the waste collection field.

Brainstorm with peers
Brainstorming on the design statement

Motivation brainstorm
With industrial design students and employees

Testing 2 mock up tests
At Schiphol to gather insights on the concepts on how passengers behave around them.

Design with Intent brainstorm
Own brainstorm

Co creation session
With Schiphol, Seenons and TULIPS stakeholders.

SCAMPER
Using the SCAMPER method to iterate on the co creation outcomes

Morphological chart
Using a morphological chart to enrichen the generated ideas.

Testing 2 prototypes
At Schiphol to gather insights on the concepts on how passengers behave around them.

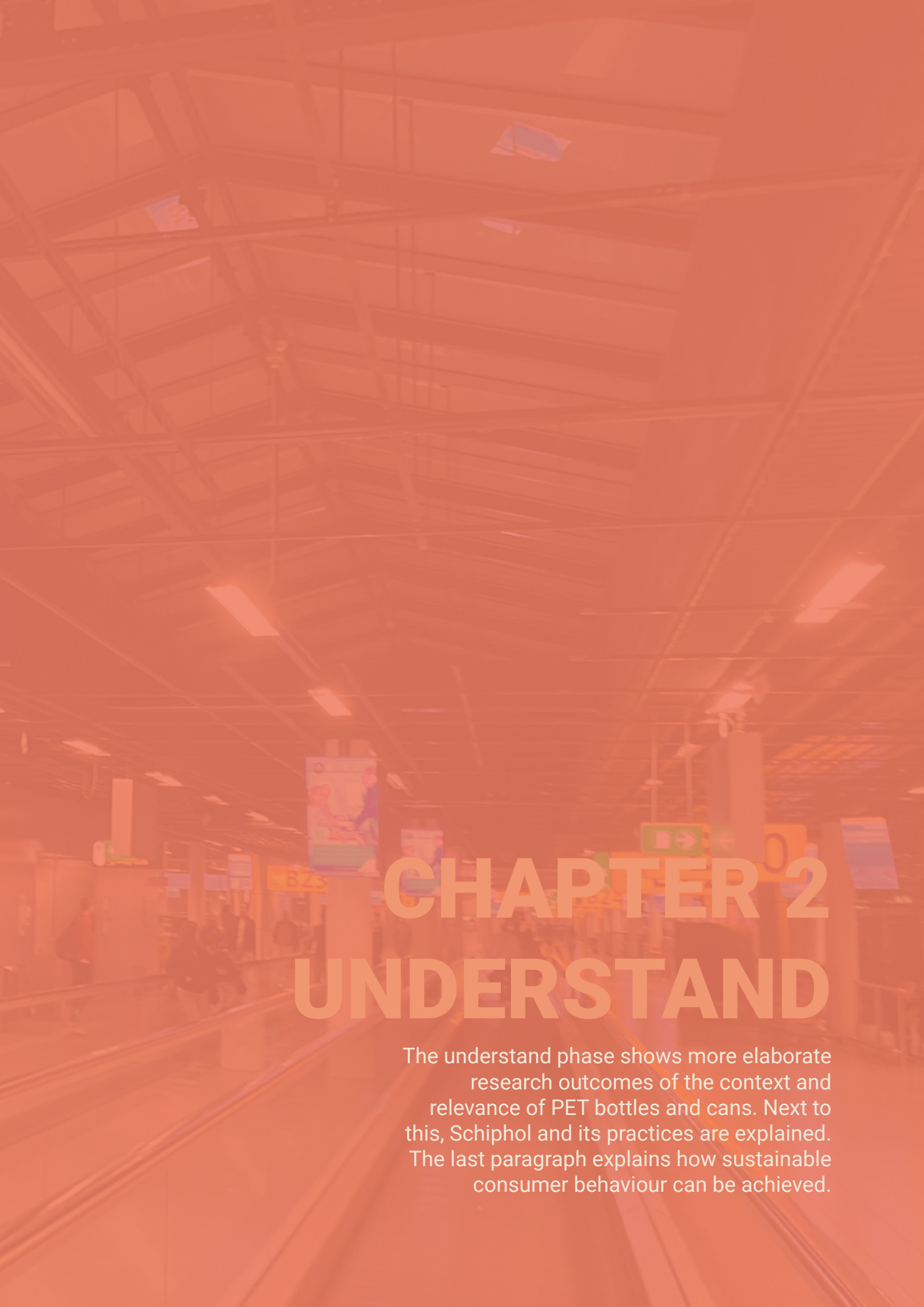
Testing final prototype
Industrial Design Engineering

Testing final prototype
Rotterdam The Hague Airport

Figure 8, Research activities overview

Takeaways 1

I This project will focus on increasing the number of returned PET bottles and cans (the discarding phase), as there are currently very few returned bottles and cans.
II Returning materials is a great way to collect materials for recycling. This project will therefore focus on the return of PET bottles and cans.
III There are currently not many donation boxes available at Schiphol. It is not clear whether the current system is not working or whether the number of boxes available is not sufficient.
IV There is currently no way for a passenger to get their deposit back at the airport, so this project also aims to find a solution that does not involve the return of a deposit.
V Passengers from different countries are likely to have different habits, and this needs to be taken into account in the design analysis.



CHAPTER 2
UNDERSTAND

The understand phase shows more elaborate research outcomes of the context and relevance of PET bottles and cans. Next to this, Schiphol and its practices are explained. The last paragraph explains how sustainable consumer behaviour can be achieved.

2.1 Context of PET bottles and cans

To show how PET bottles and cans are currently used, and how their recycling works, this chapter explains more about the usage and discarding phase. How the EU addresses this topic, how people currently behave with PET bottles and cans, and the current situation at Schiphol are all discussed. This was accomplished through a combination of desk research, interviews conducted with stakeholders, external parties, and passengers, site visits to airports, and the distribution of sensitising booklets followed by subsequent passenger interviews.

2.1.1 PET bottles and aluminium can application

Polyethylene terephthalate (PET) is the most commonly used material for bottles. The reasons PET is used for bottle packaging is explained by Welle (2010). He states that polyethylene terephthalate (PET) is the preferred material for beverage packaging worldwide due to its good material properties, unbreakability, and low weight compared to glass. PET bottles find application in a variety of beverage containers. See figure 9 for an overview on which products are typically made from PET. It can be seen that 97% is used for packaging, and 64% of the total amount of PET products is used for beverage bottles. Observations at Schiphol showed that PET bottles were refilled with water and closed off, to be used again. This is not (always) the case for glass packaging or cans packaging.

Figure 9, PET products on the market (EUNOMIA et al., 2022)

The paper of Bungărdean et al. (2013) explains that aluminium cans also have benefits when used as drink packaging. Aluminium cans are lightweight, which makes them more energy efficient to transport and reduces greenhouse gas emissions from transportation, in comparison to for example glass bottles. Aluminium cans have a long shelf life, reducing the need for preservatives or other additives in the drinks.

Takeaways 2.1.1
VI PET bottles can be closed off after opening, which makes them transportable onto the airplane.
VII Cans cannot be closed off and will therefore cause more filth than PET bottles in a return system.

2.1.2 PET bottles and aluminium can collection and recycling

PET bottles

PET bottles are ideal to recycle, and in the past decades there has been progress in recollection and recycling facilities. In 1991, the USA granted its first approval for post-consumer recycled PET to be used in direct food contact applications. Since then, there has been a huge progress in the recollection and recycling processes of PET (Welle, 2011).

According to Welle (2011), advanced decontamination methods are now available for PET that can clean post-consumer contamination to the same concentration levels as virgin PET materials. PET does not chemically react with other substances or decompose easily, making it a stable and durable material, especially for bottle-to-bottle recycling. According to Welle (2011), there are several reasons for this:

1. PET bottles have global availability and efficient recycling systems, ensuring high recovery rates compared to other plastics.

2. PET bottles can be easily sorted from waste through automated or manual methods.

3. Foreign plastics can be effectively removed from PET recycling streams.

4. Coloured PET bottles can be sorted by colour and recycled separately due to PET's transparency.

5. PET doesn't require additives like plasticizers or antioxidants.

6. Minimal contamination of printing ink occurs as PET bottles are not directly printed.

7. All PET materials in food and non-food packaging meet European and US regulations.

8. PET is inert and has minimal compound absorption during its primary use.

Welle (2011) shows that PET bottles are easily recollected and sorted through curbside collections and deposit systems, with deposit systems having the advantage of being mainly beverage bottles. The use of post-consumer recycled PET (PCR PET) into new packaging applications is driven by sustainability concerns rather than cost reduction as it is currently not cheaper than virgin PET. Combining bottle-to-bottle recycling with monomers from renewable resources is seen as a key factor for sustainable PET packaging in the future (Welle, 2011).

Overall recycling capacity has increased by 21% in two years (EUNOMIA et al., 2022). See figure 10 for an overview. Recycling capacity in Europe will need to further expand at least one third by 2029 to enable EU Member States to meet the EU 90% collection rate and the mandatory recycled content targets.

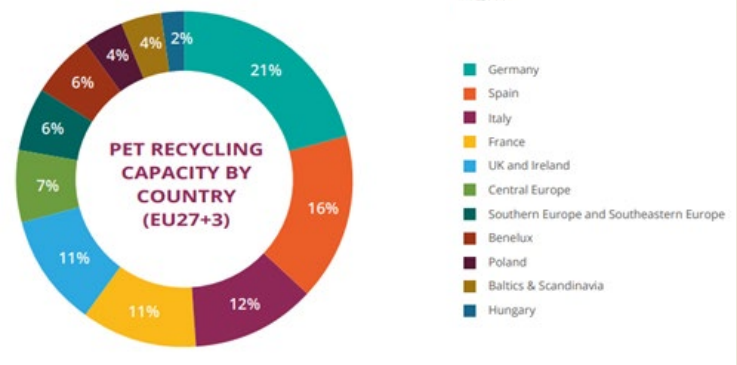


Figure 10, PET recycling capacity by country in the EU (EUNOMIA et al., 2022)

Figure 11, a bottle made from recycled PET

Aluminium cans

Aluminium cans are also a recyclable packaging option. According to Bungărdean et al. (2013) aluminium cans are infinitely recyclable without losing their quality, making them a sustainable packaging option. According to Bungărdean et al. (2013), there are some main advantages in recycling aluminium cans:
recycling aluminium cans reduces the need for virgin aluminium production, which consumes significant amounts of energy and emits greenhouse gases
Precious material is recovered and the quality is not lowered by it.
It saves energy compared to primary production, and therefore saves money.
Recycling saves 95% energy compared to developing metal from original bauxite.
It reduces mining activities
It reduces the amount of waste
It only emits 4% of CO2 compared to primary production of aluminium cans
Comparison of recycling of PET bottles and aluminium cans
When looking at the Life Cycle Assessment (LCA) of NAPCOR (The National Association for PET Container Resources) in 2023, a PET bottle is a more sustainable option compared to aluminium cans as a beverage transportation container. See figure 12 for data regarding the comparison between a PET bottle and a can. The figure shows that cans score less on multiple sustainability issues, in comparison to a PET bottle (Voloschuk, 2023). They define the following as solid waste: process wastes: (sludges and residues from material processing), fuel-related wastes: (e.g., refinery wastes, coal combustion ash), and post consumer wastes (disposed containers and packaging, including landfill and waste-to-energy residuals).

Takeaways 2.1.2
VIII PET bottles and cans are a sustainable option to contain and transport drinks. Therefore they will stay a part of the packaging industry.

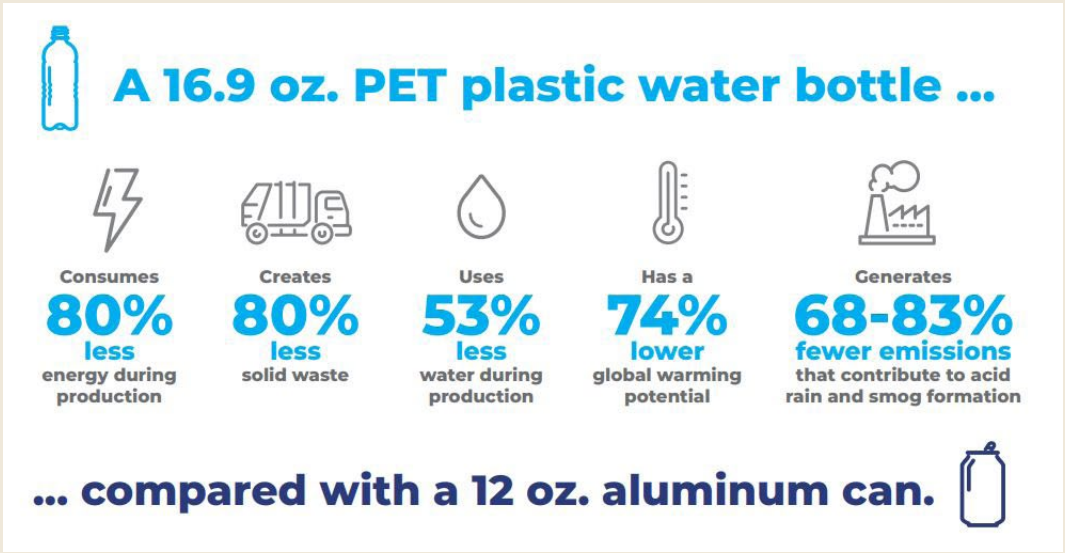


Figure 12, comparison of LCA outcomes of PET water bottle versus a can (The National Association for PET Container Resources (NAPCOR), 2023)

2.1.3 EU's current legislation on recycling PET bottles and cans

The European Union (EU) wants to increase recycling rates and reduce waste, therefore the EU has set targets. The EU has made a Circular Economy Action Plan, which includes rules to improve waste management, increase recycling rates and reduce landfilling.
Specifically for PET bottles recollection and recycling, the EU has set targets as part of the Single Use Plastics (SUP) Directive. This aims to increase the recycling of plastic waste, and reduce marine litter. The SUP Directive sets a target of collecting and recycling 90% of PET bottles by 2029 and requires Member States to implement deposit systems or other measures to make sure that 77% of single use plastic beverage bottles are collected separately by 2025 (European Parliament and Council, 2019). Currently the need for Deposit Return Systems (DRS) is seen as the main option to reach this target. See Figure 13 for PET collection rates across countries with PET DRS in place. For countries who do not have DRS in place, such as Portugal and Poland, where the DRS system will be implemented in 2023 and 2024 respectively , the collection rates are lower. In Poland, the collection rate is 43% and for Portugal 44,6%. For The Netherlands, the collection rate lies at 65%.
Nine out of the ten European countries with established DRS, have achieved recycling rates of 83% or higher. The one that does not reach the 83% is The Netherlands (65%). This could be explained by the fact that this report uses the data from 2020. In 2020 the DRS in The Netherlands only included bottles with volumes greater than 0.5L. It is expected that this recycling rate is therefore increased by now, as 0,5L bottles are also included in the DRS from July 2021.

Takeaways 2.1.3
IX The DRS system is proven to work, which is why Schiphol should integrate RVMs at the airport.
X Europe has set targets, which would help for hopefully in the future, all European countries would work together in one universal deposit system so all PET bottles and cans can be returned in multiple countries, instead of being limited to returning it in the country where it was sold.

Figure 13, PET collection rates across European countries with DRS, (EUNOMIA et al., 2022)

2.1.4 Dutch Deposit system

This section explains how the Dutch Deposit system works. To gather information about this, desk research was done and an interview was held with the organisation Statiegeld Nederland. See the table below for an overview of the interview setup.

Organi-sation	Function	Language interview	Duration interview
Statiegeld Nederland	Relation-ship manager	English	+/- 1 hour

In The Netherlands, there is legislation which states that PET bottles and cans need to have deposits. People pay 15 cents extra for deposit per drink in a PET bottle or can (less than 1 litre). For bottles bigger than 1 litre, the customer pays 25 cents. Statiegeld Nederland is the government's association (executive organisation) for PET bottles and can deposit schemes.

There has been legislation since 1991 on PET bottles larger than 1 litre. From 1 July 2021, legislation has been introduced that will require for all PET bottles to have a deposit. From 1st of April 2023, aluminium cans will also be subject to a deposit. See figure 14 for the impact of deposits on PET and can litter. As can be seen, the legislation has led to an impressive reduction in littered aluminium cans and plastic bottles. This shows that deposits do have a positive impact on the amount of littered PET bottles and cans.

There are some restrictions on returning PET bottles and cans. They need to be empty, they have to be undamaged, and the barcode should be readable. These restrictions make it hard to deliver the bottles and cans that are in theory fit for recycling, so there are materials that get lost by this selection (Zwerfinator, 2023).

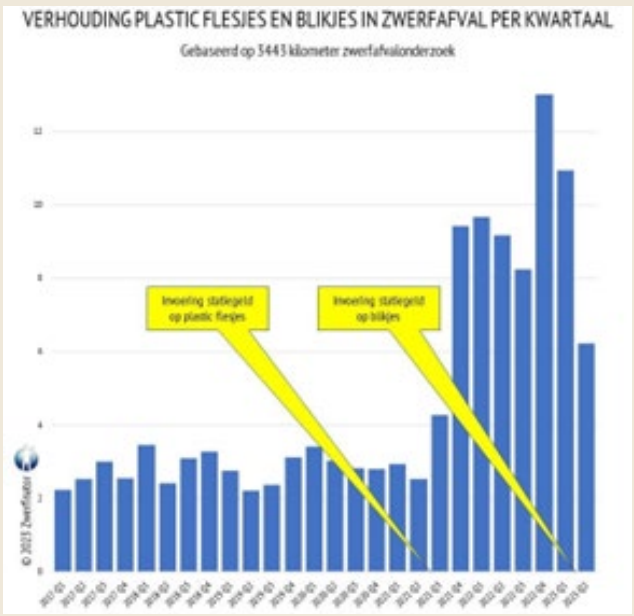


Figure 14, amount of littered PET bottles and cans found

To determine where the deposit stays when a customer does not return their PET bottle or can, an desk research analysis is made (see figure 13). When a customer buys a drink in a PET bottle or a can, they pay a deposit. When the customer returns this drink in a Reverse Vending Machine (RVM), they can get the deposit back that they initially paid. There is also an option in The Netherlands to return your PET bottle or can in a donation box, where the full value of the deposit is donated to certified charities. Customers are therefore incentivised to return their PET bottles and cans. This way the materials of the PET bottles and cans can be recycled, and therefore stay in the loop.
In figure 15 is shown how the deposit moves between client, seller and Statiegeld Nederland. In the upper section is shown how the deposit of 15 euro cents moves from one party to the other. In figure 13 can be seen that with every activity, the deposit of 15 euro cents moves from one party to another. And the money balance is shown which shows the money balance that the party is on. There is an even outcome where everyone ends up at not losing or gaining any money. Figure 15 shows how the money is transferred from party to party, but stops when the bottle is not returned. As can be seen, the value of the unreturned bottles and cans, stays parked in an unredeemed state portfolio at Statiegeld Nederland. After deduction of costs of the association and budgets used to maintain and improve the system (such as marketing campaigns and placing extra RVMs), the remainings stay parked (Statiegeld Nederland). The industry board and board of directors of Statiegeld Nederland are the ones that decide if and how subsidies/reimbursements/fees are divided over the different industries, in being able to raise the ingestion, and therefore the recycling through deposit. The podcast Alledaagse Vragen confirms this as well. There it is explained that yearly 42 million euros goes to Statiegeld Nederland, who need to use it for improving the deposit system in The Netherlands (Alledaagse Vragen, n.d.).

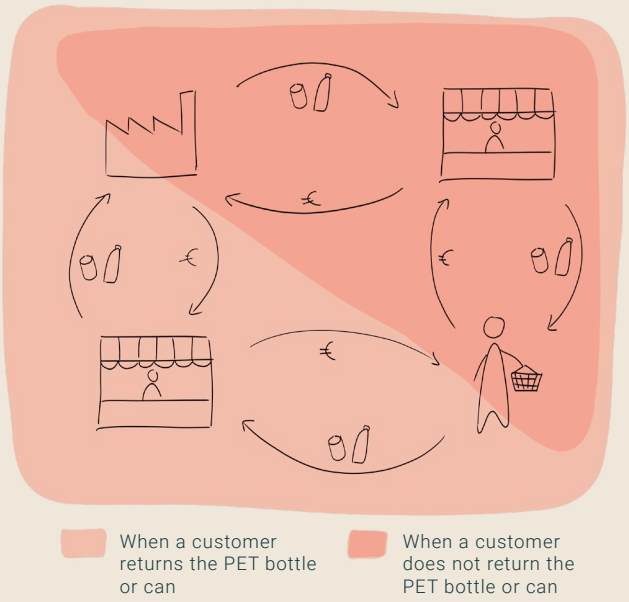


Figure 15, amount of littered PET bottles and cans found

Takeaways 2.1.4
XI Legislation on deposits on bottles and cans have shown to be effective in increasing results, which shows this monetary incentive motivates passengers to return their PET/can. It would therefore be smart to apply RVMs at Schiphol.
XII Statiegeld Nederland is an execution association for the government which is responsible for the deposit system in The Netherlands. The industry board and board of directors of Statiegeld Nederland are the ones that decide if and how the money is divided over the different industries, in being able to raise the ingestion, and therefore the recycling through deposit. They would therefore need to agree on placing RVMs at Schiphol for example .

2.1.5 Current practices on disposing of PET bottles and aluminium cans

This section will explain what practices people currently have around the disposing of PET bottles and aluminium cans. To understand this, multiple activities were done. Desk research was done, and interviews were held.
Semi structured interviews were conducted with a convenience sample, see the interview setup below.

Number	Background	Nationality	Duration interview
Participant 1	Employed	Dutch	20 minutes
Participant 2	Student	Chinese	15 minutes

Next to this, semi structured interviews with Schiphol passengers were held. Two of those at IDE, and five of those at Schiphol. See the overview below for the test setup. The passengers at Schiphol were selected by a convenience sample, as the passengers were able and willing to participate in the study there. This explains why specific countries are discussed in the following section. See confidential appendix B for the transcripts of these interviews.

Number	Background	Nationality	Duration interview
Passenger 1	IDE student	Chinese	5-10 minutes
Passenger 2	IDE student	Indian	5-10 minutes
Passenger 3	Schiphol passenger	Brazilian	5-10 minutes
Passenger 4	Schiphol passenger	British	5-10 minutes
Passenger 5	Schiphol passenger	Canadian	5-10 minutes
Passenger 6	Schiphol passenger	Bulgarian	5-10 minutes
Passenger 7	Schiphol passenger	Dutch	5-10 minutes

EU and UK

Literature shows that there are multiple practices possible regarding the use and disposal phase of a PET bottle or can in daily life. This paragraph will explain practices in Europe and the UK. PET bottles and cans are often used as drink packaging. However, disposing of a PET bottle or can is done differently.
As can be seen in figure 16, the collection rate of PET in different EU countries differs significantly per country (Unesda, 2022). Germany takes the lead with 95% collection of their PET bottles. Greece's collection rate lies far below that, namely 28%. This means that collection is not as common for Greek citizens, as it is for German citizens. The collection rates could be influenced by the presence of a Deposit Return Scheme (DRS), see figure 17 for an overview of (non-)established DRS in Europe. The conclusion could be made that a DRS has a positive influence on the collection rates in Europe, as Scandinavia has high rates and DRS in place. And on the other hand, other countries who do not have DRS in place (yet), have low collection rates.

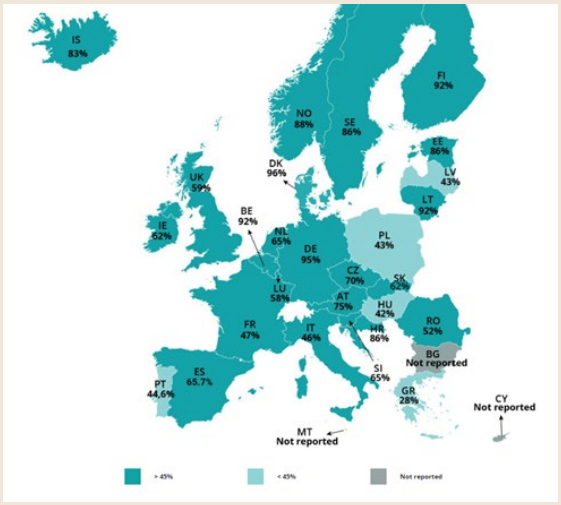


Figure 16, PET collection rates in Europe

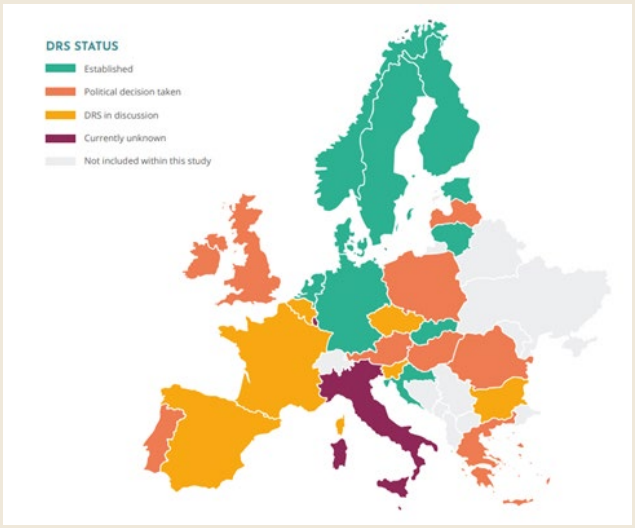


Figure 17, Deposit Return Scheme (PET market in Europe state of play 2022)

By conducting interviews with Schiphol passengers, insights were gained about the current practices of throwing away a PET bottle or can.
Passenger 6 (Bulgarian) said that back at home, there is a recycling system, which is not very organised and does not work very well, as he heard that everything goes in the same waste stream.
Passenger 4 (British) explained that they do have a system in place, where they need to separate in two streams at home; residual and recyclable. The waste handler comes to collect both of these streams but the passenger explains he does not know if the streams stay separate also after collection. He explained that there is also no DRS in place which influences the recycling of PET bottles or cans.
Passenger 7 (Dutch) explained that her waste separation behaviour is encouraged by the facilities that are in place, as the municipality collects her different waste streams such as plastic and rest. Therefore she finds it easy to separate as the threshold is low.

America & Canada

The 2021 PET Recycling Report by the National Association for PET Container Resources (NAPCOR) shows that efforts to improve the usage of PET and reutilization have been successful. The Post consumer PET collection has been higher than 1.9 billion pounds in the United States. The US has been improving their recycling rates for PET slightly, from 27.1% to 28.6% in 2021.
Participant 5 (Canadian) gave insights on the practices from Canada. The participant explained that their PET bottles are collected at homes once every while by volunteers. The money that is collected by it is donated to a local charity.

India & China

By doing desk research and conducting an interview, insights were gained in the practices of Indian citizens. Buying drinks in a PET bottle is common in India. Tap water is not safe to drink there, so water in PET bottles or other drinks in for example cans is available at almost every corner of the street. When a PET bottle is discarded, it is thrown away in the residual waste (bin). This is then hand separated by street pickers who make a living out of collecting PET bottles (PET Recycling in India, n.d.). There is no deposit system in place, but these street pickers sell the plastics to kabadiwallahs, who prepare the raw material destined for wholesalers-dealers who are able to purify these recycled materials and sell them to reprocessors. By doing an interview with an Indian student, this was confirmed (passenger 2). He explains that it is common to throw away your PET bottles and cans in the residual waste, and that there are no other recycling options available.
An interview and informal talks with Chinese students (participant 2, passenger 1) gave insights into the practices of PET bottles and cans in China. There are different systems in place in different regions. Some municipalities use separation at home with recyclable waste (like plastic), wet waste (like food) and non recyclable waste. In public areas there is also the recyclable waste stream bin, and the non recyclable waste stream bin. In smaller towns this might not be the case, and only have one waste stream to throw away waste.

Takeaways 2.1.5
XIII there are clear differences on the handling of empty PET bottles and cans throughout the world, because of policy, practical and cultural reasons
XIV DRS has a positive influence on the collection rate
XV the joining of before separated waste streams is sometimes suspected by passengers

2.2 Schiphol

This chapter explains the situation of PET bottles and cans at Schiphol. Section 2.2.1 will explain how a PET bottle or can moves to, on and from the Schiphol premises. The 2.2.2 section will explain how passengers currently behave and feel about the different options they have to dispose of or bring along a PET bottle or can.

To gather insight in the practices and operations of the waste streams at Schiphol, interviews with stakeholders that operate at Schiphol were held. See Appendix C for transcripts of these interviews.

Number	Role	Duration interview	Language interview
Stakeholder A (Schiphol)	Circular economy lead	1 hour	English
Stakeholder B (Schiphol)	Cleaning Management	1 hour	English
Catering company A	Manager	1 hour	English
Catering company B	Manager	30 minutes	English
Cleaning company A	Manager	1 hour	English
Waste handler A	Manager	1 hour	English

2.2.1 Schiphol PET journey

The PET bottle/can journey at Schiphol can be seen in figure 18. The caterers purchase drinks in PET bottles and aluminium cans from the distributor. After that, the drink is sold to a passenger through one of the restaurants or shops at Schiphol. After usage of the passenger, the discard phase of a PET bottle or aluminium can at Schiphol can go 3 ways. Option (1): it is discarded in a PET donation box (see figure 13); (2) it is discarded in the residual or plastic waste bin (see figure 14); (3) it is taken away from Schiphol grounds (through a flight or taking it home) and discarded elsewhere. Option 1 or 2 are operated by Schiphol's cleaning companies. They collect waste from public passenger areas to the recycling center ("Milieustraat"). From there, the waste handler is responsible for discarding/handling the waste from Schiphol premises to the post separation (for recycling) and incineration facility.

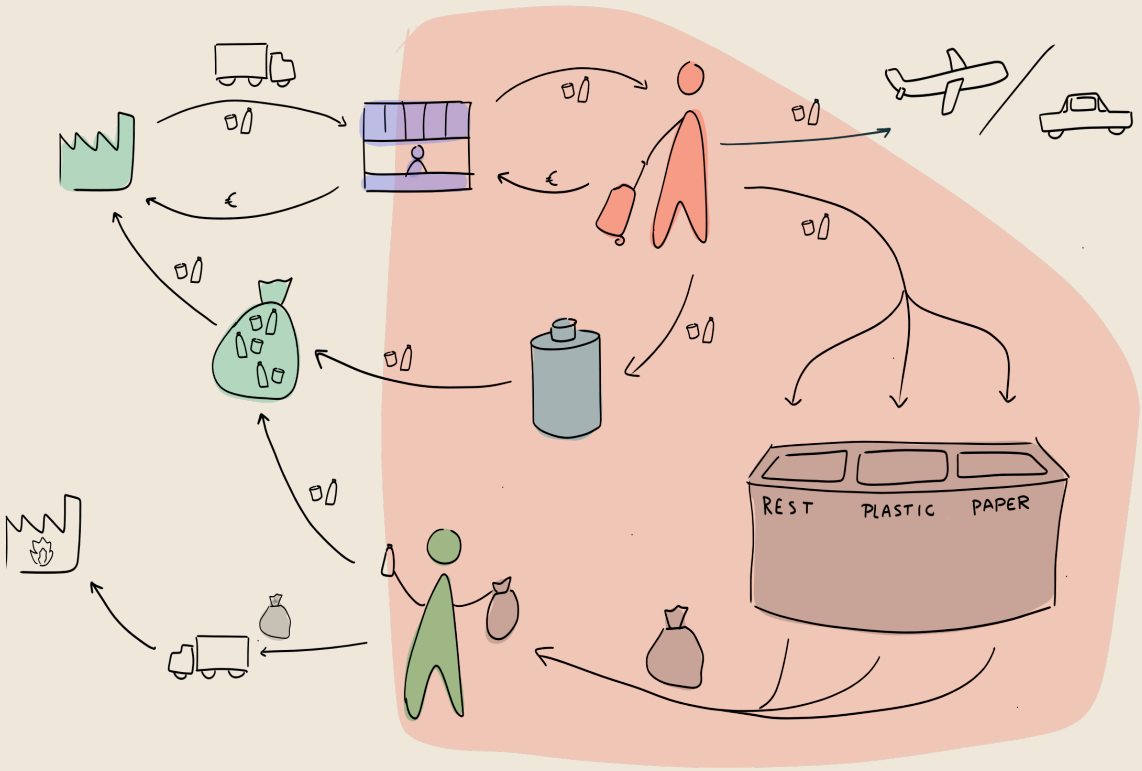


Figure 18, PET bottles and can journey

2.2.2 Schiphol practice

Observations at Schiphol
Observations were conducted at Schiphol to gather insight into how passengers behave regarding their waste disposal.

Place	Duration
Schiphol Airport behind security (airside)	2 hours

Next to this, sensitising booklets were filled in by passengers who flew from Schiphol, to gather insight in their emotions and routine. After that, interviews were held to deepen the understanding of their practices.

Participant number	Nationality
Participant 1	Dutch
Participant 2	Dutch
Participant 3	Dutch
Participant 4	Dutch
Participant 5	Dutch
Participant 6	Chinese
Participant 7	Chinese
Participant 8	Chinese
Participant 9	Chinese
Participant 10	English

As was explained in the previous section, passengers have different practices from back home, which is why they might also behave differently from one another at Schiphol.
At Schiphol, there are three routes which a passenger can take from buying a drink to disposing of a PET bottle or can. By observations at Schiphol, researching by bookles and interviews, and other interviews with passengers at Schiphol (See 2.1.5), the following three customer journeys were formed. They are ranked based on their probability.

The first and mostly done option that passengers take in disposing of a PET bottle or can, is throwing it in the FF3 waste bin. The waste safari, which was conducted by TULIPS, shows that PET bottles and cans can be found in every waste stream of the FF3 bin. They are thrown in the paper, plastic and residual waste bin. Another conclusion that could be made by the return numbers from a catering company at Schiphol (see confidential appendix D), is that this journey is done often. The interviews with passengers also show that passengers assume they do good by throwing it away in the 'recycling option' of the bin, which means that they seek the FF3 bin for the best option. But when the question was asked to an interviewed Brazilian passenger (Passenger 3) of where she would throw away her PET bottle or can when she would be in a hurry, she answered that she would not pay attention to where she would throw it, as long as it is in the closest waste bin.

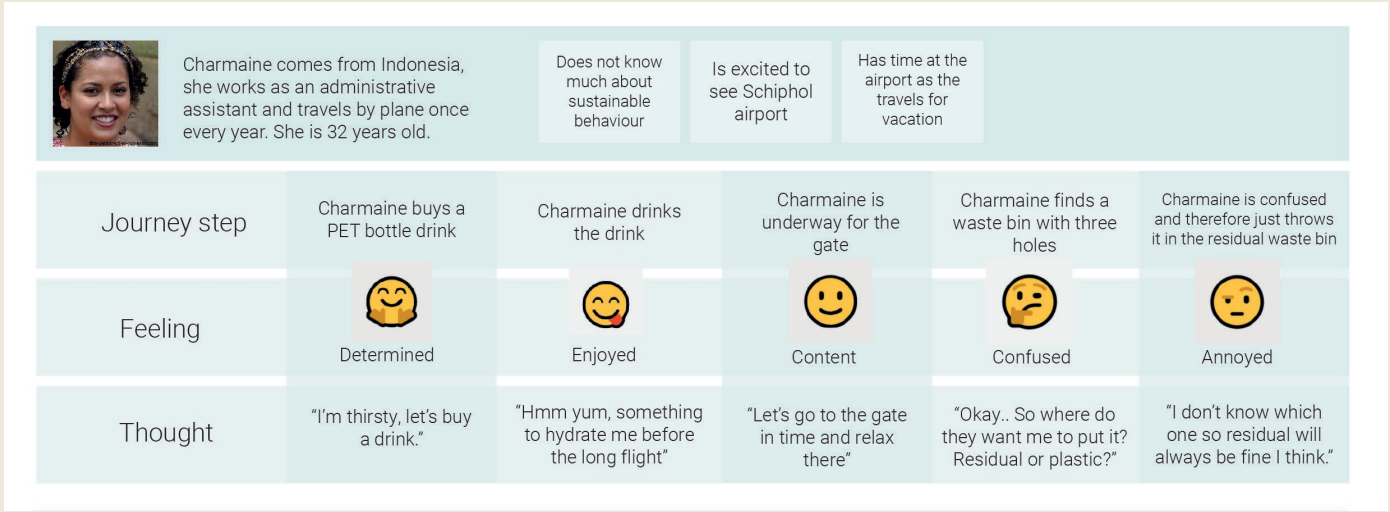


Figure 19, throwing a PET bottle/can in the residual waste bin

The second most carried out option of disposing of a PET bottle is taking a bottle away from the Schiphol premises. With interviews it could be concluded that this happens often. With talking in these interviews it could be concluded that a lot of passengers don't know that they can nowadays take a drink bottle (bigger than 100 ml) with them through security. This is why most passengers buy a drink in a PET bottle or can after security. In these interviews, a Bulgarian passenger bought two drinks in bottles because he was afraid there would not be enough opportunity in the plane to get a drink. Next to this, some passengers said to be afraid that the drinks on the plane are more expensive than at the airport (Participant 1).

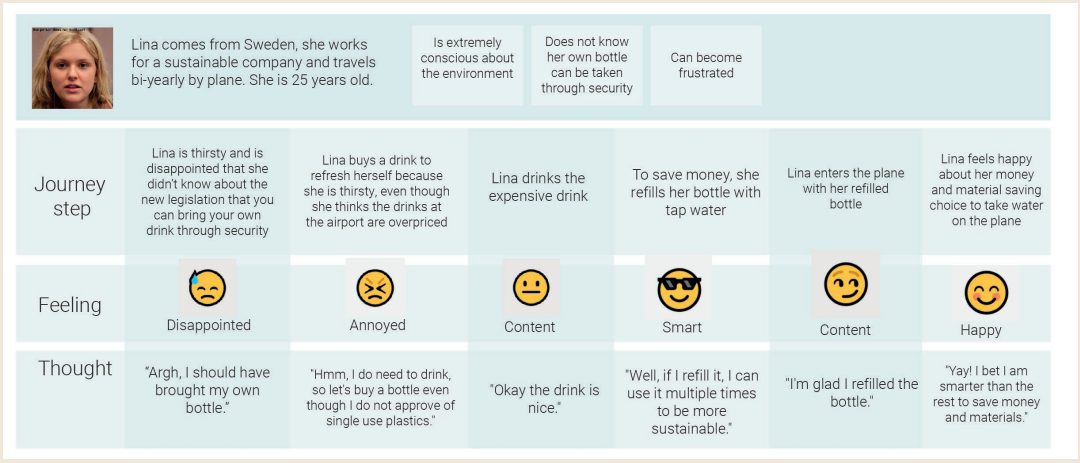


Figure 20, taking a PET bottle on the plane

The last option of disposing of a PET bottle/ can at the airport, which happens the least,, is throwing it in a PET donation box. With observations at Schiphol (Observations), the conclusion could be made that there are not many PET donation boxes available (see confidential appendix D for number). This is also currently the only option to return a PET bottle at Schiphol (Observation and interviews). A passenger therefore needs to seek for a donation box, if the passenger knows that these boxes are available. From the numbers of one of Schiphols catering companies (see confidential appendix D), it could be concluded that passengers almost do not make use of these donation boxes. By conducting interviews with Schiphol passengers, it became clear that most of them did not notice this option. By interviews with stakeholders could also be concluded that this option is not chosen often. The numbers of collected PET bottles are low, comparing them to the amount of PET bottles sold at Schiphol (see confidential appendix D). A side note on this option, is that Schiphol sees that in the public areas (landside of security), these boxes attract homeless people who want to collect PET bottles/cans there in order to return them elsewhere to earn money from it. This is unwanted by Schiphol as they often disturb Schiphol visitors and passengers.

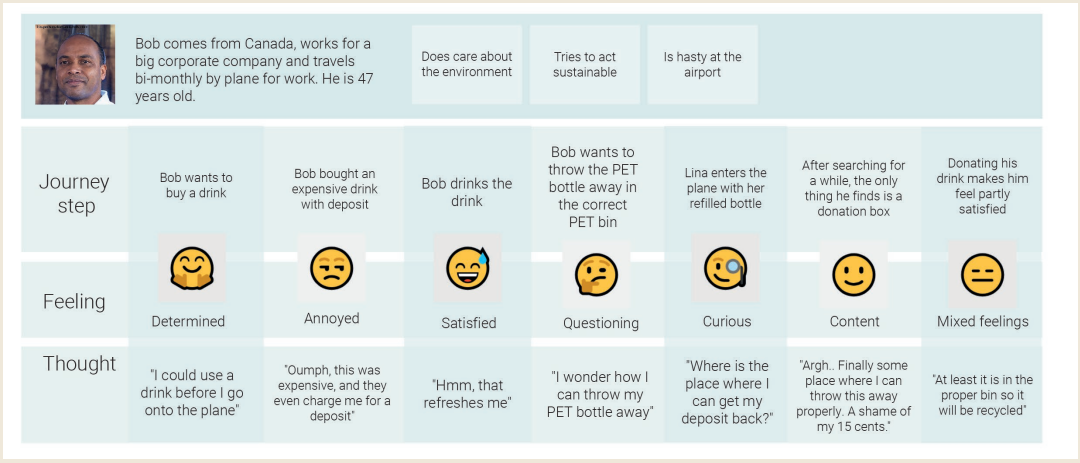


Figure 21, throwing away a PET bottle/can in a donation box

Takeaways 2.2.2
XVI Passengers do not separate their waste correctly in the FF3 bins at Schiphol.
XVII PET plastics will go into the regular plastic separation process when thrown in the FF3 bin, this deteriorates the quality of the material as it is more contaminated than when it would be collected through a separate PET waste stream. For this project it means that the aim will be on creating a separate PET and cans collection opportunity.
XVIII Current PET donation boxes are contaminated. For this project this means that PET donation boxes are not effective enough to ensure a non-contaminated waste stream.
XIX Recycling practices for PET bottles and cans vary across different countries which means that the solution needs to take into account that it needs to be clear across multiple cultures.
XX At Schiphol airport, passengers have three main disposal routes for PET bottles and cans: donating to PET donation boxes (rarely used), throwing in the residual waste bin (common practice), or taking them on the plane (regular occurrence).

2.2.3 Other transit areas/points

This chapter will discuss how other airports and transit areas/points are tackling their PET bottle/can waste returnage. Rotterdam The Hague airport and Eindhoven airport are both part of Schiphol group. Therefore they do have some of the same stakeholders who are involved in their retail and waste management, but as they are situated in different areas of The Netherlands, they do have differences in waste handling. Rotterdam The Hague airport and Eindhoven airport do have their own say in how they want to approach their waste handling. Avinor airport is also a company that handles passenger waste at the airport. Nederlandse Spoorwegen (NS) gave insights on their PET/can waste handling as they are also handling a system which could be described as a transit area.
Lastly, Brussels airport has an intervention which will shortly be described.

Rotterdam The Hague Airport

An interview was held with a Rotterdam The Hague Airport employee.

Participant	Role	Duration interview	Language interview
External stakeholder A	Sustainability advisor Rotterdam The Hague airport	1 hour	English

Next to this, a visit was made to Rotterdam The Hague airport by Yu Chen and Nika den Ouden, who are both IDE graduation students working on the same work package of TULIPS.

Company	Duration visit	Language visit
Rotterdam The Hague Airport	2 hours	English

Rotterdam The Hague Airport doesn't have a system for collecting PET bottles or cans in place yet. PET bottles and cans are sold through Food and beverage (F&B) and retail partners at the airport. The disposal of PET bottles is done through their waste bins. See figure 22 for a picture of the waste bin. Rotterdam The Hague Airport has waste bins with three sections, plastic, paper and residual. Passengers throw PET bottles in all of the waste bins, according to one of their employees.

Figure 22, Waste bins at Rotterdam The Hague Airport

Eindhoven Airport

An interview was held with an Eindhoven Airport employee.

Participant	Role	Duration interview	Language interview
External stakeholder B	Sustainability manager	1 hour	English and Dutch

Next to this, a visit was done to on-site Eindhoven Airport by Yu Chen, Nika den Ouden, and me.
Company

Company	Duration visit	Language visit
Eindhoven Airport	2 hours	English and Dutch

While speaking to Eindhoven Airport, insights were gathered about their current PET bottle/can collection system. See Figure 24 and 25 for a picture of their waste bins. Their practices are more or less the same as Schiphol. The difference is that Eindhoven Airport is currently conducting a pilot project with a RVM in their terminal. See figure 23 for a picture of the placement of the RVM. This pilot seems like it works as it only accepts PET bottles/cans, and no other waste. Data of this pilot is confidential.
Another pilot was held, where passengers' PET bottles and cans were returned in the airplane (by steward(esses)) with one of the airlines that fly from Eindhoven Airport. Results (which are confidential) showed that separation done by a steward(ess) works well with regard to keeping the PET bottles from other waste streams where it could be contaminated. This shows that having someone who actively separates the waste for passengers could help to improve the amount of returned PET bottles or aluminium cans.

Figure 23, Eindhoven Airport RVM pilot

Figure 24, waste bins at Eindhoven Airport

Figure 25, waste bins at Eindhoven Airport

Avinor Airport

An interview was held with Avinor Airport employees to gather insight in their waste management.

Participant	Role	Duration interview	Language interview
External stakeholder C	Sustainability expert Avinor Airport	1 hour	English
External stakeholder D	Sustainability expert Avinor Airport	1 hour	English

An interview was held with Avinor Airport employees to gather insight in their waste management. Avinor is a concern of 43 airports in Norway. Oslo airport is one of them. Oslo airport's goal is to have their operational waste reduced by 50% by 2030 compared to 2022 (Avinor). The waste bins that are in place can be seen in figure 25. The collection rates at Oslo airport of PET bottles are above 90% which shows that collecting them through this way is successful. At Oslo airport they collected around 187 t deposit bottles in 2022 of which the collected money of the donations goes to charity organisations. Oslo airport collects PET bottles through their through food & beverage units, in offices, and through the bins at the airport. After collecting, the bottles are transported to a different place and are then emptied and post separated by school groups and teams from associations.

They also experience the same challenge as Schiphol where homeless people try to collect bottles and cans before security, which causes disturbance
In Norway, the Deposit Return System is set up where the producers are incentivised to operate effectively in order to receive tax reduction. This makes the circular system working, as the packaging design to collection after use operates well. Infinitum is the company that facilitates this DRS in Norway and they have met the 90% collection target, a decade before the European Union deadline of collecting PET bottles. 97% of the plastic drink containers are returned, and 92% get a new purpose in new containers. In Norway, what has proven to work is that the producers of PET bottles have a responsibility in making the packaging industry more sustainable (as proposed before in this report). They can get tax advantages when they prove to recycle more, which can even lead to dropping the tax if the recycling is higher than 97% (Hale, 2021).

Figure 26, waste bins at Oslo Airport (internal presentation Avinor airport)

Nederlandse Spoorwegen (NS)

Participant	Role	Duration interview	Language interview
External stakeholder E	Nederlandse Spoorwegen	1 hour	English

Nederlandse Spoorwegen (NS) is responsible for the trains and train stations in The Netherlands. Their insights could help in finding a solution in transfer areas such as Schiphol Airport. NS tried several pilot schemes at its stations. One pilot involved a bin with people standing next to it to encourage passengers to separate their waste, but this did not work well enough. They also did a pilot with PMD (plastics, metal and drink carton packaging).
One pilot that has been set up quite recently is putting RVMs at train stations in order to let people get their deposit back. Station Utrecht has been experimenting with the deposit machines since November 2022 and was the first to do so. From November 2022 to February 2023, according to NS, it was fully used and 13,000 bottles were handed in ("Kinderziektes Zijn Eruit: Nu Ook Blik in Statiegeldmachines Station Utrecht," 2023). The NS aims to have 50 RVMS in place in the future at train stations.

Takeaways 2.2.3
XXI Eindhoven airport has a pilot with an RVM, where the first results show that the monetary incentive can motivate passengers to recycle, which could be applied in this project too.
XXII Avinor airport has a well working system as producers of PET bottles are incentivised to operate as effectively as possible, which shows that giving the producer more responsibility in the recycling system works.
XXIII NS tried out a pilot with having an employee help passengers separate their waste well, but it turned out not to work well enough, which excludes the option of letting special separation employees convince passengers to separate.

2.3 Sustainable Consumer Behaviour

Sustainable consumer behaviour refers to the actions taken by individuals and households to minimise their negative environmental impact while engaging in consumption activities. Negative environmental behaviour leads to, for example, air pollution, global warming, water shortages and loss of biodiversity. Human behaviour is in many cases the cause of these problems (DuNann Winter & Koger, 2004; Gardner & Stern, 2002; Vlek & Steg, 2007). This shows that human behaviour has to be changed in order to reduce the negative environmental impact. For this project, this means that addressing the behaviour of passengers could have an impact on the amount of returned PET bottles and cans and therefore the environmental impact of the created waste. At Schiphol, the PET bottles and cans are often not returned, so behaviour of passengers should be addressed to help reach the zero waste goal that Schiphol has set. This chapter discusses which behaviour change interventions are relevant for Schiphol to stimulate passengers to return PET bottles and cans.

2.3.1 Sustainable Consumer Behaviour

Concern & values

The concern-behaviour gap could lie in the way of pro environmental behaviour. Tam & Chan (2017) studied the influence of environmental concern on pro-environmental behaviour. According to them, environmental concern (EC) does not always mean that this environmental concern is translated to pro-environmental behaviour (PEB). This concern-behaviour gap needs to be addressed at Schiphol, in order to improve sustainable behaviour. Psychological barriers partly influence the concern-behaviour gap. Tam & Chan found with data from 32 countries, that the effects of distrust and belief in external control are both negative on PEB. The relationship between EC and public sphere PEB is also weaker in societies that have a strong present orientation. They did find that the association between EC and PEB was stronger in societies that have a higher level of looseness and individualism.
Milfont & Schultz (2016) also address this topic. They explain that environmental concerns can be categorised into egoistic concern (self-oriented), altruistic concern (concern for others), and biospheric concern (concern for the environment). Biospheric concerns and values have the strongest positive correlation with pro-environmental attitudes and behaviours. Altruistic concerns and values are also associated with more environmentally-friendly actions. Research has explored mediators and moderators of the relationship between values and pro-environmental behaviour. Attitudes fully mediate the relationship between altruistic values and pro-environmental behaviour, as Tam & Chan also explain.

Normative social influence

Tam & Chan (2017) found that environmental concern has a stronger association with pro-environmental behaviours in individualistic societies (where personal autonomy is emphasised). In collectivistic societies (where social harmony and group interdependence are emphasised), environmental concern has a weaker association with pro-environmental behaviours. Tam & Chan suggest that this could be because collectivistic societies value the opinions of others and conformity to social norms, rather than individual beliefs. Milfont & Schultz (2016) confirm that social norms play a role in fostering pro-environmental behaviour. Descriptive norms (what people typically do) and injunctive norms (what people typically approve or disapprove of) need to align to optimise influence. Aligning supportive descriptive and injunctive norms leads to stronger pro-environmental intentions. They also see that social imitation (copying the behaviours of others) and status (valuing relative over absolute status) could be used to improve PEB.
This literature shows that different cultures in different societies have a different relation between the EC and PEB. This makes it hard to determine a common ground for passengers at Schiphol, as passengers come from different societies.

Emotions

Milfont & Schultz (2016) also explain that emotions play a role in pro-environmental behaviour. Anticipated self-conscious emotions, such as pride and guilt, mediate the effects of attitudes and social norms on pro-environmental intentions and behaviours. Regarding environmentally friendly purchases, anticipated pride and guilt have a stronger connection in individualistic countries than in collectivistic countries.

General environmental concern

Milfont & Schultz (2016) state that cross-cultural data showed that the majority of the world's population supports protection of the environment as they are aware of environmental problems. They also consider looking after the environment as a personally important goal. This shows that the environmental concern is for most of the passengers present, Schiphol passengers in general will be wanting to help reduce climate change. But this concern for the environment does not always lead to sustainable behaviour (the concern-behaviour gap). This can be seen at Schiphol as passengers who do not separate their waste well enough (waste safari TULIPS).

Takeaways 2.3.1
XXIV The concern-behaviour gap needs to be addressed at Schiphol, in order to improve sustainable behaviour of passengers, as the behaviour of people influences the impact on the environment greatly.
XXV Literature shows that different cultures in different societies have a different relation between the EC and PEB. This makes it hard to determine a common ground for passengers at Schiphol, as passengers come from different societies.
XXVI Passengers might feel that their own environment (and therefore the use of the airport they fly from), does not have a bigger impact on environmental problems than places that they are not involved with.
XXVII Literature shows that the environmental concern is for most of the passengers present, Schiphol passengers in general will be wanting to help reduce climate change. But this concern for the environment does not always lead to sustainable behaviour (the concern-behaviour gap). This can be seen at Schiphol as passengers who do not separate their waste well enough.

2.3.2 Improving Sustainable Consumer Behaviour

Fogg's behaviour model

Fogg (2009) created a behaviour model which states that behaviour is influenced by three factors; motivation (the willingness to do something), ability (if people are able to do something), and triggers (the reason/ stimulus that makes people do something). This is called Fogg's behaviour model (FBM). See figure 27 for an illustration of the model.

Motivators are pleasure and pain (immediate reactions of the person), fear and hope (are anticipated by the person), or social acceptance and social rejection (which Milfont & Schultz and Tam & Chan explained to have an influence). In this case, motivation could be described as environmental concern, as this is the underlying value of why people would do something.
Ability consists of six parts: time, money, physical effort, brain cycles (cognitive effort), social deviance (breaking with socially accepted rules and norms), and non-routine (non-regular activities). Ability differs from person to person, as someone might have different money and time abilities for example.
Triggers are things that push people to behave a certain way. There are three types according to Fogg: sparks, facilitators and signals. A spark makes someone more motivated to do something. A facilitator enhances the ability to do something, while the person already has the motivation. Signals remind people to do something when the ability and motivation is already there.
See Figure 27 how the action line would be formed from the motivation, ability and triggers. Motivation, ability and trigger need to be present at the same time in order to let a behaviour occur according to Fogg's behaviour model. If one of the three elements is missing, it is unlikely that a behaviour will occur.
If motivation is very high, although the ability is low, there should be a facilitator in place and people will more likely behave a certain way. When the ability is high, but the motivation is low, there should be a spark in place in order to make behaviour more likely.
The FBM can be used in the design stage to design interventions that encourage behaviour change. This is done by increasing motivation, ability and by optimising triggers.

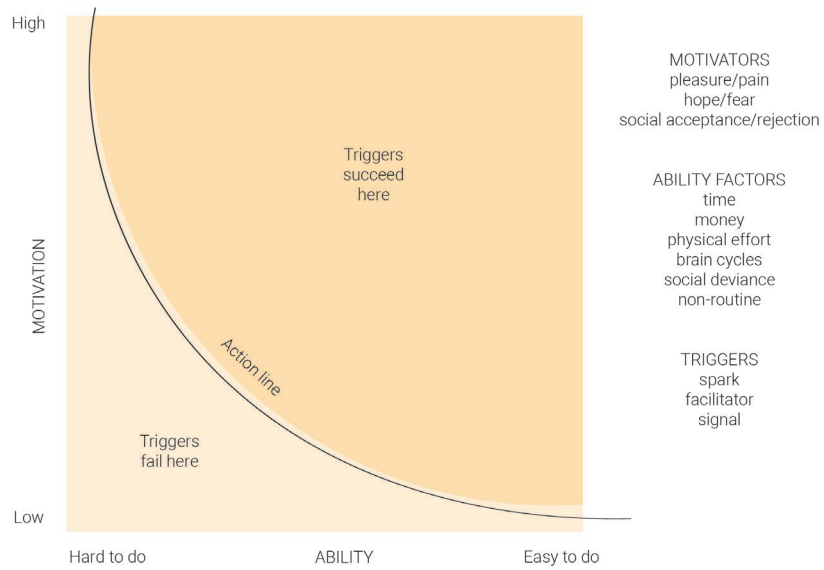


Figure 27, Fogg's behaviour model

In this project, the motivation is present in general (as Milfont & Schultz explain), but there are still barriers which make it less likely for a passenger to feel motivated. The psychological distance could be a motivator which currently does not work enough at Schiphol, as they do not feel close to environmental threats. The motivation could therefore be increased by showing the impact of the actions of passengers. During the ideation phase, this possibility will be looked into. As could be seen in the interviews/sensitising booklets interviews 2.2.2 with passengers, passengers want to spend as little time as possible to return a PET bottle/can. Therefore, they don't want it to take much physical and cognitive effort. Currently, there are not many possibilities to return a PET or can: the donation boxes are the only option, and they are very little present at Schiphol. This shows the time and effort to seek for this option is too high. Increasing the feeling of routine could be facilitated by adding this to the journey a passenger already makes by throwing waste away, as observations showed that passengers in general throw their waste away in the FF3 bins.
When both motivation and ability are included in the PET/can return proposal for Schiphol passengers, there should still be signals (triggers) that make people aware of the possibility of returning their PET bottle/can.

Steg & Vlek (2009) argue that pro-environmental behaviour is influenced by a range of factors, including personal values, social norms, and cognitive processes (which was also explained in the previous paragraphs by Milfont & Schultz and Tam & Chan and Fogg). Steg & Vlek (2009) also suggest that interventions aimed at promoting pro-environmental behaviour can be categorised as informational or structural. Informational interventions aim to educate individuals about the environmental consequences of their actions (which is called motivation in the FBM), while structural interventions modify the physical or social environment to make pro-environmental behaviour more likely (which refers to ability in the FBM).

Certain physical (structural) attributes also influence the behaviour of people. Chapter 9 explains what attributes could contribute to this.

III. Which interventions could best be applied to encourage pro-environmental behaviour?
1. Informational strategies (information, persuasion, social support and role models, public participation)
2. Structural strategies (availability of products and services, legal regulation, financial strategies)

IV. What are the effects of interventions?

1. Changes in behavioural determinants
2. Changes in behaviours
3. Changes in environmental quality
4. Changes in individuals' quality of life

Figure 28, Steg & Vlek (2009)

Informational strategies

Steg & Vlek (2009) state that informational strategies could be used to let people behave more sustainably. They define informational strategies as 'being aimed at changing perceptions, motivations, knowledge, and norms, without actually changing the external context in which choices are made'. Informational strategies therefore target motivational factors, as is also seen as an influential factor on sustainable behaviour regarding the FBM. Firstly, passengers' knowledge could be increased and therefore their awareness of environmental problems could be heightened according to Steg & Vlek (2009). This way, pro-environmental alternatives could be addressed. New knowledge is assumed to change one's behaviour by a change in attitude. In general, information campaigns do not result much in behaviour changes. However studies showed that it appeared that prompts are effective in changing behaviour. This could be seen as adding a signal at Schiphol, when using the concepts of the FBM.

Secondly, persuasion can target individuals' attitudes, altruistic and ecological values, and commitment to encourage pro-environmental behaviour. Steg & Vlek (2009) describe that previous studies showed that commitment strategies have been successful in promoting such behaviour. Another effective approach is eliciting implementation intentions, where individuals not only state their intention to change behaviour but also provide a plan on how to do so. Moreover, Steg & Vlek (2009) state that previous studies showed that individualised social marketing, which tailors information to the specific needs, wants, and perceived barriers of different population segments, has shown promising results in promoting pro-environmental behaviour. These strategies would not be possible in the Schiphol context, as people do not spend a long time at the airport, which is needed in order to plan a commitment to behaviour change per passenger. Next to this, there are differences in the population, which is why tailored marketing is not possible.

Thirdly, Steg & Vlek explain that previous studies show that social support and role models can strengthen social norms and inform individuals about others' perceptions and behaviours. This supports PEB. Sharing information and modelling behaviour have been successful in this regard. These strategies involve providing descriptive norms through writing or role models. This could be done at Schiphol by showing role models who behave sustainably and give information about the environment and PEB with regard to returning PET bottles and cans. Informational strategies are effective when pro-environmental behaviour is convenient and less costly, and they can complement structural strategies. It is important to listen to the public and incorporate participatory approaches in environmental policy-making, as they help understand perspectives, attract attention and commitment, design interventions within tolerance limits, build support, and increase public involvement. This is why testing informational prototypes in the Schiphol context should give insights on the added intervention(s) and its effectiveness. However, the effects of participatory approaches in scientific literature remain unreported.

Structural strategies

Structural strategies aim at changing the circumstances under which behavioural choices are made (Messick & Brewer, 1983). Steg & Vlek (2009) claim that structural strategies could be used to increase pro-environmental behaviour.

Steg & Vlek (2009) state that previous studies showed that when pro-environmental actions are challenging due to external barriers, structural strategies are needed to modify the circumstances and make environmentally friendly choices more attractive. These strategies aim to change contextual factors such as the availability, costs, and benefits of different behavioural options. This is comparable to the ability aspect of the FBM:
time, money, physical effort, brain cycles (cognitive effort),
social deviance (breaking with socially accepted rules and norms), and
non-routine (non-regular activities).

These strategies can be achieved through altering physical, technical, and organisational systems, implementing legal regulations, and employing pricing policies. Placing RVMs at the Schiphol premises could therefore be a strategy that could work for the return of PET bottles and cans.

Structural strategies involve rewarding desirable behaviour or penalising harmful behaviour regarding the studies that Steg & Vlek (2009) use in their review. Rewards have been found to be more effective in promoting pro-environmental actions as they are associated with positive affect and supportive attitudes. This could therefore incentivize Schiphol passengers to return their PET bottles or cans. However, rewards may have short-term effects and should be accompanied by personal convictions and goal activation. The conditions under which rewards and penalties are effective, or when a combination of both is suitable, is not clear.

The effectiveness of strategies for promoting pro-environmental behaviour depends on the specific barriers individuals face. Infrastructural measures, financial incentives, and legal measures may be necessary in different circumstances. Combining multiple strategies is often the most successful approach as there are various informational and contextual barriers to address. Tailoring interventions to the motivations, capacities, and circumstances of different target groups is crucial as different groups may have distinct reasons for their behaviour. Practical interventions typically incorporate multiple strategies and consider the diversity of target audiences.
This shows that cultural differences and therefore individual incentives are hard to conclude in one solution, which is why different approaches could help to let passengers return their PET bottles and cans more often at Schiphol, such as placing RVMs in combination with an intervention at every FF3 bin.

Takeaways 2.3.2
XXVIII The motivation (of Fogg's behaviour model) could be increased by showing the impact of the actions of passengers.
XXIX Passengers don't want to use much physical and cognitive effort, which is why there needs to be strived for this. Increasing the feeling of routine could be facilitated by adding this to the journey a passenger already makes by throwing waste away.
XXX Subsequently, signals that make people aware of the possibility of returning their PET bottle/can.
XXXI Commitment strategies would most probably not work in the Schiphol context, as people do not have a long time that they spend at the airport.
XXXII There are significant differences within the population, which is why tailored marketing is not possible.
XXXIII A strategy that could work at Schiphol is showing role models who behave sustainably and give information about the environment and PEB with regard to returning PET bottles and cans.
XXXIV Testing informational prototypes in the Schiphol context should give insights on the added intervention(s) and its effectiveness. This should help understand perspectives, attract attention and commitment, design interventions within tolerance limits, build support, and increase public involvement.
XXXV Placing RVMs at the Schiphol premises could therefore be a strategy that could work for the return of PET bottles and cans.
XXXVI Cultural differences, and therefore individual incentives, are hard to conclude in one solution, which is why a combination of multiple approaches could help to increase the return of PET bottles and cans by passengers at Schiphol. An example of this is placing RVMs in combination with an intervention at every FF3 bin.

2.3.3 PET/can collection attributes

This chapter aims to identify the attributes that could increase the collection of PET bottles and cans by conducting a literature review. I will explore existing research to uncover the various attributes that encourage recycling, leading to a more sustainable future.

Bin lid

Duffy and Verges (2009) studied if the presence or absence of a container lid has an effect on the beverage recycling behaviour of consumers. They found that the presence of specialised recycling lids increases the beverage-recycling rate by 34%. Next to this, the study showed that the amount of contaminants that entered the recycling stream was reduced by 95%. The results imply that specialised container lids offer perceptual affordances that enhance recycling compliance. Interestingly, using specialised lids did not just discourage people from discarding trash into recycling containers but it also dissuaded people from discarding recyclables into trash cans.

A study of Jiang et al. (2019) in Japan showed that a round shaped insert slot in the bin lid contributed to significantly lower contamination than a slot in the shape of a bottle when collecting PET bottles, while the preference of insert slots with a bottle shape was higher than the one with a round shape. This means that people prefer the bottle shape in order to recycle, but the results showed that a round shaped slot worked better to fight contamination.

Bin colour

The colour of bins could possibly be of influence on sustainable behaviour. A study of Kalatzi et al. (2015) found that in their study the yellow coloured recycling bin was the most preferred for recycling plastic bottles. Colours have psychological implications, conveying emotions, and affecting the central and autonomous system. However, there is limited research on the implicit meaning of colours in promoting environmentally friendly behaviour. As a design element, colour plays a role in recycling bins, with yellow being the most preferred colour among green, red, white, and black.

Leeabai et al. (2021) conducted a study in Thailand that tested trash bins for separately collecting compostable waste, recyclable waste, and PET bottles. The study found that trash bins with the least preferred colours had the highest waste separation efficiencies, while colour preference towards trash bins had no significant impact on waste collection. Lower colour preference also contributed to lower noticeability of trash bins. The study concluded that location, unit colour, and noticeability of trash bins can affect waste collection and separation performance. Increasing human awareness through appropriate design and setting of trash bins might enable more efficient collection of segregated wastes. PET bottles were found to be the easiest waste for correct disposal, but the PET bottle bin was more easily contaminated than other trash bins. The study recommends influencing human

Table 1 Brief overview of bin colours for plastic in various recycling programs

Study	*Place*	*Bin colour for plastic*
Tonglet et al. (2004)	Brixworth, England	Blue
Mee et al. (2004)	Rushcliffe, England	Grey
Kelly et al. (2006)	Australia, Massey University	Yellow
Pattnaik and Reddy (2010)	Puducherry, India	White
Ball (1990)	Germany	Green

Figure 29, Table with different bin colours from Kalatzi et al. (2015)

perception through appropriate design and setting of trash bins to enable more efficient collection of segregated waste. The study notes that low recycling rates are strongly related to poor waste sorting, and that waste sorting itself is correlated with the economic status of countries.

The study of Jiang et al. (2021) explored the effects of colour preference and noticeability of trash bins on waste collection performance and waste-sorting behaviours. The researchers found that highly preferred colours were consistent with frequently used colours in certain design items, such as the slot frame colour for combustible and incombustible waste bins and the body colour for PET bottle bins. The study concludes that colour preference is important in recycling bin design, but the effect of impressive colour alone is too weak to improve waste separation. See figure 29 for an example which shows that bin colours are various. Other factors, such as recycling bin proximity and design, also play a role in waste separation efficiency. The study suggests that the combination of preferred design items is necessary to encourage waste sorting using recycling bins. The authors recommend intensive usage of preferred-designed recycling bins through social and/or educational campaigns to support frequent perception experiences of designed recycling bins.

Signage

Studies have shown that signs above recycling bins increase compliance to recycling (e.g., Werner, Rhodes, & Partain, 1998).

From an interview with Statiegeld Nederland, the conclusion could be made that icons need to be the same in any context. This means that people will recognize a certain icon (like the Statiegeld Nederland icon) and act on it if they know that logo. The statiegeld logo needs to be used broadly in the Netherlands in order to make the message clear for people. The ultimate goal of course would be to have a worldwide clear signage for returning PET bottles or cans. Statiegeld Nederland has a fixed advertisement toolkit that can be used by companies who have a PET/can collection point.

In a meeting with a representative of De Afvalbak, he explained that icons are placed at their PET bottle bins, as this communicates that PET bottles should be thrown in the bin. See an example in figure 30.

However, Duffy & Verges (2009) found that it may not be effective to exclusively use labels. People might ignore labels if they are not displayed prominently. Next to this, outdoor settings might cause labels to tear. Lastly, the language that is used in the labels might not be understood by every user.

Figure 30, Example of signage

Location

A study of Kalatzi et al. (2015) found half of their respondents chose the closest bins from the starting point, indicating a distance effect.They also found that availability of recycling bins can influence willingness to participate in recycling schemes.

The study of Jiang et al. (2019) in Japan, showed that the setting condition of recycling bins affect the design effect. Single setting and commingled setting was tested. A single setting means the recycling bin was placed somewhere on its own, whereas in a commingled setting, it is placed alongside another bin. It was shown that the design effect was smaller than the setting conditions in their study. The commingled setting significantly decreased recycling contamination.

On top of that, in an interview with Statiegeld Nederland, it was emphasised that recycling bins for PET bottles need to be placed at convenient locations, so it is easy for passengers to recycle.

Takeaways 2.3.3

XXXVII The design of container lids, such as specialised recycling lids and round-shaped insert slots, can significantly impact recycling behaviour by increasing recycling rates, reducing contaminants, and influencing perceptive preferences. This influences the design possibilities for this project.

XXXVIII The colour of recycling bins can influence recycling behaviour, but the specific colours associated with different types of waste vary across countries. It is therefore not possible to think that one colour is associated the same for different cultures. There are a lot of different colours used for the different systems worldwide. Therefore, this project will not try to find a common ground in colours and their associations as there probably is none for the multicultural passenger population at Schiphol.

XXXIX Recycling bin design, colour preference, and noticeability affect waste collection and separation. Lower colour preference can improve waste separation efficiency. Proper bin design and placement enhance waste sorting.

XL Colour preference alone is insufficient to improve waste separation; bin proximity and design are also important. Combining preferred design elements and promoting perception experiences through campaigns can encourage proper waste sorting.

XLI Signs above recycling bins increase compliance (Werner, Rhodes, & Partain, 1998).

XLII Consistent icons, like Statiegeld Nederland's logo, prompt action and should be widely used for clear messaging.

XLIII De Afvalbak uses icons on PET bottle bins to indicate proper disposal.

XLIV Labels alone may be ineffective, if not prominently displayed or printed in an unfamiliar language (Duffy & Verges, 2009).

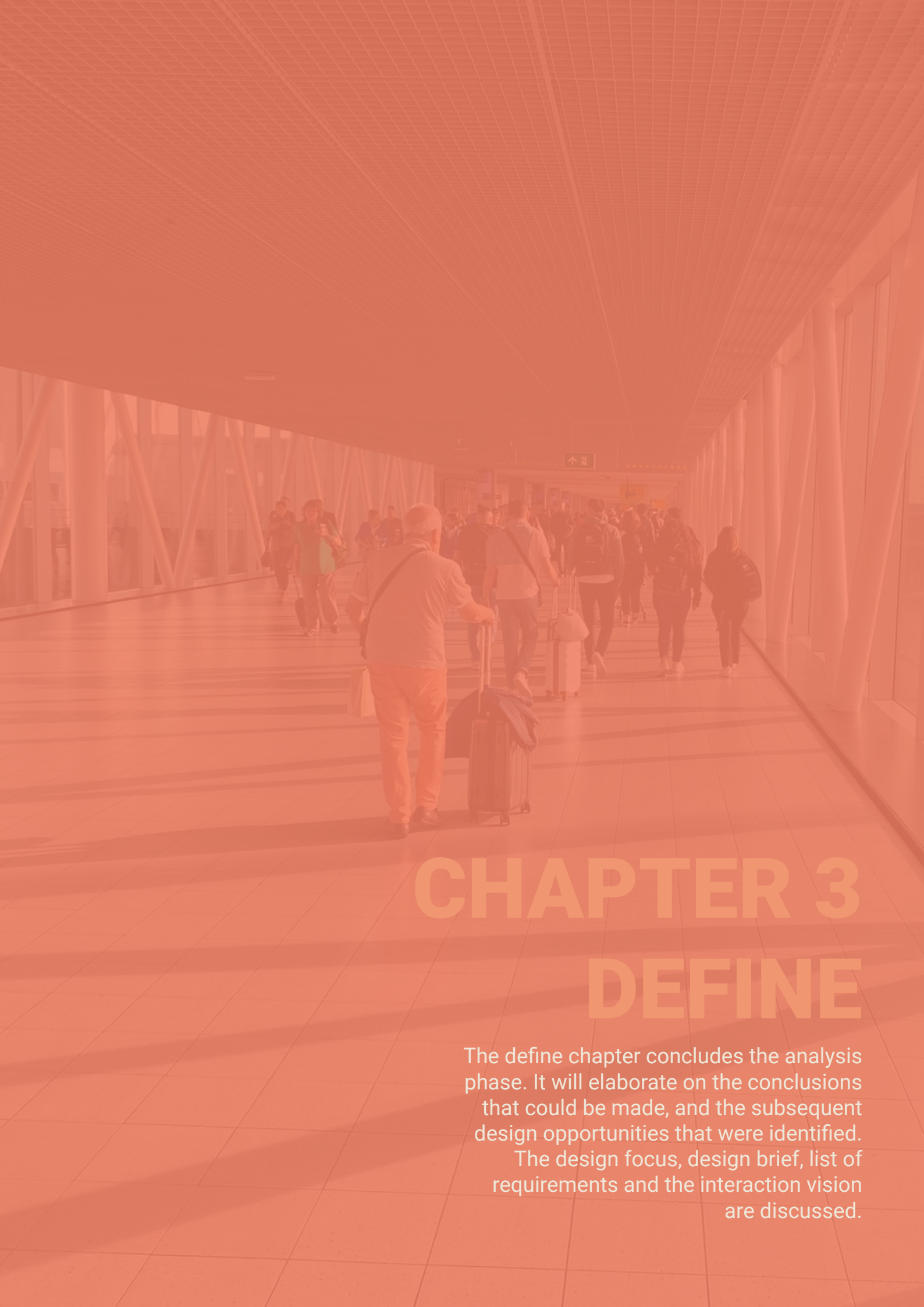
XLV Signage placement matters; it promotes cap removal when placed with other bins and reduces contamination in a single setting (Jiang et al., 2019).

XLVI Proximity to recycling bins affects bin choice and suggests a distance effect (Kalatzi et al., 2015).

XLVII Availability of recycling bins influences willingness to participate in recycling programs (Kalatzi et al., 2015).

XLVIII Setting conditions of recycling bins impact their design effect, with commingled settings reducing recycling contamination (Jiang et al., 2019).

XLIX Convenient placement of recycling bins for PET bottles is important for ease of use and passenger recycling (Interview with Statiegeld Nederland).



CHAPTER 3
DEFINE

The define chapter concludes the analysis phase. It will elaborate on the conclusions that could be made, and the subsequent design opportunities that were identified. The design focus, design brief, list of requirements and the interaction vision are discussed.

3.1 Conclusions analysis phase

When combining the takeaways of the analysis phase, design directions could be made. The combinations were made by clustering them on the following themes: sustainability, practical, time (ability), money (ability), physical effort (ability), mental effort (ability), routine (ability), sensation (motivation), anticipation (motivation), belonging (motivation) and prompts. There was no specific takeaway dedicated to time (ability), so it is not elaborated on. See below for design opportunities which are relevant for this thesis.

Design opportunities sustainability (I, II, VIII, XVII, XVIII):

Separate Collection System:
Design a separate collection system for PET bottles and cans to prevent contamination and maintain the quality of recyclable materials. This system should ensure that these materials remain uncontaminated throughout the recycling process.

Design opportunities practical (III, VII, X, XXXII, XXXVII, XXXVIII, XXXIX, XL, XLVIII):

Tailored Marketing Approaches:
Recognize the population's diversity and avoid one-size-fits-all marketing strategies. Explore ways to tailor messages and interventions to specific passenger segments to increase the return of PET bottles and cans effectively.

Multifaceted Approach:
Given cultural and individual differences, design a multifaceted approach that combines various strategies, such as placing Reverse Vending Machines (RVMs) alongside interventions at FF3 bins, to appeal to a broader range of passengers.

Design opportunities money (IV, IX, XI, XII, XXI, XXII, XXXV):

Deposit-Free Solutions:
Explore alternative methods for passengers to receive compensation or rewards without requiring a deposit return process. This could involve innovative approaches such as digital incentives or loyalty programs.
Engagement with Statiegeld Nederland:
Collaborate with Statiegeld Nederland, the government execution association responsible for the deposit system in The Netherlands, to gain support and approvals for implementing RVMs at Schiphol Airport. Work with them to allocate funds and resources effectively.

Design opportunities physical effort (VI, XVI, XLV, XVLI, XLVII):

Effective Signage Placement:
Utilise insights from research (Jiang et al., 2019) to optimise the placement of signage near recycling bins. Consider the visual hierarchy and clarity of the signage.

Proximity-Based Bin Placement:
Consider the proximity of recycling bins to passenger traffic areas and decision points, as suggested by research (Kalatzi et al., 2015). Design the layout of recycling stations and bins to make them easily accessible and visible, ensuring passengers can conveniently choose recycling over other disposal options.

Design opportunities mental effort (XVIII, XXIX):

Cultural Adaptability:
Develop a recycling solution that is culturally versatile and easily understood by passengers from various countries with different recycling practices. This involves creating a universal design that transcends language and cultural barriers.
Simplicity and Minimal Effort:
Design recycling infrastructure that requires minimal physical and cognitive effort from passengers. Make recycling an effortless part of the passenger journey by integrating recycling bins and practices seamlessly into existing disposal routines.

Establish Routine:
Create a sense of routine for passengers when it comes to recycling. Make recycling bins and practises a natural part of their journey, ensuring that recycling becomes a habitual and expected behaviour rather than an extra effort.

Design opportunities routine (V, XLIX):

Strategic Bin Placement:
Emphasise the importance of strategically placing recycling bins for PET bottles.

Design opportunity sensation pleasure/pain (XXVI):

Environmental Awareness and Engagement:
Design opportunities to increase passengers' awareness of their environmental impact, emphasising that their actions at the airport can contribute to broader environmental solutions. Develop campaigns, educational materials, or interactive displays that illustrate the connection between individual actions at the airport and global environmental challenges. Encourage a sense of responsibility and empowerment among passengers to make environmentally conscious choices while travelling.

Design opportunity anticipation: hope/fear (XXIV, XXV, XXVII, XXXIV):

Addressing the Concern-Behavior Gap:
Develop strategies and interventions at Schiphol Airport that bridge the gap between passengers' environmental concerns and their actual sustainable behaviours. This may involve communication campaigns, incentives, or educational initiatives to motivate passengers to act in environmentally responsible ways.

Cultural Sensitivity:
Recognize the cultural diversity of Schiphol's passenger base and design interventions that are sensitive to these cultural differences. Tailor environmental messaging and initiatives to resonate with passengers from various societies to create a more inclusive and effective sustainability program.

Design opportunities prompts (XXX, XLI, XLII, XLIII, XLIV):
Visibility of Return Options:
Implement prominent and attention-grabbing signals or signage throughout Schiphol Airport to continually remind passengers of the option to return their PET bottles and cans. Use visually appealing and informative signage to attract attention.

Signage above Recycling Bins:
Following research findings, consider placing signs above recycling bins to increase compliance with the right separation of waste. These signs can provide clear instructions and motivate passengers to use the bins correctly.

Consistent Iconography:
Use consistent and universally recognizable icons, such as Statiegeld Nederland's logo, for messaging related to PET bottle and can recycling. These icons can help convey information without relying on language barriers and should be widely employed for clear and consistent messaging.

Icon Usage on Bins:
Similar to De Afvalbak's approach, incorporate icons on PET bottle bins to indicate the proper disposal method. These icons should be intuitive and easily understood by passengers.

Prominent Display of Labels:
Ensure that labels and signage are prominently displayed in high-traffic areas and are easily visible to passengers. This is crucial as labels alone may be ineffective if not prominently positioned or if they are in an unfamiliar language.

Design opportunities belonging: acceptance/rejection (XXIII, XXXII):
Role Model Influence:
Design a strategy that incorporates the influence of role models who demonstrate sustainable behaviours. Role models can help inspire passengers to engage in sustainable actions, including the proper disposal of PET bottles and cans. Combine this with informative messaging to educate passengers about environmental concerns and Personal Environmental Behavior (PEB).

3.2 Design focus

- The design focus will be behind security, where there will only be Schiphol passengers (and employees) included in the scope.
- Also, the focus will be on the current FF3 bins, and not providing complete newly designed bins.
- The aim is on the passenger's separation, so that there is least amount of post separation needed. The problem will therefore be tackled at the source.

3.3 Design goal

3.3.1 Design statement

By combining the insights of the analysis phase, a design statement is formed.
The design needs to have ability, motivation and triggers that will stimulate pro-environmental behaviour. Therefore, the design solution space does not lie in one design. The design phase will be approached in multiple ways, which will be combined into one recommendation.

The design statement is used as a guideline for the design phase:

'To design a PET bottle and can return opportunity for passengers that have the time behind security which enables them to return their PET bottle or can by providing them a return point next to every FF3 bin'

Ability

Currently, the ability to return a PET bottle is low. There are not many PET donation boxes in place and they are often not well visible. The ability therefore needs to be enhanced.
The design possibility here would be to design the presence and placement of PET bottles and aluminium can donation points. As the analysis phase showed, passengers don't want to use much physical and cognitive effort, which is why there needs to be strived for this. Increasing the feeling of routine could be enhanced by adding a return possibility at every FF3 bin, as passengers will throw waste away there. The design phase will therefore aim on creating a prototype as an add on to the FF3 bin. At this .
RVMs have been proven to work in other environments (EH, NS), which is why this would be a great addition for Schiphol.

Motivation

At Schiphol, multiple cultures are present. These passengers have different practices, as can be seen in Chapter 2.8. Next to this, passengers have different values, which is why tailored marketing is preferred, but not realisable. However, literature showed that passengers in general do want to act pro-environmentally. The design phase will explore ideas which strengthen the motivation for passengers to behave sustainably, which could be done by increasing awareness and knowledge. This could for example be done by showing the impact of the actions of passengers or showing role models.

Triggers

As there are currently not many triggers available which makes returning PET bottles and cans happen often (Obs). Schiphol uses other signage than statiegeld has in place, whereas universal communication is key to stimulate pro environmental behaviour. Passengers also have different associations with different bin colours as shown in literature, which shows that the trigger of colours is not universal. Next to this, the current PET donation boxes do not have multiple languages or visual language which makes it not able to be a trigger for all passengers. Lastly, there are no signs (which could act as triggers) around the passenger journey that show where the bins can be found. To conclude, it is important to optimise triggers in order to stimulate PET bottle and can collection. This project will focus on increasing the motivation and ability, which is why there should be signals in place for people to return their PET bottles/cans.

3.4 Interaction vision

To enhance the passenger's sustainable behaviour, an engaging interaction should be strived for. An interaction vision is therefore used, to keep this in mind.
The interaction vision is described through an analogy:

'The interaction should feel like a chat around a bonfire, where the stories make it fun and engaging, and the warmth of the fire is inviting to stay engaged.'

See figure 31 for an illustration of a bonfire interaction.

The attributes which in my opinion should be included in the final design are:

- Fun
- Engaging
- Inviting

This interaction vision and its attributes are used in the next chapters as inspiration on how the interaction of the design should be.

Figure 31, Bonfire interaction

3.5 List of requirements

The analysis provides several insights into the use and context of PET bottles and cans at the airport and its users, all of which are summarised below in the list of requirements.

Number	Requirement	What is addressed	Addressed stakeholder	Takeaways
1	Avoiding PET and cans to go in FF3 bin	Sustainable requirement	Sustainability	XLV
2	Should be clear for non-English speaking passengers	Mental effort (ability), Belonging (motivation)	Passenger	XIX
3	Avoiding contamination with other waste than PET bottles and cans	Sustainable requirement	Sustainability	XVII, XVIII
4	Low effort for passengers to put PET bottle or a can in	Mental effort, Physical effort (ability)	Passenger	XXIX
5	Attention grasping	Physical effort (ability)	Passenger	XXXIV, XXXIX
6	Fit with FF3 bin looks	Routine	Passenger	XXXIX
7	Volume	Sensorial motivation (pleasure of being at a clean airport), and practical requirement	Passengers, Cleaning company A	Cleaning company interview
8	Easy to stay/keep clean	Sensorial motivation (pleasure of being at a clean airport), and practical requirement	Cleaning company A, cleaning company B	Cleaning company interview
9	Scalability	Practical requirement	Schiphol	XLVII
10	Easy to empty	Sensorial motivation (pleasure of being at a clean airport), and practical requirement	Cleaning company A, cleaning company B	Cleaning company interview
11	No waste bags needed in prototype	Sustainable requirement	Sustainability	Cleaning company interview
12	Fun to put PET bottle or can in	Sensorial motivation	Passenger	Interaction vision
13	Buget friendliness	Practical requirement	Schiphol	Schiphol interview

CHAPTER 4
EXPLORE

The explore phase shows the ideation, conceptualisation and concept testing outcomes. Most of the time, there has been determined which design activity fits the stage, then the design activity is done and an evaluation is done (by the author with help of information gained in the analysis phase, passengers and/or stakeholders).

4.1 Ideation phase

4.1.1 General brainstorm session

Partici-pant	Role	Natio-nality	Duration session	Language session
Participant 1	IDE graduate student	Dutch	1 hour	Dutch
Participant 2	IDE graduate student	Dutch	1 hour	Dutch
Participant 3	IDE student	Dutch	1 hour	Dutch
Participant 4	IDE student	Dutch	1 hour	Dutch

To spark creativity for starting the design phase, a creative session was organised.

The brainstorm focused on the question: How can passengers be encouraged to return their PET bottles/cans along their journey at the airport? This was a simplification of the design goal that was stated in chapter 3.3.1.The focus did not lie specifically at ability, motivation or triggers, in order to stay open minded. The full session agenda can be seen in appendix G.
First, the research group is asked to rephrase the problem as given (PaG) into the problem as perceived (PaP) to make them feel more responsible for the design problem. Next, the Research group was asked to ideate on the PaP in multiple rounds where they were able to hitchhike on the previously generated ideas from their peers. At the end, the ideas were clustered on two axes; ability and motivation, and a discussion was started to conclude the session.

After letting the participants brainwrite options on the post its and hitchhiking on each others ideas, the following sheets were made:
The following setup was created after the ideation phase. By discussing, the ideas were placed on the two axes of ability and motivation.

Takeaways 4.1
After the ideation, a sheet with two axes was set up in order to place the ideas in the correct place. The axes were ‘Motivation’ and ‘Ability’. The brainstorm gave numerous original ideas, and sparked creativity. One learning point is that the axis needed to be different: they should have been the C-box, where feasibility and innovativeness are used as axes. The ideas that were generated also were an inspiration for further personal ideation.

Figure 32, brainstorm session

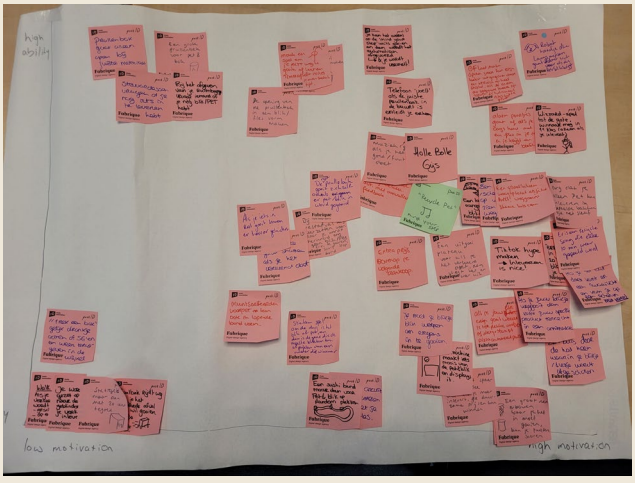


Figure 33, sheets plotted for ability and motivation

4.1.2 Brainstorm on motivation

Participant	Role	Nationality	Duration session	Language of session
Participant 1	IDE graduate student	Dutch	1 hour	English
Participant 2	IDE graduate student	Chinese	1 hour	English
Participant 3	IDE employee	Unknown	1 hour	English
Participant 4	IDE employee	Unknown	1 hour	English

Together with another IDE graduation student (Nika den Ouden), who was graduating on separating waste at Schiphol, a setup was created in order to find out which motivators could address acting sustainably at the airport. This brainstorm is therefore aimed more generally at sustainable waste disposal. We prepared 3 passenger types that the participants could contribute from. These personas were identified as the 3 ways a passenger could approach sustainability. The following passenger types were made:
The participants were asked to choose one passenger type, and generate their first ideas from that point of view (brain dumping). They used matching sticky notes in order to know afterwards which persona the idea was generated from.
Next, they were asked to generate ideas on the more specific motivation themes of the FBM: pleasure/pain, hope/fear, acceptance/rejection. After that, the ideas were placed on a C-box, with its axes innovativeness and feasibility.

Figure 35, participants dividing their ideas on the C- box

Takeaways 4.1.2
- At the end of the session, the participants were asked to choose their favourite out of the generated ideas on the C-box, and sketch a poster about it, with concluding it to a more visual idea.

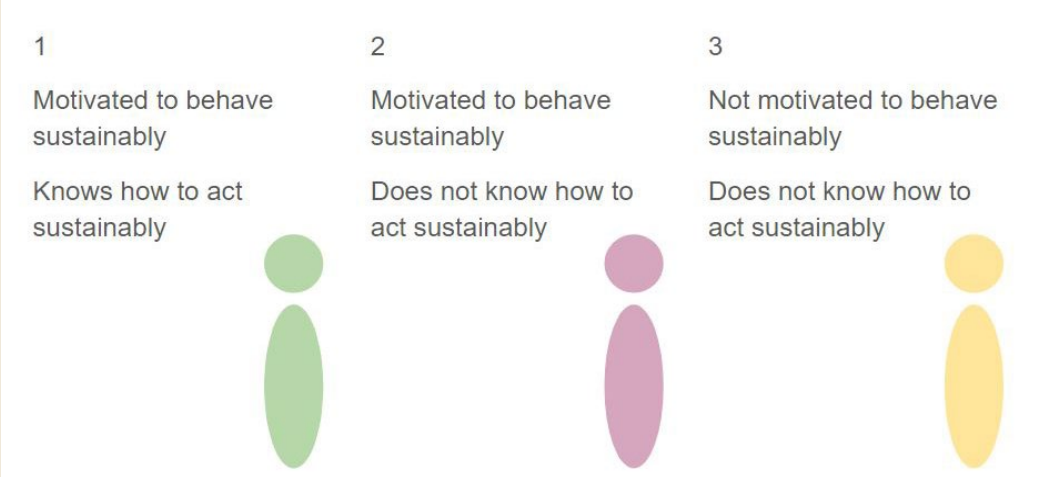


Figure 34, Identified passenger types for the motivation brainstorm

4.1.3 Design with Intent brainstorm

Participant	Role	Nationality	Duration session	Language of session
Participant 1 (the author)	IDE graduate student	Dutch	4 hours	Dutch

To dive into generating ideas myself, a brainstorm was done on the design statement which was given in chapter 6. The goal is to generate as many ideas as possible that are also out of the box, but without losing the sustainability view in doing so.

The Design with Intent cards (Dan Lockton, David Harrison & Neville A. Stanton, 2010) are an idea generating tool that will be used for generating possible ideas for the problem. The Design with Intent (DwI) cards can help a designer to inspire for generating new ideas. The DwI proposes questions, through a certain worldview, which is called a lens. There are 8 lenses that each have around 10 to 15 cards with different patterns.

During the brainstorming session, on average one idea is generated for every card with a pattern. After generating the ideas, they were divided into a C-box (Delft Design Guide). The two axes of a C-box are innovativeness and feasibility. In dividing them, the innovativeness and feasibility were estimated, and therefore an innovative and feasible box was generated with which the project could proceed for the next steps. The most promising ones were selected from the 'Easy to implement - Innovative' box. Posters were made to explain the ideas. See the next chapter for the created posters.

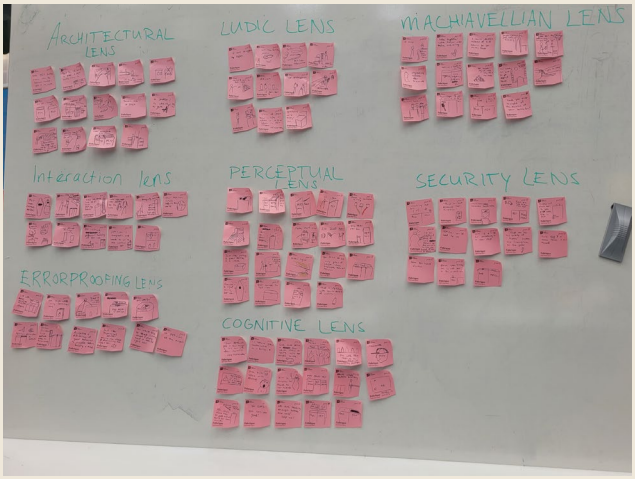


Figure 36, Overview of all the created Post Its

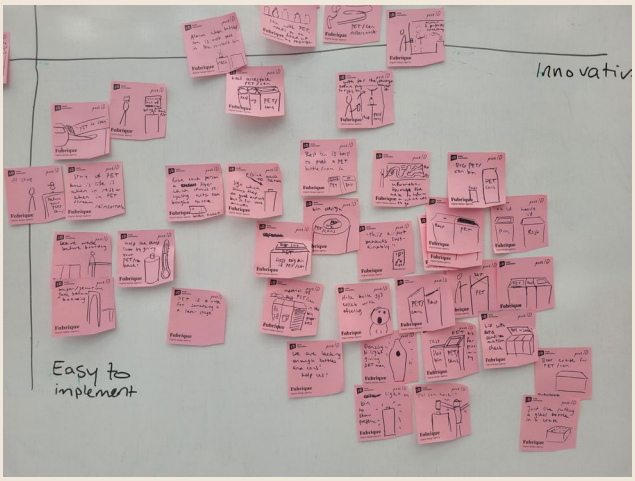


Figure 37, innovative and feasible box

Takeaways 4.1.3
- A design with intent brainstorm can be used for generating ideas for uncontaminated collection of PET bottles and cans.

4.1.4 Mock up tests

Participants	Role	Nationality	Duration session
5	Schiphol passengers	Unknown	1,5 hour

During the ideation phase there was room for a test day at Schiphol. Therefore a mock up test was done. The first mockup was formed to see if people noticed the donation box (see figure 38), when there is a sign placed around it which makes them aware of the donation box.
The hypothesis is that people do not notice the donation box enough, so this test will show whether they act upon a sign which makes them more aware of the donation box.
The goal of the test is to find out if people notice the signs and if they act upon it.
The second mockup (see figure 39) consisted of a poster which was placed at the FF3 bins, to make people aware of the presence of the donation box.

Figure 38, first mockup

Figure 39, second mockup

Takeaways 4.1.4
By observing at the first mockup, one passenger was seen to hover its bottle above the plastic bin of the FF3 bin, and after some hesitation, was led to the donation box and disposed of his PET bottle there. This shows that it needs to be very clear where your PET bottle or can should go, otherwise it would still end up in the FF3 waste bin.
The second mockup did not seem to work well enough. This is probably because it is a quite static poster, where a passenger needs to put in (too) much effort to go and find the donation box. The fact that people do not want to put in much effort and do not want to walk long for disposing of their PET bottle or cans is strengthened. This is why the next phase should also look at the option of adding something at the FF3 bin, which was also proposed in chapter 6.
After taking down both of the mockups, the first arrow mockup was transported and surprisingly attracted a lot of attention from the passengers. See figure 48 for the example. This could give the insight that providing information for passengers could work better if it is shown to them in a dynamic way.

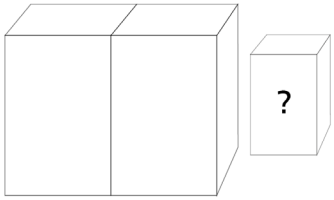
Figure 40, attention during transport

4.2 Conceptualisation concept directions

This chapter explains the concept directions that were generated from the brainstorm phase. First, the initial concept directions that were formed by the DwI brainstorm are shown. After that, an iteration has been made in order to make the concept directions fit better with the next design activity.

4.2.1 Concept directions

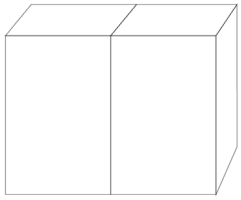
1. Addition to FF2/FF3



Adding something next to every FF2/FF3 bin which makes clear that the ideal option is to put the PET bottle/can in the separate bin.

What can be put next to the FF2/FF3 bins to encourage handing PET/can in there?

2. Example bin



A bin which visually shows what needs to be put in.

How can we show what needs to go in which bin?

3. Absence

Creating a place which clearly lacks PET bottles/cans, so people are nudged to fill this gap.

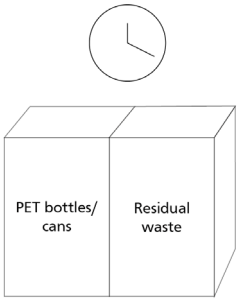
What setup can we create which makes passengers want to fill the gap in the setup?

4. Fun experience

Making handing in a fun experience.

How can we make returning your PET/can a fun experience?

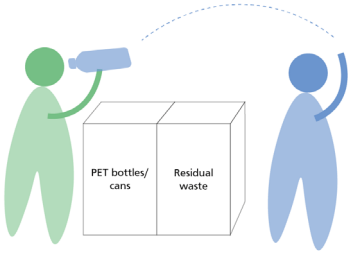
5. Thinking time



If the discarding time is longer, the passenger will maybe take more time to think about correct waste separation.

How can we let people take longer to throw something away?

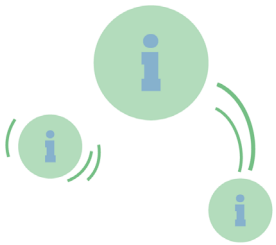
6. Responsibility



Passengers will in this concept be responsible for the PET bottle/can of the previous passenger who discarded it.

How can we make passengers be responsible for the waste separation of the previous passenger?

7. Dynamic information



Information can be dynamic which could make people aware of something.

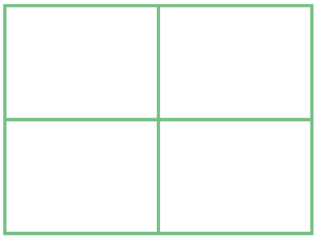
How can we dynamically give information about recycling/returning PET/cans at Schiphol?

8. Static information

Passengers need to be informed by Schiphol that their PET bottle/can can be recycled.

How can we inform passengers in a static form to let them know they can return their PET/can at Schiphol?

9. View information



Passengers will look around them when they sit at the gate.

How can we inform passengers that they can recycle their PET/can when using the view that they have when sitting at the gate?

Takeaways 4.1.1
- There are nine concept directions (identified) that can drive the development of a favorable design concept
- The design concepts cover several subjects, in particular behaviour influence, user satisfaction, practicality and information.

4.2.2 Co-creation session

To include Schiphol with the design phase, an online co-creation session was held. The participants consisted of two Schiphol employees, one Seenons employee and one TULIPS employee. The setup can be seen in appendix I.

Partici-pant	Role	Natio-nality	Language of session	Duration session
Participant 1	Circular economy lead	Spanish	English	2 hours
Participant 2	Schiphol waste expert	Dutch	English	2 hours
Participant 3	Seenons employee	Dutch	English	2 hours
Participant 4	TULIPS	Dutch	English	2 hours

For this session, the main goal was to include Schiphol with designing a solution for the problem statement, and create an open minded setting for further stages. Next to that, the outcomes of the criteria discussion and the winning ideas should help in the next stages of the design phase.

Takeaways 4.1.2
As can be seen in figure 59, it became clear that these criteria are important (ranked on importance)

Next to these criteria, scalability is important for Schiphol, as they would like to have the proposal be implemented throughout Schiphol.
The ideas that came out of the co-creation session can be seen below:

Numerous other ideas were generated, which helped in the further steps of the ideation phase, where more detailed ideas were merged into concepts.

To ideate further on the design directions, two design methods are used. First, the SCAMPER method will be used, and after that the morphological chart is used.

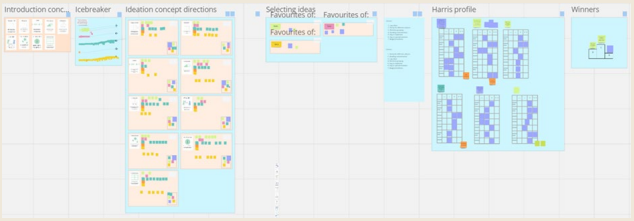


Figure 41, the co-creation session in miro

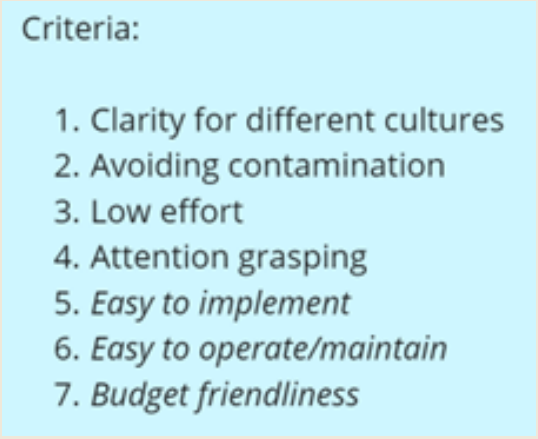


Figure 42, criteria outcomes

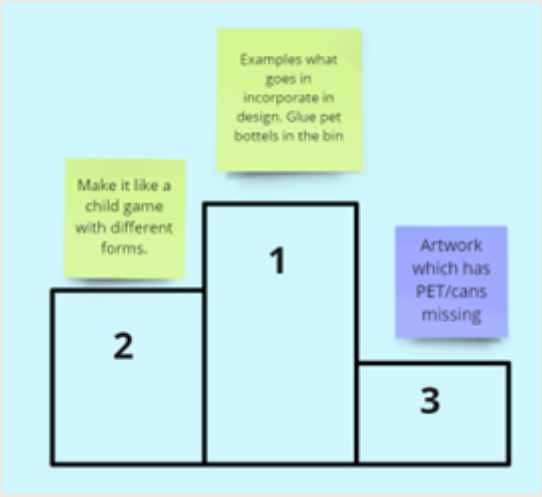


Figure 43, idea outcomes

4.2.3 SCAMPER

Zie morphological chart voor betere introductie
A SCAMPER was executed on the 3 ideas that came out of the co-creation session. SCAMPER stands for Substitute, Combine, Adapt, Modify, Put to another use, Eliminate and Reverse. With peers, the three directions were discussed and for each of them, the SCAMPER themes were applied in order to broaden the concepts.
The following ideas were generated

Takeaways 4.1.3
While this method broadened the ideas of which the ideation method started with, it did not deliver any truly novel ideas. This is why another method was put to use in order to come to extra possibilities in the concept directions. However, there was one insight made that the child's game did not spark my interest, which is why this concept direction was left out of the ideation in the next phases.

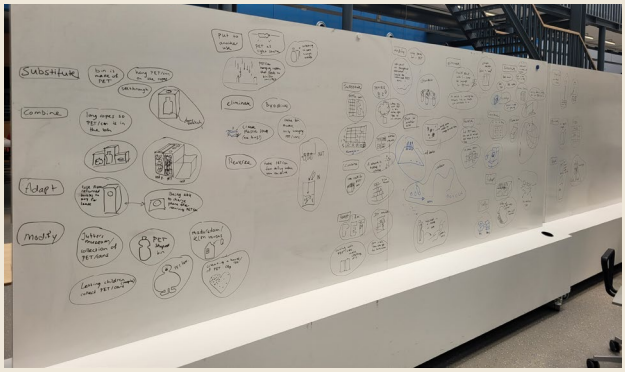


Figure 44, SCAMPER sketches on whiteboard

4.2.4 Morphological chart

The two selected idea directions from the SCAMPER method were further explored by creating a morphological chart. A morphological chart is a tool which can be used for exploring and generating potential solutions to design challenges (Delft Design guide). It is a structured method that breaks down a problem into parts and then systematically combines different options to create new potential concepts. The goal is to find innovative and novel solutions by combining various elements in a structured manner.

The morphological chart on the left shows what it is required to do, and right from these options on how this can be facilitated are shown. After filling in the table, combinations could be made that seem to be fruitful.
The first concept direction could be described as ‘showing examples of PET bottles and cans on the bin’. See figure 62 for the morphological chart that was formed from this concept direction.

The second morphological chart was formed around the concept direction which could be described as ‘PET bottles and cans as an artwork’, see figure 63.

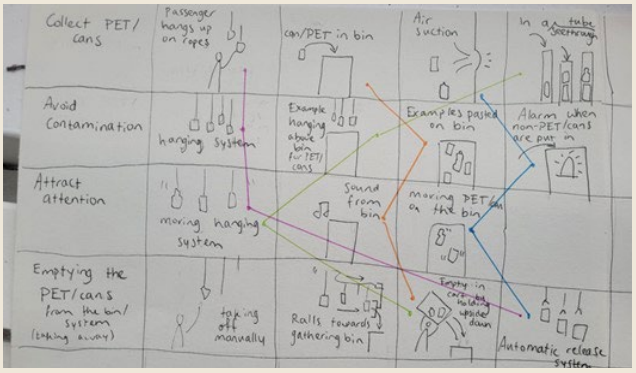


Figure 45, morphological chart on ‘showing examples of PET bottles and cans on the bin’

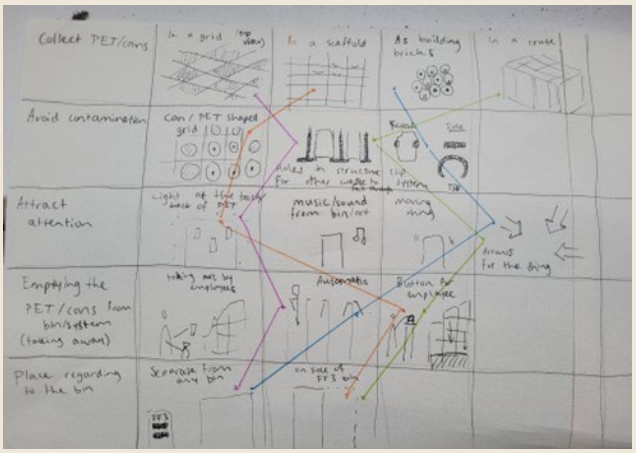


Figure 46, morphological chart on ‘PET bottles and cans as an artwork’

4.2.5 Design concepts based on Morphological chart

Per chart, one line was followed as this was seen to be the most feasible in the Schiphol context, and these two ideas were worked out into two concepts. See the next chapter for the sketches and descriptions of the concepts.

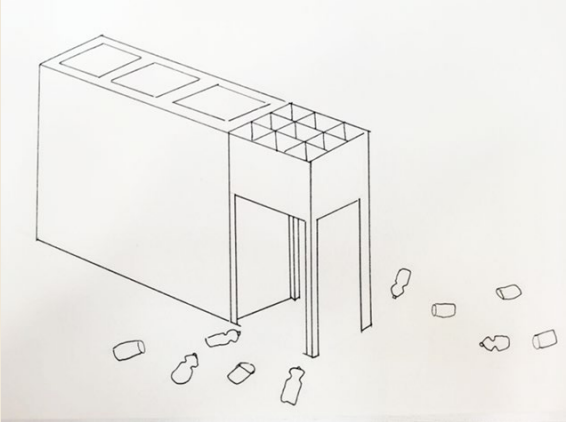


Figure 47, sketch PET bottle/can crate concept

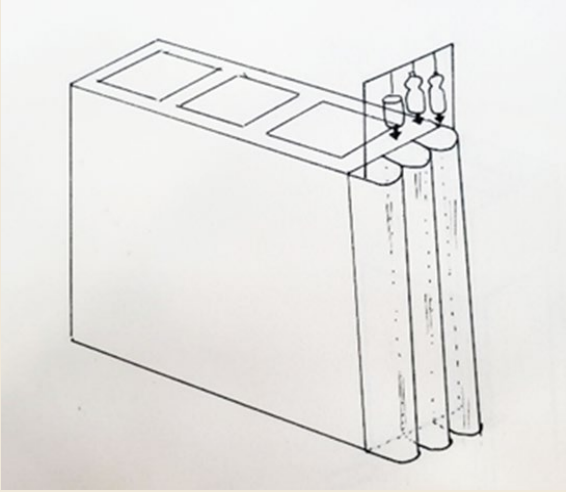


Figure 48, sketch PET bottle/can tube concept

This idea focuses on adding the option of PET bottles and cans to the FF3 bins. The concept is similar to when people look at examples of returned glass bottles, we could try to encourage people to behave the same way. For example in Pathé cinemas, crates are placed in order to let people return their glass bottles when having finished watching the movie. Another aspect of this idea is that stickers will be pasted on the floor, that lead the passenger to the waste bin. Also information and/or visuals will be needed to be shown on the crate part itself. This could be placed at each FF3 bin.

This concept consists of a (see through) tube, where information is shown on and the returned PET/cans can be seen from the outside. On top, there will be a hanging mechanism to show real (3D) examples of an empty can or bottle, with an arrow at the bottom. This shows that that is supposed to go in the tube. This could be placed at each FF3 bin.

4.3 Testing concepts at Schiphol

By testing the two concepts within the context of Schiphol Airport, insights were gained regarding passenger behaviour. The following paragraphs present the outcomes of conducting semi-structured interviews with passengers. See appendix M for information regarding the test setup.

4.3.1 PET bottle/can crate concept test

The prototype PET bottle and can crate concept was placed adjacent to an FF3 bin, and passenger behaviour was observed from a discrete area. Two passengers who disposed of their PET bottles or cans in the prototype were interviewed to gain insight into their behaviour. An interview was not successfully conducted with a third passenger, as they did not speak English. The interview setup is displayed below:

Duration	Interviewed passengers	Nationality passengers	Language interviews
2 hours	2	American, Dutch, Unknown,	English

Figure 49, PET bottle/can crate concept in Schiphol context

Outcomes 4.3.1
See figure 66 for the prototype in the context. The following insights were gathered on the crate concept:
Seven passengers disposed of their bottles in the crate.
7 disposed PET bottles in FF3 bin.
Of these passengers, two were interviewed, and both found the concept clear thanks to the visual examples.
One passenger emphasised that, although they did not usually separate their waste at home, they felt willing to do so here because it required so little effort.
No other waste was put in the crate prototype. (requirement 3)
One passenger noted that the examples showed a PET bottle being placed in one row and a can in another, although it is not strictly necessary to do so.
One passenger whom I wished to interview did not speak English, indicating that this concept was comprehensible to her without being able to read the text.

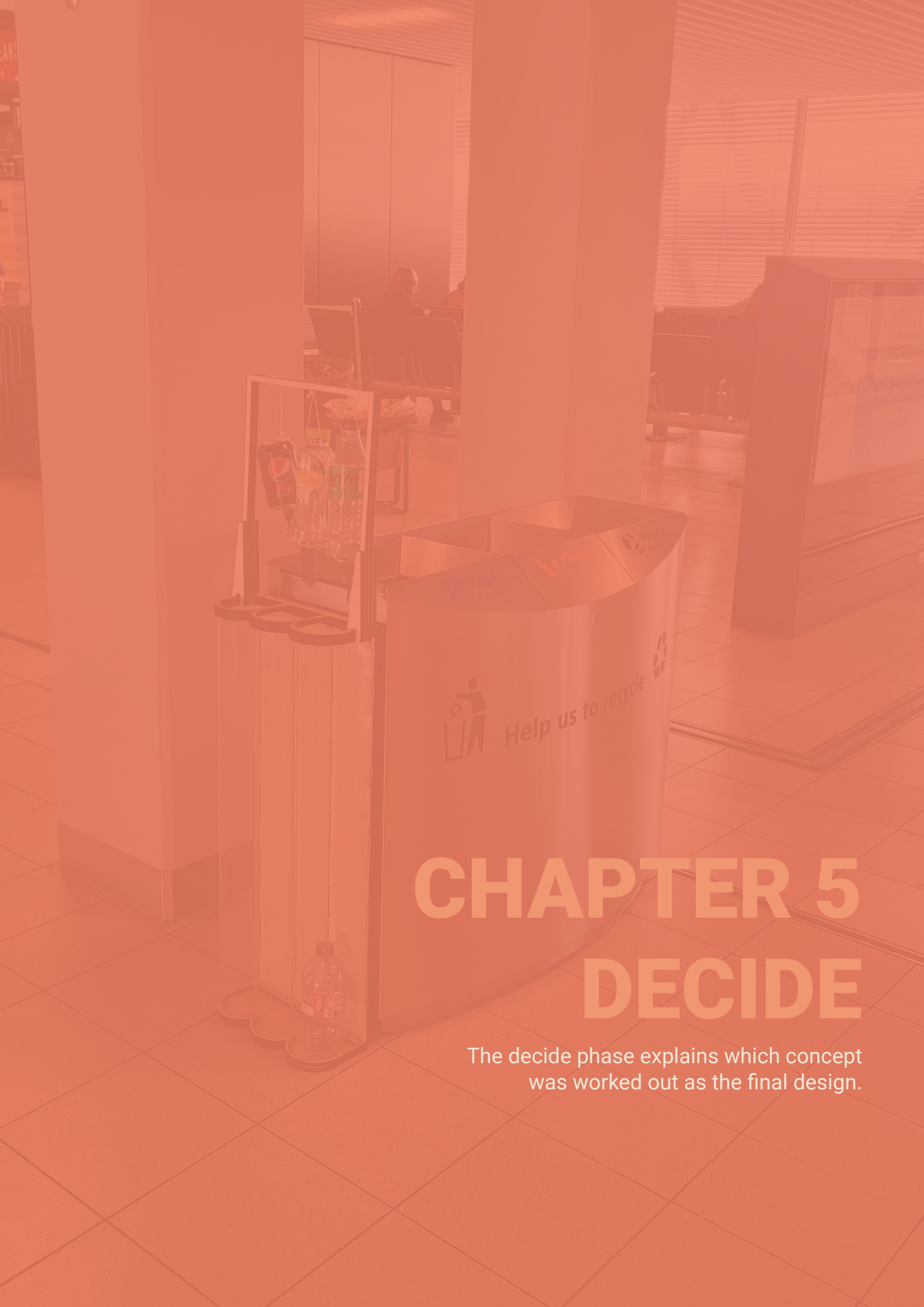
4.3.2 PET bottle/can tube concept test

The prototype PET bottle and can tube concept was placed adjacent to an FF3 bin, and passenger behaviour was observed from a discrete area. One passenger who disposed of their PET bottles or cans in the prototype were interviewed to gain insight into their behaviour. The interview setup is displayed below:

Duration	Interviewed passengers	Nationality passengers	Language interviews
2 hours	1	Dutch	Dutch

Figure 50, PET bottle/can tube concept in the Schiphol context

Outcomes 4.3.2
See figure 50 for the prototype in the context. The following insights were gathered about the crate concept:
No other waste was put in the tube prototype.
Most of the planes, and consequently, the passengers, departed during this time slot of the second tube prototype test phase. Therefore, there were few passengers who discarded any waste, let alone a PET bottle or can, in the area.
2 passengers who were interviewed during the crate prototype test explained that they thought this second prototype was more elegant.
One of the first passengers interviewed was not enthusiastic about the hanging mechanism that showed examples of bottles and cans.



CHAPTER 5
DECIDE

The decide phase explains which concept was worked out as the final design.

5.1 Concept choices

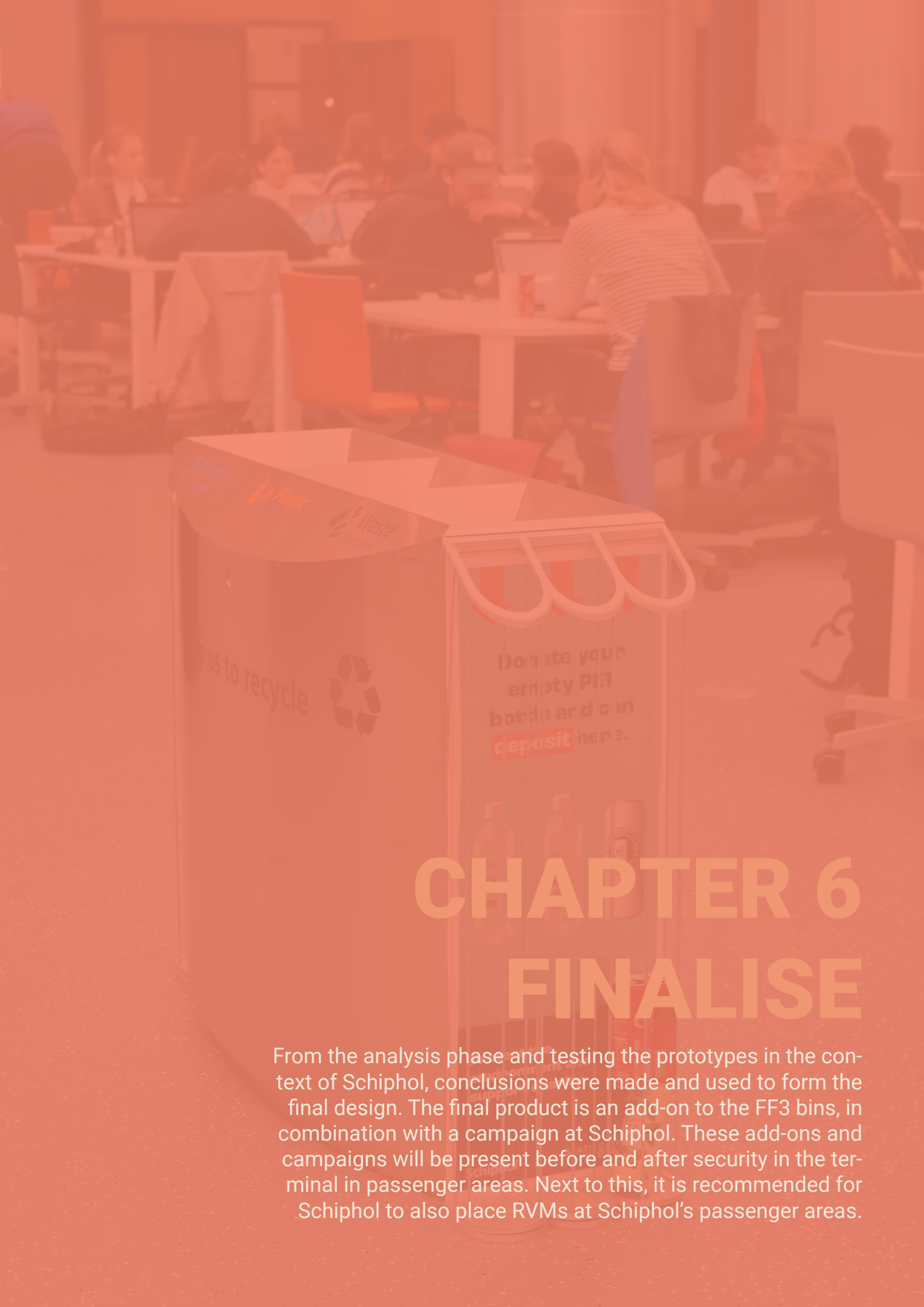
A combination from the two concepts discussed in 4.3.1 and 4.3.2 is sought after, as they both have desirable attributes and non desirable attributes. The current redesign would include the elegance of the tube concept and the visual examples of the crate concept. The low effort should be still strived for.

Improvements of the concept should include the interaction by cleaners, how it will be handled. This should take cleanliness into account, as well as passengers who dispose of their PET bottles and cans in the add-ons, as well as cleaners who empty the add-ons.

There should also be more attention on informational strategies, which were not included in the prototypes.

Also the look and feel should be taken into account during the final design proposal.

The next phase will make an iteration on this and will propose a final design for the physical add-on on the FF3 bin.



CHAPTER 6
FINALISE

From the analysis phase and testing the prototypes in the context of Schiphol, conclusions were made and used to form the final design. The final product is an add-on to the FF3 bins, in combination with a campaign at Schiphol. These add-ons and campaigns will be present before and after security in the terminal in passenger areas. Next to this, it is recommended for Schiphol to also place RVMs at Schiphol's passenger areas.


Plastic
Paper
Papier
us to recycle
Donate your
empty PET
bottle and can
deposit here

FINAL DESIGN

6.1 Final Design

6.1.1 Final prototype in context - renders

The physical product consists of a metal frame which is placed at at both sides of every FF3 bin which is present at Schiphol.
The proposal is to also have RVMs in place at various places at Schiphol. This add-on is therefore an addition which enables ignorant passengers to return their PET bottles and cans correctly.

Next to this, a campaign is designed, to make passengers more aware of returning and recycling possibilities and impacts.


Return your empty PET bottle and can.
Recycle like others!
Schiphol
STATIEGELD NEDERLAND


Your bottles and cans will 100% be recycled when you return them.
Schiphol
STATIEGELD NEDERLAND
ARTIS lives

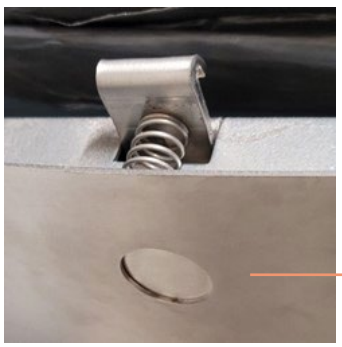
6.1.2 Technical overview

Metal (stainless steel) frame, welded together

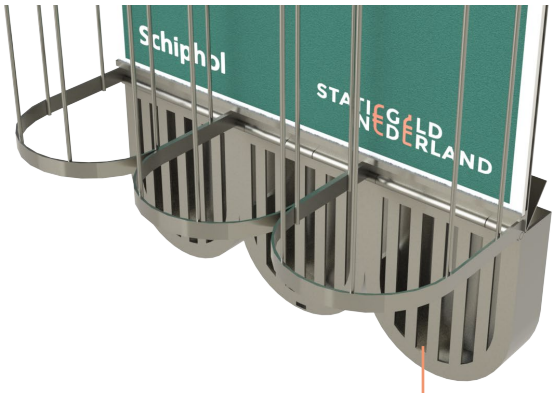
Replaceable flat poster backboard

Poster in Statiegeld Nederland Corportate Identity (appendix O)

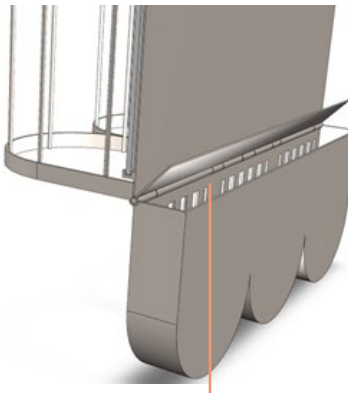
Hinge with liquid and sponge reservoir



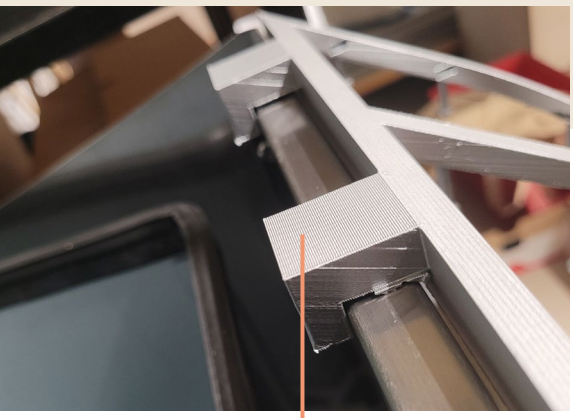
Button to open frame, letting bottles and cans out



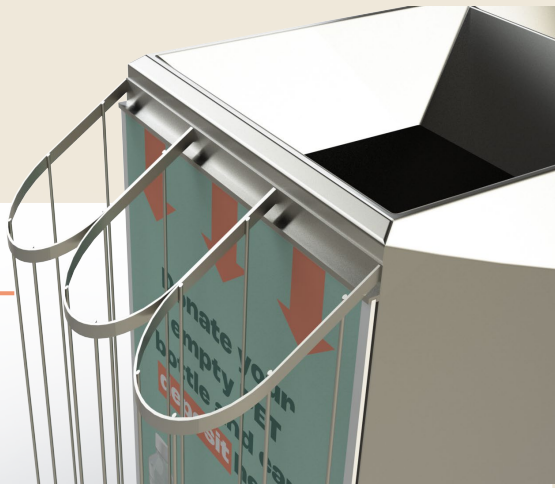
Grid to allow liquids from PET bottles and cans go through



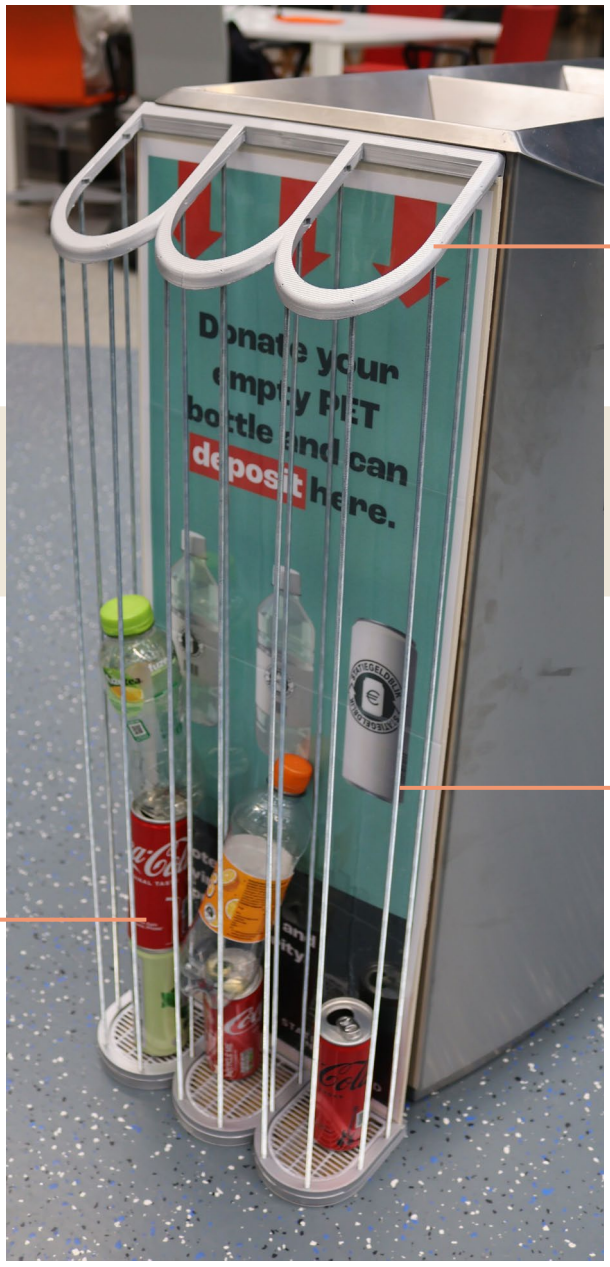
Sponge in liquid reservoir



Hooks clamped under FF3 bin lid



Sloped top part to fit appearance of FF3 bin (see appendix N)



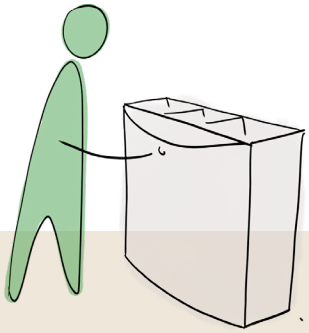
Round shaped to fit shape of PET bottles and cans

Metal (stainless steel) frame fits appearance of FF3 bin

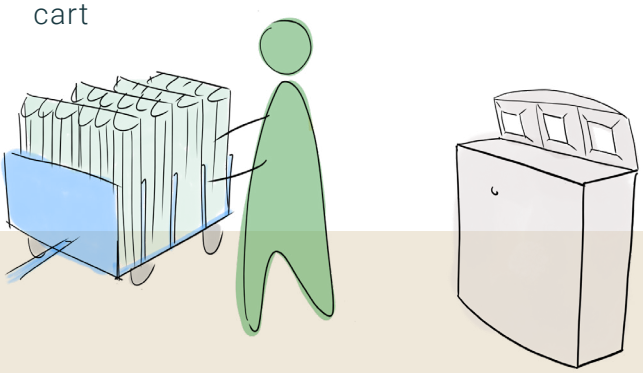
Enough capacity (see confidential appendix E)

6.1.3 Scenario handling add-ons

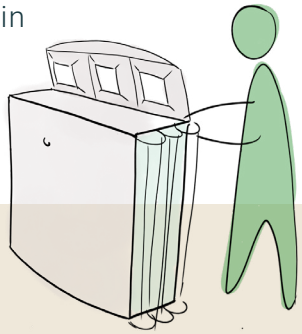
The employee pushes on the button to open the FF3 bin lid



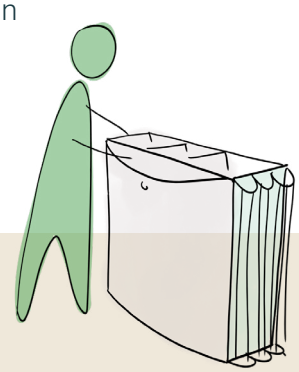
The employee takes an add-on from the cart



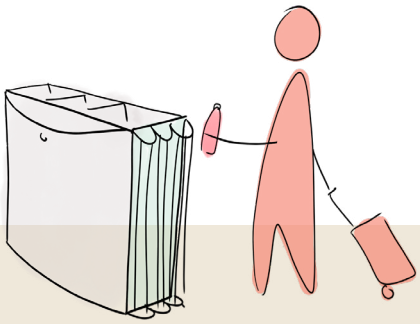
The employee clamps the add-on on the FF3 bin



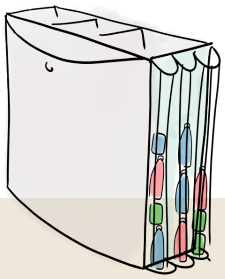
The employee closes the lid so the add-on will stay steady



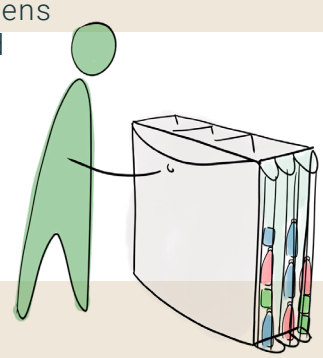
Passengers place their PET bottles and cans in the add-on



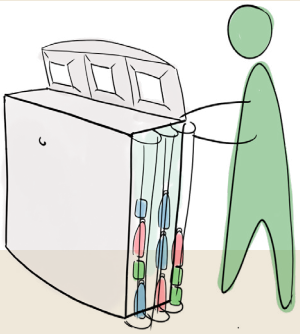
The add-on gets filled with PET bottles and cans



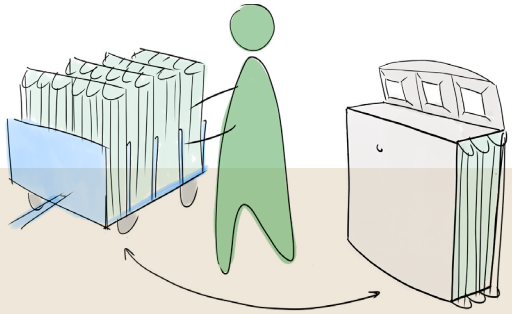
The employee opens up the FF3 bin lid



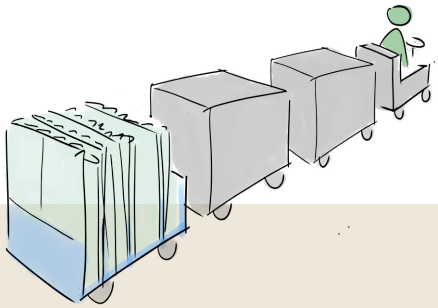
The employee takes the add-on from the FF3 bin



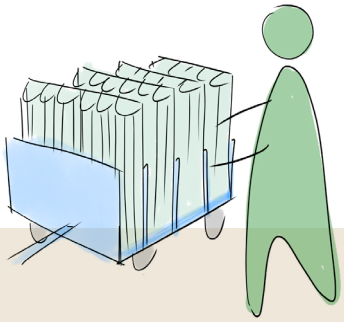
The employee swaps the full add-on with an empty add-on



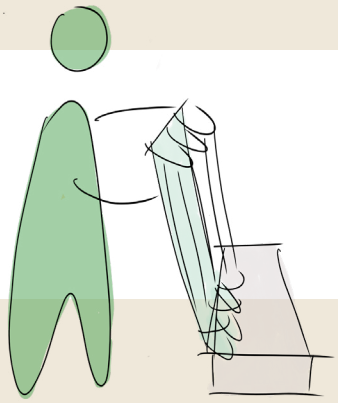
The employee takes the cart with full add-ons backstage



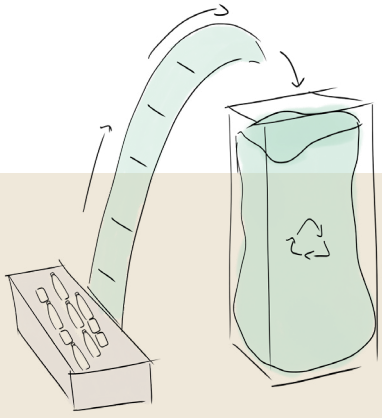
The employee takes the add-on one by one



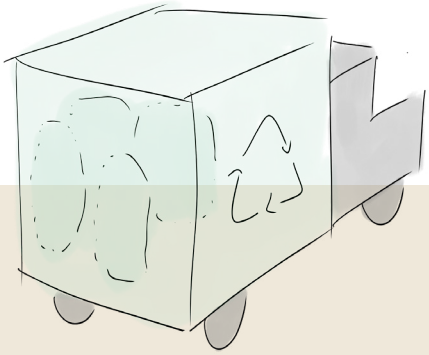
And empties them by pushing the bottom button and empty the bottles and cans in a container



A Statiegeld Nederland lift will take the bottles and cans up in the Statiegeld Nederland waste bags

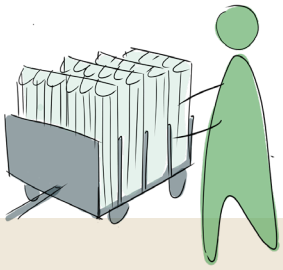


The Statiegeld Nederland bags will be taken from Schiphol to recycle them

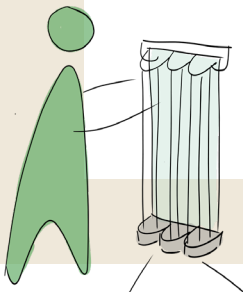


6.1.4 Scenario cleaning add-ons

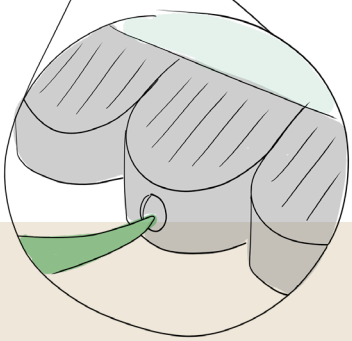
The employee takes the add-on from the cart



The employee hangs the system above the collection container

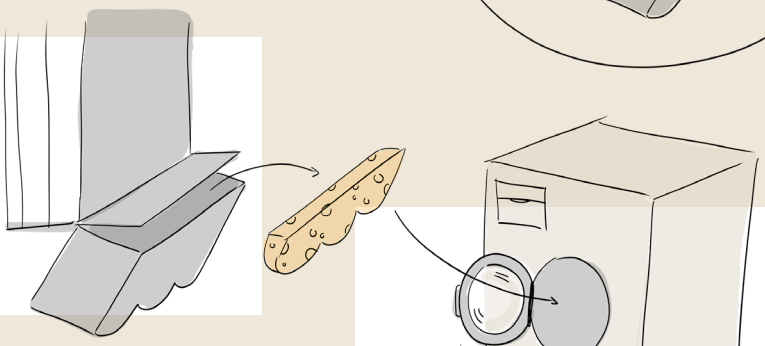


The employee pushes the button of the liquid reservoir



The PET bottles and cans will go out of the frame, into the container

The back lid will be opened



The sponge is taken out and will be put in the washing machine

6.1.5 Campaign

The final design proposal also includes a campaign. This addresses the motivation, ability and triggers of Fogg's behaviour model. The campaign proposal consists of multiple components that communicate to the passengers:

1. Posters in add-ons
2. Communication through floor to add-on
3. Posters and screen visuals
4. Shop information

These campaign materials are designed by the author. All of these options use the corporate identity of Statiegeld Nederland, as literature showed that there should be consistent use of visuals and colours. The corporate identity of Statiegeld Nederland can be used royalty free, as this increases the amount of returned PET bottles and cans. See appendix O to a link to the used toolkit.

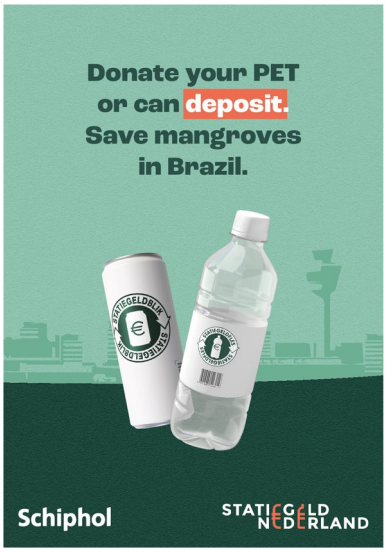
Posters in add-ons

Firstly, posters in the add-ons will provide passengers with signage (see design opportunity 9) to show the function of the add-ons. An example can be seen in figure 51. The posters can be changed, the slogans can be replaced with others to address the message of returning and recycling in various ways. The layout of the poster should always include the Statiegeld Nederland PET bottle and cans examples. The message of returning your PET bottle or can should be clear as well. Next to this it should include the message where the money will be donated to, preferably mentioning the charity's name.
Also the arrows, logo of Statiegeld Nederland and Schiphol should be included.

Figure 51, Add-on poster example

Posters

To provide passengers with a multifaceted campaign (Design opportunity 2 & 9), posters were designed. These posters can be changed into different charities, other campaign ideas, but the arrows, visual examples of bottles/cans and the text should always be present to make the passengers aware of the purpose of returning their PET bottles and cans.

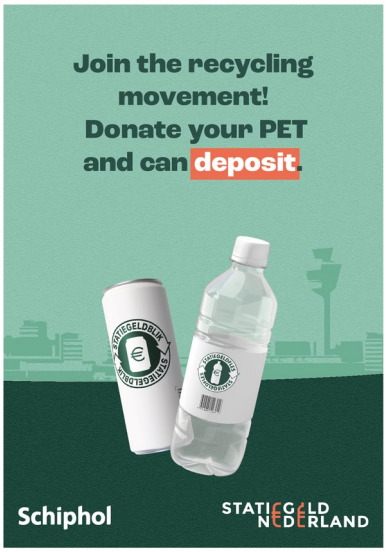


A first poster proposal (see figure 52), shows the positive impact a poster could convey, to show passengers what they would contribute to. This is in line with design opportunity 7. This awareness could be raised by an example slogan like 'Donate your PET or can deposit. Save mangroves in Brazil.' or 'Return your PET bottle and can. Save the Australian reefs.' These slogans can be changed, dependant on the gates and their corresponding flight destinations.

Figure 52, Poster example 1

A second proposal addresses the need to return, and the recycling possibility. This proposal is in line with design opportunities 7 and 10.

Figure 53, Poster example 2



The third poster proposal addresses the social proof concept of Cialdini. This proposal is in line with design opportunity 9. It also addresses Fogg's social acceptance/rejection motivation factor. It enhances the feeling of belonging to a certain, in this case sustainable, group.

Figure 54, Poster example 3

Shop information

To inform the passenger also at the moment of buying a drink, and introducing them to the recycling system in place, the shops should also provide them with triggers.

A proposal for shops like the grab & fly kiosks would be to provide passengers of information on the return of their empty PET bottles and cans. See figure 57 for the example in the context.
One proposal, is to place flyer holders containing a flyer which shows a visual example of the RVM and add-ons. See figure 55 for an example. Next to this, the screens can be used to convey the return and recycling message. See figure 56.

Figure 56, Informational poster for screens

Figure 55, Example of poster on where to return

Figure 57, Grab & fly proposal

6.2 Validation

To validate whether the add-on is successful, two tests were conducted. A comparative test was conducted at IDE on two days, one week apart from each other. Next to this, a validation study was done at Rotterdam The Hague Airport (RTHA).
The test setup can be seen Q.

6.2.1 Study setup

Type of study	Location	Amount of test days	Amount of handed out drinks	Participants	Day of the week	Testing time
Comparative study	Industrial Design Engineering (IDE)	2	18 cans 9 bottles each testing day	IDE students	Friday 15 & 22 september	9.00-17.00
Validation study	Rotterdam The Hague Airport	1	None	Passengers	Tuesday	9.00-17.00

For the comparative test at IDE, the add-on was placed at an empty FF3 waste bin. At the end of the period, it was examined to determine if the add-on influenced the amount of PET bottles and cans that were thrown away in the FF3 bin or in the add-on. To mimic the situation of Schiphol, with passengers drinking a drink and after that disposing of their PET bottle or can when empty, drinks were handed out at the IDE faculty to IDE students. The following was taken into consideration. Firstly, the participants were not told that they were participants in research. They were told that the drinks were leftovers, so they were unbiased in their behaviour of disposing of the PET bottle or can. Secondly, the participants were not asked to do anything in particular with the bottle or can after they had finished their drink. Thirdly the drinks were handed out cold, so they were more likely to drink the drink at their current place, instead of taking the drink home.

For the validation study at Rotterdam The Hague Airport, the add-ons were placed at a waste bin. At this test, the add-ons were examined at the end of the test period, to determine whether participants threw away their PET bottles and cans correctly.

Drinks were not provided to the participants (passengers) by the researcher.

After letting the add-ons stay at their place for eight hours, conclusions could be made on four different criteria. These are explained in the following paragraphs.

6.2.2 Amount of returned PET bottles and cans

To validate whether the requirement 1 is met, the amount of returned PET bottles and cans is analysed.
The add-ons collected PET bottles and cans in both the IDE context, as well as the Rotterdam The Hague Airport. Below can be found what the amounts of these were.

IDE

	In add-on	Disappeared/ unknown
Amount of PET bottles	4	5
Amount of cans	11	7

RTHA

	In add-on
Amount of PET bottles	7
Amount of cans	1

As can be seen above, both PET bottles and cans were collected in the add-ons at the IDE testing day. More than half of the beverage containers that were handed out initially, were disposed of correctly into the add-ons.
The add-ons also showed successful results at Rotterdam The Hague Airport. See above for the amount of returned PET bottles and cans in the add-ons. This means that in the context of a real airport with passengers, the add-on collects both PET bottles and cans.
The conclusion can be made that requirement 1 is met.

Figure 58, Add-ons at IDE

Figure 59, Add-ons at RTHA

6.2.3 Avoiding PET bottles and cans in waste (FF3) bin

Secondly, to determine whether the add-on avoided PET bottles and cans to go into the FF3 bin (residual, plastic or paper waste stream), an analysis was done. Below can be seen how many of the PET bottles and cans ended up in the residual waste stream at IDE during the prototype testing. Below, two snapshot photos are shownthat were taken during the add-ons testing day at RTHA.

IDE

	Paper waste	Plastic waste	Rest waste	In add-on	Disap-peared/ unknown
Amount of PET bottles	0	0	0	4	5
Amount of cans	0	0	0	11	7

RTHA

It can be seen that the add-on has collected 5 PET bottles from 9.00 to 14.00. From 14.00 to 17.00, two PET bottles and one can were collected.
See figure 60 for a picture taken at 14.00, which shows a PET bottle in the plastic waste stream. Next to this, a photo taken at 17.00 can be seen in figure 61. A can was disposed of in the residual waste stream. It can therefore be concluded that not all PET bottles and cans ended up in the add-on. There were limitations in place for the validation, which will be discussed in 6.3.

Figure 60, Picture taken at 14.00

Figure 61, Picture taken at 17.00

From the table above follows that at IDE, the add-ons avoided 100% of the handed out PET bottles and cans to go into the FF3 bin, and therefore the general waste stream.
At RTHA, the conclusion can be made that not all of the PET bottles and cans were collected in the add-ons.
Design requirement 1 is therefore met at IDE, but not fully at RTHA.

6.2.4 Contamination in add-ons

Design requirement 3 stipulates that the solution should avoid contamination from other waste than PET bottles and cans. Both tests showed no contamination in the add-ons. See figures 62 and 63 for the status at the end of the test period at IDE, and figures 64 and 65 for the status at the end of the test period at RTHA.

Figure 62, Side 1 of add-on at IDE

Figure 63, Side 2 of add-on at IDE

Figure 64, Side 1 of add-on at RTHA

Figure 65, Side 2 of add-on at RTHA

The conclusion could be made that there was no other waste in the PET and cans add-on, and therefore design requirement 3 was met.

6.2.5 PET bottles or cans

It is interesting to look into the difference of collected PET bottles and cans during the comparative study at IDE. See figure 66 for the counts of the different drink container types in the different bin types. Splitting the data into cans and PET, and the type of waste stream in the FF3 bin, we can see that there were only cans that were left behind in the FF3 bin in the baseline test. The assumption is that this is the case, because cans cannot be closed off and can cause bags to get stained with leftover liquid. Students therefore presumably take the PET bottles with them, to bring back to an RVM, or to use again as liquid containers. Despite the presumed higher bar for people to leave their PET bottles, four bottles were still collected during the prototype test. This implies that a behaviour change could be seen: several cases showed that they preferred to put it in the add-on than taking it somewhere else. An explanation for this could be the mentioned donation to charity when putting it in the add-on.

6.2.6 Evaluation and discussion results

The conclusion from the validation study could be made that the placement of the add-on leads to passengers returning both their PET bottles and cans. Moreover, they were induced to discard it in a far greater number into the add-on than into the general waste bins at the IDE test. A (near) complete stop of wrongly discarded drink containers could not be proven, as both a PET bottle as well as a can were identified in the general bins during the test at RTHA. Next to this can be concluded that the add-on did not contain other waste than PET bottles and cans, which shows that contamination is avoided. These outcomes show an improvement in a clear and clean PET bottle and can waste stream..

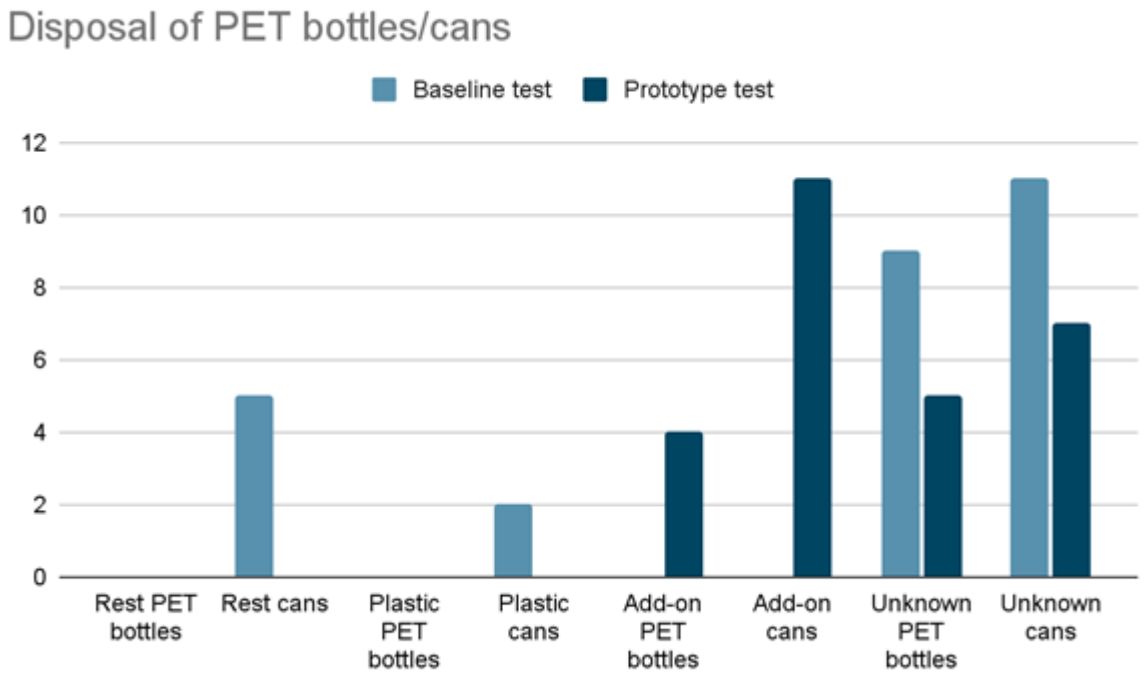


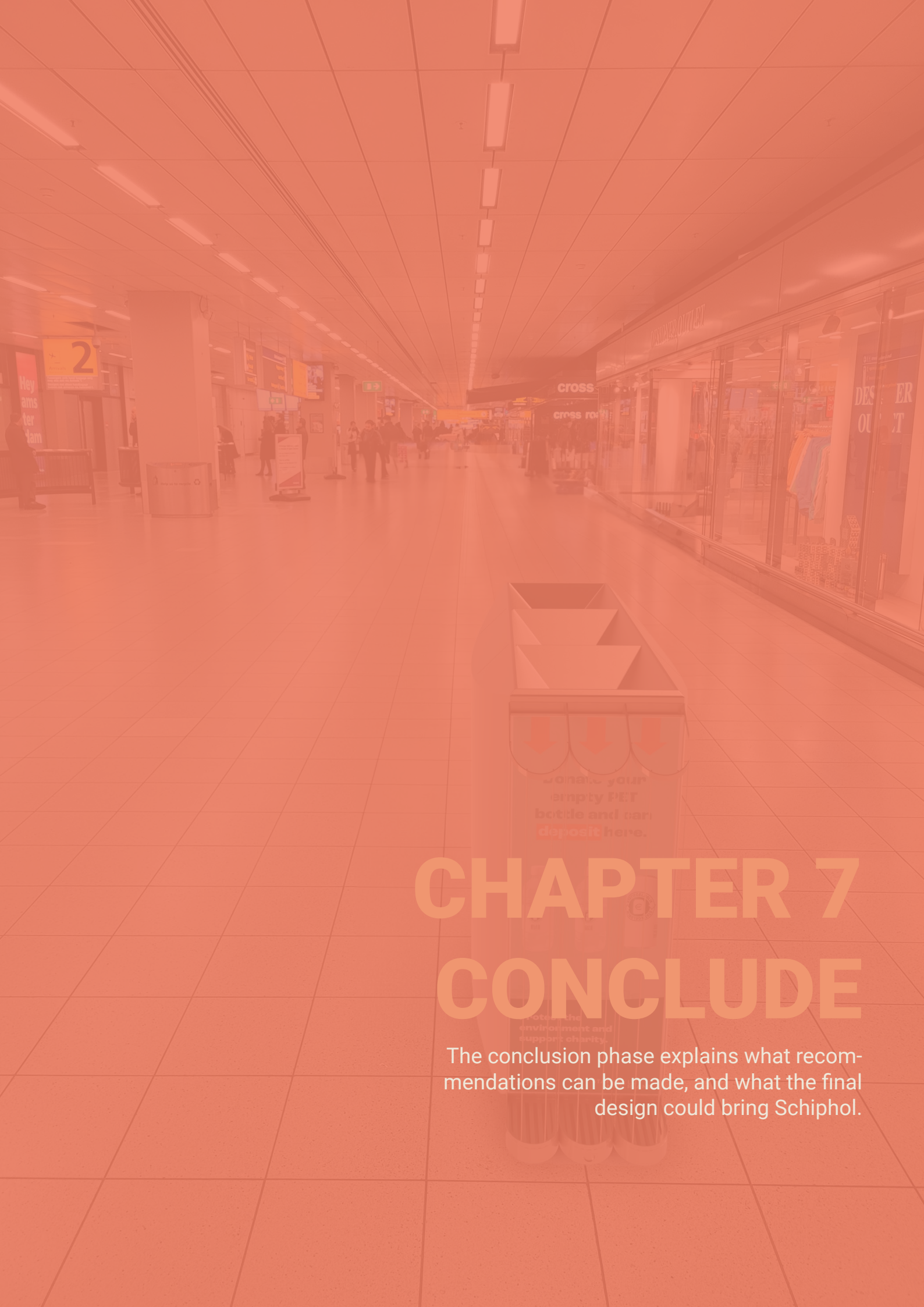
Figure 66, Side 2 of add-on at RTHA

6.3 Evaluation prototype testing

The testing was conducted with certain limitations, which must be acknowledged for a comprehensive understanding of the assessment process.
Firstly, the add-on only was tested for a limited amount of time within a day, which shows only what the add-on would yield for this timeframe. The airport is open for more hours than the tested time. It is not clear if the times outside of business hours cause different behaviour of passengers, for example when they are more tired. Ideally, the add-on is tested for a longer amount of time.Within the limited timeframe, a representable as possible time slot was chosen for RTHA: the time of day contained departures as well as arrivals and the the time of the year the test was representative as it was neither in the busy summer period nor in the uncrowded low season.
Secondly, the environment of the add-on plays a role. The add-on is now tested in the Rotterdam The Hague Airport Terminal, whereas the add-on is ideally also tested at Schiphol airport. Rotterdam The Hague serves mainly intracontinental flights for, whereas Schiphol also has a high share of intercontinental flights. Moreover, Schiphol has a transfer hub function, which Rotterdam The Hague does not have. It is presumed that this has an effect on the nationality or background of the passengers.

Thirdly, another environmental limitation is in place. The current add-on was placed at only one waste bin, which makes it possible that passengers put their PET bottles and cans in another waste bin than the bin with the add-on. Preferably every waste bin within a clear boundary, such as a pier or a concourse, therefore should have an add-on to be able to really determine the passengers' behaviour in an extensive way. This could also give better insight on the impact of the PET bottles and can return.
Fourthly, only the add-on was now tested in this research. The final design also proposes a campaign that influences the passenger behaviour. It is therefore unknown what the final design, combining the add-on and the campaign, would bring about. Regardless, it is not reasonable to expect that the campaign would decrease the returned PET bottles and cans into the add-on.

In short, a longer, larger scaled comparative study at Schiphol is needed to be able to make more extensive conclusions on the final design's influence on the return behaviour of PET bottles and cans by passengers. Nonetheless, some interesting conclusions were drawn from this test.



CHAPTER 7
CONCLUDE

The conclusion phase explains what recommendations can be made, and what the final design could bring Schiphol.

7.1 Recommendations

7.1.1 Recommendations final design

To make sure cans cannot fall out of the add-on, the metal frame should be strong enough to stay in place. Currently the metal frame is slightly too flexible, which creates the possibility of taking PET bottles and cans out, or falling out.

The current add-on has a background where it is shown that the deposit will be donated to charity. However, this is placed very low, which causes PET bottles and cans to cover up this text quickly. It is therefore necessary to show this message clearer (at the top for example, or at the campaign posters).

When the add-on is placed in combination with RVMs at Schiphol, this could cause people to collect them from the add-on, and bring them to the RVMs. This is sustainability wise not a problem. There does need to be observed If the issue would occur where passengers cause nuisance by collecting and bringing them to RVMs. If this is the case, a lid could be placed on the add-on which makes the PET bottles and cans able to go in, but not get out, to avoid this behaviour.

A last recommendation is to update the signage on the FF3 bins, to make clearer that PET bottles and cans should go in a separate waste stream than residual, plastic and paper. Inspiration could be gathered from the graduation project outcomes of Nika den Ouden.

7.1.2 Other recommendations

DRS (RVM) at airport, Tikkie confirmed that they are currently working on the possibility to get deposit money back on a foreign bank account (Tikkie klantenservice).
Testing at what points PET bottles and cans are thrown away most, and optimizing the collection by cleaners on when to empty where
Samenwerken met Dopper: https://www.moodiedavittreport.com/schiphol-airport-retail-ceases-sale-of-packaged-water-and-strikes-sustainability-partnership/

7.2 Conclusion

A common method of evaluating an innovation process, is to regard its feasibility, viability and desirability. Through these three subjects, the conclusion is drawn.

7.2.1 Feasibility

Can it be done?

The final design proposes both a physical add-on and a campaign.
A successful prototype of the add-on has been made. It is possible to easily connect this add-on to the current FF3 bins. On top of that, a plan has been made for the cleaners to empty and replace the add-ons, which has been integrated in the current process.
Therefore, it can be stated that from a perspective of practicality, the design is feasible.
The business perspective also needs to be regarded. Attention should be put in to provide a detailed production plan. Subsequently, production time should be determined, as well as costs. This could be a rather big investment, as it should be placed twice at every FF3 bin.
The campaign should take less time, and could be achieved in a short timeframe. The campaign is less costly to execute. This could be widespread all over Schiphol to provide passengers with information about PET and cans return.
Overall, there should be assessed by a design team if this investment is worthwhile, looking at the quickly changing legislation regarding waste separation. This proposal should be a step towards circularity.

7.2.2 Viability

Does it fit the users' needs?

Schiphol's aim to increase the amount of returned PET bottles and cans is addressed in this project. This increase could be achieved by implementing the design proposals. Other stakeholders' (such as cleaners) needs were taken into account during the design phase of this project, to make the add-on as intuitively and easy to handle as possible. Passengers showed positive results in showing a less contaminated waste stream for PET bottles and cans through the add-ons in the test, as a significant number of both PET bottles and cans were put into the add-on, whereas wrongly disposed drink containers decreased. A rough estimation on the potential impact showed that Schiphol could collect 14.400 PET bottles and cans with the add-on, when using the results from RTHA validation and putting that in the Schiphol context. See confidential appendix F for the rough estimation. Moreover, the add-ons were not contaminated with other waste. The impact could even be greater when the add-ons are combined with the proposed campaign. The campaign will likely increase the passenger's environmental concern and pro-environmental behaviour. This will result in passengers willing to help recycle and separate, and will therefore help reach Schiphol's goal to become zero waste by 2030.

7.2.3 Desirability

Will it survive on a longer term?

Waste and circularity is subject to quickly changing regulations. This was also experienced during this project. Various legislations were implemented during the months of this project, and this will also be the case for the future. However, the add-ons proposal will very likely stay relevant for a longer term, since a separate and uncontaminated PET bottles and cans recycling stream is beneficial towards a circular future. The materials will stay in the loop, and it will therefore contribute to a more sustainable future.
A recommendation is to look at a combination of Nika den Ouden's proposal for waste separation at Schiphol, and try to implement this with this proposal to potentially leading to a step closer to reaching circularity at Schiphol airport.

7.2.4 Combining subjects

The goal of this project was to create a design towards higher return of PET bottles and cans at Schiphol airport.
Through a triple diamond design process, a design has been made to tackle this challenge. The design combines an add-on to the current FF3 waste bins and a poster campaign.
The design is feasible, mainly because of its proven prototype and integration into the current waste handling process. The tests showed it is also viable, as the results proved positive. Lastly, the design is also desirable as a separate and uncontaminated recycling stream is beneficial towards a circular future.
However, before it can be implemented at Schiphol, more testing and an assessment whether the investment is worthwhile have to be conducted.

Reflection

The past months have been challenging, but also quite fun. Currently I can call myself an expert on PET bottles and cans. I am proud of the final design, and the learnings I take with me for the rest of my career as a designer.

Stakeholder management
To be able to talk to so many people who have so many insights on this topic is a lot of fun. I enjoyed the talks about sustainability, and the enthusiasm every person had during our talks.

Testing
Testing in the intended context has been proven in the last phase to be valuable in making conclusions. Preferably, this testing could have taken place more often and for a longer period, which woud have enriched the outcomes of the validation phase. However, this was quite difficult to execute, is what the reality showed. This was also the case because different project timelines had to be aligned. The timing of the testing moments were not always right according to my timeline.

No-solo-worker
I did find this graduation project quite lonely, which shows I would really like to work in a team in the future. I am quite insecure, and making decisions is therefore not my strongest point. It was therefore nice to have others with whom I could ‘spar’ with.

Asking for advice
Also, I learned that it is okay to ask for help with activities you are not an expert in. This is also a very educative experience.

References

Ackermann, L., Mugge, R., & Schoormans, J. P. (2018). Consumers' perspective on product care: An exploratory study of motivators, ability factors, and triggers. Journal of Cleaner Production, 183, 380–391. https://doi.org/10.1016/j.jclepro.2018.02.099

Afvalfonds verpakkingen. (2022, November 1). Eerste webinar over SUP-richtlijn - 1 november 2022 [Video]. Youtube. https://www.youtube.com/watch?v=D9rmAF9HqHA

Alledaagse vragen. (n.d.). NPO Luister / BNNVARA. https://open.spotify.com/episode/0159dUCezmWcC2BbdMQirL?si=24b7160f188446dc

Bergquist, M., Nyström, L., & Nilsson, A. (2020). Feeling or following? A field-experiment comparing social norms-based and emotions-based motives encouraging pro-environmental donations. Journal of Consumer Behaviour, 19(4), 351–358. https://doi.org/10.1002/cb.1813

Bungărdean, C. M., Soporan, V. F., & Salanţă, O. C. (2013). Considerations on the life cycle and recycling of aluminum beverage cans. International Journal of the Bioflux Society, Volume 5(Issue 2).

Duffy, S., & Verges, M. (2009). It Matters a Hole Lot. Environment and Behavior, 41(5), 741–749. https://doi.org/10.1177/0013916508323737

EUNOMIA, Petcore Europe, Plastics Recyclers Europe, & Natural Mineral Waters Europe. (2022). PET market in europe state of play 2022. Eunomia Research & Consulting.

European Commission. (2020). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: A new Circular Economy Action Plan for a Cleaner and More Competitive Europe. https://ec.europa.eu/environment/circular-economy/pdf/new_circular_economy_action_plan.pdf

European Parliament and Council. (2019). Directive (EU) 2019/904 of the European Parliament and of the Council of 5 June 2019 on the reduction of the impact of certain plastic products on the environment. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019L0904&from=EN

Facts about the climate emergency. (n.d.). UNEP - UN Environment Programme. https://www.unep.org/facts-about-climate-emergency

Hale, T. (2021). 97% Of Plastic Bottles Are Recycled Under Norway's Radical Environmental Scheme. IFLScience. https://www.iflscience.com/97-of-plastic-bottles-are-recycled-under-norways-radical-environmental-scheme-51785

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

Kalatzi, I. K., Nikellis, A. E., Menegaki, A. N., & Tsagarakis, K. P. (2015). The preferred bin colour for recycling plastic bottles: evidence from a student's sample. Progress in Industrial Ecology, an International Journal, 9(3), 256. https://doi.org/10.1504/pie.2015.073429

Leeabai, N., Areeprasert, C., Khaobang, C., Viriyapanitchakij, N., Bussa, B., Dilinazi, D., & Takahashi, F. (2021). The effects of color preference and noticeability of trash bins on waste collection performance and waste-sorting behaviours. Waste Management, 121, 153–163. https://doi.org/10.1016/j.wasman.2020.12.010

Milfont, T. L., Duckitt, J., & Cameron, L. D. (2006). A Cross-Cultural Study of Environmental Motive Concerns and Their Implications for Proenvironmental Behavior. Environment and Behavior, 38(6), 745–767. https://doi.org/10.1177/0013916505285933

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

PET bottle collection. (2023, June 30). Schiphol. https://www.schiphol.nl/en/schiphol-group/page/pet-bottle-collection/

PET recycling in India. (n.d.). http://www.petrecycling.in/pet-recycling-in-india/

Royal Schiphol Group. (2023). Annual report 2022.

Stahel, W. R. (2016). The circular economy. Nature, 531(7595), 435–438. https://doi.org/10.1038/531435a

Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. Journal of Environmental Psychology, 29(3), 309–317. https://doi.org/10.1016/j.jenvp.2008.10.004

Tam, K. J., & Chan, H. (2017). Environmental concern has a weaker association with pro-environmental behavior in some societies than others: A cross-cultural psychology perspective. Journal of Environmental Psychology, 53, 213–223. https://doi.org/10.1016/j.jenvp.2017.09.001

The Double Diamond - Design Council. (2005). https://www.designcouncil.org.uk/our-resources/the-double-diamond/#:~:text=The%20Double%20Diamond%20is%20a,a%20CC%20BY%204.0%20license.

The National Association for PET Container Resources (NAPCOR). (2023). Life cycle assessment of predominant U.S. beverage container systems for carbonated soft drinks and domestic still water.

TULIPS. (2022, November 4). Home - TULIPS. https://tulips-greenairports.eu/

Verdubbeling aantal reizigers Schiphol in 2022. (2023, January 9). nieuws.schiphol.nl. Retrieved July 11, 2023, from https://nieuws.schiphol.nl/verdubbeling-aantal-reizigers-schiphol-in-2022/?

Voloschuk, C. (2023, March 6). Environmental impact of PET bottles lower than glass bottles and aluminum cans, study says. recyclingtoday.com. Retrieved July 7, 2023, from https://www.recyclingtoday.com/news/environmental-impact-of-pet-bottles-lower-than-glass-bottles-aluminum-cans/#:~:text=The%20LCA%20found%20that%20a,the%20formation%20of%20acid%20rain

Welle, F. (2011). Twenty years of PET bottle to bottle recycling—An overview. Resources Conservation and Recycling, 55(11), 865–875.

Zwerfinator. (2023). Meldpunt #Blikschade. Zwerfinator. https://zwerfinator.nl/index.php/2023/05/01/meldpunt-blikschade/