Developing a Circular Cup System at Schiphol Airport

Master Graduation Thesis

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Preface

As I complete this report, it signifies the wrapping up of this project at Schiphol Airport, the possibility of finally getting some sleep, and the impending conclusion of my master's journey in the Netherlands.

During the five months I spent working on this project for Schiphol Airport, I experienced many firsts, engaged with diverse stakeholders, and faced numerous challenges. It was my first time conducting interviews with a wide range of clients and working on a project under real-world pressures. I feel honored to have taken on this project, even though the process was much more difficult than I had anticipated. I encountered various obstacles—language barriers, cognitive differences, time constraints, as well as physical and emotional stress. The journey was tough, and often, I didn't even have the time to feel frustrated; I had to quickly adjust concept to meet the next deadline. Despite the detours, these experiences are invaluable treasures in my life.

Firstly, I am fortunate to have had such a dedicated and responsible team of supervisors. Sonja was always willing to listen to my ideas and guide me in the right direction, even when I was stubborn about my own thoughts. She encouraged me to learn new things and discover problems on my own, teaching me to be critical. Giulia was academically rigorous and provided detailed feedback on my reports, guiding me step-by-step on how to write a well-structured report. Elisabeth was incredibly patient and meticulous, teaching me useful skills and how to communicate effectively with clients, even going out of her way to provide client support. They invested a lot of effort in guiding me, and I'm motivated to put in even more effort to fulfill their expectations.

Next, I am grateful for the assistance and time invested by all the stakeholder companies involved in this project. Schiphol Airport provided us with numerous resources and support during our research. Many stakeholder companies generously offered insights and information that enriched my design outcomes. I also want to thank all the users and friends who participated in the research for their contributions to the project.

Lastly, I want to thank my parents for supporting my decision to continue my studies in the Netherlands, giving me the opportunity to learn and experience more valuable things.

Now, I am ready to continue my journey as a designer~

Yu Chen

Executive Summary

The global shift towards sustainability has spotlighted the environmental implications of disposable takeaway coffee cups, particularly their contribution to landfill waste and ocean pollution. This report delves into the pressing challenge of reducing disposable cup waste at Schiphol Airport, especially in light of the impending Dutch regulations effective from 1 January 2024, which prohibit establishments from offering disposable plastic cups for on-site consumption.

Through comprehensive literature reviews and desktop research, I explored potential market alternatives, analyzing them from regulatory, business, consumer, and sustainability perspectives. My findings suggest that polypropylene (PP) cups are emerging as a preferred alternative to disposable paper cups after considering various factors.

Observations at Schiphol Airport and interviews with passengers provided insights into their preferences and perceived challenges regarding sustainable cup solutions. While there's a general preference for lightweight, portable, and easy-to-dispose cups, some concerns have emerged regarding the cleanliness and hygiene of reusable cups made from new materials, as well as the inconvenience of bringing personal cups to the airport.

Stakeholder interviews highlighted challenges they face due to the new regulations, such as limited kitchen space for washing, concerns about brand experience, increased workload for cleaning companies due to improper disposal, and the difficulty of finding a one-size-fits-all solution.

In response to these challenges and insights, I propose a new service system, "Cupmates: Journey to a Zero-Waste Future." This system introduces reusable PP cups, complemented by branded sleeves for various shops, ensuring brand experience. Passengers pay a deposit for the cup and lid, which is refunded upon returning the used items to smart return box equipped with an electronic payment system. An optional QR code provides users with more information about the Cupmates service. The backend process involves a centralized collection, in-airport dishwasher cleaning, and redistribution for the cups.

Feedback from potential users and key stakeholders suggests that this solution is both feasible and viable for airport implementation and satisfactory for passengers. The report also offers recommendations for implementation, ensuring a smooth transition to a more sustainable future at Schiphol Airport. This project offers a possible solution for Schiphol Airport to address the challenges of single-use plastics and transition towards a more sustainable operational model.

Content

01

Introduction

1. Project Introduction

1.1 Background

1.1.1 EU and Dutch government regulations

The disposable takeaway coffee cup, with its water-resistant polyethylene lining and plastic lid, has emerged as a prominent symbol of the prevalent throwaway culture, encapsulating the notions of convenience, impermanence, and environmental concerns (Walter and Broom, 2013). However, contrary to popular belief, these cups cannot be effectively recycled, leading to their frequent disposal in landfills or improper disposal, exacerbating the global issue of (micro)plastic waste and potential ocean pollution (Sandhu et al., 2021). The escalating presence of large quantities of these cups in landfills has prompted growing concerns among governments and societies, especially in Europe. In response to these concerns, the European Union has taken action to minimize plastic usage and increase recycling rates, as exemplified by Commission Implementing Decision (EU) 2022/162, which aims to address the environmental impacts associated with single-use plastics by implementing measures to reduce their consumption and promote recycling (EUR-Lex, n.d.).

In line with this initiative, Dutch government regulations have stipulated that, starting from 1 July 2023, customers must pay for disposable plastic cups and food packaging when they collect food or drinks or have them delivered. Companies are obligated to provide reusable alternatives, and from 1 January 2024, establishments in the Netherlands are no longer allowed to offer disposable plastic cups and (meal) containers to their customers for use on site (Business.gov.nl, 2022). There are two exceptions to these new rules. The first exception is for businesses that collect single-use plastics for high-quality recycling, especially cups or food packaging made from PET. To be eligible for this exception, businesses must register with the Human Environment and Transport Inspectorate (ILT), collect the materials themselves, and submit them for recycling, with the minimum required collection percentage increasing annually. The second exception is for healthcare institutions and closed institutions, which are permitted to continue using disposable plastic cups and packaging due to safety and hygiene regulations (Business.gov.nl, 2022).

To ensure customer awareness, businesses should inform customers about the option to bring their own cups or food containers or offer alternative options that can be returned. Pricing guidelines provide flexibility for businesses, suggesting €0.25 for cups, €0.50 for a meal (including multiple packaging pieces), and €0.05 for pre-packaged vegetables, fruits, nuts, and portion packs. There is a high-quality recycling exception for PET cups, requiring registration, self-collection, and submission for recycling, with the collection percentage increasing annually (from 75% in 2024 to 90% from 2027) (Business.gov.nl, 2022). According to Company F's website (the new waste management company for Schiphol), “high-quality recycling”, enabling the material to be used again for food contact, is currently unfeasible with existing technology (Company F, n.d.).

Therefore, high-quality recycling solutions will not be considered in this project, which will use disposable paper cups as a case study, aiming to introduce new ideas to reduce single-use waste. These regulations aim to reduce plastic waste, promote reusable alternatives, and ensure sustainable practices in food and beverage consumption.

1.1.2 Context

Schiphol Airport has set a visionary goal to become the world's most sustainable and high-quality airport by 2050, emphasizing the reduction of single-use plastics as a crucial component of this vision (Schiphol's Vision 2050, 2022). Aiming to operate zero-waste airports by 2030, Schiphol adopts a waste hierarchy approach that prioritizes reusing and recycling materials to their maximum potential, while minimizing resource consumption and prioritizing environmental stewardship. The airport's focus on circular design principles, such as reuse, upcycling, and closed loops, not only enhances its own sustainability but also provides valuable insights for recycling single-use plastics globally. Additionally, as part of the Tulips project funded by the European H2020 program, Schiphol Airport's commitment aligns with the broader initiative to showcase sustainable solutions for airports across Europe, emphasizing pollution reduction and zero-waste principles. The collaborative efforts and outputs of the Tulips project will further advance sustainable practices in airport environments, reinforcing Schiphol's dedication to reducing single-use plastics and contributing to a more environmentally conscious aviation industry.

1.2 Initial assignment

1.2.1 Problems & Aim

Schiphol Airport, renowned as one of Europe's prominent international airports, caters to a substantial influx of passengers, consequently leading to a significant demand for paper cups on its premises. According to data provided by Company A, the airport annually consumes 9 million disposable paper cups. This research project aims to address the pressing challenge of reducing disposable cup waste at Schiphol Airport, particularly in light of upcoming regulations that require alternative solutions.

1.2.2 Research question & Focus

The research question guiding this project is: How can we design a feasible cup service system at Schiphol Airport that ensures a satisfying drinking experience for passengers while effectively minimizing disposable waste, in line with upcoming regulations? Considering the forthcoming regulations on disposable paper cups set to take effect in four months, this project will primarily focus on addressing the situation four months from now.

1.2.3 Scope

Conceptual scope

The scope of the concept for the disposable coffee cup project focuses on the cup and lid parts associated with disposable paper cups and plastic, specifically designed for hot beverage containment. Many disposable cups for hot beverages currently available in the market are made from petroleum-based plastics like styrofoam, polypropylene, or polyethylene-coated paper. These materials are chosen for their excellent heat retention properties and leak prevention (Triantafillopoulos & Koukoulas, 2020).

Geographic scope

Disposable paper cups are used in various locations at Schiphol Airport, including both before and behind security areas, as well as the office areas. However, for the purpose of this project, the gastronomic area after the security check has been selected as the primary focus. This decision was made based on the following reasons:

1) Diversified cup usage: Currently, there are more shops after the security check at Schiphol Airport than before security, and the types of cups they offer are more diverse (Schiphol, n.d.). This also extends to a more comprehensive coverage of user behaviors. By concentrating on cup usage in this area and examining the operational aspects of the system, a more comprehensive understanding of the overall airport situation can be achieved.

2) Effective resource utilization: by narrowing the geographical area of study, available resources can be utilized more efficiently. This allows for a more in-depth analysis and a detailed understanding of cup usage patterns, disposal practices, and associated behaviors. The research will be able to provide a more comprehensive and rigorous insight into the chosen area.

It is important to note that while the study focuses on a specific area, efforts were made to ensure the findings have broader applicability. Generalizability to other regions will be considered, and appropriate recommendations will be formulated to accommodate different contexts (see chapter 6).

1.3 Project approach

In order to guide the process and support research and ideation activities, the project follows a Triple Diamond structure (fig,1), inspired by the Double Diamond model (Design Council, 2019). The methodology represents a design process based on exploration (i.e. divergent thinking) and definition (i.e. convergent thinking) of a project. The Double Diamond contains four phases: discover, define, develop and deliver. The Triple Diamond structure of this thesis repeats the phases of the second diamond with a different focus while adhering to the same phases. Despite its linear visualization, the process is carried out in an iterative manner. The Triple Diamond model was chosen for this project for the following reasons:

1) Applicability to the entire service system: The Triple Diamond model encompasses all stages of the design process, allowing for a comprehensive approach that considers the entire service system. From problem identification to implementation and delivery, this model ensures that all aspects of the project are taken into account.

2) Stakeholder and relevant party involvement: The Triple Diamond model emphasizes the involvement of stakeholders and other relevant parties throughout the design process. By engaging these key individuals, we can gather diverse perspectives, valuable insights, and incorporate their needs and expectations into the final solution. Iterating on the second diamond ensures comprehensive and feasible solutions (Fig 1). However, if the focus is solely on developing a standalone product, the Double Diamond method suffices, as it encompasses multiple diamonds in different configurations (Mortimer, 2022).

Considering these factors, the Triple Diamond model offers a flexible and suitable design approach for this project, providing a framework to tackle the complexities of the service system, involve stakeholders, and develop comprehensive and feasible solutions.

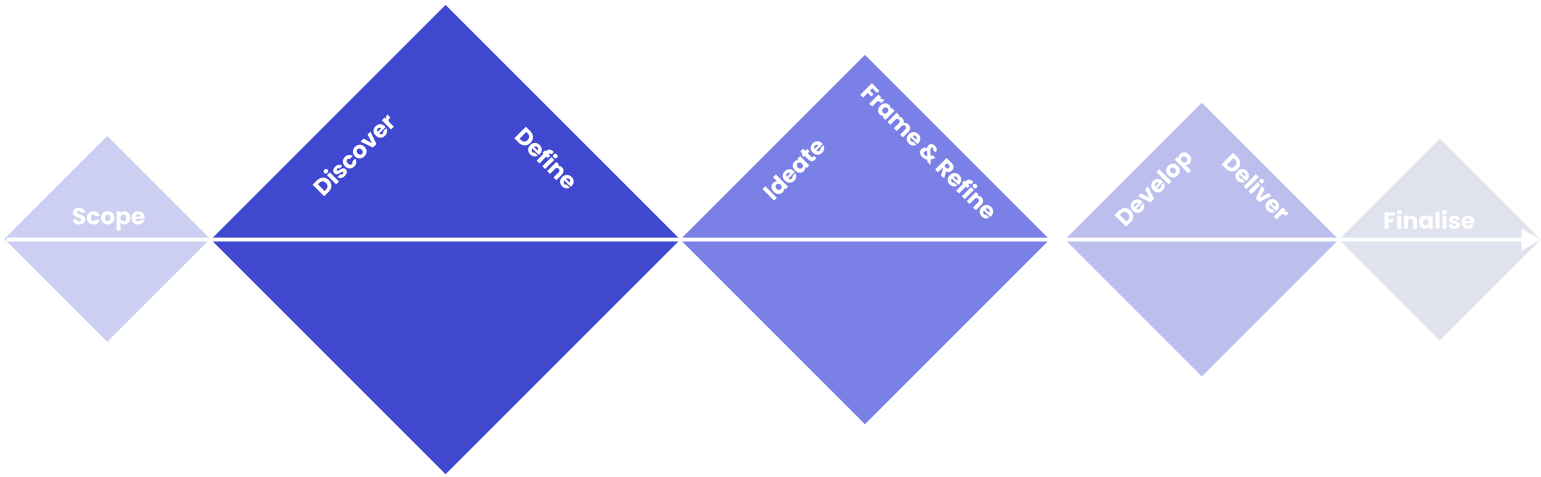


Figure 1 : Triple-diamond Model applied to this project, drawn by the author

1.4 Key takeaways

- This research project aims to address the pressing challenge of reducing disposable cup waste at Schiphol airport, particularly in light of upcoming regulations that require alternative solutions .
- The scope of the concept for the disposable cup project specifically designed for hot beverage containment.
- The primary research question is how to develop a feasible cup service system at Schiphol Airport that both improves the passengers' drinking experience and reduces disposable waste in accordance with regulations.
- This project adopts the Triple Diamond structure, an extended version of the Double Diamond model, to ensure a thorough design process that emphasizes stakeholder involvement, covers all stages from discovery to delivery, and addresses the complexities of the service system at Schiphol Airport.

02

Discover

2. Discover

2.1 Introduction & approach

Introduction

The Discover phase of this project consisted of desk research (including literature review), observation conducted at Schiphol Airport and semi-structured interviews with users and stakeholders. Through an intensive exploration and analysis of the desk research, it was possible to create a framework of knowledge to establish the focus of interest and the problem scope on which I want to contribute.

Observation

Non-participant Observation was carried out in the gastronomic area after the security check at Schiphol Airport. The purpose of the observation is to gather first-hand information by directly observing and recording the performance of passengers in real environments. During the observation process, the POEMS observation framework was used to implement observations in the airport scene from the five dimensions of people, objects, environment, messages and services, The POEMS framework ensures that observers consider key factors, providing a comprehensive understanding of the observation process. (“POEMS,” n.d.)

Interview

In the process of user and stakeholder research, semi-structured interviews were used. Before the interview, I clearly defined the interview objectives for the target group, developed an interview outline, and encouraged participants to provide comprehensive and specific responses through the use of open-ended, clear, and unbiased questions. After the interview, Grounded Theory Method (GTM) (Glaser & Strauss, 1967) was used to structure the analysis process of the results. This allowed me to extract key insights from the interviews and establish a foundation of data for subsequent analysis.

Context mapping

It was used to help designers to get to a deeper understanding of what users know, feel and dream (Sleeswijk Visser et al., 2005). Since the interviewees included passengers who had been to the airport before, the week before the formal interview, the interviewees were provided with booklets to help them recall their experience of drinking beverages at the airport, completing the sensitization of the interviewees.

2.2 Theory

2.2.1 Introduction

The theoretical part of the research was obtained through literature review. The literature review provided a comprehensive understanding of theories and research findings related to disposable paper cups and user behavior. It helped identify research gaps, valuable references, and areas that require further investigation for this project. This review shaped the foundation of this project and provided useful insights for the Define phase.

The theoretical research was driven by the following questions：

a. Why are disposable paper cups & lids widely used ?

b. Why is it difficult to recycle disposable paper cup & lids?

c. What factors may influence user behaviour towards disposable paper cups (including lids)?

d. Which model on behavioral change may be applicable to the context of cup system?

2.2.2 Overview of disposable paper cups & lids

Overview of disposable paper cups

According to the comprehensive study by Triantafillopoulos and Koukoulas (2020), the market currently offers both single-wall and double-wall paper cups. The choice between these two types typically depends on the specific requirements and preferences of the manufacturer or brand.

Single-wall paper cups have been identified as a common choice for serving hot beverages such as coffee. Their structure is constituted by a single layer of paper material, supplemented with a thin coating for insulation and moisture resistance. The barrier coating, predominantly made of Polyethylene (PE), is extruded or laminated onto the paperboard. Furthermore, the authors mention that the outer layer may be coated to improve both the printability and the heat sealability of the cup. For the final assembly, the end edges are usually melt-bonded together, typically using hot air or ultrasound techniques.

Concerning double-wall cups, these cups have been specially designed to maintain the temperature of hot or cold beverages over a longer duration (Triantafillopoulos & Koukoulas, 2020).

They are a preferred choice for specialty coffee drinks, premium coffee shops, and situations where a slow and leisurely enjoyment of the beverage is desired. The authors point out that the double-wall cups have a unique two-layer structure with an air gap between them, resulting in improved temperature retention. Certain double-wall cup designs employ a combination of layers, with either an additional air gap or polymeric insulating stripes between the outer and inner paperboard layers, to provide superior thermal insulation.

Overview of disposable cup lids

Plastic, particularly polypropylene or polystyrene #6, is used to make many disposable coffee cup lids. These petroleum-based plastics are durable and flexible, but they are difficult to recycle due to their composition and the limited market demand for recycled versions. Polyethylene terephthalate (PET) is a polymer derived from the polymerization of ethylene glycol and terephthalic acid, both of which can be sourced from petroleum hydrocarbons. The use of plastic coffee cup lids contributes to the growing issue of single-use plastic pollution, prompting a need for more sustainable and recyclable alternatives (Osbourne, 2023).

Coffee cup lids have long been used for takeaway beverages, offering benefits such as preventing leaks and spills , retaining aromatic compounds in freshly brewed coffee, and aiding in heat retention.While these benefits are clear, the necessity of lids for all coffee beverages is a topic of debate. For instance, smaller volume drinks like espressos might not necessarily need them. In an effort to promote sustainability and reduce waste, some coffee shops have shifted their practices. Instead of providing single-use items like cup lids by default, they require customers to specifically request them. This strategy has been effective in fostering more eco-conscious consumption habits (Osbourne, 2023b). However, there's a legal dimension to consider, If a customer gets burned by a hot beverage, the store could be held responsible and might have to compensate the injured party. The compensation could be monetary or other forms of reparation, depending on the severity of the harm. Moreover, if the store benefited in any way from their negligence, they might owe even more (Dutch Law Institute, 2023). Therefore, while sustainability is crucial, ensuring customer safety by providing cup lids remains paramount.

Factors Influencing the preference for disposable paper cups and lids: Individual and Business perspectives

Individuals often choose disposable paper cups and lids due to habit and prevailing social norms. Environmental unawareness and perceived inconveniences with reusable cups also influence this choice. Businesses, on the other hand, prefer disposable cups for their cost-efficiency, branding potential, and ease of distribution, assuming they align with customer preferences (Smith, 2020). Below are the main reasons for choosing to use disposable paper cups and lids that I have organized based on the literature (Fig. 2 and Fig. 3).

Why Users prefer using disposable paper cups & lids
Habit: Many people are simply used to using disposable cups and haven't considered alternatives
Convenience: They are easy to use and dispose of, especially for people on the go.
Perceived Hygiene: Many believe that single-use cups are more hygienic as they are used only once.
Social Norms: People often do what others around them are doing. If everyone is using disposable cups, an individual is more likely to do the same
Perceived Barriers to Using Reusable Cups: Some believe that carrying a reusable cup can be inconvenient or that they are hard to clean
Lack of Knowledge: Some users are unaware of the environmental impact of single-use cups.
Especially for lids
Hygiene: Especially in settings where health and cleanliness are paramount, disposable lids ensure that each customer gets a fresh, uncontaminated lid.
Prevent spills and maintain the temperature: Many customers expect a lid with their beverage, especially if they're on the go, to prevent spills and maintain the temperature of their drink. *(Smith, 2020)*

Figure 2: Factors Influencing the preference for disposable paper cups: Individual perspectives, drawn by the author

Why Businesses prefer selling disposable paper cups
Cost-effective: In many cases, it's cheaper to buy disposable cups in bulk than to invest in reusable alternatives.
Branding: Businesses can easily brand disposable cups with their logo or promotional messages.
Perceived Customer Preference: Many businesses believe that their customers prefer disposable cups for their convenience.
Ease of Distribution: It's easier to stack and distribute disposable cups, especially during peak hours. *(Smith, 2020)*

Figure 3: Factors Influencing the preference for disposable paper cups: Business perspectives

2.2.3 Problems in dealing with waste disposable paper cups & lids

Recyclability of disposable paper cups

Despite paper being the most recycled material in both municipal and commercial solid waste, the majority of waste coffee cups still end up in landfills or are incinerated (US EPA 2017). This is true even though both brand owners and consumers promote recycling (Garrison et al. 2016). These fragments can easily spread through the ecosystem, posing potential environmental and health risks (Narayan 2011).

Even if disposable cups are utilized and returned to a coffee shop, their recyclability may be compromised due to contamination from organic substances or other food packaging materials. the inability of many recycling facilities to commit to processing food- contaminated waste streams.

Misconceptions about recyclability

The main issue is that many people believe that because waste disposable paper cups are usually made of paper, they are recyclable in the same way as other types of paper waste. The truth isthat they are difficult to recycle. The glue that holds the parts of the cup together, as well as contamination in the cups, cannot be removed during the recycling process. The plastic liner in disposable paper cups, often made of polyethylene (PE), poses challenges for recycling due to its combination with paper fibers. (Yuhui, 2018)

Social barriers in stakeholder collaboration

The successful recycling of disposable paper cups relies on several factors, including local government policies and the availability of recycling facilities such as paper mills and plastic processing plants. Achieving effective recycling requires substantial cooperation among various stakeholders, including municipalities, manufacturers, suppliers, customers, and neighboring businesses. However, implementing efficient collaboration of this magnitude can be extremely challenging in practice.

Limitations in recycling equipment and technology

Recycling of waste disposable paper cups is only possible in highly specialised recycling facilities, and there are currently only a few recycling facilities that can process PE-infused paper cups. Moreover, many recycling facilities are unable to handle waste streams contaminated with food residues, further complicating the recycling process (Triantafillopoulos & Koukoulas, 2020)

Challenges with cup lids

The problems with coffee cup lids stem from their composition and recycling challenges. While plastic lids prevent spills, they are typically made from petroleum-based plastics like polypropylene or polystyrene #6, which are difficult to recycle. The process of sorting, cleaning, and melting polypropylene for recycling is costlier than producing new lids. (Link, 2020)

Difficulties in identifying black plastics in recycling processes

Recycling machines use infrared (IR) light to identify different types of plastics based on how they reflect this light. Black plastics, however, absorb all wavelengths of light, including infrared. This absorption means that when IR light is shone on black plastics, they don't reflect it back, making it challenging for machines to recognize and sort them. This often leads to black plastics being misidentified or not sorted in the recycling process. (insights from expert)

2.2.4 Consumer behavior research towards disposable paper cups

Consumer behavior towards disposable paper cups is multifaceted, influenced by convenience, societal norms, and environmental awareness (Allison et al., 2021a). Allison et al. (2021a) highlighted environmental concerns and barriers to adopting reusable alternatives, suggesting that financial incentives and environmental messaging can sway consumer choices. Despite the environmental superiority of reusable systems, consumers often prioritize convenience (Ligthart & Ansems, 2007). Community engagement can bridge this awareness gap, with local businesses playing a pivotal role (Niimi & Lynch). Poortinga and Whitaker (2018) reinforced this, indicating that a blend of environmental messaging, alternatives, and incentives can shift behaviors. Furthermore, there's a growing consumer demand for sustainable products, signaling an evolving consumer landscape (Triantafillopoulos & Koukoulas, 2020).

In essence, while convenience and societal norms currently drive the widespread use of disposable paper cups, research shows that consumers are becoming more aware of and willing to adopt more sustainable alternatives. Effective interventions, community engagement, and sustainable design innovations all play important roles in shaping this behaviour.

2.2.5 User behaviour model

Introduction to the focus on user behavior models

The increasing focus on using user behavior models to influence behavior has been well-documented (Fogg, 2009). Numerous studies underscore the efficacy of these models in both analytical and practical contexts (Perros et al., 2022; Alexander et al., 2014). In this project, the emphasis is on enhancing the passenger experience. A review of models like the Fogg model, COM-B model, and TPB model reveals their distinct advantages in various applications. For example, Filippou et al. (2016) merged Fogg's behavioral model with the Hook model to foster positive learning habits. Alexander et al. (2014b) employed the Theoretical Domains Framework and COM-B model to pinpoint barriers in the Healthy Kids Check program, offering insights into behavior change strategies. In the sections below, I will elaborate on the significance, applications, and insights derived from the COM-B model, providing a clearer understanding of their relevance and utility in the context of this project.

Exploration of the COM-B Model

The COM-B model asserts that an individual's Capabilities (psychological and physical), Opportunities (social and physical) and Motivations (automatic and reflective) interact with each other to influence Behaviour. Capability refers to individuals' physical or psychological attributes, including their physical fitness, mental capacity, and decision-making abilities. Opportunity refers to the social and physical factors that create opportunities for behavior, such as cultural norms and the physical environment. Motivation can be categorized as automatic or reflective, encompassing intentions, desires, evaluations, habits, and instincts that drive human behavior (Allison et al., 2021a).

These COM-B categories can be elaborated into the Theoretical Domains Framework (TDF). It includes 14 Theoretical Domains, representing individual, socio-cultural and environmental factors influencing behaviour (Fig.4). The interconnection between COM-B categories and TDF domains is illustrated in Figure 5, emphasizing that COM-B and TDF can be viewed as essential components within the toolbox of behavioral science frameworks utilized to conduct a comprehensive behavioral diagnosis, thereby facilitating a deeper understanding of the contextual influences on behavior (Michie et al., 2011b).

TDF domain	Explanation
Knowledge	An awareness of the existence of something
Skills	An ability or proficiency acquired through practice
Social/professional role and identity	A coherent set of behaviours and displayed personal qualities of an individual in a social or work setting
Beliefs about capabilities	Acceptance of the truth, reality or validity about an ability, talent or facility that a person can put to constructive use
Optimism	The confidence that things will happen for the best or that desired goals will be attained
Beliefs about consequences	Acceptance of the truth, reality or validity about outcomes of a behaviour in a given situation
Reinforcement	Increasing the probability of a response by arranging a dependent relationship, or contingency, between the response and a given stimulus
Intentions	A conscious decision to perform a behaviour or a resolve to act in a certain way
Goals	Mental representations of outcomes or end states that an individual wants to achieve
Memory, attention and decision processes	The ability to retain information, focus selectively on aspects of the environment and choose between two or more alternatives
Environmental context and resources	Any circumstance of a person's situation or environment that discourages or encourages the development of skills and abilities, independence, social competence and adaptive behaviour
Social influences	Those interpersonal processes that can cause individuals to change their thoughts, feelings, or behaviours
Emotion	A complex reaction pattern, involving experiential, behavioural, and physiological elements, by which the individual attempts to deal with a personally significant matter or event
Behavioural regulation	Anything aimed at managing or changing objectively observed or measured actions

Figure 4. The Theoretical Domains Framework – 14 domains of individual, socio-cultural and environmental influences on a behaviour (Cane et al., 2012)

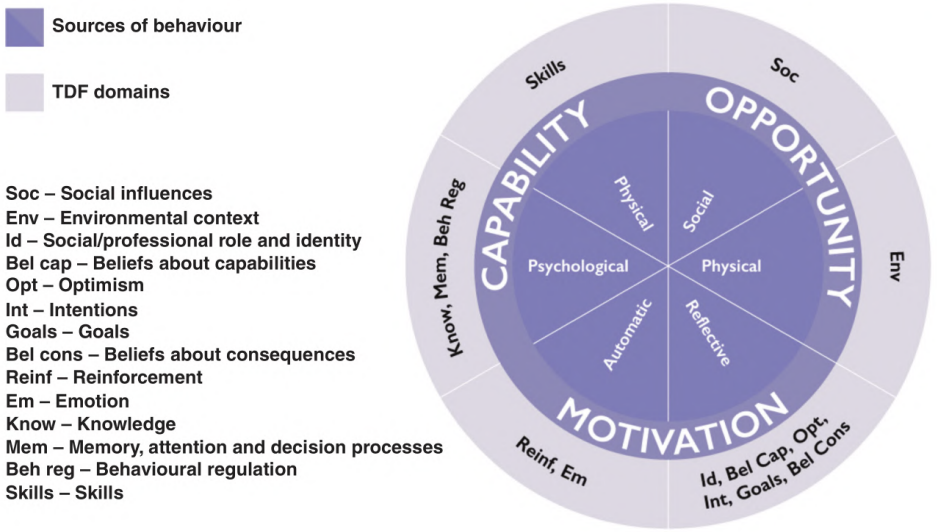


Figure 5: Relationship between COM-B categories and TDF domains

Applications and Insights from the COM-B Model

The COM-B model, a structured approach to understanding behavioral influencers, has been pivotal in clinical settings and is now expanding to other behavior-centric research areas (Perros et al., 2022b), like the cookstove sector (Thompson et al., 2018b). Its application spans research on LPG use among pregnant Guatemalan women (Williams et al., 2020) to interventions promoting exclusive LPG use in multiple countries. Ays¸e Lisa Allison et al. delve into the factors affecting single-use and reusable cup choices, emphasizing the COM-B model's role in crafting interventions to minimize plastic waste. These interventions, rooted in the psychological constructs of the COM-B model, aim to pivot behavior towards eco-friendly cup selections. Key determinants like convenience, cost, environmental consciousness, societal norms, and personal values shape cup usage. Interventions tailored to these determinants can foster sustainable cup choices. Given the insights from the COM-B model's past applications, especially concerning disposable cups, it's apt to incorporate it into this project. Typically, the COM-B model is integrated during the initial design stages, particularly in the Define phase, to grasp user behavior and discern cup use influencers. It also offers a holistic framework for devising potential solutions by evaluating various intervention aspects.

2.2.6 Insights from Theory

People and businesses prefer disposable cups and lids for a variety of reasons, including convenience, societal habits, cost-efficiency, and branding opportunities.

The challenges in dealing with waste disposable paper cups and lids include the complexity of the recycling process, misconceptions about their recyclability, limited specialized recycling facilities for, cost-effectiveness concerns for polystyrene (PS) lids, and difficulties in identifying black plastics in recycling processes

Consumers are becoming more aware of and willing to adopt more sustainable alternatives. Effective interventions, community engagement, and sustainable design innovations all play important roles in shaping this behaviour.

The COM-B model provides a valuable framework for assessing the diverse factors that impact individual, sociocultural, and situational influences on behavior, making it useful for identifying targets for behavioral interventions (Allison et al., 2021). Consequently, in this project, I opted to use the COM-B model for analyzing and organizing the factors that influence passenger behavior.

2.3 Practice

2.3.1 Introduction

The theoretical part of the research was obtained through literature review. The literature review provided a comprehensive understanding of theories and research findings related to disposable paper cups and user behavior. It helped identify research gaps, valuable references, and areas that require further investigation for our project. This review shaped the foundation of this project and provided useful insights for the Define phase.

The theoretical research was driven by the following questions：

a. What are the current alternatives to disposable paper cups and lids? What is the cup alternative that benefits both consumers and businesses?

b. What solutions are available to reduce disposable paper cup waste? And which aspects of these solutions provide valuable lessons for further consideration?

c. What are the cup systems currently implemented at other airports? Are there any aspects that can be learned from?

2.3.2 Alternatives to disposable paper cups

To address the challenges associated with recycling polyethylene (PE)-coated paper cups, researchers have pursued two primary strategies. The first approach focuses on developing specialized recycling technologies to effectively separate and process cup materials, including the polyethylene coating (Triantafillopoulos & Koukoulas, 2020). Notably, the Sustana pulpmill in Wisconsin has achieved progress in efficient recycling by successfully separating coffee cup fibers and converting them into pulp for recycled market pulp, which is utilized by WestRock to produce new cups (Triantafillopoulos & Koukoulas, 2020). The second approach focuses on researching alternatives to disposable paper cups. There are two main types of alternatives to disposable paper cups (including lids): reusable cups, single-use sustainable cups and lids.

Single-use sustainable cups

To find environmentally friendly alternatives that can replace traditional PE-coated cups, researchers are investigating various materials and manufacturing techniques for single-use cups (Triantafillopoulos & Koukoulas, 2020; Niimi & Lynch, 2017). The review conducted by Triantafillopoulos and Koukoulas (2020) provides a comprehensive overview of materials and their technological advancements aiming to replace PE liners in paper cups, including compostable cups made of kraft paper and recyclable cups made of acrylic resin. Research into alternatives to disposable plastic paper cups has progressed, with innovations such as Colombier's EcoBarrier™ technology offering potential solutions. Meeting both EU regulations and FDA standards, this approach generates a water- and grease-resistant material devoid of plastic. Nonetheless, the broader acceptance of these solutions has faced challenges due to elevated costs associated with bio-based polymers, the scarcity of composting facilities, inconsistent recycling standards, and the necessity to ensure compatibility with hot beverages to prevent potential litigation concerns. Additionally, consumer behaviors and their willingness to pay premium prices for sustainable products remain challenging. Despite strides made, the ultimate goal—a readily biodegradable paper cup requiring no specialized industrial composting—is still unattained. Successful resolution requires cooperation across value chains, communities, and governments to establish proper recovery infrastructures.

In summary, the absence of a disposable alternative that fully meets requirements can be attributed to a convergence of factors. These encompass the complex interplay between environmental regulations, technological limitations, economic feasibility, consumer behaviors, and the infrastructure needed to support these alternatives (Johnson, 2019; Green et al., 2018). While promising innovations have emerged, the intricate nature of the challenges posed by cost, recycling systems, and consumer preferences has hindered the realization of a comprehensive solution that addresses all criteria effectively (Smith et al., 2020; Colombier, 2021).

Reusable alternatives

Various reusable alternatives to disposable paper cups are currently available. Reusable coffee cups made of materials like glass, ceramic, or insulated stainless steel offer durability and temperature retention but can be bulky and require regular cleaning (Zaitsava, 2022). Travel cups made of stainless steel or BPA-free plastic provide portability and insulation, though they may not fit in standard cup holders (Plastic Free July, 2023). Biodegradable cups made from plant-based plastics or compostable materials reduce environmental impact but require specific industrial composting facilities (Disposable Paper Cups - Disadvantages and Alternatives, n.d.). Silicone cups, collapsible and lightweight, are easy to clean and carry but may lack insulation.

Additionally, cups made from plastic offer a lightweight and durable option, with some designs being collapsible

for easy portability.Polypropylene (PP) is generally considered more suitable for reusable cups used to store hot beverages compared to High-Density Polyethylene (HDPE), Polycarbonate (PC), and Polyethylene Terephthalate (PET). This is because PP has a higher melting point and superior chemical stability, ensuring safety and taste preservation when exposed to heat (Andrady, 2015). Moreover, unlike PC, PP doesn't have concerns related to BPA leaching at high temperatures, making it a safer choice for consumers (Bittner et al., 2014). Meanwhile, HDPE's melting point is generally lower than PP, and PET can degrade when exposed to very hot liquids, further underscoring PP's appropriateness for hot beverages (Hopewell et al., 2009). Choosing the most suitable alternative depends on individual preferences , business preferences and environmental considerations, weighing advantages such as waste reduction and durability against factors like convenience and cost.

Customer's own cup

Despite positive attitudes towards reusing coffee cups, individuals often face practical limitations when it comes to consistently bringing their own cups to cafes (Niimi & Lynch, 2017). This highlights the challenges in motivating consumers to adopt reusable cup practices consistently.

Research limitations

While these studies offer a range of solutions and alternative ideas, it is crucial to recognize their limitations. To ensure effective recycling, it is essential to refer to local recycling guidelines and facilities. Additionally, it is important to consider the cost implications of utilizing new materials, as many of them can be expensive to produce. Finding a balance between material effectiveness and cost feasibility is vital. Moreover, the successful implementation of new cup systems necessitates collaboration with municipalities, regional communities, and cross-government entities to establish a well-functioning recovery infrastructure capable of handling and processing these cups effectively.

2.3.3 Alternatives to disposable cups lids

Alternatives to disposable paper cup lids include reusable cup lids, biodegradable cup lids. Reusable cup lids, made of durable materials like silicone, plastic, or stainless steel, can be used multiple times and reduce waste(Amazon.com : Reusable Coffee Cup Lids, n.d.). Biodegradable cup lids, made from plant-based plastics or compostable materials, offer an eco-friendly option that naturally breaks down over time (Biodegradable Coffee Lids by NAECO, n.d.). The choice of the most suitable alternative depends on factors such as functionality, sustainability, and user preferences. However, currently, biodegradable cup lids are not completely plastic-free, and a lid that complies with Dutch regulations has not yet been found.

2.3.4 Comparison of possible alternatives

In light of the upcoming Dutch government regulations, it is crucial to conduct a comprehensive comparative analysis of alternative cup options for Schiphol Airport. This analysis also includes lids, which are commonly used in conjunction with cups. The evaluation framework for this analysis is divided into three main perspectives: consumer perspective, business perspective, and sustainability perspective. This multi-faceted approach ensures that the assessment covers various dimensions, providing a holistic view of the potential alternatives to disposable paper cups. From the consumer perspective, understanding preferences is essential. This insight will help identify which alternative aligns most closely with passengers' choices and offers them a better experience. From a sustainability standpoint, the focus is on evaluating the environmental impact of potential alternatives throughout their entire lifecycle—from production to usage to recycling. The ultimate goal is to identify the most eco-friendly option available.

On the business front, a thorough examination of cost-effectiveness is pivotal. This includes not just immediate costs but also the potential for long-term savings, as highlighted by Dodd et al. (2020). Secondly, the impact of cup choices on brand value and perception is another critical factor. It plays a significant role in maintaining and enhancing the brand experience across various airport brands(Hutchinson et al., 2021). Furthermore, practicality and ease of implementation for different cup types are essential considerations. The chosen alternative must seamlessly integrate into the airport's operational dynamics, especially during peak hours(Thompson et al., 2018).

By evaluating these perspectives holistically, I aim to not only comply with regulatory requirements but also facilitate a smooth transition to alternatives that resonate with both passengers and the business requirements of Schiphol Airport. As shown in Figure 6, a comparative analysis of potential alternatives is provided, incorporating insights from both academic literature and online information to offer a multi-faceted perspective.

Comparative Insights: The ideal cup alternative for consumers

In the bustling environment of airports, travelers prioritize speed, convenience, and cost. While silicone cups are lightweight, they tend to be pricier than PP (Polypropylene) cups. Ceramic mugs, susceptible to breakage and being relatively heavy, might not be the top choice for those in a rush to catch their flights. PP cups, being cost-effective and lightweight, emerge as the go-to option for a quick drink. Stainless steel cups, despite their superior temperature retention, might be less favored due to their heft and potentially higher cost for single-use. Biodegradable cups, though competitively priced and appealing to eco-conscious travelers, might still be a tad pricier than PP cups. Taking into account the single-use nature at airports and consumer expenditure, PP cups seem to be the preferred choice for travelers.

Comparative Insights: The ideal cup alternative for businesses

In the dynamic environment of airports, businesses prioritize efficiency and convenience. Silicone cups offer durability and flexibility for airport use, but their return or recycling logistics could complicate operations. Ceramic mugs, though aesthetically appealing, risk breakage and entail higher replacement costs due to their fragility. Reusable PP (Polypropylene) cups emerge as a front-runner due to their lightweight, low cost, and potential synergy with a deposit-return system. Stainless steel cups may be less popular due to their weight and cost, despite their commendable durability and temperature retention. Biodegradable reusable cups are an environmentally friendly option, but their decomposition time and associated costs should be considered. For businesses, PP reusable cups and biodegradable cups appear to be the most practical in airport single-use scenarios.

Conclusion

In the fast-paced setting of airport operations, both passengers and businesses are in search of solutions that strike a balance between convenience, cost, and sustainability. Polypropylene cups, with their cost-effectiveness and user-friendliness, might be the preferred choice for passengers, while from a business standpoint, they could be the most economical option. Considering sustainability, the ideal alternative to paper cups should not only meet the immediate needs of travelers but also align with the long-term operational and environmental objectives of airport enterprises.

		Ceramic mugs	Reusable Polypropylene(PP) cups	Silicone cups	Stainless steel cups	Biodegradable reusable cups	Customer's own cup
Description		• Excellent heat retention • Bulkier and heavier than disposable paper cups • Fragile and prone to breakage	• lightweight and heat-resistant thermoplastic (Yuhui, 2018) • Perfect for to-go coffee due to its ability to maintain coffee temperature (Yuhui, 2018)	• Suitable for both hot and cold beverages. Can withstand a wide temperature range (Jutionsilicone, 2023) • Colorful and stylish (Jutionsilicone, 2023)	• Safety, durability, sustainability and beauty of the food-grade (Steelys Drinkware, n.d.)	• Made from materials like PLA (polylactic acid), which is derived from renewable resources like corn.	• Depending on the specific use scenario, the type of cup a user brings will vary. In an airport setting, users are more likely to carry travel cups.
Applicable scenarios		• Best suited for sit-down cafes, restaurants, or home use.	• Commonly used in fast-food chains, takeaway joints, or events where quick service is essential	• Great for travelers or campers due to their collapsible designs	• Ideal for on-the-go scenarios such as commuting, traveling, hiking, or gym sessions.	• Suitable for cafes, restaurants, picnics, outdoor events, or daily use.	• Suitable for all scenarios
Business Perspective	Cost-effectiveness	• Higher initial cost, especially for branded or customized designs. • Long-Term Savings: Durable and have a long lifespan. They do not need frequent replacement, resulting in reduced ongoing expenses (Ligthart & Ansems, 2007).	• Lower initial cost, especially in bulk, offering potential for higher profit margins. • Long-Term Savings: PP cups are durable and reusable, leading to long-term cost savings as compared to disposable cups.	• Moderate initial cost.	• Higher initial cost but durable, potentially reducing long-term replacement costs.	• More expensive than traditional plastic cups • Long-term benefits such as improved brand image and customer loyalty	• Do not incur any initial cost for the business since they are brought by the customers themselves.
	Branding & Customization	All options are customizable, but costs and methods differ. Stainless steel and PP cups may be less expensive for bulk customization.(Printful, 2021)				• Improve a company's brand image by appealing to environmentally conscious consumers and potentially increasing customer loyalty.	
	Practicality and implementation	• Reducing the need for frequent replacements. • Popular in cafes and restaurants, but might not be feasible for takeaway customers	• Easy to transport (Yuhui, 2018)			• Businesses must think about how to store, distribute, and collect these cups, especially if they want them returned and composted.	• The easiest to implement, but often face practical limitations when it comes to consistently bringing their own cups to cafes (Niimi & Lynch, 2017)
Consumer Perspective	Customer acceptance and experience	• Trends show some consumers enjoy their coffee seated, while others prefer on-the-go due to time or preference. (Bitner, Ostrom, & Morgan, 2008)	• Designed for on-the-go, suitable for takeaway • Widely accepted and popular among eco-conscious consumers • Excellent heat retention and insulation, enhancing the drinking experience	• Silicone cups are lightweight, durable, and can withstand varying temperatures. They offer a modern aesthetic and are often collapsible, making them portable. (Amazon.com: Customer Reviews: Silicone Cups - Teal, n.d.)	• Stainless steel cups are popular because they retain temperature, ensuring that hot drinks stay hot and cold drinks stay cold. They are long-lasting and ideal for travel. However, they can be heavier than other alternatives(Mitchell, 2023)	• Can provide a sense of contributing to environmental sustainability for consumers	• Allows for personalization and the convenience of using one's preferred cup. • More comfortable with the hygiene of own cups
Environmental Impact		• A natural material that does not release harmful substances when in contact with hot liquids, making it a healthier choice for consumers (Sandhu et al., 2021). • Ceramic mugs have fewer environmental impacts than travel mugs(stainless steel) or paper cups(Recyc-Québec, n.d.)	• PP is fully recyclable, which means there is less waste in landfills. The recycling process of PP material does not release any toxic chemicals, making it environmentally friendly (Triantafillopoulos & Koukoulas, 2020)	• Silicone has a few environmental disadvantages, it's not the perfect material in all applications. (Packaging & Packaging, 2022b)	• Reusable, recyclable & better for the planet (Steelys Drinkware, n.d.)	• Providing an eco-friendly and sustainable option for coffee lovers on-the-go.	• Significantly reduce the waste generated by disposable cups

*Note * The current evaluation and comparison of cups carry inherent uncertainties due to factors such as varying usage frequencies, cleaning requirements, durability differences, and regional disparities in resource availability and waste management.*

Figure 6: Comparison of possible alternatives, drawn by the auther

2.3.5 Case studies of current reusable cup systems

Introduction

To develop a sustainable and efficient circular cup system for Schiphol Airport, I have examined existing models such as RECUP, CupClub, Billie Cup, KeepCup, Packback, and Swapbox. These models were selected for their innovative and scalable approaches, technological integration, and positive consumer feedback. Given that these reusable cup systems already excel in sustainability by using eco-friendly alternatives to disposable cups, our comparative analysis focuses primarily on business and consumer considerations. Our primary objective in this study is to acquire a comprehensive understanding from both business and consumer perspectives. This will guide us in designing an environmentally sustainable yet operationally efficient reusable cup system for Schiphol Airport, with the ultimate aim of inspiring future sustainable initiatives. Following a brief introduction of each case, Figure 7 will present a table summarizing the unique features of each model from both business and consumer perspectives.

RECUP

The RECUP system introduces a sustainable substitute in an effort to combat the wastefulness of disposable cups. A €1 deposit is required from customers who choose to receive their coffee in RECUP cups. The customer can return the cup to any of RECUP's partner locations in Germany after it has been used to get their deposit back. The cup's lid is the only thing that needs to be purchased separately. By creating an app that includes a list of all of its partner stores, RECUP has made it easier for customers to return their deposits. The system reduces waste and offers an alternative for those who don't want to carry (RECUP / REBOWL, n.d.). You can see how RECUP works with Figure 8.

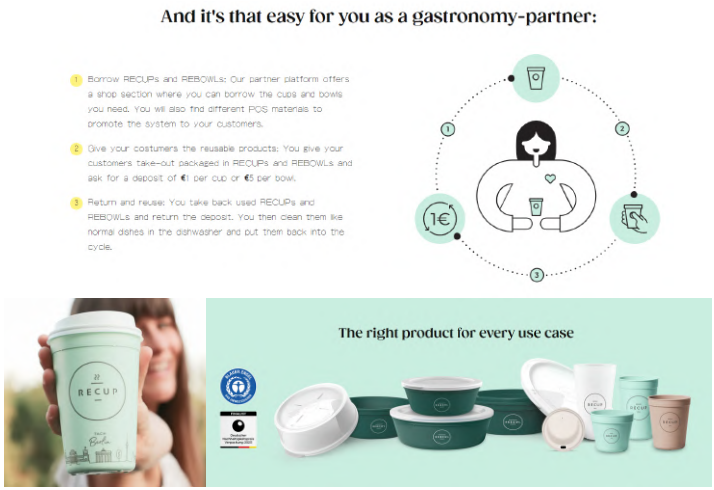


Figure 8 .RECUP. Retrieved from https://recup.de/en/

CupClub

CLUBZER, formerly known as CupClub, provides a zero-waste packaging solution, primarily in London. Their goal is to offer complete waste-free convenience for takeaway, delivery, and other uses. CupClub utilizes technology, such as RFID tags and mobile interfaces, to track and reward users within a reusable cup system. The cups are made from polypropylene [PP] and the lids are made from low-density polyethylene [LDPE] (Fig.9). They're universal materials that can be recycled by anyone. The comprehensive service model facilitates cup return and motivates user engagement. However, establishing a robust logistics infrastructure and managing cup loss or damage pose challenges ("Cup Club," n.d.). The business has collaborated with numerous brands and received praise for its initiatives to advance sustainability and lessen plastic pollution. Their system of reusable packaging is not only helpful to the environment, but also convenient for both customers and businesses.

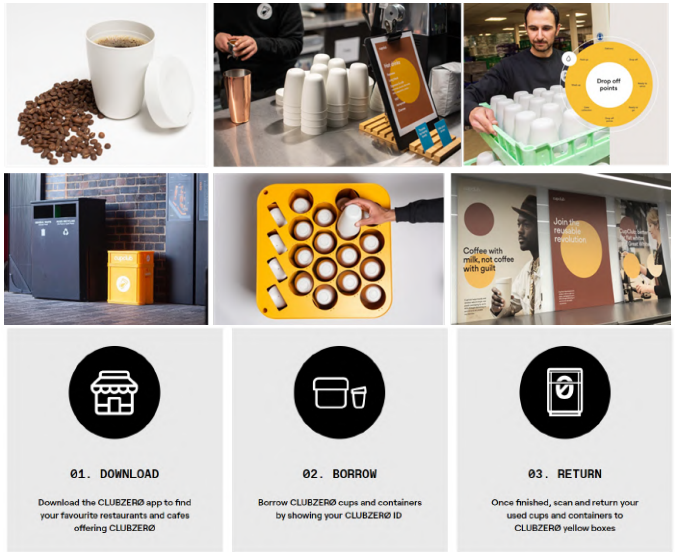


Figure 9 .CupClub. Retrieved from https://recup.de/en/

Billie Cup

The Billie Cup is a reusable cup made of recyclable polypropylene (Fig.10). It offers durability, ease of cleaning, and different cup sizes with corresponding lids. Customers pay a small deposit for a drink in a Billie Cup, which operates on a deposit-return model. They can then return the cup to any participating location and receive their deposit back. The system is intended to be both user-friendly and environmentally friendly, with the goal of significantly reducing the number of disposable cups that end up in landfills (Billie Cup, 2023).

Figure 10: Billie cup. Retrieved from https://billiecup.com/the-cup/

KeepCup

Originating from Melbourne's dynamic coffee scene, KeepCup stands as a trailblazer in sustainable drinkware. Established with a vision to combat the environmental toll of disposable cups, KeepCup masterfully merges style with purpose. Their designs, showcased in Figure 11, are not only eco-friendly but also trendy, offering users a distinctive customization feature. This personalized approach, coupled with their worldwide influence, positions KeepCup not merely as a product but as a movement, catalyzing a shift towards daily sustainable practices (KeepCup, n.d.).

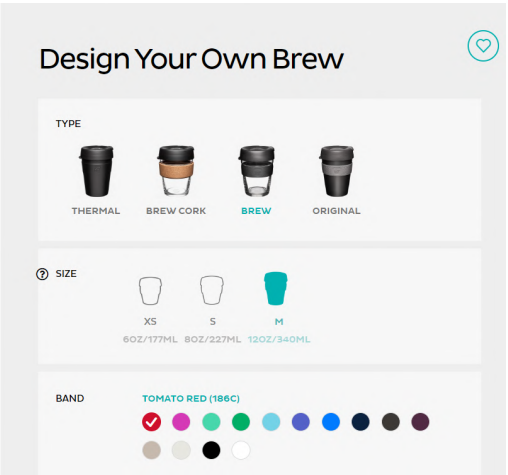


Figure 11: Keep cup. Retrieved from https://eu.keepcup.com/design-your-own-brew?size=186&band=TR&lid=VR&plug=PAS

Packback

PackBack offers a unique reusable system designed to eliminate disposable packaging, primarily catering to the needs of consumers in fast-paced environments like restaurants. The system operates on two main models: deposit-based and account-based. In the deposit-based system, consumers can borrow a reusable item in exchange for a small deposit. Upon returning the item to one of PackBack's SmartBins, they receive their deposit back. This system has been implemented in places like Erasmus University and the University of Applied Sciences in Amsterdam. The account-based system, implemented at Erasmus University in Rotterdam, operates through the PackBack app. Here, users don't need to pay a deposit upfront. Instead, when they borrow a reusable item, it's added to their account, and upon returning it to a SmartBin, the item is recognized and removed from their account. This flexibility in systems ensures that both businesses and consumers can choose a model that best fits their needs, making the transition to reusables smoother and more efficient (PackBack Network, n.d.).

Swapbox

SwapBox offers a holistic eco-friendly solution tailored for businesses aiming to transition to reusable packaging. Their integrated Eco-System combines Washing as a Service, Packaging Rental, and advanced Tracking Technology to promote sustainability, operational efficiency, and cost-effectiveness. By leveraging SwapBox's comprehensive services, businesses can significantly reduce waste, optimize costs, and utilize cutting-edge tracking innovations, all backed by a team of dedicated experts. This approach positions SwapBox at the forefront of sustainable packaging solutions, catering to the evolving needs of environmentally-conscious businesses. (SwapBox, n.d.).

Company	Business Perspective	Consumer Perspective
RECUP	**Unique selling proposition:** RCUPs are made from used paper cups, offering a unique marketing angle. **Cost:** The production might be pricier due to the recycling process, but the unique selling point can justify a higher retail price.	**Design:** The push-down lid on the cup is a distinctive feature that many users find creative. **Environmental Impact:** Customers value the product's recycled status.
CupClub	**Operational model:** CupClub operates on a returnable packaging service for drinks. Businesses can join the network, potentially gaining more clients. **Cost:** There's an initial setup cost, but the model promises reduced waste management costs in the long run.	**Convenience:** Users can pick up a drink in one location and return the cup to any member store. **Incentives:** Consumer can receive reward and points
Billie Cup	**Operational changes:** Adopting the Billie Cup system might necessitate operational adjustments, especially in handling returns and ensuring the cups are cleaned and sanitized efficiently.	**Convenience:** The return system of Billie Cup might be seen as an extra step for consumers. **Hygiene concerns:** Given that the cups are reused, there might be concerns about their cleanliness.
KeepCup	**Cost-effectiveness:** Higher initial cost but justified by brand reputation. **Branding and marketing:** Effective use of social media and environmental campaigns.	**Usability:** Compatible with most coffee machines. **Design and customization:** Trendy design with color customization.
Packback	**Efficiency and technological Integration:** PackBack's efficient design, combined with smart technology, streamlines tracking and management for easy business integration. **Targeted services:** Offer tailored solutions that cater to specific business needs	**Convenience:** SmartBins are always nearby, very easy to return.
Swapbox	**Diversified services:** Provide business with multiple services such as packaging, cleaning, collection, tracking, etc.	**Professional cleaning service:** may be able to reduce user concerns about cleaning reusable cups

Figure 7: Comparison of unique features from business and consumer perspectives for selected reusable cup models

Conclusion

The highlighted cases provide key insights into the design and implementation of reusable cup systems. By understanding these cases from both business and consumer standpoints, there is potential to design a system for Schiphol Airport that is both environmentally friendly and operationally efficient. The specific type of circular cup system that would be most suitable for Schiphol Airport requires further research and analysis.

2.3.6 Schiphol Airport Research

Introduction

Amsterdam Airport Schiphol serves as the country's primary gateway to the rest of the world. Schiphol has evolved into one of Europe's best-connected hub airports, with 313 direct destinations (Schiphol | Schiphol Group's Annual Report, n.d.). The initial research on Schipol Airport focused on the following research questions:

a. What is the current consumer group for hot drinks purchases at Schiphol Airport?

b. What types of cups are currently provided at the airport, and what is the usage and recycling process for these cups?

c. Who are the stakeholders involved in the cup system at the airport, and how does the system operate?

Approach

Through desk research and stakeholder interviews (see chapter 2.5), a comprehensive understanding of the cup system at Schiphol Airport was obtained, laying the foundation for identifying problems and design opportunities within the service system in the subsequent stages.

Result

Segmentation of passengers at Schiphol Airport

Schiphol Airport primarily serves international passengers, with the majority coming from European countries and significant numbers from the U.S. and China (Schiphol Airport Guide, 2022).

Amsterdam Schiphol Airport predominantly caters to international travelers, with 98.8% of its routes being international and only 1.2% domestic. The majority of these international passengers hail from European countries, as evidenced by the top flight routes connecting to nations such as Greece, Spain, the UK, Italy, and Germany. However, there's also a considerable influx from non-European regions, notably the United States and China. This data underscores Schiphol's role as a major European hub with significant global connections (Schiphol Airport Guide, 2022).

Based on European trends, Schiphol's primary passengers are likely those aged 25 to 44, with fewer aged 65 and above.

The predominant age group of passengers that is most active in terms of yearly trips across all EU28 and EFTA countries is the 25 to 44-year-olds (Fig.12). They are closely followed by the age group of 45 to 64 years old. On the other end of the spectrum, individuals aged 65 and above are the least active in terms of travel. While these trends are consistent across the countries, there are specific countries within each age bracket that exhibit the highest and lowest travel activities (European Research Team, 2014).

Considering Schiphol airport serves a significant portion of European travelers, it can be inferred that the major age group of passengers at Schiphol likely aligns with these broader European trends: predominantly individuals between 25 to 44 years old, with a lesser number of travelers aged 65 and above.

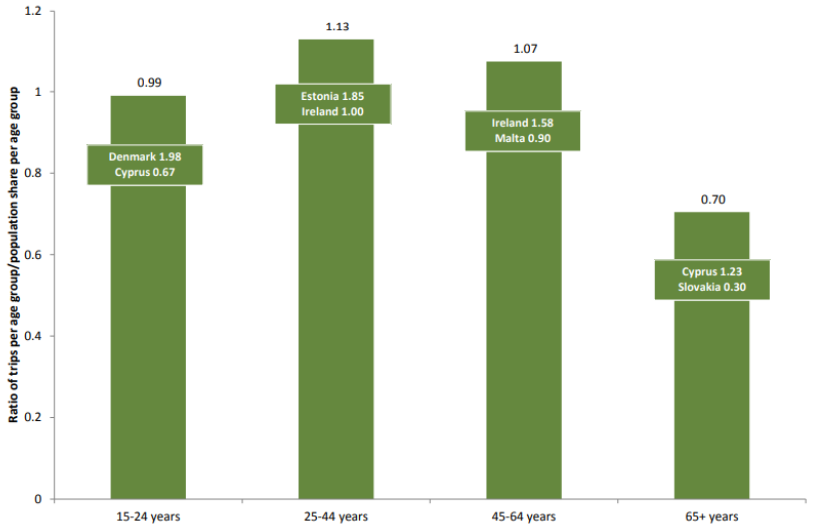


Figure 12: Travel activity of different age groups (data: Eurostat, 2014 b)

The journey of disposable paper cups at Schiphol Airport

Drawing from field research, which included two visits to Schiphol Airport (see chapter 2.5), insights from stakeholder interviews (chapter 2.5), and data from desk research (Company D, n.d.) (Amsterdam Airport Schiphol, 2022), the journeys of two types of beverage cups currently in use at the airport have been mapped out (Fig. 13).

Disposable paper cups go through two stages in the cup system at Schiphol Airport. The first stage occurs within the airport premises, where waste bins are used to collect the cups. Cleaning companies are responsible for collecting these disposable paper cups. The collected waste is then transported to Company D, a waste management company, for centralized sorting and processing. Previously, Company D, as Schiphol's designated waste processing company, utilized transport trucks to convey the waste to specialized treatment facilities.

The second stage takes place outside the airport. Company D transports the waste to their facilities, where they carry out high-quality sorting and processing. Company D specializes in waste management and has the capability to separate the waste into different material types. The diagram illustrates the waste streams for various components of disposable paper cups (refer to confidential appendix A). This systematic process ensures that the disposable paper cups are properly collected, sorted, and processed, minimizing their impact on the environment.

Figure 13: Journey of disposable paper cups at Schiphol Airport, drawn by the author

The journey of reusable cups at Schiphol Airport

The second category of cups at Schiphol Airport is reusable cups, primarily made of ceramic. These cups are exclusively used within the airport premises. Customers can place the used cups and trays on tables or designated collection points. Shop staff collect these cups and transport them to the kitchen area for thorough cleaning and sanitization. This recycling process ensures that the ceramic cups can be reused, minimizing waste and promoting sustainability within the airport environment (Fig. 14).

Figure 14. Journey of reusable cups at Schiphol Airport, drawn by the author

2.3.7 Eindhoven Airport visit

Introduction

Eindhoven Airport is, in terms of travellers, the largest regional airport in the Netherlands (Eindhoven Airport (EIN) 2023), but significantly smaller than Schiphol . It is situated near Eindhoven and primarily focuses on regional and low-cost flights. It has a more limited flight network, serves fewer passengers, and offers a more modest range of amenities. While Schiphol Airport is a bustling international gateway, Eindhoven Airport caters more to regional and cost-conscious travelers (Wikipedia-bijdragers, 2023, Information obtained from the visit).

Approach

The three-hour visit to Eindhoven Airport primarily aimed to gain insights from the Milieumanager at Eindhoven Airport NV regarding the current practices surrounding cup provision and handling. Throughout our visit, the Milieumanager guided us through the post-security area and the centralized waste collection zone. We were granted permission to capture photographs pertinent to our project. These images, organized post-visit, can be viewed in Figure 15, all of which were taken by the author during the tour.

Findings

During visits to the airport and discussions with the manager, several noteworthy findings emerged. Firstly, there is a prevalent culture of takeaway coffee cup usage ingrained in people's habits, similar to the way beer is commonly consumed from glass cups even when alternative options are available at airports(from the discussions during the visit). Secondly, the design of waste bins may have a significant impact on user behavior. Textual and visual cues, such as unique shapes and transparent appearances provide clear indications of the specific types of waste to be disposed of. Lastly, it was observed that images maybe more universally understandable compared to words, making them particularly effective for users with diverse linguistic backgrounds and nationalities. These insights shed light on the importance of considering user behavior and communication strategies when implementing cup systems at airports.

Figure 15: Bins, coffee cups, recycling location, photographed at Eindhoven Airport

2.3.8 Rotterdam The Hague Airport Visit

Introduction

Rotterdam The Hague Airport, has held the position of the second regional airport in the Netherlands, based on passenger numbers, since the end of 2006. Situated in the Zestienhovensepolder, just north of Rotterdam, the airport is under the ownership of the Schiphol Group (Wikipedia-bijdragers, 2023b). Rotterdam The Hague Airport, is smaller than Schiphol, focuses on regional and low-cost flights, and provides a more modest range of amenities (Information obtained from the visit).

Approach

The visit to Rotterdam The Hague Airport consisted of a single visit lasting two and a half hours. The process was similar to the visit to Eindhoven Airport, with initial communication via email to clarify the purpose and basic information of the visit. The primary goal was to gain insights from the Sustainability Advisor at Rotterdam The Hague Airport about the current cup provision and waste management practices. The Advisor addressed any questions or concerns in real-time as they emerged during our tour. As part of the visit, the Sustainability Advisor led us through the post-security areas and the central waste collection facility. With the necessary permissions in place, we documented our observations through photographs, which are presented in Figure 16.

Findings

At Rotterdam The Hague Airport, passengers frequently opt for reusable coffee cups in the airport's coffee shops. Several factors contribute to this choice. The airport's operating hours, beginning at 7 am, combined with a limited flight schedule, afford passengers a more leisurely pace, making them more inclined to choose reusable cups over disposable ones (information gained from the Advisor). Moreover, the airport café, with its inviting ambiance, features eco-friendly design elements like wooden tables and chairs, subtly nudging passengers towards sustainable choices. Such design considerations, coupled with the airport's active promotion of reusable coffee cups, underscore its commitment to fostering an environmentally-conscious passenger experience.

Figure 16: Bins, restaurant, photographed at Rotterdam The Hague Airport, photographed by the author

2.4 Observation

2.4.1 Introduction

Observation method was used to gather information on the usage of cups, user behaviors, bin design, the environment, messages, and services at Schiphol Airport. The primary emphasis was on understanding the process and behavior of users from use to disposal of disposable cup waste. While the central observation group consisted of 10 individuals, the behaviors of other passengers at the airport using cups were also taken into account. This observation session, which lasted roughly three hours at Schiphol Airport, aimed to address the following key questions:

a. What types of cups are commonly used by passengers at the airport?

b. How do passengers navigate the process from using the cup to its eventual disposal?

c. What facilities or services does the airport offer for cup recycling?

2.4.2 Procedure

The POEMS observation method was employed to systematically collect data on different aspects related to disposable paper cups and their recycling. Trained observers, equipped with observation checklists, conduct structured observations in the selected areas (Fig.17).

These checklists were crafted around the five pillars of the POEMS framework: *People* (passengers), *Objects* (such as hot beverage cups, stirrers, lids, napkins, and bins), *Environment* (like dining areas, lounges, cafes, and other zones), *Messages* (information influencing user behavior), and *Services* (like hot beverage sales, cup recycling, and waste removal). Each checklist detailed specific behaviors and attributes to monitor within each category, encompassing aspects like user actions during cup disposal, available cup varieties, bin design and placement, and the availability of services (Fig.17). Beyond the checklist's specified factors, additional relevant observations related to these five elements were also noted. Throughout the observation, key observations were documented using a mobile phone, ensuring no faces were captured.

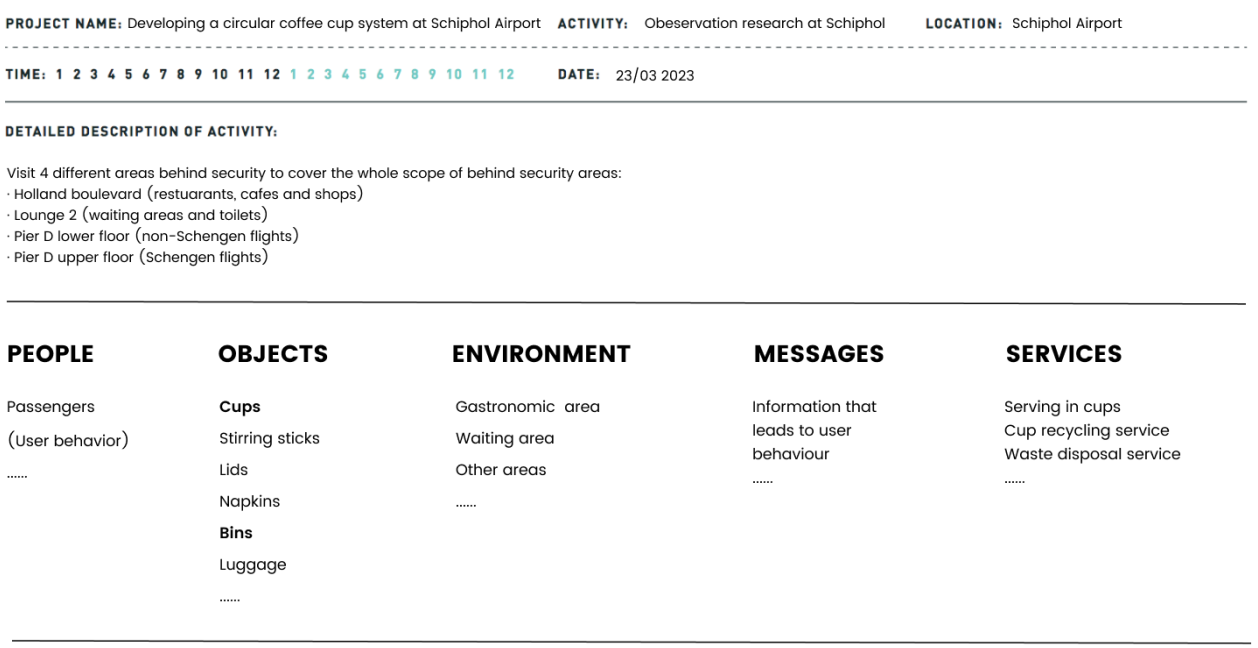


Figure 17. Schiphol Airport observation framework based on POEMS, drawn by the author

2.4.3 Observation result

The research process adhered to ethical guidelines in a strict manner, with all aspects of the observation implemented with the consent of Schiphol Airport to ensure ethical compliance. Following the observation, the gathered information was carefully categorized and organized according to the observation framework. The key insights derived from this process are outlined in Figure 18.

Observation Categories	Key insights
Passengers (N=10)	• Number of luggage carried: Most of the observed passengers carried more than two pieces of luggage. • Hot beverage preferences: More passengers were observed drinking coffee than tea. • Additional waste sources: Passengers who are sitting will also order desserts, especially in the dining areas, accompanied by napkins, food packaging boxes, and other potential waste (Fig.19).
Cups for hot beverages	• Ceramic mugs: Passengers using ceramic mugs are mostly seated. • Disposable paper cups: The majority of passengers use disposable paper cups . • Lids: Passengers who are walking around mostly have lids on their cups.
Bins	• Coffee shop's own waste bin: Single waste disposal entry for all trash including cups and lids, often with residual liquid at the entrance (Fig.20). • Normal bins at Schiphol: Three waste disposal openings, labeled as plastic, paper, and waste. Disposable paper cups were found in all three compartments, but they were predominantly located in the "other waste" (Fig.20). • Lack of liquid disposal: There is no separate space for the disposal of residual liquids in the current trash bins at the airport.
Cup and Waste Disposal	• Combined disposal: Passengers using disposable paper cups tend to stuff small pieces of waste (such as napkins) into the coffee cup before throwing it into the trash bin. • Lack of waste sorting among disposable cup users: Most passengers using disposable paper cups do not sort their waste but instead throw it directly into the bin.
Environment	• Vibrant color scheme at Schiphol Airport: The airport frequently uses bright colors like orange in its environment, creating a lively and energetic atmosphere (Fig.21). • Time-Pressed atmosphere: The atmosphere in the main gastronomic zones and lounges appeared to be somewhat rushed due to passengers being pressed for time.
Messages	• Information dissemination channels: There are various mediums within the airport for conveying information to users, including standees, billboards, and posters (Fig.22). • Communication methods: Information is primarily conveyed through text and icons to guide user behavior (Fig.23).
Services	• Types of cups provided: The types of cups provided vary from store to store within the airport. Some restaurants that offer dine-in services provide ceramic or mug cups, while many shops only offer disposable paper cups. • Variety in disposable cup sizes and types: Many shops offer disposable paper cups of different sizes and types.

Figure 18. Key insights from observations, drawn by the author

Passenger observation results

Insights from the passengers' perspective reveal several key behaviors and preferences: most carry more than two pieces of luggage, have a preference for coffee over other hot beverages, and often consume additional food items, generating more types of waste. These observations help to clarify the habits and needs of airport passengers, providing a foundation for meeting their requirements more effectively.

Cup observation results

From the category of cup usage, the majority of passengers opt for disposable paper cups, often with lids, especially when they are on the move. In contrast, those who choose ceramic cups are generally seated and are fewer in number. This information could guide the selection and design of cups to better suit user behaviors and preferences.

Waste disposal observation results

In terms of waste disposal, two main types of bins are observed at the airport: those provided by individual shops and standard airport bins. Shop-specific bins often have a single opening, leading to mixed waste, while standard airport bins offer categorized compartments that are frequently misused. A common issue across all bins is the absence of a designated space for residual liquids, which may be a contributing factor to inefficient recycling processes. Insights into waste disposal behavior indicate that many passengers prefer to dispose of all waste collectively, and most do not segregate their waste. While this behavior may reflect a desire for convenience, it could also lead to lower recycling efficiency. These observations suggest that future design solutions may need to address the underlying reasons for these behaviors to encourage more effective waste sorting.

Environmental and Messages observation results

Environmental and informational insights suggest various channels and methods for conveying information to passengers, such as standees, billboards, and icons. These could be strategically employed in future design phases to create solutions that align with the atmosphere and user needs at the airport.

Service observation results

Key insights into services currently provided at the airport will be invaluable for subsequent analysis and design stages, offering opportunities to enhance service efficiency by aligning with existing airport services and conditions.

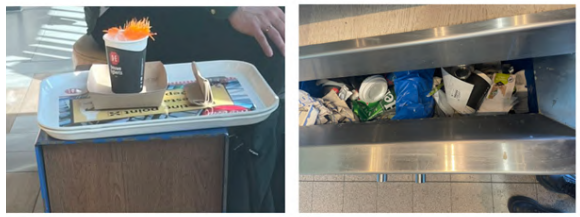


Figure 19. Passengers' food waste, photographed by the author

Figure 20. Shop-specific bins and normal bins, photographed by the author

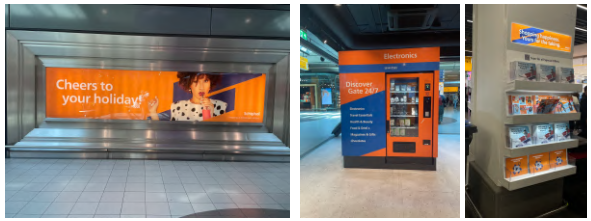


Figure 21. Vibrant color scheme at Schiphol Airport, photographed by the author

Figure 22. Various mediums within the airport, photographed by the author

Figure 23. Communication methods, *photographed by the author*

2.5 Interview

2.5.1 Interview with stakeholders

Stakeholder interviews are vital in developing a circular coffee cup system at Schiphol Airport. They offer valuable insights into the needs and expectations of the airport management, shop operators, and consumers, helping identify issues and opportunities within the current system. This collaborative process encourages stakeholder support, directly informs design decisions, and helps mitigate risks, ultimately paving the way for an effective, sustainable circular cup system tailored to the unique airport environment. The overview of stakeholder interviews is shown in Figure 24. The stakeholder interviews were driven by the following questions：:

a. Why is it difficult to reduce single-use cup waste at Schiphol Airport?

b. Potential problems with prohibitation on single-use plastic cups & the introduction of a new cup system in the future.

Figure 24. Stakeholder interviews overview, drawn by the author

Stakeholder map & System map

Before conducting interviews with various stakeholders, it is first necessary to understand who the stakeholders are in the current airport cup system, what each stakeholder's responsibilities are, and what the relationships are between the stakeholders within the system. The information from desktop research was used to create a stakeholder map to get an overview of the responsibilities and priorities of all stakeholders in the current airport system (Fig.25). According to the map, Schiphol, travellers, food and beverage companies are at the top of the hierarchy and are the system's key stakeholders, which means that these stakeholders have a significant influence on the service system and must be prioritised in order to understand their interests, concerns, expectations, and goals. Following that are cleaning companies and waste management company, with whom cooperation and frequent updates must be maintained, and finally, some stores and restaurants that are indirect stakeholders in the system. It's important to note that Company F and Company E are set to take over from Company D as the waste management providers at Schiphol Airport.

The new stakeholder map is visualized in the Figure 26. The analysis of the stakeholder map in the first phase ensures that no relevant stakeholders are overlooked, as well as an assessment of each stakeholder's level of influence and impact, and the prioritisation of resources for the later phase.

More information in confidential appendix

Figure 25. Current stakeholder map at Schiphol Airport, drawn by the author

Figure 26. New stakeholder maps for the coming months at Schiphol Airport, drawn by the author

The System Map expresses each stakeholder's position in the waste disposal service model as well as their cooperation. It is easier to understand how the current system works by analysing the flow of information, finance, and materials among the system's stakeholders (Fig.27).

Current system map

Material Flow

Information Flow

Financial Flow

More information in confidential appendix

Figure 27 .Current system map at Schiphol Airport, drawn by the author

Food & Beverage Company A

Company A is a major global food and hospitality company. Their specialty is bringing vibrant local brands into airport terminals, as well as developing and operating their own innovative, custom-designed restaurants. They are primarily in charge of the food and beverage brands found after airport security checks. This includes collaborating with well-known brands , as well as running their own brands (Company A, n.d.).

I conducted two interviews with Company A. The first was an online interview, structured in three stages. Initially, I introduced the purpose of the interview and briefly sought consent for recording it through a form. This form was later emailed to Company A's staff for review and signature. Once consent was obtained, the formal interview commenced. Due to Company A's internal access restrictions, I was unable to transcribe the audio recording. Instead, I summarized the key points in a Microsoft Word document. The detailed interview plan can be found in Appendix A.

The second interview was conducted during on-site visit at the airport, where staff from Company A guided us through their main dining areas and shops located behind security checkpoints. This tour also included a look at some of their back kitchens. During this visit, I took notes and captured crucial quotes on my phone. I later organized the key findings from both the online interview and the on-site visit into a table, which includes detailed descriptions and corresponding quotes (Fig 28).

Campany	key information	Description	Quotes
Company A	**Challenges from new regulations**	Challenging to implement a single solution that all businesses would accept. (Different brands have different strategies, especially large brands).	"So we don't have one-size-fits-all solutions because whatever we do here might not be."
		Different companies manage different areas within the airport, involving numerous stakeholders and contributing to the complexity of the airport system.	"This part is managed by us, but the area there is managed by the airport, which is very large and each area is managed by a different company."
		Limited space for washing in the kitchen makes it difficult to fully transition to reusable cups	"The problem is that currently we only have so much room for cleaning."
	Concerned about the brand experience	Very concerned about the brand experience	"We are very respectful of each brand's strategy and passenger experience."
	Current waste disposal situation	Sometimes the task of collecting the garbage falls to the cleaning company, but sometimes the company itself has to hire someone to handle it	"Company D. It's very technical. I don't know exactly. Sometimes Company D needs to collect all the garbage. Sometimes it's the cleaning company."
	Waste collection and recycling responsibility	If a company cannot prove that 95% of cups end up in the correct recycling area, then there might be repercussions	"But even for a compound, if they cannot prove that 95% of the cups ends up here and are actively recycled.."

Figure 28 .Interview result with Company A, drawn by the author

Food & Beverage Company B

Company B is a partner of Schiphol with innovative catering concepts. Company B distinguishes itself through the development of appealing and well-organized concepts in which guest-oriented employees, quick service, and a freshly prepared range are central, even on the go (Company B, n.d.). Unlike Company A, Company B's responsibility lies primarily in the shops before the security check, and it does not involve cooperation with major brands. The interview process and main issues were similar to those with Company A. The interview results were as shown in the table below (Fig.29). I have classified the insights from the stakeholder interviews by company type and compiled the results into three tables.

Campany	key information	Description	Quotes
Company B	**Challenges from new regulations**	**Increased costs, the difficulty of managing different types of venues, and the impracticality of expecting guests to bring their own cups are all possible problems**	"we are still busy with the with this law. This afternoon. We have a goal with our management to discuss the new rules and there are many possible directions to choose. If we look after the coffee cups, they will be more expensive evil in my field."
		Limited space for washing in the kitchen makes it difficult to fully transition to reusable cups	"there is going to be some difficulties in washing the dishes that we just don't have a solution for for all the locations yet""
		Difficulty in aligning the brand marketing strategies with the new regulations, especially if different brands have their logos on the cups.	"if you talk about the duty, Italian concept, it's our concept but we are using daily coffee with a famous mark in the world... It will be be important on the cups as well as because when you lose your signing, that will be a difference. It is a different situation probably but yeah, I think all those business partners have to discuss the situation with each other. How to manage this in the future. I really don't know."

Figure 29. Interview result with Company B, drawn by the author

Cleaning Company C

Company C, a cleaning company operating at Schiphol Airport, provides expert cleaning services across various sectors, ensuring a clean environment throughout. Company C operates under a vision of contributing to a cleaner, better environment. (Company C, n.d.). The interview process and main issues were similar to those with Company A. The interview results are as shown in the table (Fig.30).

Technology Company E

Company E, founded in 2019, is a technology-driven enterprise committed to fostering a waste-free world. Their innovative platform and app enable businesses to effortlessly schedule waste collection in the most efficient and eco-friendly manner. The collected waste is then repurposed into new products, aligning with the company's sustainability goals (Company E, 2023). According to information gathered from the interview, Company E primarily focuses on data analysis and dashboarding. The interview process and key discussion points closely mirrored those with Company A. The findings from the interview are presented in the table (Fig.30).

Waste Management Company D

Company D is a waste management company that provides holistic solutions in collecting, recycling, and disposing of diverse waste types. Catering to businesses, municipalities, and other organizations, Company D places a strong emphasis on eco-friendly waste management strategies aimed at mitigating the adverse environmental impact of waste. They strive to promote resource recovery and recycling. In collaboration with their clients, Company D formulates custom-tailored waste management plans that align with both sustainability goals and legal obligations. (Company D, n.d.-b) Specifically, Company D manages waste collection and processing across all of Schiphol., The interview process and main issues were similar to those with Company A. The interview results are as shown in the right table (Fig.30).

Campany	key information	Description	Quotes
Company C	**Dilemma of Coffee Cup Waste Collection**	Coffee cups often are not empty when they're disposed of, causing spillages which create more work and need more resources to clean up. It makes the process less efficient.	"The biggest problem is coffee cup waste. It's not empty. So people have half her drink and they check it in the bin and maybe there's a little bit something sharp. And the moment they pull out the bag, then all the coffee, coffee and and all the drinks spilled all over."
		Coffee cups come from various sources. Each has a different type of cup, complicating the collection process.	"Different type of coffee cups. So we've got coffee shop brand is totally different type of cup than the cup from maybe the Burger King or the cup from.."
	Challenges from new regulations	The introduction of more reusable coffee cups might increase the workload for cleaning companies as they might wash their cups, increasing the need for cleaning.	"So that for me as a cleaning company point of view would mean extra work and and and more usage of soaps and cleaning that I don't know and for the non reusable just so that you just drink it once it will be the same.."
	Cultural and Language Barriers	Passengers from different cultures may have varying levels of awareness or interest in recycling and reusable cup use	"And it's also like you are very focused here in little Netherlands on this whole circular thing and a lot of international passengers are totally unaware.."
Company D	**Challenges from new regulations**	Potential loss of paper volume in their collection, impacting their operations and possibly, profitability.	"I would think we are going to lose volume of paper in our collection.."
	Future possibilities with coffee waste	The company has experimented with making other products from waste such as soap, coffee cups, and makeup like scrubs. These are small projects to explore new, sustainable product possibilities.	" We can make soap with it, we can make coffee cups, and what you maybe have seen but also make-up like scrubs, but those are all more like small projects just to see what we can do with it."
Company E	**Role and responsibility**	Data, dashboarding, and roadmapping	"So Company E is also responsible for all data and dashboarding... we are responsible for showing them the dashboards and also generate insights from the dashboarding in order to make that roadmap."
		Airport regulations need to be followed	"So we can connect the best one in place, but at Schiphol, you have regulations and you can only collaborate with one says of the regulations over there."
	Future focus	Focus on what cups will be offered to passengers in the future	"And I also think it's important to keep in mind, like right now the coffee the disposable coffee cup isn't that is a separate stream, but from January onwards that will not be a stream anymore, because it's not allowed to have that all you have to have that stream in general". "a reusable cup people are also allowed to bring their own their own cup. So that might also be just something to keep in mind. It's also part of the legislation."

Figure 30. Interview result with Company C, Company D, Company E, drawn by the author

Stakeholder Interview results

From the stakeholder interviews, several key challenges and concerns emerged regarding the implementation of new regulations to reduce single-use cup waste at airports:

Space constraints

The limited kitchen space hinders the full transition to reusable cups, as there isn't enough room to wash and sanitize them efficiently.

Brand experience

Companies, especially well-established brands, are deeply concerned about maintaining their brand experience. Any change in the cup system, like introducing logos of different brands on cups, might dilute their brand identity.

Operational challenges

Coffee cups are often not empty when disposed of, leading to spillages. This not only creates additional cleaning work but also makes waste management less efficient.

Complex airport system

The airport ecosystem is intricate, with different companies managing various areas. This multi-stakeholder environment adds layers of complexity to any proposed solution.

Diverse business strategies

It's challenging to find a one-size-fits-all solution due to the varied strategies of different brands. Notably, large brands have specific requirements and strategies that might not align with a universal solution.

Conclusion

The stakeholder interviews have illuminated two paramount challenges in introducing a reusable cup system at airports: the limited space available for cup cleaning and the preservation of brand experience. The spatial constraints in airport kitchens significantly hinder the feasibility of a swift transition to reusable cups, necessitating innovative solutions that optimize the cleaning process within these confines. Equally vital is the concern of brands, especially prominent ones, about maintaining their distinct brand identity in the face of a universal cup system. As I move forward in designing a reusable cup system, it's imperative to prioritize solutions that address these space and branding challenges, ensuring both operational practicality and brand fidelity.

2.5.2 Interview with passengers

Research setup

Through desk research in the preliminary stage, useful insights were summarized from both theoretical and practical perspectives. These insights included the reasons for the widespread usage of disposable paper cups and lids, the challenges in recycling disposable cup and lid waste, and the factors that may influence user behavior. Additionally, through on-site observations, phenomena that could potentially affect airport waste recycling were observed, and underlying reasons were analyzed. By conducting interviews with airport passengers, the aim is to further understand their behaviors and the reasons behind their cup usage and disposal processes. Therefore, the following research question has been formulated:

a. Why is it difficult to reduce single-use cup waste at airports?

b. What factors may facilitate user behavior change?

c. Potential problems with prohibitation on single-use plastic cups & the introduction of a new cup system in the future.

Purpose and Approach

A qualitative research approach was chosen for this research, as the research goal emphasized a greater focus on the reasons behind passenger behavior, uncovering problems in the use and handling of disposable cups by passengers.

GTM: The Grounded Theory Method (GTM) (Glaser & Strauss, 1967) was chosen as the data analysis method to build frameworks of knowledge on these three themes, based on the data itself. Furthermore, GTM is combined with design research methods and techniques such as Contextmapping (Sleeswijk Visser et al., 2005) and Sensitising (Sanders & Stappers, 2012).

Sensitising: Sensitising refers to the preparatory stage before an interview, where participants delve into the topic by gathering personal experiences and augmenting their comprehension, frequently under the guidance of tasks or a workbook. Its objective is to adequately ready the participants and foster an open-minded attitude. Employing generative exercises is aimed at uncovering implicit knowledge, which is typically inaccessible through conventional research methods (Sanders & Stappers, 2012). In this study, participants received both a consent form and a sensitising booklet before the interview session. The booklet served to immerse participants in the topic, guiding them in reflecting on their past experiences with cups at the airport. This specific approach to sensitising aimed to concentrate the interviewee's focus on the research topic during the conversation, aid in the recall of previous instances of paper cup usage at Schiphol Airport, and provide constructive guidance for the impending interview.

Selection of Participants

Due to the lack of permits for interviewing passengers directly at the airport, this study was limited to conducting interviews with passengers who had visited Schiphol Airport in the past month. I targeted passengers who had either consumed beverages or disposed of cup waste during their visit.

When interviews are conducted at airports, passengers are often in a hurry to catch their flights, which limits the opportunity for in-depth conversations. This time constraint can impede the gathering of valuable insights. By selectively interviewing passengers who have recently visited the airport, I can overcome these time limitations and ensure a more thorough collection of information through one-on-one, in-depth conversations.

Sampling

In this study, a total of twelve participants were interviewed (N=12); seven were international passengers, and five were Dutch passengers (Fig.31). According to previous user research discussed in Chapter 2.3, the number of intercontinental passengers significantly exceeds that of European passengers. Consequently, the decision to include a higher proportion of international passengers in the sample was a strategic move designed to minimize sampling bias.

Detailed information about the participants is provided below. While previous research has not shown significant differences in consumer behavior based on gender, I still aimed to achieve a roughly equal gender balance among participants to mitigate any potential gender-related impact on the study's results.

	Gender	Age	Nationality	Education	Duration
T1	Male	23	Chinese	University	45min
T2	Female	24	Chinese	University	15min
T3	Male	24	Dutch	University	50min
T4	Male	22	Spanish	University	25min
T5	Male	24	Chinese	University	25min
T6	Female	27	Dutch	University	10min
T7	Female	27	Chinese	University	15min
T8	Male	35	Turkish	University	25min
T9	Female	32	Chinese	University	10min
T10	Female	27	Chinese	University	40min
T11	Male	32	French	University	10min
T12	Female	27	Dutch	University	40min

Figure 31. Selection of participants who have visited Schipol Airport within two months

Interview Process

- *Preparations: Sensitizing*

The sensitizing booklet was sent to the interviewees four to five days before the formal interview (Fig.32). The content of the booklet was based on the user's reflection of their last airport experience and was designed based on the interview plan（see Appendix C). Finished booklets were returned either in person or by taking photos and sending them back. The finished booklets were discussed in interview sessions. The match with the interview outlines has been evaluated multiple times. In addition, all exercises were piloted with two people and iterated on based on their feedback.

The booklet begins with a brief introduction to the purpose of the booklet, following the flow of the passenger experience, from the baggage preparation stage, purchase stage, drinking stage and waste disposal stage, guiding the passenger to recall and describe the scene and mood of the time. In order to improve the usability of the booklet, as many stickers (moods, cup types) or pictures of real-life scenarios (types of bins available at the airport) as possible were made available for participants to refer to and fill in. At the end of the booklet, the participants were asked to write down their suggestions or expectations in the context of the gradual ban on disposable paper cups. For a complete setup of the sensitizer, please refer to Appendix B. Out of the 12 participants, 8 completed and returned the booklet, while the remaining 4 were unable to do so due to personal reasons.

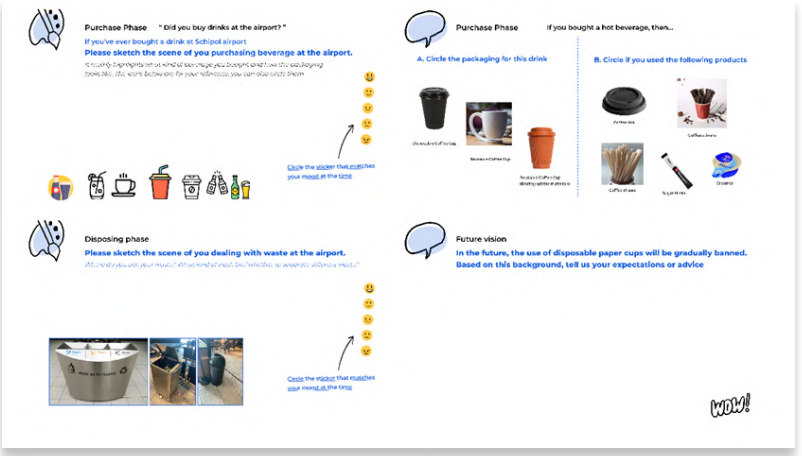


Figure 32. SensitIzing booklet, designed by the author

- *Conducting the Interviews*

In-person interviews were conducted with participants, during which their informed consent was obtained. The interviews were recorded using a mobile phone for accurate data capture. The entire interview process was divided into three stages. The first stage was the wrap-up session, where we carried out brief self-introduction, elucidated the purpose of the interview, and asked for consent to record the interview.

Next was the formal interview, which was divided into four parts. The first set of questions was based on the participants' previous experiences of drinking beverages at the airport and the feedback recorded in the booklet. I inquired about their use and disposal of cups at the airport. (Specificinterview questions can be found in the Appendix C.) The first part was centered around understanding passenger behaviors and their deeper triggers within an airport setting.

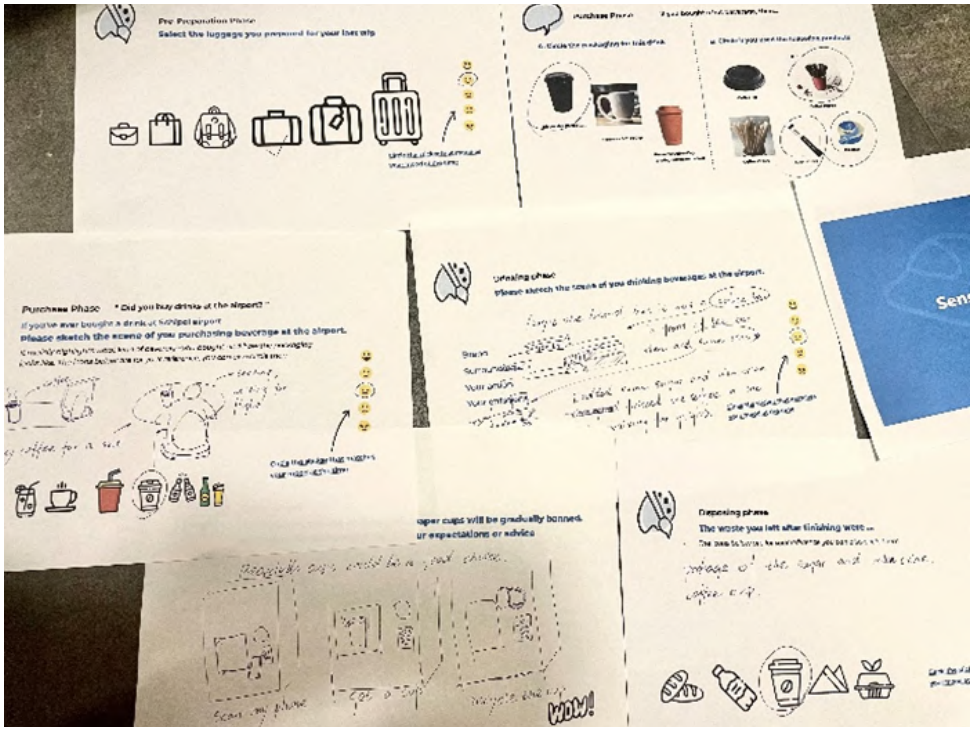


Figure 33. Received booklets, photographed by the author

The second part focused on the participant's sustainability. I sought to gauge personal awareness about recycling and the connection between individual sustainability practices and user behavior. The third part dealt with participants' experiences in daily cup use scenarios. Insights were drawn from understanding the participants' daily routines. The fourth part gathered opinions and suggestions about future regulations and potential new cup systems. Specific questions were adjusted based on actual circumstances and responses of participants. This flexible approach facilitated a more natural contemplation for participants and was conducive to uncovering deeper reasons. The final stage of the interview involved wrapping up and thanking the participants for their time and contribution. Audio recordings of the interviews were transcribed into text using Microsoft Word, ensuring the preservation of data for analysis.

Data Analysis

As previously argued, the Grounded Theory Method (GTM) (Glaser & Strauss, 1967) was chosen as the data analysis approach to construct theoretical frameworks. First, all interview transcripts were automatically transcribed by the transcription tool in Microsoft Word. Subsequently, they were re-transcribed by hand to prevent mistakes and to preserve descriptive validity. All coding stages of GTM are executed; open, axial and selective coding respectively. This first round of open coding was done individually. During the coding process, the coding process has been reviewed by another student specialized in design to stimulate the investigator's triangulation. Before the second cycle of coding, a coding book was made. For each case, the codes from the interviews were clustered and got labelled with a theme. In this way, relationships between the codes were found. For the second cycle coding, a cross-case analysis was done. Through iterative analysis, key themes and findings emerged from the data, which were then integrated with existing literature to develop a comprehensive understanding of cup usage at Schiphol Airport. Here the results are presented for codes more than or equal to 4 (Fig.33).

Category	Theme	Code	Examples (Quotes)	Key insights
Current situation	**Prior knowledge of disposable paper cups**	Ambiguous or wrong perceptions	*"Because I think the coffee cup is made of paper."* *"Basically no I only know that he may be able to be recycled."*	**Most participants are not clear about the recycability of disposable paper cups and had misconceptions.**
	Use of cups and lids	More drink beverages after the security check	*"The security check is the biggest enemy, so we will pass the security check first."* *"I usually rarely drink coffee before security check because I'm not sure how long the security check would take."* *"I might consider sitting inside and having a cup of coffee if I'm waiting there three or four hours in advance."*	**Most participants choose to drink beverages after security checks because they feel time pressure during the checks.**
		Cup lid to prevent leakage	*" Particularly with a small open container, even a minor jostle can cause a spill. "* *" Cup lid, stirring stickes I will use all "*	**Most participants use cup lids to prevent drinks from leaking**
	Reasons to use disposable paper cups	Many stores only provide disposable paper cups	*"The store only provided disposable paper cups. "*	**Currently most stores only provide disposable paper cups users generally have no choice**
		Benifits of using disposable paper cups	*"I'm used to using disposable cups because it's convenient and I can always throw them away. "*	**Disposable paper cups are convenient (light, portable, easy to throw away)**
	Challenges to use reusable cups	Cleaning issues	*" I will choose disposable cups at the airport, because I am not sure if the ceramic cups are clean. "* *" One of the bigger concerns is hygiene, and in the airport in a large crowded environment, there are all kinds of people you will feel more like this cup from any country anyone may have drunk it, so it reinforces this concern about the lack of hygiene.. "*	**Some participants had concerns about using reusable cups due to the complex airport environment (viruses, bacteria, heavy traffic, etc.) .**
		Inconvenience	*"Ceramic cups can not be carried away, very heavy and easy to break "* *"I didn't want to waste time returning the cups to the store, it was inconvenient "*	**Most of the participants thought it was inconvenient to use reusable cups(ceramic mugs) at the airport (Heavy, easy to break, need to return to the store).**
	Challenges to use their own cups	Own cups take up space	*"Because it takes up space and you already have so much stuff "*	**Most participants will not bring their own cups to the airport, because it takes up space.**
	Disposal behaviour	Uncertain waste thrown into other waste	*"What I can't sort will be thrown into other waste "*	**Most participants prefer to throw their waste into other waste (because they are not sure how to throw it)**
	Factors affecting waste disposal behavior	Ambiguous or incorrect perceptions lead to incorrect behavior	*"I consider the leftovers as food, so I will throw away other waste. "*	**Most people don't know or have misconceptions about the recyclability of disposable cups and lids, which can lead to inappropriate disposal**
		Education has an impact on user behavior	*"Because I obviously know that this cup is a paper cup and not plastic, so I will have some hesitation in throwing it. "* *"After being educated, I will now decide to throw it all in the middle. "*	**Educated users(Documentaries, courses, word of mouth,etc) will have a significantly different approach to paper cup waste disposal and are prone to make more sustainable choices**
		Sources of recycling knowledge	*"Because I have seen the documentary on Japanese garbage disposal."* *"After studying design for so many years, I am re-educated every day."* *"By talking to others i know this things."*	
	Daily choice	Prefer ceramic mugs	*"Ceramic cups give me a better experience because the texture is better. "*	**In everyday scenarios, each participant's choice of cup varies. Most participants choose to use ceramic cups, believing that they provide a better experience(texture).**
Future vision	**Views on the existing new cup system**	Cleaning issues	*"The mug I know it will be thrown in the dishwasher right. But billie cup washes very poorly. "* *"It's easy to lost coin. "*	**Most participants were concerned about the cleanliness and convenience of the new lightweight cups(return issues)**
		Inconvenient experience	*"Billie cups are very inconvenient to take away after drinking, you must also wash clean. "*	
	Expectations for the new system	More convenient service	*"if it is easy to bring it back. "* *"Must be able to get me to the return point quickly. "*	

Figure 33. Coding result

Result of user interviews

Benefits of using single-use cup

The convenience associated with disposable cups - their lightweight design, portability, and ease of disposal - make them an ideal solution for the fast-paced, transient nature of airport environments.

Limited options available for passengers at the store

The ubiquity of disposable paper cups at most airport stores restricts choice for users, often making these single-use items the default option.

Barriers to use resuable cups:

The results revealed that the potential switch to reusable cups at airports is impeded by several factors. Additionally, the practicality of reusable cups in an airport setting is called into question, with concerns raised about their potential for damage, and the inconvenience associated with needing to return the cups to the store. Thus, these barriers pose substantial challenges to the successful implementation of reusable cups in airports.

Barriers to bring their own cups

The results suggested that the majority of individuals were reluctant to bring their own cups to the airport, primarily due to the concern that it would consume valuable luggage space. This highlights a practical barrier to the adoption of personal reusable cups in an airport setting.

Lack knowledge or have misconceptions of proper recycling:

The results revealed that there is a significant knowledge gap and prevalence of misconceptions regarding proper recycling procedures among the participants. Many of them demonstrated a tendency to dispose of their waste into “Other waste”, primarily due to uncertainty regarding correct disposal methods. Furthermore, it was apparent that most individuals lacked of accurate knowledge or harbored misconceptions about the recyclability of disposable cups and lids. This lack of understanding can consequently lead to improper disposal of these items, exacerbating the waste management issue.

Education fosters sustainable disposal practices

The results demonstrated that users who are educated about environmental issues—through avenues such as documentaries, courses, and word of mouth—exhibit significantly different behaviors regarding disposable paper cup waste. These informed individuals tend to approach waste disposal more responsibly and are more inclined to make sustainable choices, highlighting the influential role of environmental education in shaping waste management behaviors.

Difficult to eliminate passengers' concerns about the use of lightweight reusable cups made from new materials

Addressing passengers' reservations about adopting new reusable cups, such as the Billie cup, at airports has emerged as a substantial challenge. Two main concerns dominate their hesitation: hygiene and the return process. Many passengers question the cleanliness of these reusable cups made from new materials like PP, while others are deterred by the perceived inconvenience of returning the cups after use. Together, these concerns may impede the widespread acceptance of such sustainable solutions in airport settings.

Other insights from passengers

Most participants found the procedure of security checks to impose a significant time pressure, leading them to opt for consuming their beverages afterwards. Furthermore, they generally prefer using cup lids, a preventative measure to guard against any potential leakage of their drinks. On a day-to-day basis, however, the choice of cup for each participant varies significantly. The majority lean towards ceramic cups, perceiving them as providing a superior drinking experience due to their texture.

Conclusions from Interview results

- ***Optimal hot beverage container preferences for airport passengers:***

The ideal beverage container for airport passengers needs to balance convenience with sustainability. As travelers navigate the hustle and bustle of airports, they often prioritize lightweight, portable, and easily disposable cups, which complement their transient nature in such environments. Moreover, there's a clear inclination towards cups with lids to prevent potential spillage, especially during security checks or while boarding. Regular travelers also show a preference for ceramic cups during their day-to-day routines, valuing the tactile experience they provide. Therefore, an optimal airport beverage container should consider these preferences while introducing sustainable practices that cater to the fast-paced nature of air travel.

- ***Challenges in adopting sustainable cup solutions at airports:***

Adopting sustainable cup solutions at airports presents a set of unique challenges. First and foremost is the prevailing ubiquity of disposable paper cups in airport stores, making them the default and often the only option available. Transitioning to common reusable cups (ceramic mugs) faces resistance due to concerns about their potential for damage and the associated inconvenience of returning them after use. Even when passengers recognize the environmental benefits, practical concerns, such as the space a personal reusable cup might consume in luggage, can deter their adoption. Moreover, there is a significant knowledge gap among travelers regarding proper recycling procedures, leading to misconceptions and incorrect disposal habits. Lastly, cleanliness and hygiene concerns surround the use of reusable cups, which can be a dealbreaker in an environment where health and safety are paramount.

Passenger interview limitations

- The inability to conduct research with passengers in the airport setting limits the ability to gather insights into passengers' current thoughts and behaviors in specific scenarios, relying instead on users with past experiences, which may result in deviations from real-time operations or perspectives in the airport setting.
- Due to ease of access, the surveyed users primarily fell within the 22-40 age range, failing to cover other age groups, which may introduce biases in the research findings.

Passenger segmentation results

After conducting the interviews, the participants were segmented according to the established airport passenger classification model. By integrating the Copenhagen taxonomy with Harrison, Popovic, and Kraal's (2015) passenger segmentation model, we can derive a comprehensive framework that captures the intricacies of beverage consumption behaviors at Schiphol Airport. Given that both Copenhagen and Schiphol stand as significant European aviation hubs, accommodating a varied passenger demographic, it's plausible to anticipate overlapping passenger behaviors and expectations. The broad behavioral overview provided by the Copenhagen taxonomy, coupled with the detailed insights from Harrison et al., aligns seamlessly with Schiphol's objective of discerning the unique preferences of its hot beverage consumers. It's worth noting that this integrated framework encompasses all user categories identified during our interviews. With the dual-framework approach and the research's emphasis on hot beverage consumption at Schiphol, adjustments were implemented to fine-tune the model specifically for this study, as depicted in Figure 34.

- *Engaged sippers (airport enthusiast drinkers)*

  Low time sensitivity, high level of engagement

Engaged Sippers are travelers who immerse themselves in the airport experience. They often seek a nice spot to sit and enjoy their drink while taking in the ambiance of the airport. Their preference leans towards high-quality, reusable, or artistically designed cups that enhance their drinking experience. When it comes to consuming their beverage, they tend to savor each sip, drinking slowly and appreciating the flavor, rather than rushing through. Two of the participants in the interviews fell into this category

- *Passive drinkers (time filler drinkers)*

  Moderate time sensitivity,low level of engagement

Passive Drinkers primarily consume beverages as a means to pass the time. They aren't particularly discerning in their drink choices, valuing convenience above all. As such, they're likely to opt for disposable cups or whatever is most commonly provided at the airport. Their drinking behavior is moderate, neither too fast nor too slow, serving mainly as a way to keep occupied. Three of the participants in the interviews fell into this category

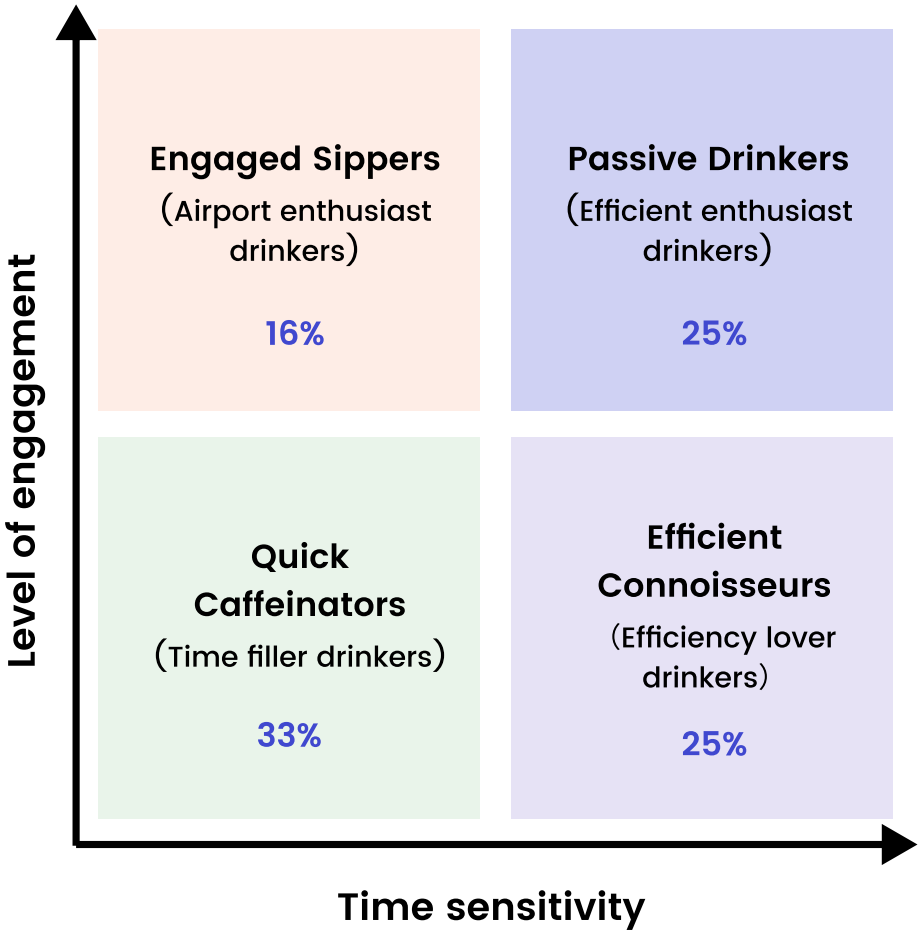


Figure 34. Passenger segmentation results

- *Quick caffeinators (efficiency lover drinkers)*

  High time sensitivity, low level of engagement

Quick Caffeinators are all about efficiency. They primarily drink hot beverages for the functional benefits, such as a caffeine boost. Their focus on speed means they're likely to choose fast, convenient, disposable cups, allowing them to finish their drink and move on with their journey promptly. Their approach to drinking is brisk, consuming their beverage quickly to get the energy they need. Four of the participants in the interviews fell into this category.

- *Efficient connoisseurs (efficient enthusiast drinkers)*

  High time sensitivity, high level of engagement

Efficient Connoisseurs strike a balance between efficiency and quality. While they're conscious of time, they don't want to compromise on the quality of their drink. Their cup preference might lean towards high-quality yet convenient options, like lidded ceramic mugs or stainless steel cups. In terms of consumption, they drink at a moderate pace, ensuring they can move on in a timely manner but still enjoy their beverage's taste. Three of the participants in the interviews fell into this category

Insights from user segmentation

The segmentation of passengers at Schiphol Airport reveals varied beverage consumption behaviors, dominated by Quick Caffeinators, who prioritize speed and convenience, followed by Passive Drinkers, who are relatively indifferent. Efficient Connoisseurs, though fewer, seek a quality experience without compromising efficiency, and the smallest group, Engaged Sippers, truly cherish their airport beverage experience. As we transition from disposable cups to other alternatives, our primary focus should be on offering a system that ensures quick and efficient service while maintaining a high-quality drinking experience and emphasizing the importance of sustainability. This balance will cater to the diverse needs and preferences of all passenger categories.

2.6 Key takeaways

- Based on the results of the desktop research, polypropylene cups, with their cost-effectiveness and user-friendliness, might be the preferred choice for passengers, while from a business standpoint, they could be the most economical option.
- The findings reveal that participants' lack of knowledge and misconceptions about proper recycling lead to incorrect disposal behaviour and misunderstandings about the recyclability of disposable cups and lids, exacerbating waste management issues.
- The stakeholder interviews highlight two main challenges for implementing a reusable cup system at airports: limited kitchen space for cup cleaning and the need to preserve brand identity, necessitating solutions that optimize both operational feasibility and brand expierence.
- The findings show that individuals with environmental education are more likely to practice responsible waste disposal and make sustainable choices, highlighting the role of education in improving waste management.
- The ideal beverage container for airport passengers should be both convenient and sustainable, offering lightweight, portable, and easily disposable cups with lids to prevent spillage.
- There's a need to pay greater attention to the needs of international passengers, the majority of whom come from European countries, as well as to focus on the majority of passengers who prioritize speed and convenience.
- Passengers are particularly concerned about the cleanliness and the convenience of the return process for reusable cups made from new materials.
- The adoption of personal reusable cups in airports is hindered by the practical barrier of limited luggage space, as individuals may be reluctant to bring their own cups for this reason.

03

Define

3.1 Problem Statement

The key takeaways of the Discover phase, led to the definition of the problem. Moreover, together with the insights gathered from the initial research, it was possible to formulate a future vision and design directions. In the Define phase, I narrowed down the focus to passenger behavior. This decision was motivated by two reasons. Firstly, passengers are the end users of the project, and they are the direct beneficiaries of the final service system. Through user interviews, it became clear that passengers have a high dependence on disposable paper cups. The smooth operation of the new system also relies on the passengers' acceptance of it. Secondly, from interviews with stakeholders (see chapter 2), I found that they pay great attention to the user's brand experience. All service systems at the airport strive to minimize disposable plastic waste while ensuring a positive passenger experience. Balancing this, it's crucial to maintain the service system's business feasibility. Thus, in the Define phase, my primary focus was on understanding passenger behavior to strike this balance.

Here is my problem statement:

Faced with new regulation, how can a feasible, viable, and sustainable cup system be developed at Schiphol Airport that not only complies with new regulations but also encourages passenger use and aligns with business interests?

3.2 Problem analysis

To understand the problems and its causes thoroughly, I used the COM-B model to better analyze the problems, behaviors involved, identify barriers and enablers and to design interventions that will promote the desired behavior (Fig.35).

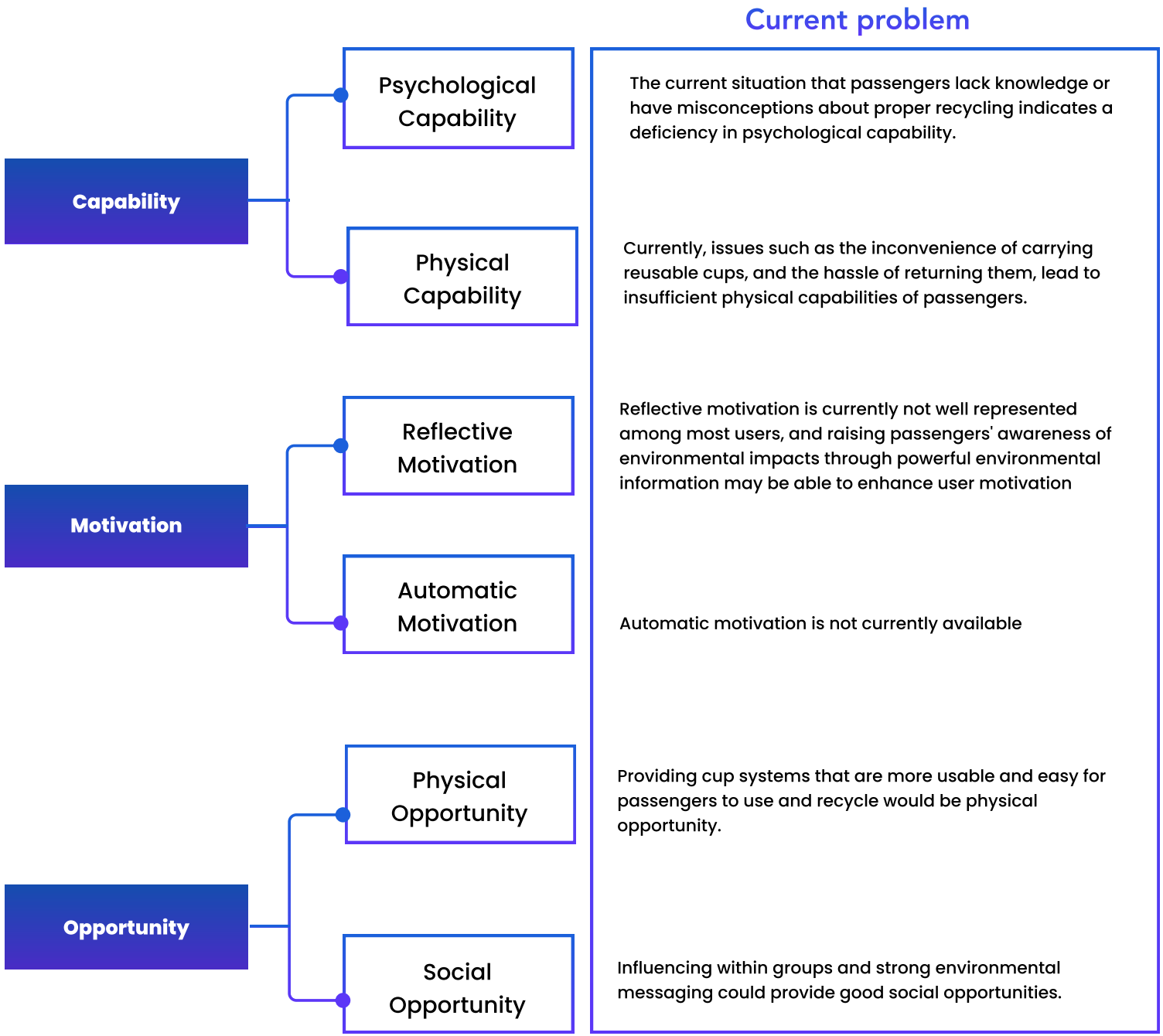


Figure 35. Current problems mapped to the COM-B model.

Barriers and Enablers

Based on preliminary analysis and the application of the COM-B model, the current barriers include insufficient psychological capabilities due to users' lack of knowledge or misconceptions. Insufficient physical capabilities are driven by the lack of a cup system that is easy for passengers to use and return. Passengers' motivation is inadequate due to the lack of both automatic and reflective motivations. However, there are also factors present that could promote user behavior change. Enhancing passenger education can improve psychological capability, and leveraging social norms may enhance social opportunity and motivation.

3.3 Future Vision

By considering the conclusions of Discover phase, the definition of the problem and the application of the COM-B model, it was possible to formulate a future vision for the design intervention.

In order to reduce the waste from single-use plastic cups at Schiphol Airport, we aim to enhance passengers' capabilities and motivations, and create both physical and social opportunities, to provide a feasible circular cup system that passengers are willing to use and participate in recycling.

3.4 Design Interventions

Mapping the results of the preliminary research to the COM-B model, the following design interventions were derived (Fig.36).

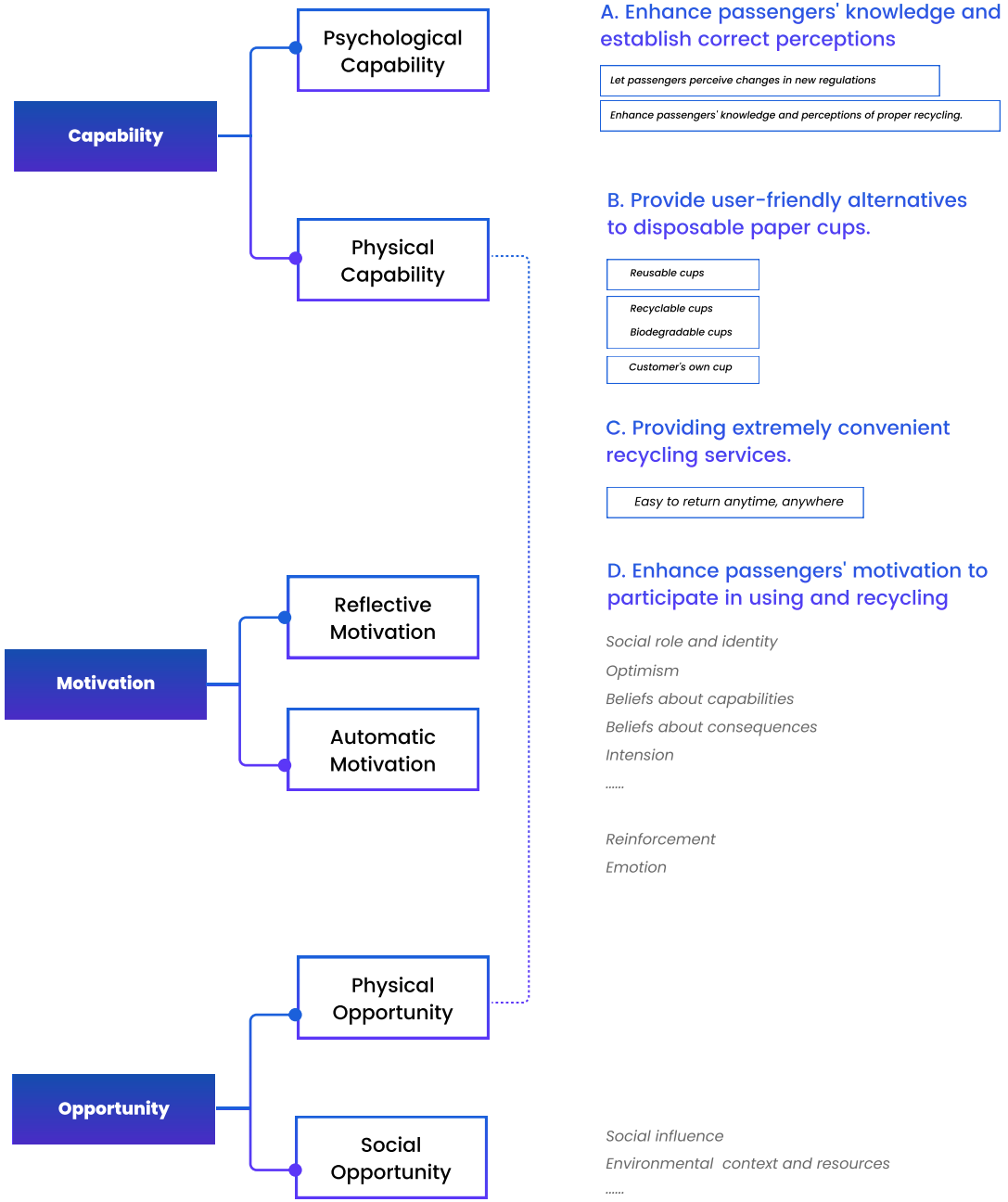


Figure 36. Design interventions mapped to the COM-B model

Enhance passengers' knowledge and establish correct perceptions.

Based on the results of the initial research analysis, passengers' lack of recycling knowledge and misconceptions can easily lead to inappropriate recycling behaviors. The implementation of new regulations ideally requires some publicity for passengers to sense the change in advance (interview insights), enabling passengers to understand and accept the regulations, and contribute more effectively to sustainability.

Provide user-friendly alternatives to disposable paper cups.

In response to passenger demands derived from interviews for cups that are portable, lightweight, and clean, I aim to select appropriate alternatives to disposable paper cups based on my desk research. Taking into account the variable times and personal habits of passengers within the airport, I also intend to offer a variety of alternatives, including ceramic cups for those who wish to sit and drink, as well as support for users bringing their own cups (for instance, for airport office staff). Our final selection will consider the needs of other stakeholders, incorporating factors like brand promotion issues and cost implications into our comprehensive evaluation.

Providing extremely convenient recycling services.

In response to the demand identified in the interviews for passengers to quickly return their cups, I am considering setting up several return points within the airport. This would allow users to easily locate a return station shortly after finishing their beverages.

Enhance passengers' motivation to participate in using and recycling

Based on the analysis of research results, passengers currently tend to use disposable paper cups in the airport and have certain concerns about using reusable cups make of new material. This leads to a lack of enthusiasm for alternatives to disposable cups. Observations and interviews further reveal issues with the improper disposal of these disposable cups. Therefore, it's essential to not only encourage passengers to consider reusable cup alternatives but also to actively participate in cup returning (or recycling) to ensure the system functions effectively.

To gain a clearer understanding of which design interventions should be implemented at various stages of the passenger journey, these four design interventions are mapped onto the passenger journey. This helps to specify the type of design intervention needed at each stage (Fig.37).

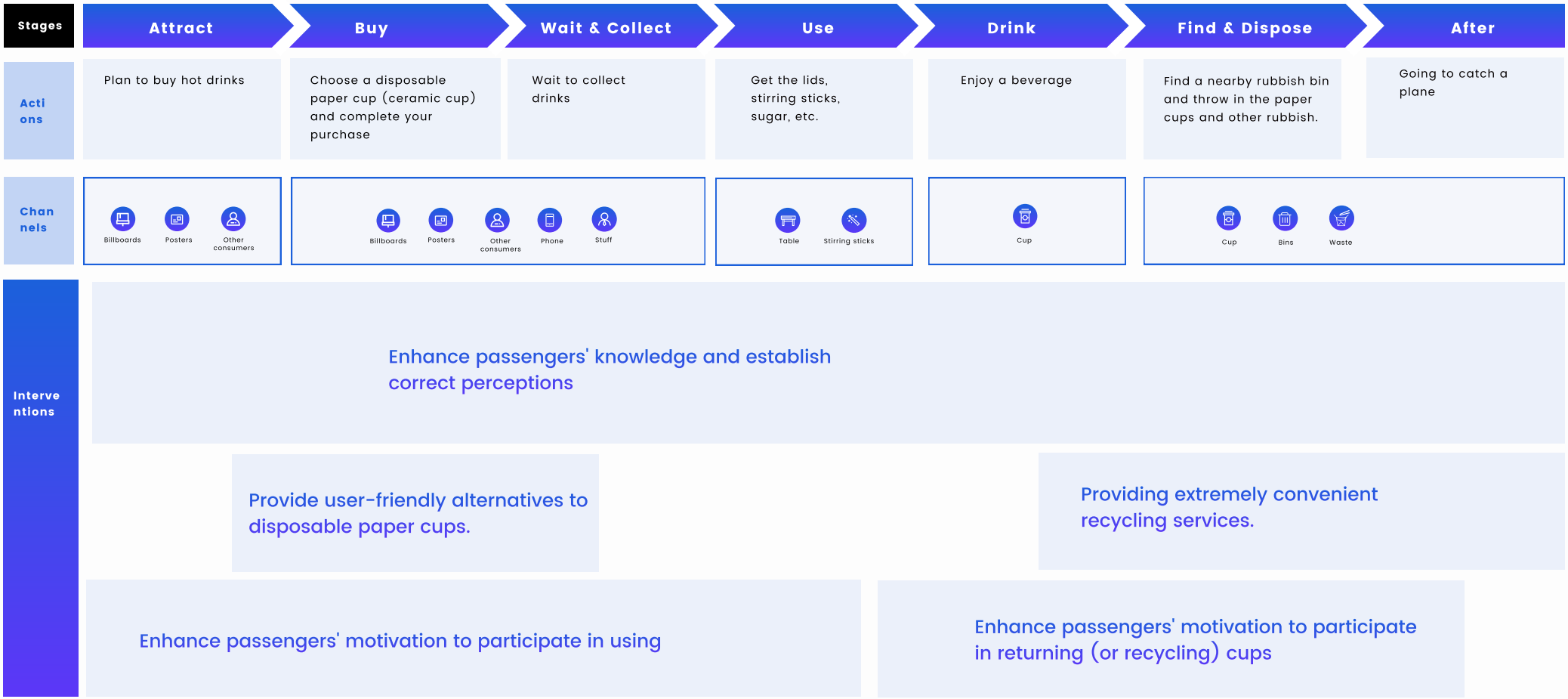


Figure 37. Design interventions mapped to the user journey

04

Ideate

4. Ideate

4.1 Introduction & approach

In the Define phase, I have identified five design interventions (chapter 3.4). Therefore, the creative session revolved around addressing these problems:

a. What kind of alternative to disposable paper cups would you like to use at the airport?

b. How might we enhance passengers' knowledge and establish correct perceptions?

c. How might we enhance passengers' motivation to participate in using alternatives?

d. What kind of cup return service do you want at Schiphol airport?

e. How might we enhance passengers' motivation to participate in return & recycling?

Creative Facilitation

Creative Facilitation (Tassoul, 2009) was used to structure the two conducted creative sessions with designers. The sessions, incorporating a variety of methods such as Brainwriting, Scamper (Van Boeijen et al., 2014), were designed to foster an environment where all participants were encouraged to contribute their ideas and viewpoints. This collaborative process ultimately facilitated the development of more useful and innovative solutions.

Brainwriting

Brainwriting is a group creativity technique that encourages participants to generate and share ideas individually, primarily through writing, but also allowing for expression through drawing in this session. The process involves introducing the purpose and guidelines, individual idea generation, exchanging and building upon written and visual ideas in multiple rounds, and concluding with a group discussion to evaluate and select the most promising concepts. By fostering collaboration, facilitating the cross-pollination of ideas, and emphasizing the quantity of generated ideas, brainwriting promotes the development of diverse and innovative solutions. Based on the five main problems identified during the Define phase (paragraph 4.4), brainwriting consists of five rounds, each dedicated to idea generation focused on a specific question.

Morphological chart

A morphological chart is a visual tool used in service design projects to explore and generate potential solutions for designing or improving services in a systematic manner. It works by dividing the service into different parameters or components, allowing designers to experiment with different combinations and variations. It promotes team members' creativity, divergent thinking, and collaboration. The chart makes it easier to analyse and evaluate solution options based on specific criteria, resulting in the creation of innovative and customizable service concepts (Van Boeijen et al., 2014b). In this project, the morphological chart, with its clear presentation of idea options corresponding to the five key questions, provided participants with insights to develop a comprehensive service design solution.

Scamper

SCAMPER is a creative thinking technique used in service system design projects to generate innovative solutions. It involves substituting, combining, adapting, modifying, putting to another use, eliminating, and reversing elements of the service system. By applying these prompts, designers can explore alternative perspectives and uncover opportunities for improvement and innovation. In the second round of solution iteration, participants were invited to apply the SCAMPER method to innovate based on the solutions from the other group, with the expectation of obtaining more optimized and improved solutions.

Harris profile

The Harris Profile, also known as the New Product Profile, is an evaluative graphical tool designed to appraise design concepts by highlighting their strengths and weaknesses. It employs a specific set of criteria and measures them on a four-point scale (Boeijen, 2017). In my project, I used Harris Profile to undertake assessments on desirability, feasibility, viability, and sustainability. This utilization aimed to provide a consolidated view of the design concepts under consideration. The results from this application offered a clear and structured insight into where each concept stood against these critical parameters, guiding subsequent

Ecodesign strategy wheel

The ecodesign strategy wheel, a qualitative tool, assesses a product's sustainability across its entire lifecycle by delving into strategies for each lifecycle stage (Huulgaard & Remmen, 2012). This tool was employed to measure the sustainability of various cup service concepts, covering the whole duration of the product-service system. The wheel served a dual purpose: firstly, to judge the overall sustainability of different concepts, and secondly, to analyze the strengths and weaknesses of each concept in terms of sustainability. This analysis then provided the foundation for creating the optimal concept in subsequent phases.

Life cycle assessment (LCA)

The Life Cycle Assessment (LCA) is a systematic approach to evaluating the environmental impacts of a product or service throughout its life cycle (Finnveden et al., 2009). The purpose of the conceptual assessment used for the three cup services is to understand their environmental performance and identify potential improvements. The results of the LCA can substantiate the ecodesign strategy wheel assessment, enabling the identification of key areas for sustainable design and innovation.

4.2 Creative Sessions

4.2.1 Creative Session setup

During the creative phase, designers from three disciplines - Integrated Product Design (IPD), Service Design and Planning (SPD), and Design for Interaction (DFI) - brainstormed solutions to the issues highlighted in chapter 5.1. SPD designers focus on system strategies, IPD on product recommendations, and DFI on human-computer interaction. Each session had representatives from all disciplines, and since they've used Schiphol Airport, they provided both professional and user insights. Brainstorming took place offline in two sessions, where ideas were jotted on sticky notes and later organized on an A1-sized paper.

4.2.2 Participants

In the creative session 1, six designers, including myself, participated in the first creative session. They were recruited based on their study background in design. The participants' study background and current occupation are displayed in Figure 38. The participant information for the second creative session is shown in Figure 39.

	Study background	Current occupation
D1	Msc Industrial Product Design	Graduate student
D2	Msc Industrial Product Design	Graduate student
D3	Msc Strategic Product Design	Graduate student
D4	Msc Strategic Product Design	Graduate student
D5	Msc Design for interaction	Graduate student
D6	Msc Strategic Product design	Graduate student (me)

Figure 38. Participants of Creative Session 1

	Study background	Current occupation
D7	Msc Industrial Product Design	Graduate student
D8	Msc Design for interaction	Graduate student
D9	Msc Design for interaction	Graduate student
D10	Msc Strategic Product Design	Graduate student
D11	Msc Strategic Product Design	Graduate student
D12	Msc Strategic Product design	Graduate student

Figure 39. Participants of Creative Session 2

4.2.3 Procedure

An overview of the phases and exercises is displayed in Figure 40. Participants were given the opportunity to ask questions for clarification at all times throughout the session.

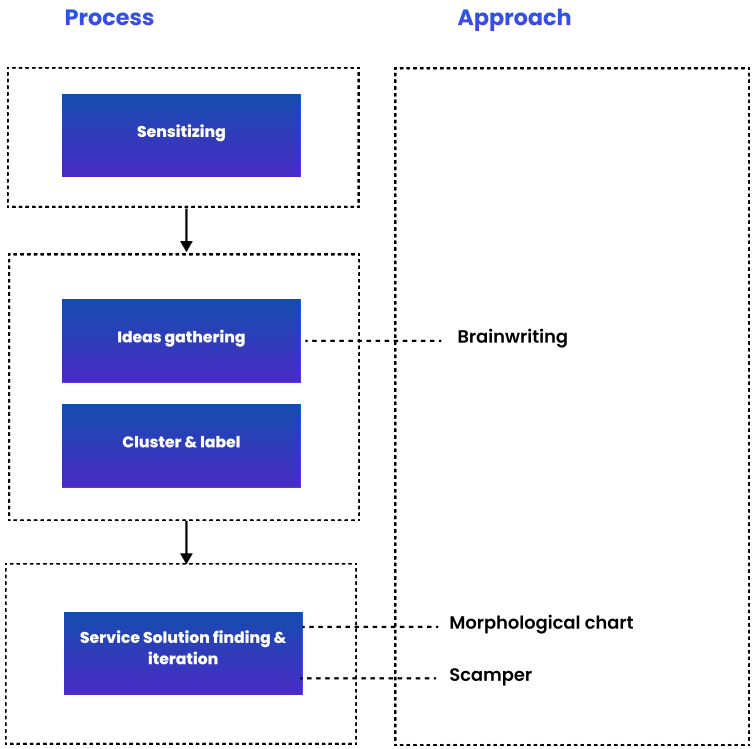


Figure 40. Process of Creative Session 1&2

Sensitizing

Sensitization session was created to ensure equal understanding of the design case and sufficient preparation for the exercises prior to the session. In this session, the participants were introduced to the background of the project, problems identified during preliminary research, and the future vision. The process and content of sensitization is shown in Figure 41. Photos and videos captured during field research at Schiphol airport were shown to give the participants a sense of the actual situation and scenarios. Throughout the process, opportunities were provided for the participants to ask questions at any time, maximizing their understanding of the project's context and the problems that need to be addressed. This session lasted for approximately half an hour.

Time	Action	Content	Aim
10min	**Introduction** Project background & plan for the session	Introduce the background of the project and the process of creative session	Enable participants to quickly understand the project background and the entire process and timeline of the ideation phase
10min	**Introduction** Current situation & Future vision	Current situation of airport cup usage, problems identified during the research and the vision for the future	Enable participants to understand the current situation, issues, and future vision at airports in order to clarify the problems that the ideation needs to address
10min	**Contextualization**	Introduce the passenger journey, from finding shops in the post-security area to purchasing beverages, handling cups, and heading to the boarding gate. Support the explanation with pictures and videos.	Clarify the focus on the passenger journey and immerse the participants in the scenario to facilitate ideation specifically for this journey

Figure 41. Sensitizing process in Creative Session

Brainwriting

In the process of brainwriting, ideation was conducted based on the five key questions mentioned earlier (chapter 4.1). Each round of the discussion is centered on a specific question, following the sequence of the passenger journey—from awareness to usage, and finally to disposal. This structured approach helps participants immerse themselves in the passenger experience and brainstorm ideas relevant to each stage. Participants initially jot down their thoughts on sticky notes. These notes are then discussed and elaborated upon by the group before being placed in corresponding sections on a large A1 sheet of paper. In the final step, participants collaborate to sort and categorize the sticky notes, consolidating similar or related ideas and organizing distinct ones, thereby achieving a more coherent presentation of the outcomes. After all the session finished, the results of the two creative sessions using brainwriting were organized using Miro(Fig.45 and Fig.46).

Figure 42. Creative session 1, photographed by the author

Figure 43. Post-it presentation in creative session 1, photographed by the author

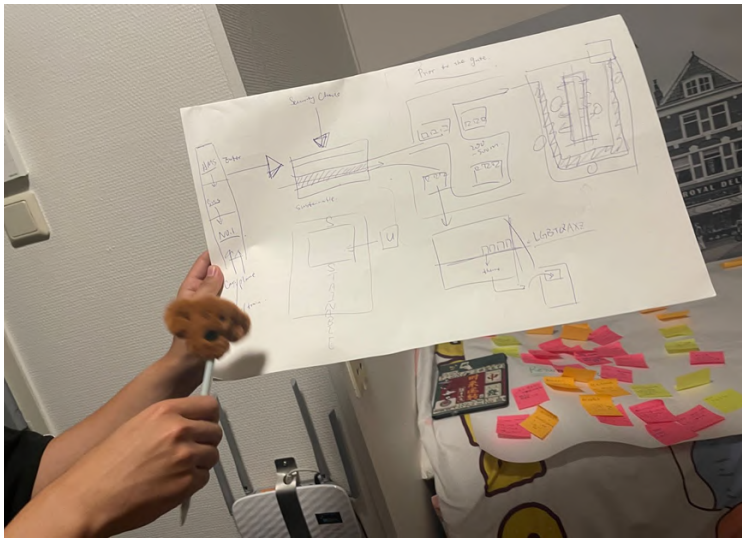


Figure 44. A group was explaining their service system solution in Creative session 2, photographed by the author

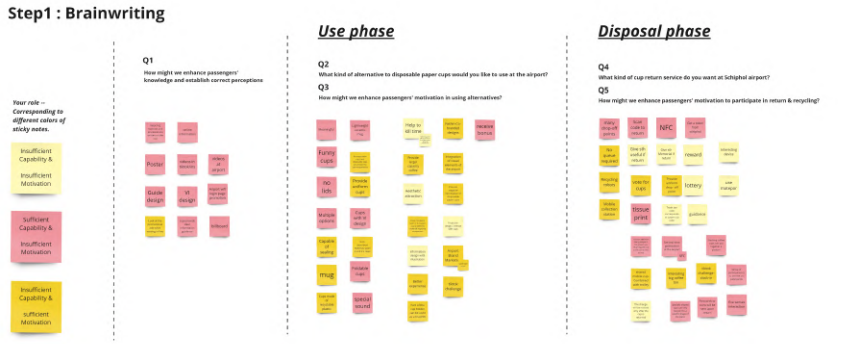


Figure 45. Brainwrting result of two creative sessions organized by the author in Miro

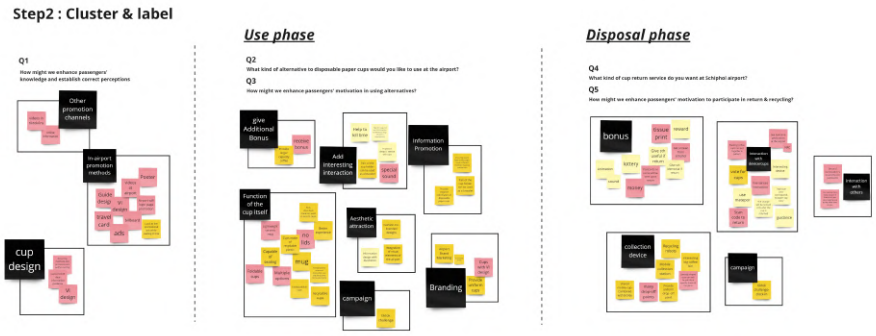


Figure 46. Categorized results of two creative sessions organized by the author in Miro

Procedure

In each offline creative session, participants were divided into two groups, tasked with developing a comprehensive service design solution based on the ideas generated from the five key questions. Following this, the groups exchanged their solutions and utilized the SCAMPER technique to enhance and innovate based on the proposed solutions from the other group. After generating the solutions of each round, each group had 10 minutes for presentation, which was followed by a discussion session where both groups engaged in conversations regarding the solutions.

The morphological chart, organized using Miro by the author, after the two creative sessions was shown in Figure 15. The morphological chart results from the two creative sessions. Figure 14 illustrates the working principle of a morphological chart (Fig.47). In a service design project, as the final output is a complete service system, the ideas generated for various identified problems need to be combined into a comprehensive service design solution. On the left side are the key problems to be addressed in the process, including enhancing knowledge and awareness, cup types, improving usage motivation, etc. Option1, 2, and 3 represent the ideas generated in the two creative sessions (Fig.48).

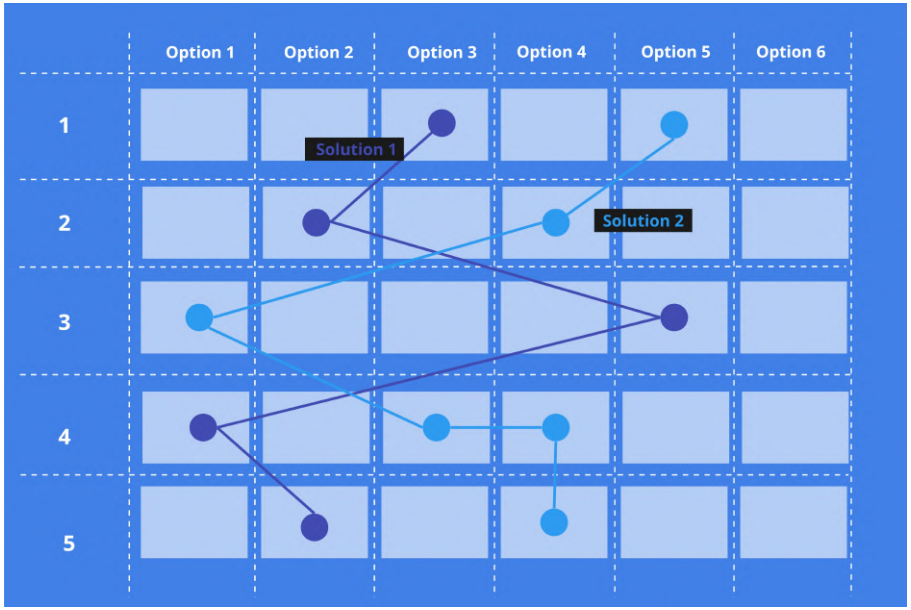


Figure 47. Explanation of how a morphological chart works as ideation tool in a system design project

	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8	Option 9	Option 10	Option 11	Option 12	Option 13
Enhance Knowledge & awareness	cups provide clear information guidance(Recycling methods and processes)	In airport: poster / billboard/ VI design / card / advertising	In airport: Airport wifi login page promotion	In airport: VI design	online information (Airline official website)	videos in tiktok / ins							
Types of cups *Multiple options Functional requirements*	Current ceramic cups & mug	consumer's own cup	Biodegradable cups	Cups made of recyclable plastic	Lightweight ceramic mug	Capable of sealing	no lids—— no plastic use	Non-absorbent material					
Increase motivation to use	Aesthetically attractive cups (visual / illustration / Co-branded design)	The cup holder can be torn off as a bracelet, the bracelet has guidance information	Take the cup and search the airport for different drop-off points (interactions)	Use the cup will make a special sound	Show the plastic layer in the paper cup & different material recycling comparison	Provide negative information of disposable paper cups	Provide larger capacity coffee if use alternatives	establish a sustainable airport brand (like echo)	receive bonus				
Return(dispose) service	many drop-off points	Mobile collection station	Recycling robots	interesting big coffee bin	shared mobile cup- Combined with trolley								
Increase motivation to return (dispose)	Specially shaped cups can only be put into a specific shape of the plane	vote for cups	Stacking coffee cups can put together a pattern	Give sth Memorial if return (token / Postcards)	Give sth useful if return	Animation/sound will appear after return	Scan code to return - get money back	use matepor	Sense of participation"you are the xxx paticipants	see how many people in the airport are returning the cup at the same time as you	guidance	See real-time geolocation at the airport (NFC)	tiktok challenge

Figure 48. Morphological Chart - Results of Creative Session 1&2

4.3 Concept 1: In-house basic recycling

The first systematic concept is the result of further optimization after combining the following options (Fig.49). In the service system concept, multiple options can simultaneously influence a design goal. The picture presents all the options included in Concept 1.

Initiate a series of airport posters to guide passengers in perceiving changes and strengthen awareness: Upon entering the airport, passengers will gain an understanding of the current new cup service and other information through a series of posters or billboards posted by the airport. This allows them to perceive changes even before purchasing a beverage (posters launched by Schiphol Airport & individual businesses). Each poster includes a QR code that directs passengers to a web link where they can learn about the new cup strategies, why disposable plastic cups are no longer provided, and gain additional relevant knowledge. Given that passengers will be connected to airport Wi-Fi, this web link can also be accessed from the Wi-Fi connection page, guiding passengers to click and view.

Inform customers of current cup strategies and encourage customers to use reusable cups through billboards and menu information: When passengers are preparing to purchase a drink from a store, the store informs customers of what the current disposable paper cup alternatives are through billboards and menus (Fig.51), and specifically recommends dine-in or takeaway cups (depending on the services provided by different stores).

Provide information on the cup to increase the motivation to use alternatives and urge the return of the cup: Considering that the cup is a key touchpoint in the user journey, users will be easily attracted by the information on the cup. The information can be slogans encouraging users to contribute to sustainability, or the benefits of using reusable cups, in the form of illustrations and text combined.

Provide brand logo on the cup sleeve to ensure brand experience: Printing logos of various brands on the cup sleeves not only effectively conveys brand identity, but compared to printing logos directly on the cups, which would require sorting by brand, it also improves distribution efficiency.

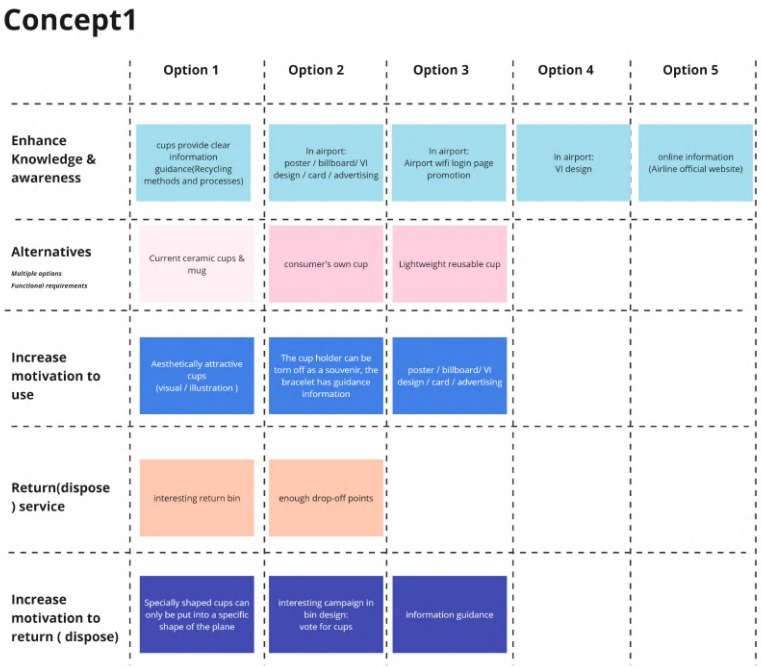


Figure 49. Options combined in concept 1

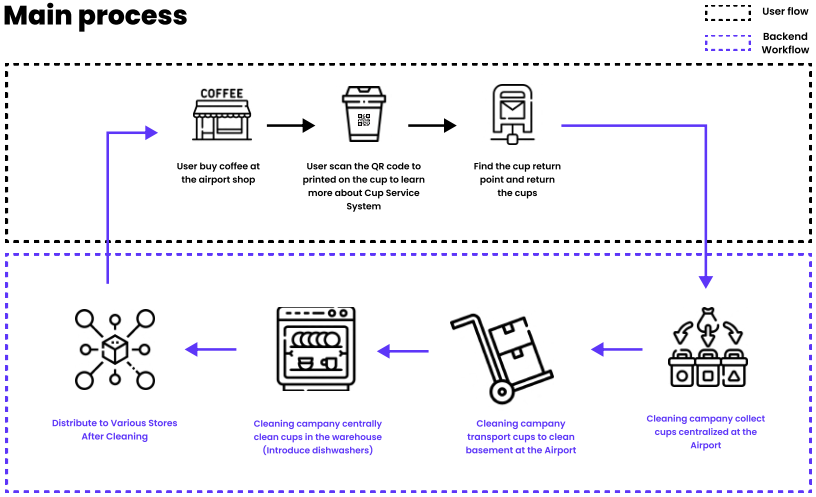


Figure 50. Main process in concept 1

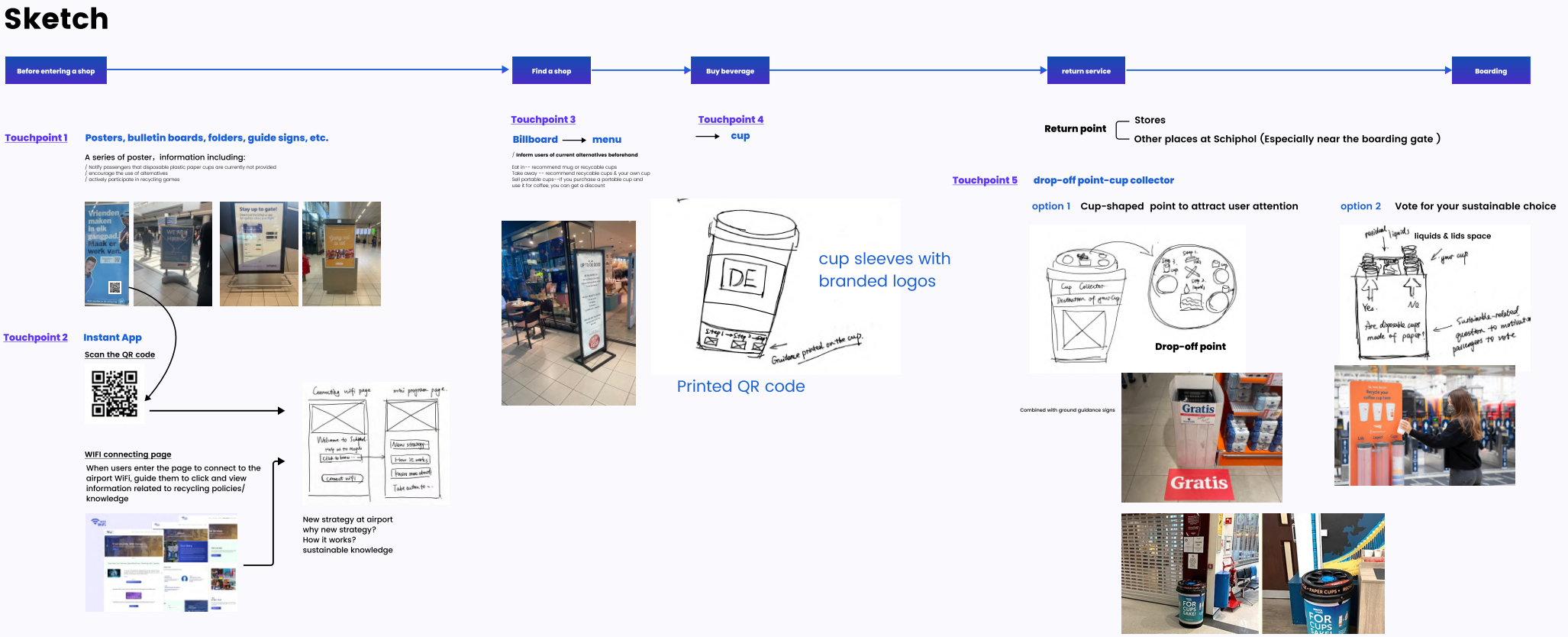


Figure 51. Sketch of concept 1

Create an attractive drop-off point to enhance recycling (returning) motivation: Firstly, ground signage can be used to inform users that this is a recycling point. The attractive collection bin applies information design to guide passengers to recycle correctly (Fig.51). Another interesting design choice for cup collection bins introduces a voting game(Fig.51), subtly leading users to return their cups while making a choice.

Centralised collection and cleaning of cups at Schiphol: It is suggested to set up a cleaning warehouse at the airport and introduce efficient cleaning equipment for cup cleaning. Initially, the cleaning company will collect all the used cups, transport them to the warehouse, complete the cleaning process, and then distribute them to various stores.

4.4 Concept 2: Barcode gamified outsourced cleaning

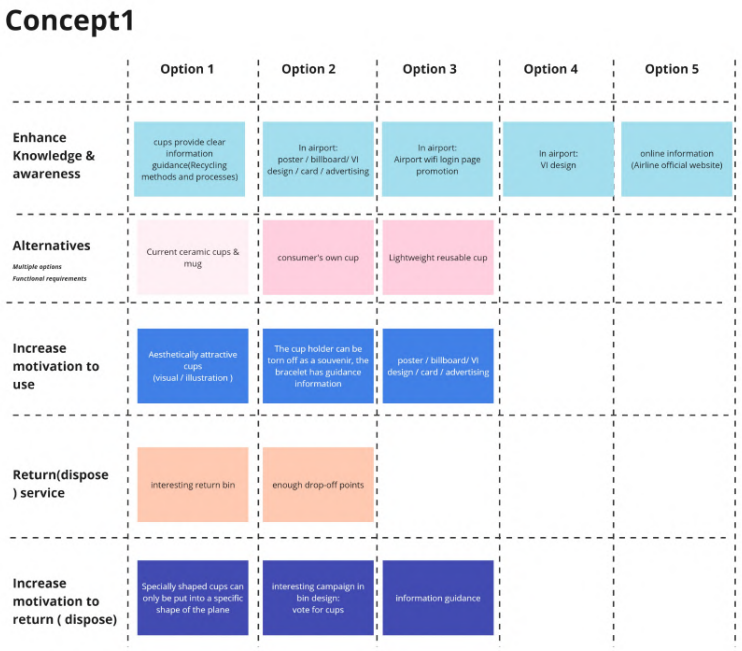


Figure 52. Options combined in concept 1

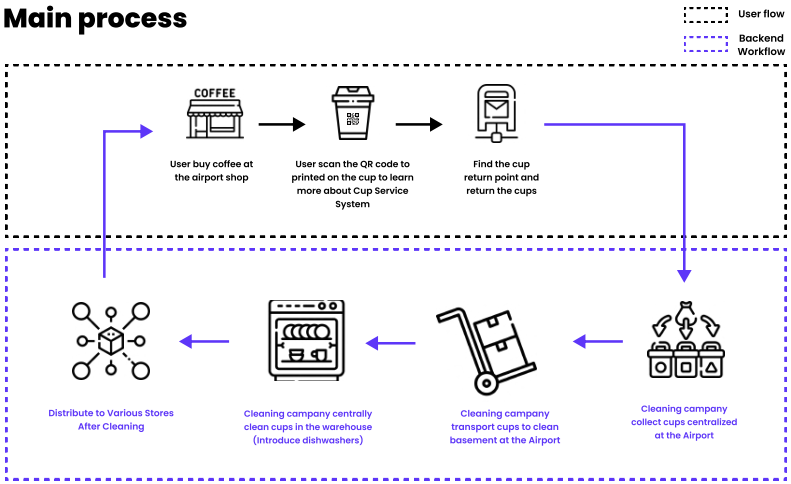


Figure 52. Main process in concept 2

Introducing metaphor and gamification: According to Caskin (2007), metaphors can act as useful tools to understand and make sense of what is 'fuzzy' or unfamiliar. They help make things visible and have the power to ease collaboration and engage people (Price et al., 2018; Sanders & Stappers, 2018; van Boeijen et al., 2013). Metaphors empower passengers to translate challenges into something tangible and using such playful metaphors allowed them to perceive the challenges and problems more lightly, opening up the perspective that nothing is impossible. (The Value of Using Metaphors as a Participatory (Research) Method - Participatory City Making Lab Lab, 2021). In a service design project, gamification enhances user engagement by transforming routine processes into rewarding experiences. It encourages desired behaviors and fosters a sense of achievement and community, thereby improving user satisfaction, loyalty, and overall involvement with the service (Lupton & Thomas, 2015).

In the gamification setting, we view the cup as a passenger and its movement in Schiphol Airport as a sustainable journey of the cup. We will present the interaction between the cup system and passengers in a gamified manner, enhancing passenger participation motivation and enabling passengers to understand the cup service more easily. The specific application of metaphors can be seen in Figure 53.

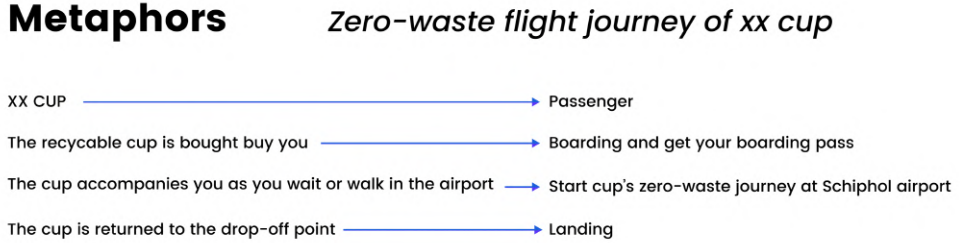


Figure 53. Metaphors used in concept 2

Promote through information design of touchpoints such as posters, billboards, and web link: gamified cup service through various channels such as posters and billboards. Online engagement will be fostered through TikTok challenges aimed at attracting user participation. Once inside the shop, diners will be offered mugs or ceramic cups, while those opting for takeaway will receive reusable, lightweight, and portable cups, henceforth referred to as 'S-cups.'

This specially designed in-mould label will resemble a boarding pass, symbolizing that the S-cup has secured its boarding pass and its zero-waste journey at the airport is about to commence. The label will feature a barcode for scanning and returning, and a QR code. Scanning this will direct users to a web link where they can discover the entire story of the S-cup's flight plan and operating guide, view and save the special boarding pass, and pinpoint cup return locations (Fig.54).

Leveraging the power of the brand: Apart from the specific implementation, I hope to create a brand for Schiphol Airport's new cup service. Combining Schiphol's current commitment to sustainability and the gamified cup service, we can build a completely new and sustainability-related brand, where touchpoints within the cup system will have distinctive brand identities.

Centralised collection and cleaning of cups outside Schiphol: In the initial phase, the airport's cleaning service will be responsible for collecting and packaging all used cups. These will then be transported by a logistics company to a cleaning facility. After undergoing the cleaning process, the cups will be returned to the airport and distributed to various stores.

Figure 54. Sketch of concept 2

4.5 Concept 3: RFID smart deposit system

Concept 3 employs cups equipped with RFID tags for streamlined tracking and management. The cup sleeve features a printed logo for brand visibility. Upon returning the cup, users are required to swipe a card on the designated return box to reclaim their pre-paid deposit. The backend operations for Concept 3 align with those of Concept 1, involving centralized cleaning within the airport prior to distribution to various retail locations (see Fig. 56).

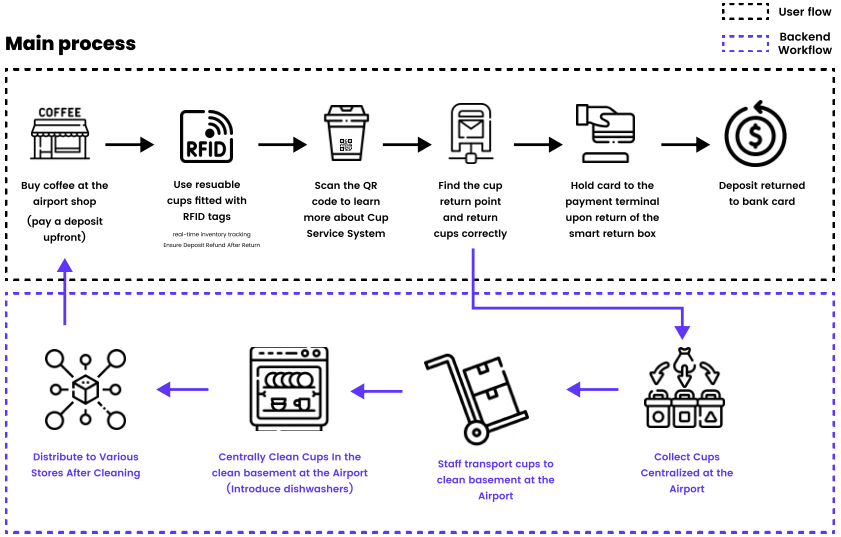


Figure 55. Options combined in concept 3

Figure 56. Main process in concept 3

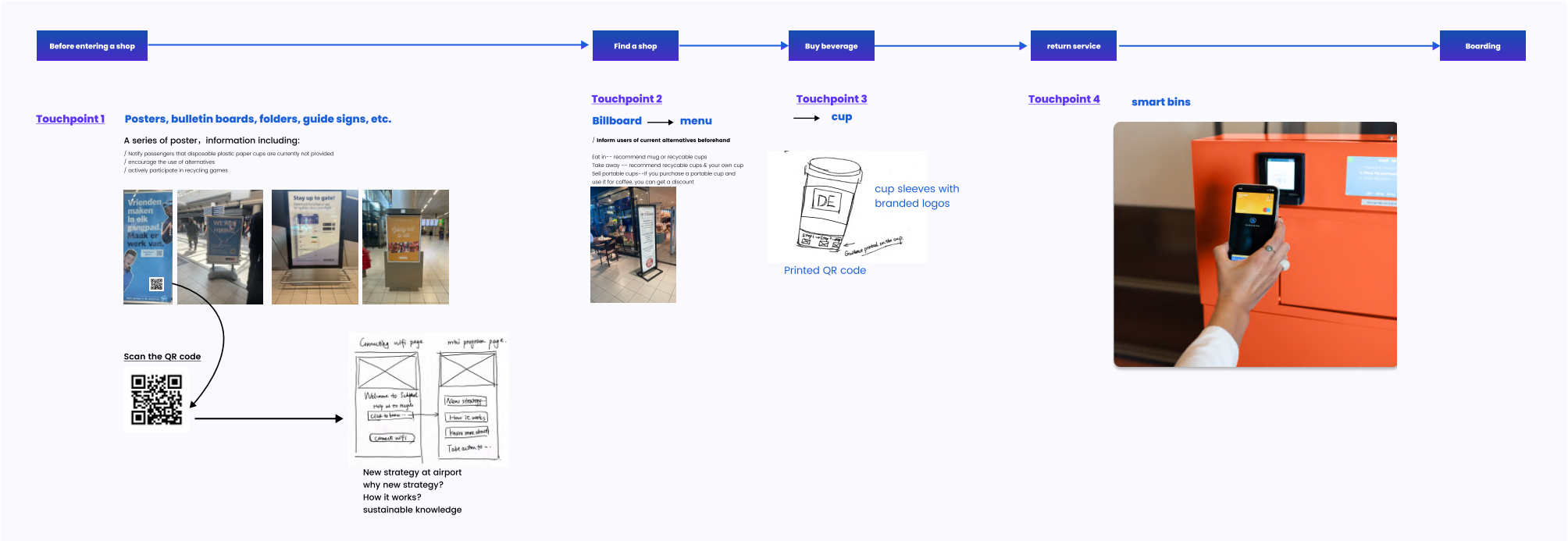


Figure 57. Sketch of concept 3

4.6 Concept 4: Bioblend single-use solution

Concept 4, illustrated in Figure 57, represents an optimized solution that primarily employs disposable biodegradable cups as an alternative. The main challenge post-usage is to boost user motivation for proper recycling. To address this, one innovative idea is to design recycling bins in the shape of a coffee cup, complete with clear signage. This would guide users in separating cups, lids, and residual liquids for effective recycling.

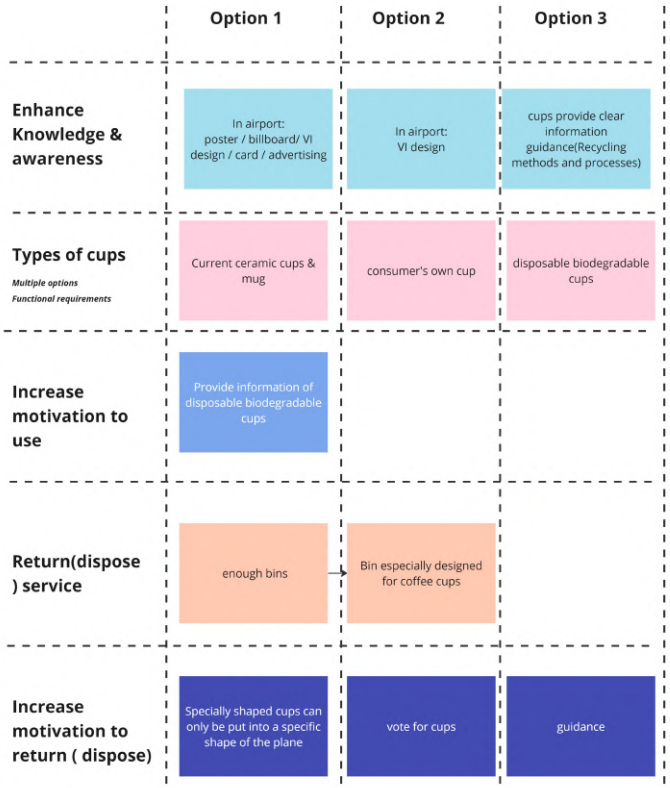


Figure 57. Options combined in concept 4

4.7 Overview of concepts and analysis

	Cup & lid Material	Cup add-ons	Cup return box	Cup Cleaning	Transportation
Concept 1	polypropylene (PP)	• Printed QR code • cup sleeves with branded logos	• Normal return box • Cup lid, cup, and residual liquid partition	Machine cleaning	In-airport transport and distribution
Concept 2	polypropylene (PP)	• Printed brand logos • Cup is affixed with a QR code and a barcode • Cup sleeves(optional)	• Smart return box • Cup lid, cup, and residual liquid partition • Self-scan • Rewards on paper	Machine cleaning	• Cups are collected from within the airport and transported to a warehouse outside the airport. After cleaning, they are transported back to the airport • Distribute to certain shops
Concept 3	polypropylene (PP)	• Printed QR code • Cup sleeves with branded logos • Taged with RFID	• Smart return box • Cup lid, cup, and residual liquid partition • Reader hardware • Deposit system (Electronic payment system)	Machine cleaning	In-airport transport and distribution
Concept 4	Biodegradeble paper cups		• Normal return box • Cup lid, cup, and residual liquid partition		In-airport transport and distribution

Figure 58. Overview of the concepts

From Figure 58, we can see an overview of the four proposed concepts. All four concepts retain the existing ceramic cups for dine-in use and encourage passengers to bring their own cups. In terms of materials only Concept 4 introduces biodegradable paper cups. However, based on the results of the literature review, there is currently no disposable cups that can meet regulations (chapter 2.3.2) and also eliminates the risk of consumers being scalded by high temperatures. Therefore, Concept 4 can be directly ruled out at this stage. The comparative assessment of Concepts 1, 2, and 3 will focus more on evaluating their differences.

4.8 Concepts evaluation

4.8.1 Introduction

The goal of this evaluation session is to assess and validate the three concepts using the Four Pillars of Service Design Evaluation: desirability, feasibility, viability, and sustainability, as illustrated in the Figure 59 (Werdmuller, 2018). Through this analysis, I aim to identify the most desired, feasible, viable and environmentally friendly aspects among the three concepts to derive the optimal solution. The procedure for concept evaluation is illustrated in Figure 60.

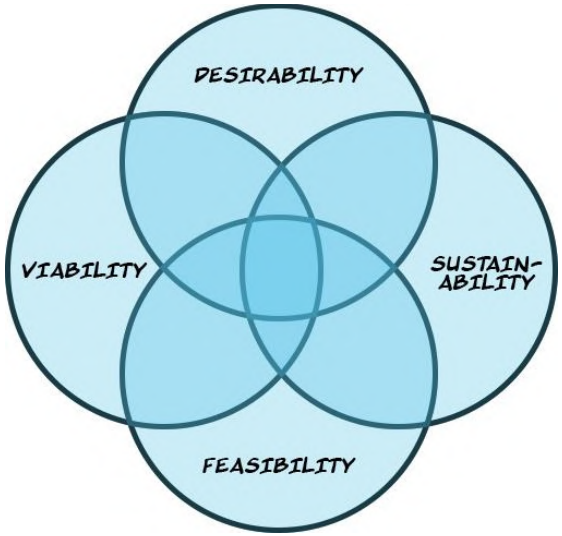


Figure 59. The Four Pillars of Service Design Evaluation: Desirability, Viability, Feasibility, and Sustainability (Werd I/O, 2018)

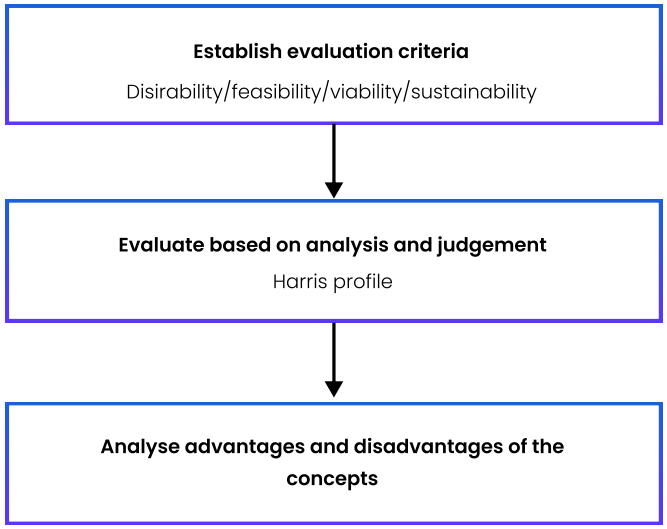


Figure 60. Procedure of concept evaluation

4.8.2 Establish evaluation criteria

Desirability criteria: Based on the definition of 'Desirability', it refers to the extent to which a product or service meets the needs, desires, and preferences of its target users (Singh, n.d.-b). The criteria for evaluating desirability come from Chapter 3, which addresses design strategies that encourage behavioral changes, prompting passengers to actively use and engage with the system.

Feasibility criteria: The criteria for assessing feasibility primarily originate from Chapter 2, which gleans vital insights from interviews with various stakeholders. In line with the definition of feasibility, technical viability is also incorporated into the evaluation criteria (Make:Iterate, 2023).

Viability criteria: The criteria for evaluating viability not only stem from its definition (Make:Iterate, 2023) but also consider the possible financial losses due to the possibility of the cups being taken away by the users.

Sustainability criteria: The sustainability criteria were derived from the ecodesign strategy wheel (Alves et al., 2016).

4.8.3 Evaluation results

The evaluation results from the Harris profile clearly show which concept is superior in terms of Feasibility, Viability, Desirability, and Sustainability. For specific details on how these evaluation results were derived for each assessment item, see Appendix D.

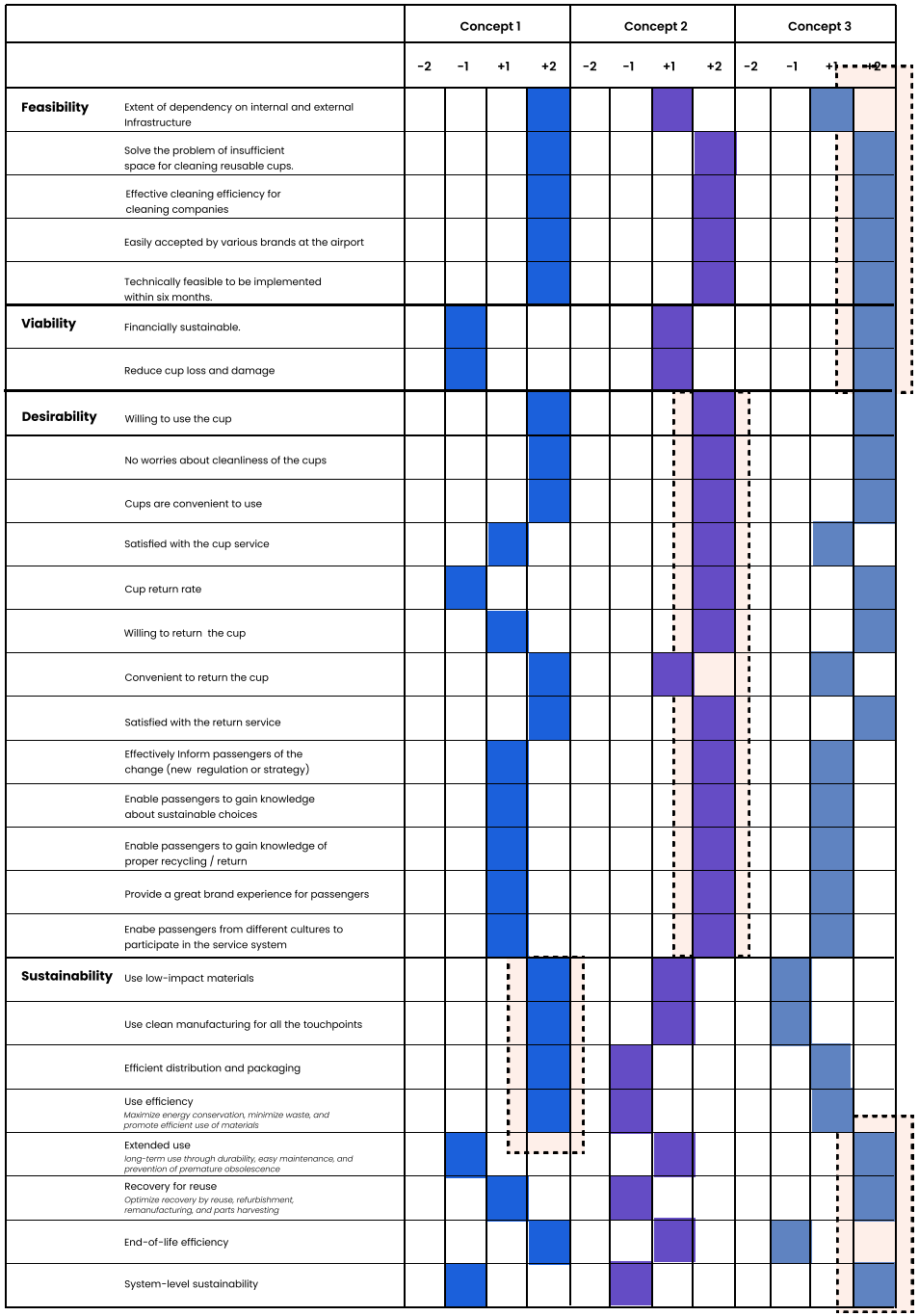


Figure 60. Harris profile evaluation result

Feasibility and Viability evaluation result

With regards to feasibility and viability, Concept 3 performs the best. The primary difference among the 3 concepts lies in the Viability dimension. Concept 3 uniquely integrates a cup with an embedded RFID tag and branded cup sleeve, employs a deposit system, and ensures cleaning within the airport. From a business standpoint, these approaches are exceptionally advantageous. Below is an explanation of how concept 3 scores better with regards to RFID tags, the deposit system, and in-airport dishwasher cleaning.

RFID-tagged cups: RFID-tagged cups of Concept 3 present a superior choice for businesses compared to IML-tagged cups (Concept 2) and regular cups (Concept 1). Their real-time tracking capabilities streamline inventory management, reduce wastage, and offer enhanced customer experiences through personalized services(Bottani & Rizzi, 2006). Unlike IML cups, which primarily focus on aesthetics, RFID cups harness data analytics for insightful business decisions. Their durability, security features, and integration capabilities further position them as a cost-effective option, making them a holistic solution for optimizing business operations and maximizing profitability (Ngai, Moon, Riggins, & Yi, 2008).

Furthermore, the consistently decreasing price of RFID, as indicated by Swapbox data, signifies potential reductions in operational costs for businesses in the long run (Fig. 61).

Branded cup sleeve: Branded cup sleeve of Concept 3 offers distinct advantages for businesses, especially in settings like airports with multiple stores. When a logo is printed directly on a reusable PP cup, each cup becomes specific to a particular store. In an airport with 82 stores, this means that after cleaning, each cup must be meticulously sorted and returned to its specific store, adding logistical complexity and potential for errors. On the other hand, using a uniformed cup across all stores with only the branded sleeve carrying the logo simplifies the distribution process. Post-cleaning, the cups can be distributed to any store without concern for matching logos, and the appropriate branded sleeve can be added at the point of sale. This streamlined approach not only reduces logistical challenges but also allows for more flexible and efficient routing, saving time and resources. Moreover, whether the logo is printed directly on the cup or solely on the sleeve, both methods effectively showcase the brand identity, ensuring brand visibility and recognition among consumers.

Deposit system: The deposit system for reusable cup systems is pivotal for businesses in shaping consumer behavior and achieving cost efficiencies. By implementing a deposit, businesses create a financial incentive that encourages consumers to return and reuse cups, fostering a culture of responsibility and sustainability (Sandhu et al., 2021b). This approach not only promotes environmental consciousness but also translates to tangible cost savings. Given that the production or acquisition of new cups is often more expensive than reusing existing ones, the deposit system's ability to ensure a higher return rate of cups directly benefits a company's bottom line(Sandhu et al., 2021b).

In-airport dishwasher cleaning: In-airport dishwasher cleaning has a distinct advantage over outsourcing the cup cleaning process to third-party companies located elsewhere. Businesses can eliminate transportation and shipping costs by cleaning directly at the airport, resulting in a faster turnaround time. This method not only aligns with sustainability goals by reducing the carbon footprint associated with external transportation, but it also provides the flexibility to manage peak

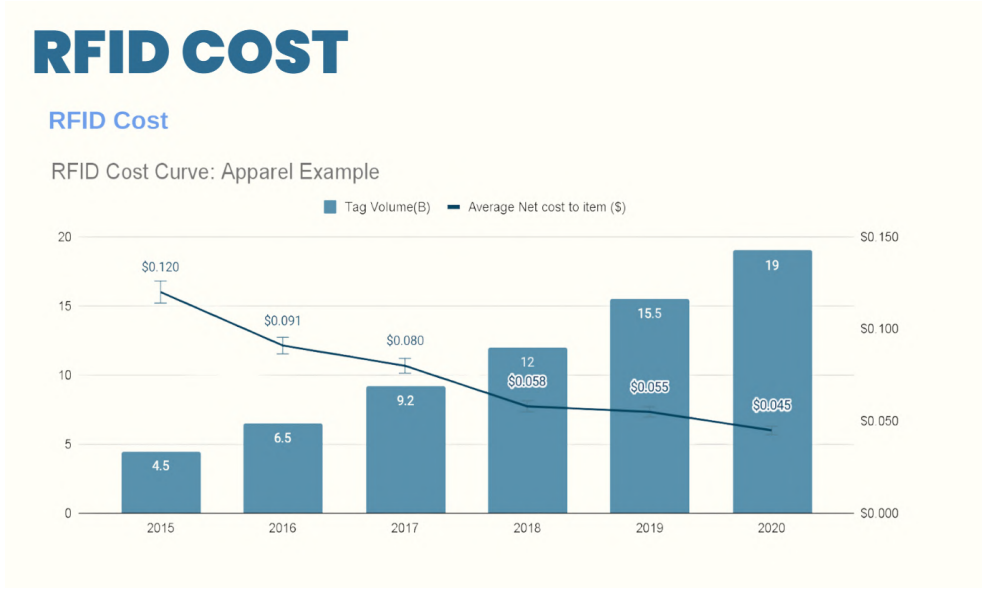


Figure 61. RFID cost, data from swapbox

demand. Furthermore, it enables better inventory management, thereby positioning in-airport cleaning as a more strategic and cost-effective option for businesses.

Desirability evaluation result

When looking at the desirability criteria scores, concept 2 scores best because it employs metaphors and gamification to enhance user understanding and engagement. Metaphors make complex ideas relatable, while gamification elements motivate users to interact and behave in desired ways. Together, they effectively guide user behavior and spread information more efficiently.

Sustainability evaluation result

When viewed from a sustainability perspective, based on the Ecodesign Strategy Wheel, Concept 1 exhibits the best overall performance in terms of sustainability. Concept 1 mainly performs better in terms of low-impact materials, clean manufacturing, efficient distribution and packaging, and use efficiency. However, Concept 3 has a higher recycling rate due to the adoption of a deposit system, and performs best in the areas of recovery for reuse, end-of-life efficiency, and system-level sustainability. For a detailed evaluation analysis, please refer to Appendix D.

LCA calculation results analysis

Delving deeper into the environmental implications, the Life Cycle Assessment (LCA) results provide further insights. Key assumptions for the processes can be shown in Figure 62. The specific LCA (Life Cycle Assessment) derivation and calculation process can be found in Appendix E.

According to the results of the fast-track LCA (Life Cycle Assessment) (Fig.63 & 63 & 65), the environmental impact of producing different cups in the three concepts is quite similar. In terms of the production and recycling of boxes, Concept 3, with its RFID sensing and POS systems, has the greatest environmental impact, followed by Concept 2 with its QR code-enabled recycling bins, and lastly the standard return box(Fig.4) . However, when analyzing a use-case scenario involving 25,000 cups a day and considering the different return rates for the cups in each concept, Despite Concept 3's RFID and POS system boxes having the greatest environmental impact, Concept 3 has the highest recturn rate for cups. As a result, from a life cycle perspective, the production of new cups is reduced. Therefore, viewed from the entire life cycle, Concept 3 has the lowest overall environmental impact.

Key assumptions for the processes

Assumption 1: It is assumed that the daily cup deployment is 25,000 cups.

Assumption 2: The common part of the cups in the three concepts is made up of a 54-gram cup body and a 4.5-gram cup lid.

Assumption 3: Due to the loss rate of the cups, it's difficult to estimate the lifespan of a single cup. The lifespan of the cup is considered with the return rate.

Assumption 4: The cups in these three concepts all produced by the company Swapbox.

Assumption 5: The recycling bins in the three concepts are all produced by the company PACKBACK, located in Rotterdam

Assumption 6: Users handle and use all three types of cups with consistent force and frequency

Assumption 7: The cups and lids in all three concepts are washed in the same dishwasher

Assumption 8: In Concept 1, the lifespan of the return box is 5 to 10 years, with an average of 7.5 years. In Concept 2, the return box (with a scanning system) has a lifespan of 3 to 7 years, averaging 5 years. In Concept 3, the return box (equipped with an RFID sensing system and POS system) has a lifespan of 2 to 6 years, with an average of 4 years.

Assumption 9: The return rate of ordinary return box is 60% (for the explanation of the return rate, see Appendix E), the return rate of boxes with scanning is 90%, and the return rate of boxes with RFID sensing and POS systems is 95% (Cupclub, 2018).

Assumption 10: The end of life of the cups is neglected in the scenario analysis because the Cup club showed that the EOL of the cups had little impact on the overall environmental impact.

Figure 62. Key assumptions for the processes

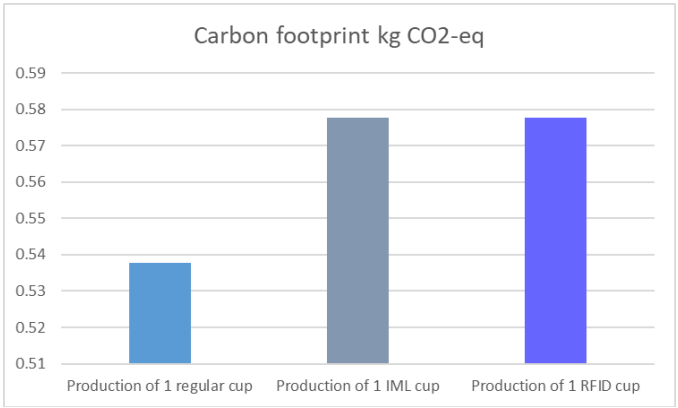


Figure 63. Comparison of the environmental impact of cups in the three concepts

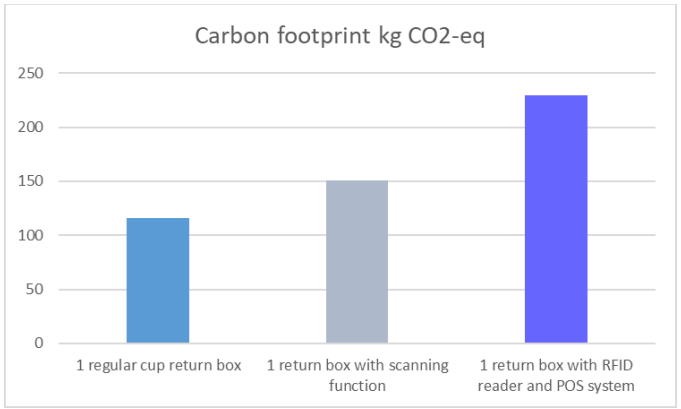


Figure 64. Comparison of the environmental impact of return boxes in the three concepts

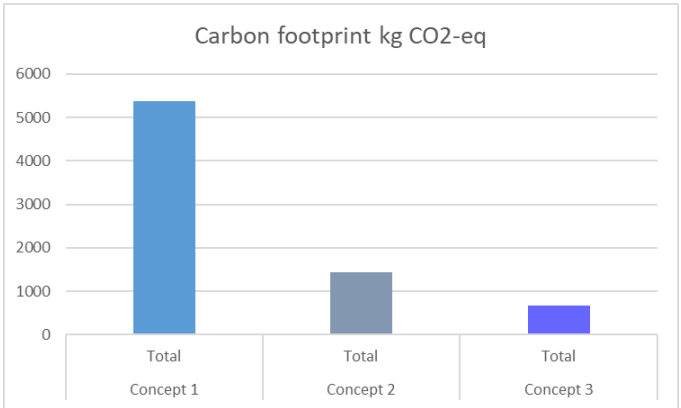


Figure 65. Comparison of the three concepts considering the return rate

Conclusion of the Harris Profile evaluation results

Given the pressing need for swift project implementation and market entry, emphasis is placed on Feasibility and Viability. Consequently, the service framework of Concept 3 has been chosen as the foundation, incorporating a deposit system, branded cup sleeve and on-site airport cleaning. To further enrich the user experience, elements of gamification and metaphorical storytelling from Concept 2 will be integrated. Notably, among the three concepts, Concept 3 stands out with the most favorable day-to-day environmental footprint. Therefore, the final service framework will amalgamate the strengths of all three concepts to deliver an optimized solution.

4.9 Key takeaways

- For project that need to be implemented in a short time, feasibility and viability should be prioritized when evaluating concepts, while also considering user desirability and sustainability.
- Cups equipped with RFID tags offer real-time tracking capabilities, which streamline inventory management, reduce waste, and enhance customer experiences through personalized services. Furthermore, considering the declining costs of RFID technology in recent years, implementing a new reusable cup system could offer significant advantages for businesses.
- To make the reusable cup service more viable, implementing a deposit system is essential.
- Using separate cup sleeves is a good choice as it not only shows the brand identity but also alleviates the logistical pressure of distributing cups with printed logos.
- The introduction of gamification and metaphors may increase passenger desirability for the service, mainly manifested in better conveying service information
- In the process of calculating the environmental impact through LCA (Life Cycle Assessment), it is necessary to consider the different return rates of cups in different concepts to obtain a comprehensive sustainability assessment result.

05

Develop

5. Develop

5.1 Introduction & approach

In the Develop phase of the project, the aim was to finalize the concept. Through comprehensive desktop research and rigorous design validation, I systematically refined the details of the design. This was done to guarantee the feasibility and viability of the final concept, with a keen focus on enhancing passenger inclination and satisfaction towards using the new service.

Harris Profile

In this chapter, I utilized the Harris Profile as an analytical tool to evaluate and compare current deposit systems. Through this assessment, I aimed to identify the deposit system most suitable for an airport's reusable cup system.

Interview

Interviews were conducted with passengers who visited Schiphol Airport within the past week and with the key stakeholder. The objective was to validate the service design concept against desirability, feasibility, and viability criteria. By obtaining constructive feedback and optimization suggestions from these interviews, I aimed to refine my service concept, setting the stage for the delivery of the final service design solution.

5.2 Final concept development

5.2.1 Method & Procedure

Combine & optimize service framework based on Harris profile result

- Implement the service framework of Concept 3 as the foundation.
- Incorporate a deposit system, branded cup sleeve and on-site airport cleaning.
- Integrate elements of gamification and metaphorical storytelling from Concept 2 to enhance the user experience.

Invite Company A to evaluate the optimized service concept

Given Company A 's prominent role in managing and collaborating with major food and beverage brands at Schiphol Airport, their evaluation of the optimized reusable cup system is vital to ensure seamless integration and alignment with the airport's service dynamics.

I conducted a 30-minute online interview via Zoom with the Senior Commercial Vice President of Company A to assess the optimized service concept. This evaluation drew heavily on insights from prior interviews, focusing on the feasibility and viability of the concept in addressing existing issues outlined in chapter 2. Following their feedback, the specifics of the optimization were further refined.

Desk research and analysis to optimize service details

Upon clarifying the service framework and design elements, features such as the deposit and payment systems were further refined and optimized.

Invite passengers to evaluate the final concept

In order to obtain feedback and evaluate the Cupmates service from passengers at Schiphol Airport, I invited passengers who have been to Schiphol Airport in the past week to evaluate the final concept. Their feedback will be instrumental in refining and making the final concept more desirable for passengers.

5.2.2 Integrated service framework optimization

In the finalized service framework, I've adopted the core of Concept 3. Here's how it works: Customers receive cups with a branded cup sleeve embedded with RFID tags and pay an initial deposit. After use, consumers can conveniently return the cup to a smart return box equipped with an RFID reader hardware and electronic payment system. By simply swiping their card at this box, their deposit is refunded. The used cups are then gathered by the cleaning team and taken to a dedicated cleaning facility within the airport. Using professional dishwashers, the cups are thoroughly cleaned and subsequently redistributed to various airport stores. To elevate the user experience and drive greater adoption, I've woven in the engaging metaphors and gamified elements from Concept 2. Key points in the optimized service framework can be seen in Figure 66.

To enhance user experience and encourage wider acceptance, I've incorporated the captivating elements of metaphors and gamification from Concept 2 into our refined service idea named "Cupmates." This concept envisions the cup as a fellow passenger embarking on an eco-conscious expedition through the airport, weaving together metaphors and gamification. By transforming the cup's journey into an engaging adventure, passengers are motivated to actively engage and gain a deeper understanding of the cup service. This fusion of metaphors and gamification brings forth the notion of "Cupmates," where the cup symbolizes both sustainability and shared encounters, forming a cohesive and engaging concept.

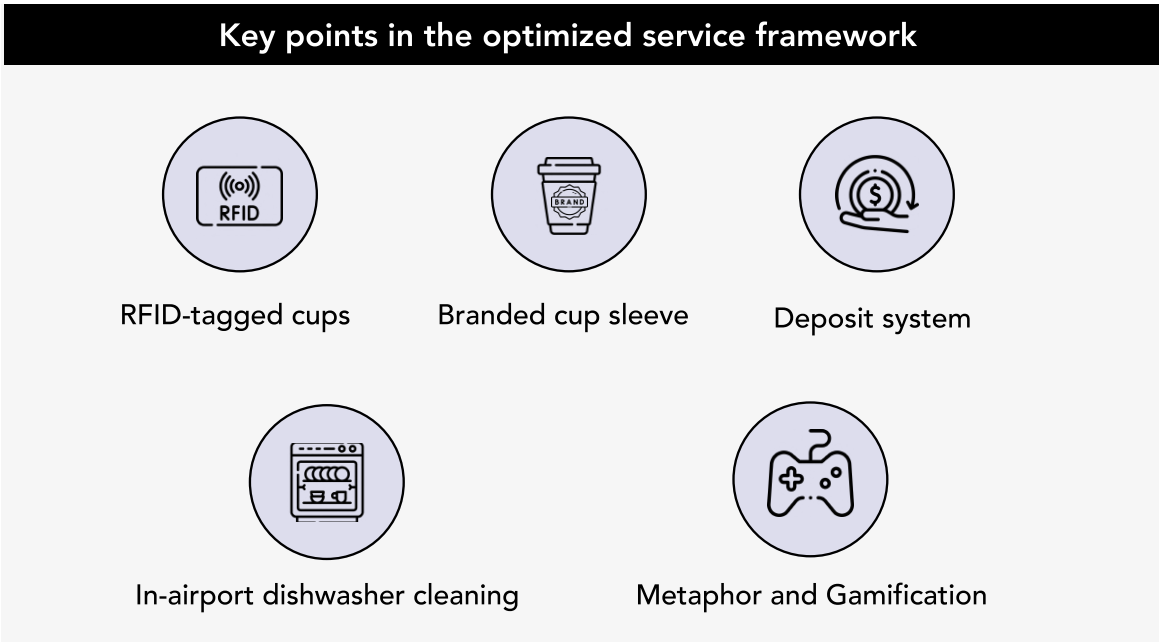


Figure 66. Key points in the optimized service framework

5.2.3 Stakeholder evaluation of the optimized service concept

After receiving feedback from Company A, they expressed contentment with the direction of my concept and confirmed the feasibility and appeal of the Cupmates service solution. Key insights include their recommendation of a 1 euro deposit to ensure optimal user engagement, the need for cup stackability without size constraints, and the suggestion to acquire on-site dishwashers for efficient operations. These insights not only highlight the potential of the service but also provide clear avenues for further refinement. They also emphasized guiding users on managing residual liquids and proposed that cleaning processes be carried out directly within the airport. For a comprehensive overview of this feedback, please refer to Figure 67.

Incorporating Company A's feedback, areas identified for refinement in the final solution included:

- Improve and elaborate on the electronic deposit system.
- For the cup design, incorporate features that allow for easy stacking.
- For the design of the return box, consider refining its structure to accommodate residual liquids and estimate its capacity based on the given information about the number of return boxes.

Theme	Key insights	Quotes
Feasibility and viability	• The whole solution is feasible and great	*"The concept is really looking great also if you use the system, you don't need a lot of extra stuff as people will bring back the cup themselves. "* *"So, I think this(the whole service) really is a nice solution. "*
Deposit system	• A deposit system is vital for cup return. • The deposit system design is appealing and aligns with current trends. • Emphasizing digital payments over cash aligns with consumer habits. • Suggested deposit price is 1 euro.	*" You really need a deposit system otherwise people will throw it away in a normal bin and then you will lose your cups "* *" [The whole system] actually looks great. And this is totally aligned. What I am working on at the moment with packback but there are several several solutions, like you don't pay a deposit upfront but if you don't return the cup then you will get charged. "* *" You see the decrease in cash, year on year and I believe it's now 85% cards at the airport and still growing so I wouldn't focus on the cash "* *" This is what we also do at Burger King. We take the cost of the cup and the deposit should cover these costs and with one euro you can cover the cost. And if you go higher than one euro, it will be a barrier. "*
Cup	• Solution for cup sleeves, though creating single-use materials, is positively viewed for its potential in brand awareness and feasibility. • Ensure the cups can be stacked, there is no specific size requirement	*" I really liked this solution. The downside of it is you still create single use materials. But I think this was a nice step. in the right direction. So people still can have the brand awareness. You don't get all different cups with prints on it. So yeah, I truly believe this could work. "* *" Because normally what we do with the paper cups is make sure they all have the same diameter 。 The same circle, the top of the glass is always the same distance. So it doesn't matter if you put in 20 ounce cup or 12 ounce cup . "*
Dishwasher	• Prefer to buy dishwashers at the airport	*" Best way would be to have a dishwasher at the airport where you can handle all so it stays on the roof and you minimize sort of export. "* *" if we have cleaning area in the airport basements, we would prefer to purchase a dishwasher. "*
Clean area	• The decision to keep cleaning operations in-house or outsource them is under consideration. In-house could be beneficial.	*" We still are looking at do we need one cleaning area somewhere in the basement or Schiphol or should we do it externally? There are two solutions "* *" So for us the best solution would be to keep it in house, but it's also a solution to discuss with people "*
Return box	• Consideration needs to be given to residual liquids in cups; a disposal system for liquids is essential to avoid damaging the machines. Approximately 60-70 bins would be required.	*" What you also should think about is the rest of the liquids all most of the times there is some liquid inside the cups when people are finished. So you need somewhere they can put their liquids and then add a cup otherwise if they put all the liquids in the machine this will hurt your machine. "* *" We need at least around 60-70 of these bins "*

Figure 67. Company A evaluation result, drawn by the author

5.2.4 Comparative assessment of deposit systems

Purpose and procedure

Based on feedback from Company A, a comparative analysis of prevalent deposit systems was undertaken to prevent cup loss. The goal was to identify the system best suited for Schiphol Airport users. The following are the comparison steps (Fig.68).

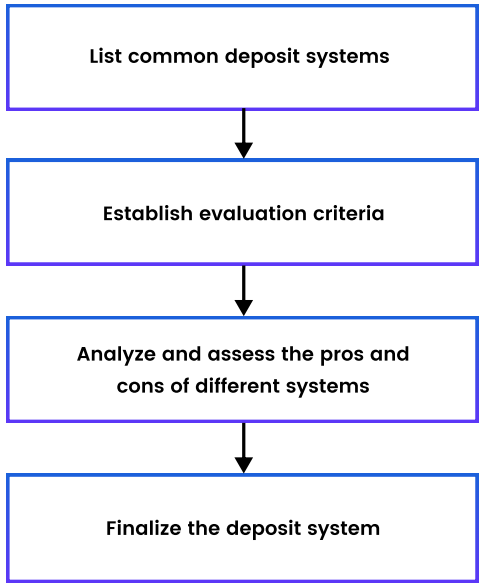


Figure 68. Comparison steps

Current deposit systems analysis

Deposit systems for reusable items are broadly categorized into two main types (Fig.69). The first type is the non-account deposit system, which includes:

- **Category A:** Systems where deposits are returned in cash, such as the Verti Music Hall Reusable Cup System (Hall, n.d.).
- **Category B:** Systems where deposits are automatically refunded upon card swiping, as observed in certain Packback reuse systems (PackBack, n.d.).
- **Category C:** Systems where returns provide bonuses, like machines that give cash-offsetting receipts for recycled plastic bottles (Reverse Vending, n.d.)."

The second category is the account deposit system, which comprises:

- **Category D:** Systems like CLUBZERØ (formerly known as CupClub) where returned deposits are issued as gift vouchers for future purchases (CLUBZERØ, n.d.).
- **Category E:** Systems where deposits are credited back to a registered merchant account, similar to a Starbucks loyalty account. An example of this is Munich's "Re-Cup" system.
- **Category F:** Systems where refunds are directly credited to a linked bank card. In this setup, a bank account is linked to the supplier's registered account, and deposits are automatically transferred to the bank account."

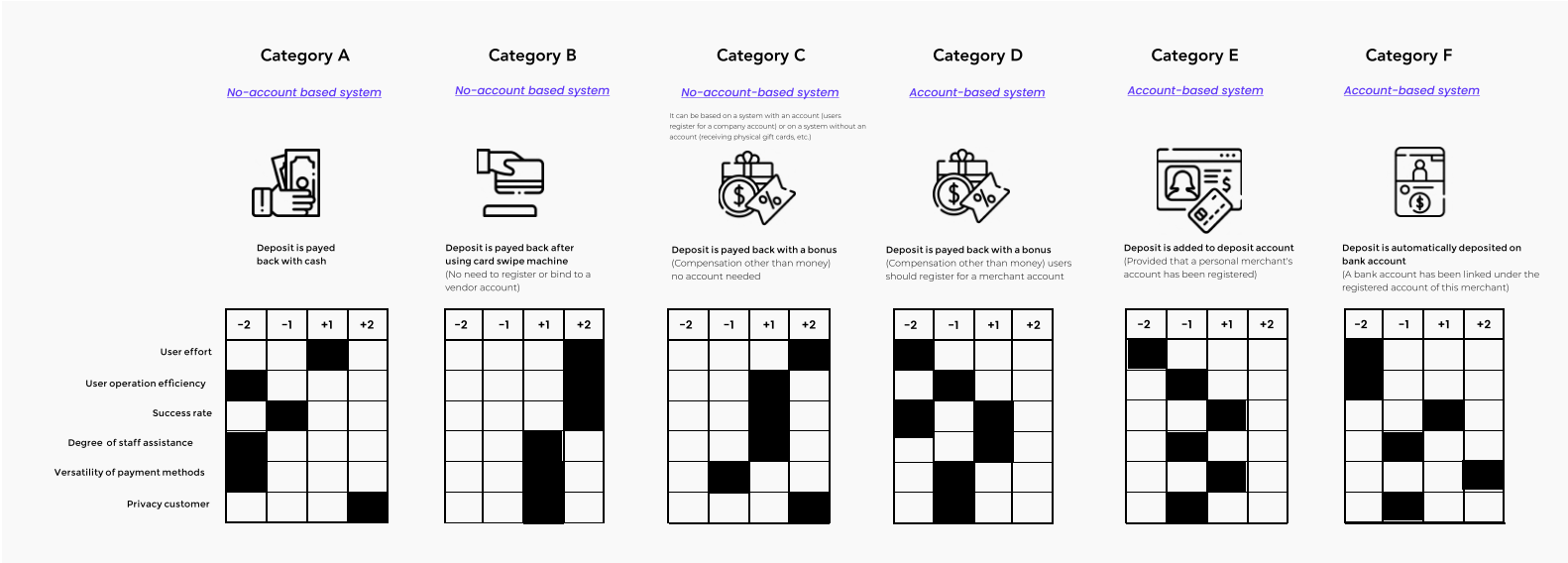


Figure 69. Comparison of current deposit systems

Evaluating various deposit systems from the perspectives of both users and staff offers a holistic view of their effectiveness. Key considerations include user effort, operational efficiency, success rate, versatility of payment methods and privacy protection for users, and the degree of staff assistance required. Category B stands out as the most efficient, reducing user operational costs, ensuring a high success rate, and lessening the need for staff intervention. This evaluation aims to optimize the user experience while maximizing staff efficiency. The results from the evaluation using the Harris profile are shown in Figure 69. For an in-depth analysis of each criterion, see Appendix F.

The deposit system suitable for the new service

Given the need for efficiency and ease of use, especially for airline passengers, the most suitable deposit system is **Category B deposit system**, where consumers pay an upfront deposit, which is then refunded upon the proper return of the cup through a card swipe. This approach aligns with both business needs and consumer convenience. Insights from interviews with experienced travelers, detailed in chapter 2, underscore the importance of these considerations. Among the various deposit system options, this no-account based deposit system stands out for its speed and simplicity. This deposit system offers a streamlined approach, eliminating the need for account registrations or linking bank cards, allowing passengers to save time and focus on other travel-related activities.

Company A had previously suggested an alternative where consumers use the cup first, and if not returned within a set timeframe, the deposit would be automatically deducted (see chapter 5.1.3). However, this poses a challenge since the cup isn't linked to a consumer's bank card at the point of rental. It becomes difficult to determine which card should be charged if the cup isn't timely returned. Such a method is more suited for products directly linked to bank accounts. At its core, our objective is to streamline the deposit process, elevate the travel experience, and reduce potential stress for travelers.

5.2.5 Analysis of electronic payment systems

Purpose and procedure

While Company A recommended emphasizing electronic payment methods, additional desktop research is essential to determine the most appropriate electronic method for Schiphol Airport users.This analysis aims to evaluate the existing electronic payment systems to identify the most suitable deposit payment method for Schiphol Airport's consumers.

Current electronic payment system in the Netherlands

The Netherlands is a leading figure in the realm of digital payments (Fig.70), often hailed as an innovator in transitioning away from cash (E-commerce in Europe, 2016). This has positioned the country as one of the most approachable European markets for e-commerce. With the evolution of technology and changing consumer preferences, sectors like retail, tourism, and electronics in the Dutch e-commerce space are witnessing significant growth.

When it comes to preferred payment mechanisms, iDEAL is the top choice for online transactions (iDEAL, n.d.). Supported by nearly all major Dutch banks, it facilitates direct online purchases using bank accounts. Apart from iDEAL, the Dutch market sees a wide adoption of various payment cards and methods, including Maestro by Mastercard, V Pay by Visa, and the SEPA Direct Debit system (Adyen, n.d.). Renowned global card brands, Mastercard and Visa, have a notable footprint in the Netherlands. Furthermore, with its vast user base, PayPal, a prominent digital wallet, is also a popular choice among the Dutch (PayPal, 2020).

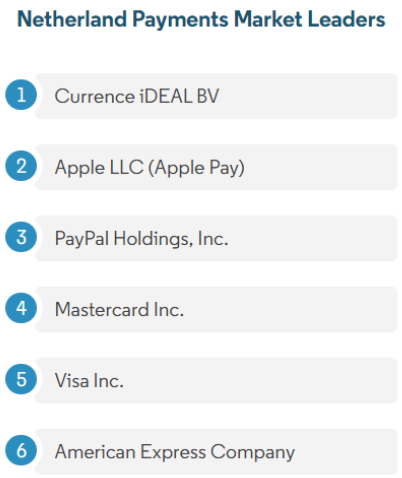


Figure 70. Netehrland payments market leaders, derived from Mordor Intelligence

Current examples of electronic payment systems applied to smart recycling bins.

Packback, a company from the Netherlands, is paving the way for advanced electronic payment systems that can be applied to smart return box. They currently serve institutions and businesses like Erasmus University Rotterdam and KFC. They offer two payment systems: one based on accounts and another on deposits. In the deposit system, users get a refund via Tikkie when they return packaging(Packback, 2023). What's more, Packback plans to allow refunds to international bank accounts soon through a partnership with Tikkie (information gained from a student report). Below is the smart recycling bin put into use by the Packback company (Fig.71).

On the other hand, Nayax, a global fintech firm, is revolutionizing the electronic payment landscape by offering a comprehensive operating system and payment platform suitable for various retailers (Fig.72). Nayax's versatility is evident in its wide range of accepted payment methods, from traditional swipe and EMV cards to modern mobile wallet payments like Apple Pay and Samsung Pay. Their recent collaboration with Kiosk to design the Touch Screen Kiosk Credit Card Reader Payment Systems further emphasizes Nayax's capability to provide tailored payment solutions, catering to diverse payment preferences globally (Nayax, n.d.). Both Packback and Nayax's efforts highlight the growing versatility and global reach of electronic payment systems.

Taken together, these examples indicate a trend towards more user-friendly, efficient, and globally accessible payment methods in the realm of smart recycling. Such innovations not only enhance user experience but also promote sustainable practices by incentivizing recycling through immediate electronic rewards

Figure 71. Smart Recycling Bin Implemented by Packback Company (Source: Packback Network Consumers, https://packback.network/consumers/)

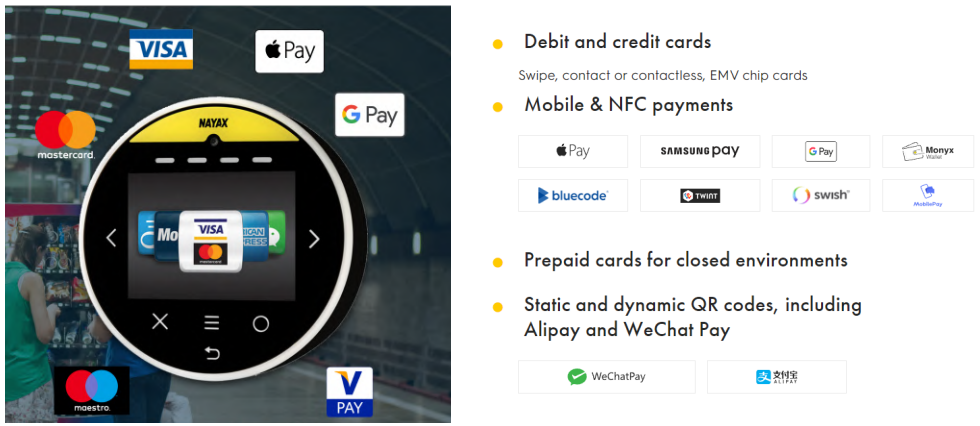


Figure 72. Onyx contactless card reader cashless payment methods provided by Nayax (Source: Nayax, https://www.nayax.com/solution/onyx/)

Ideal characteristics of the payment system for the new service

Given the international consumers of Schiphol Airport, predominantly from European regions (see chapter 2), the payment system for the reusable cup initiative should be both user-friendly and versatile. An easy-to-install credit card reader, capable of processing a variety of cashless transactions — including prevalent european payment methods — is essential. This ensures adaptability for diverse payment preferences. The system should also feature an intuitive interface with multilingual instructions to cater to the global audience.

To ensure swift deposit refunds upon cup return and card swiping, it's vital to optimize the electronic payment system. This can be achieved through hardware enhancements, such as integrating high-performance card readers for rapid data processing and selecting high-speed network devices to minimize transfer delays. On the software front, refining payment algorithms, employing efficient database techniques for quicker data retrieval, and maintaining regular software updates are essential to guarantee optimal system performance.

5.3 Passenger validation

5.3.1 Purpose & Method

Following feedback from stakeholders and in-depth research into design details, I refined the final concept. Given that a key aspect of this project's future vision (see chapter 3) is to encourage passengers to embrace the new service, I aimed to identify any potential challenges that future airport passengers might encounter when interacting with the service. This was to ensure they have a seamless experience. Additionally, I sought to assess the overall passenger satisfaction with the refined solution.

To achieve these objectives, I interviewed 8 passengers who had visited Schiphol Airport within the past week. My choice of this specific group was driven by two primary considerations:

1) All these users have visited Schiphol Airport within the past week before the interview, so they still have impressions of the airport environment, procedures, and even the process of purchasing beverages, making them more relatable to the Cupmates service experience.

2) These users are also potential future users of Cupmates, their feedback and suggestions are valuable for optimizing Cupmates. Details about the participants can be seen in the Figure 73.

To obtain a more comprehensive assessment of the service system from the participants, I provided them with a passenger evaluation questionnaire at the end of the interview, asking them to fill it out (Fig.75). After all interviews and questionnaire submissions were finished, I conducted a comprehensive analysis of both user feedback and the collected evaluation data. This approach helped provide a thorough understanding of participants' perspectives and contributed to a well-rounded evaluation of the service system's performance.

	Age	Date of visit to Schiphol	Interview time	Interview format	Nationality	Duration
U1	23	2/08/2023	6/08/2023	Online interview	Chinese	25min
U2	24	2/08/2023	8/08/2023	Online interview	Chinese	45min
U3	31	11/08/2023	12/08/2023	Online interview	Chinese	30min
U4	22	9/08/2023	10/08/2023	Offline interview	Dutch	45min
U5	26	9/08/2023	10/08/2023	Online interview	Dutch	30min
U6	58	9/08/2023	10/08/2023	Online interview	Chinese	30min
U7	48	9/08/2023	10/08/2023	Online interview	Chinese	30min
U8	26	10/08/2023	11/08/2023	Offline interview	Chinese	45min

Figure 73. Passenger evaluation information

5.3.2 Procedure

Considering that some participants were based outside the Netherlands, I conducted interviews online, while a select group engaged in in-person discussions. Each session generally lasted about 30 minutes. I initiated each interview by presenting an overview of the expected Cupmates service experience from the perspective of a passenger, tracing their journey through the system. I then encouraged participants to evaluate the service holistically and provide their insights and feedback based on a set of predetermined questions. All interviews were recorded with the consent of the participants.

a. Does the entire service align with your airport needs?

b. Would you consider using the new service?

c. What's your overall impression of the service concept? Are there specific aspects you particularly appreciate or have concerns about?

5.3.3 Passenger validation: insights and questionnaire analysis

Insights from Interviews

From the interview results (Fig.74), most of the interviewees are willing to accept the Cupmates service overall. They would be willing to use it and correctly return the cups. Some interviewees think the new service is interesting, and most give positive feedback on the overall service of Cupmates.However, at the same time, as can be seen from the chart, they also raised some questions and suggestions for optimization from the passenger's perspective, which played a significant role in optimizing the scheme. Directions for optimization include:

- In addition to web links, other touchpoints should emphasize the dishwasher cleaning and hygienic features of the cups.
- Improve the information design of the card-swiping area to make it more user-friendly.
- Simplify the user's operation steps on the return box.
- Take into account the management and disposal of cup sleeves.

Theme	Key insights	Examples (Quotes)
Acceptance of the new service	The overall service is acceptable and can meet my needs.(6)	*"I believe Europeans, particularly Western Europeans, will accept this solution!" -U2* *"This service is perfectly acceptable to me." -U5*
Overall satisfaction with new service	The overall service is interesting.(4)	*""I feel the overall effect is good, especially the cartoon design of the cup."-U2*
Cup cleaning information communication problems	Cup cleaning info is unclear and may be missed. (3)	*"Only the web link talks about the cups being cleaned with a dishwasher. This is what I'm worried about. If I don't scan it, I won't know the cup is cleaned well.." -U7* *"How do they clean the cup? I'm concerned." -U6*
Information design problems in the return box's card-swiping area	Card-swiping info is not so clear and attention-grabbing.(3)	*"The card-swiping info is fuzzy. Why swipe the card? If it just says "swipe," I won't know if it's taking or giving back money." -U3*
Operational problmes on the return box	It would be better if the operations on the return box could be simplified.(3)	*"If I'm short on time and have to separate the cup first, it's a hassle." -U7*
Cup sleeve disposal problem	No clear steps for the cup sleeve disposal. (3)	*"If the return box is next to a regular bin, I might throw the sleeve there. otherwise I'm not sure" -U1* *"What do I do with the sleeve? Do I return it too?" -U8*

Figure 74. Insights from passenger Interviews

Questionnaire results analysis

Figure 75 shows the meanscore given by participants (N=8) on the concept.The analysis of the questionnaire results reveals participants' overall satisfaction with the Cupmates service. High-rated aspects include perceived service transformation, positive beverage experiences, brand awareness, and willingness to return cups. However, certain issues received lower ratings, notably accessibility of information on sustainable choices and the deposit system. These insights underscore the service's positive impact while pinpointing specific areas for refinement, aligning with the goal of enhancing the user experience and communication of sustainable practices within the Cupmates service.

Figure 75. Passenger questionnaire result

5.4 Refining the concept: Feedback integration

Based on feedback from stakeholders and passengers, I refined the design concept. Here's an overview of the improvements made:

Highlighting cup cleanliness information

From passenger feedback, it was evident that the cleanliness information of the cup, which was deeply embedded in a web link QR code, was hard to locate. Addressing this, the information design was optimized at more accessible touchpoints. The operation instructions on the standees was modified to emphasize that the cups undergo professional cleaning and highlight their cleanliness features. Similarly, the service features on the cups and billboards were adjusted and emphasized. A comparison of the design touchpoints before and after optimization is shown in Figure 76.

Figure 766. Information design before and after optimization

Return box design enhancement

Incorporating feedback from stakeholders (consideration for residual liquid handling) and passengers (uncertainty about sleeve disposal and desire for simplified operations on the recycling bin), several refinements were made to the return box design:

- A designated area for sleeve placement was added, guiding users to dispose of the sleeves separately from the cups. This prevents contamination of paper sleeves and improves recycling efficiency.
- To both guide users in pre-treating residual liquid and simplify their operations, the new return box design encourages users to place the cups upside down. This ensures any residual liquid drains out automatically. A specific area at the bottom of the box collects this liquid, ensuring separation from the cups, enhancing the cleaning efficiency, and eliminating the need for users to pour out residual liquid separately. Clear visual designs in the updated return box guide users for correct recycling. A comparison of the return box design before and after the optimization is illustrated in the provided Figure 77.

Figure 77. Comparison of return box design before and after

Optimizing card swiping area information design

Passenger feedback indicated that the purpose of the card-swiping area was unclear. In response, the optimized design supplements and emphasizes information that users find essential. A comparison of the information design before and after optimization is shown in Figure 78.

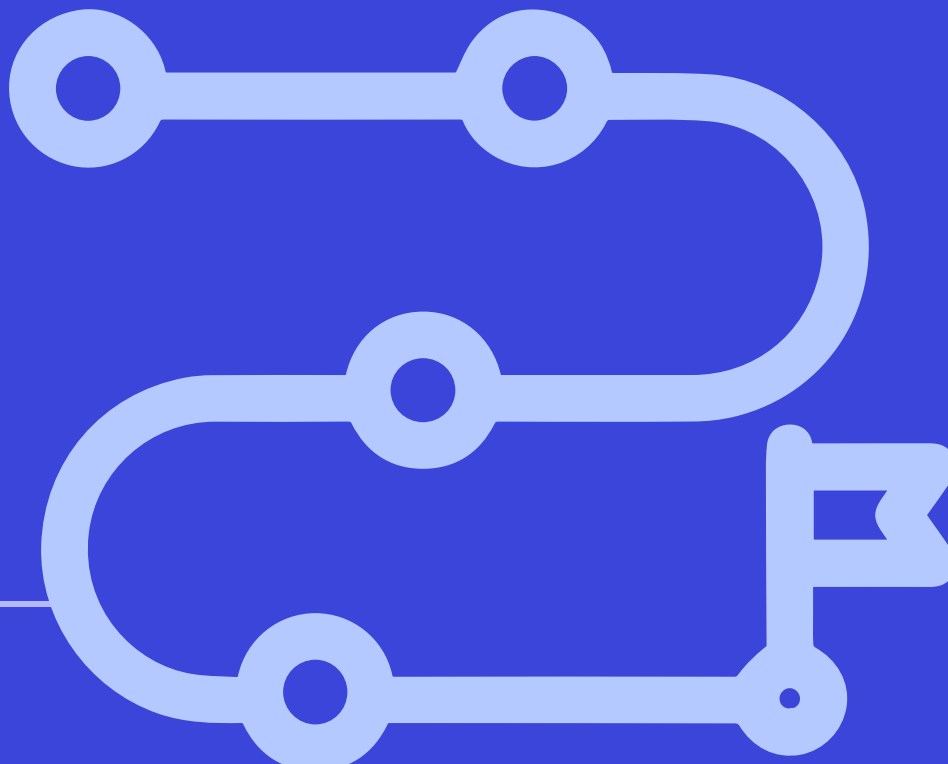
Figure 78. Comparison of card swiping area information design before and after

5.5 Key takeaways

- Passengers involved in the evaluation are generally willing to accept and are relatively satisfied with the Cupmates service.
- Feedback from Company A, one of the critical stakeholders, indicates that the current solution is highly feasible and is viewed as an effective solution.
- Considering that passengers in a rush to catch a flight might not scan and access the web link, key information of the new service should be displayed prominently through other touchpoints like promotional posters and on the cups themselves.
- A deposit system without account registration is more suitable for airport settings. Future endeavors should consider introducing systems supporting international electronic payment methods to enhance convenience for airport users.
- Regarding the design of the return box, there's a need to simplify user interactions and ensure efficient separation for cups, lids, sleeves, and residual liquids.

06

Deliver



6. Deliver

6.1 Introduction & Approach

In the Deliver phase, the concept of the new cup service system was delivered , having been shaped based on feedback from the concept evaluation and insights from both stakeholders and passengers. This chapter starts with an overview of the new system. Following this introduction, the business strategy was explored, setting the stage for its strategic framework. The focus then shifts to the user journey, detailing pivotal touchpoints and complementing them with illustrative design visuals.

Service blueprint

After clarifying the concept of the new cup service system, the service blueprint aids in organizing all the processes that make up the service in a visual way. This includes the customer journey, front-office operations visible to the customer, back-office operations invisible to the customer, and key touchpoints. The service blueprint uses language that is easy to understand to promote cross-functional collaboration and coordination, thereby facilitating effective service evaluation and delivery (Bitner et al., 2008).

Stakeholder map

Using a four-quadrant matrix, a stakeholder map categorizes stakeholders according to their influence and interest in a reusable cup service project. These quadrants delineate stakeholders with high influence-high interest, high influence-low interest, low influence-high interest, and low influence-low interest (Tristancho, 2023). Such a map is pivotal in comprehending and managing stakeholder relationships, ensuring effective communication and informed decisions to promote sustainable cup usage throughout the project's duration.

System map

Cupmates' system map is a visual representation of the intricate web of relationships and flows between various stakeholders. It provides insights into Cupmates' operational complexities by highlighting material, information, and financial flows. The map emphasises the significance of effective communication and collaboration among stakeholders, the requirement for streamlined processes to ensure material recycling and financial transactions, and the importance of information dissemination for optimal service delivery. It gives a comprehensive picture of how each entity in the system interacts with and contributes to the overall service ecosystem.

Business Model Canvas

The business model canvas is a visual tool that offers a comprehensive snapshot of a service's core components, such as value proposition, infrastructure, customer types, and financial aspects, aiding in strategic understanding and decision-making. (Business Model Canvas | Service Design Tools, n.d.) For the Cupmates service, the Business Canvas was drawn to facilitate a structured and holistic understanding of how the service fits into the broader marketplace, the value it offers to customers, and the resources required to deliver that value.

6.2 Overview final design

Cupmates provides a reusable cup service enriched with gamification for airport passengers, offering a smooth and captivating experience. This concept imagines the cup as a fellow passenger named Mx.Cupmate, setting out on an eco-aware journey through the airport, blending metaphors with game elements. When customers start using the Cupmates cup, it's similar to assisting Mx.Cupmate in initiating their zero-waste journey at Schiphol Airport. Each return box serves as a landing point for Mx.Cupmate, and the proper return behavior of consumers ensures a smooth landing for Cupmate. As a token of encouragement and commemoration, every consumer using the Cupmates service can scan a code to access a weblink, receiving a special sustainable electronic boarding pass of Mx.Cupmate. This can be shared on social platforms to commemorate their memories at Schiphol Airport.

Delving into the mechanics of the Cupmates system: Customers receive cups with a branded cup sleeve embedded with RFID tags and pay an initial deposit. After use, consumers can conveniently return the cup to a smart return box equipped with an RFID reader hardware and electronic payment system. By simply swiping their card at this box, their deposit is refunded. The used cups are then gathered by the cleaning staff and taken to a dedicated cleaning facility within the airport. Using professional dishwashers, the cups are thoroughly cleaned and subsequently redistributed to various airport stores.

Cup design

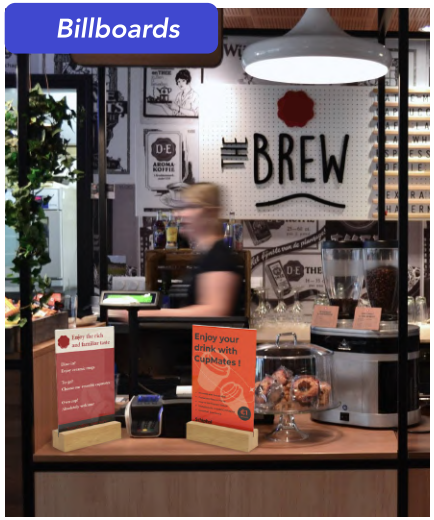
Unified cup design *Cup with a branded sleeve (for illustration purposes only)* *Multiple sizes of cups*

Smart return box

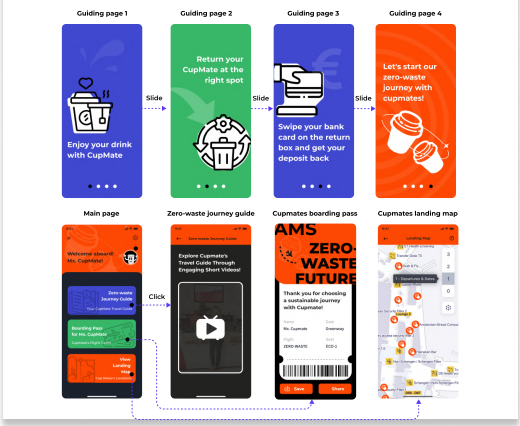
Promotional poster

Standees

Billboards



Weblink accessed by scanning the QR code



6.3 Business strategy

6.3.1 Cupmates service: design and process overview

Incorporating feedback from stakeholders and passengers, the new service system is called Cupmates: Journey to a Zero-Waste Future. It employs the use of metaphor and gamification by metaphorically depicting the newly introduced reusable cups made of PP material as a passenger named Mx. Cupmate. When airport passengers start using these cups, it symbolizes the beginning of assisting Mx. Cupmate on their zero-waste journey at Schiphol Airport. In addition to the reusable cups available in the store, such as the mug, consumer's own cup will also be supported and encouraged.

Figure 79 outlines both the primary consumer steps and the backend processes. For consumers, the journey begins with purchasing a beverage and selecting a cup. They then pay a deposit. Upon finishing their drink, they return the cup and swipe their card on the designated return box, which triggers an automatic refund to their bank card. Optionally, consumers can scan a QR code that directs them to a specific web link. In contrast, the backend operations consist of staff gathering the returned cups and transporting them to a dedicated cleaning area located in the airport's basement. Here, a professional dishwasher ensures the cups are thoroughly cleaned. Once sanitized, these cups are redistributed to various shops within the airport.

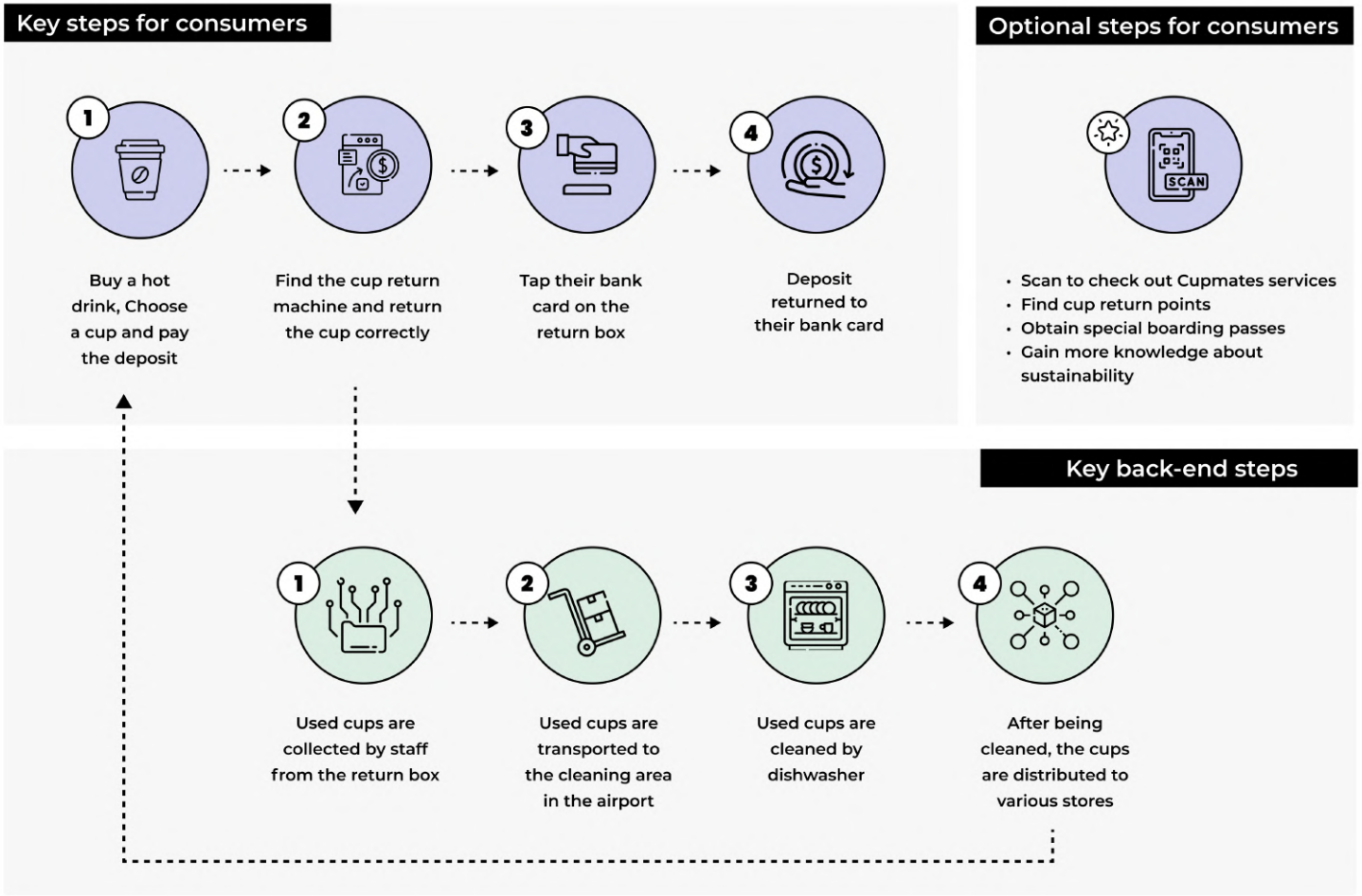


Figure 79. Design and process overview

6.3.1 Service blueprint

From a user perspective, the service consists of six key stages: entering the airport, purchasing beverages, enjoying the drink, returning the cup, receiving the deposit back, and engaging on social platforms. The first two stages focus on capturing users' attention, generating interest, and initiating proactive search. The stages of purchasing beverages and returning the cup emphasize facilitating user behavior, while the sharing stage emphasizes promoting the cup service by users. The new user journey can be clearly seen from the service blueprint (Fig.80). The specific user journey and touchpoints were analyzed in detail in Chapter 6.4. From the stakeholder's perspective, the service blueprint for Cupmates showcases how various elements, including frontstage employee behavior, backstage actions, and technology, interplay to provide a comprehensive view of current operations.

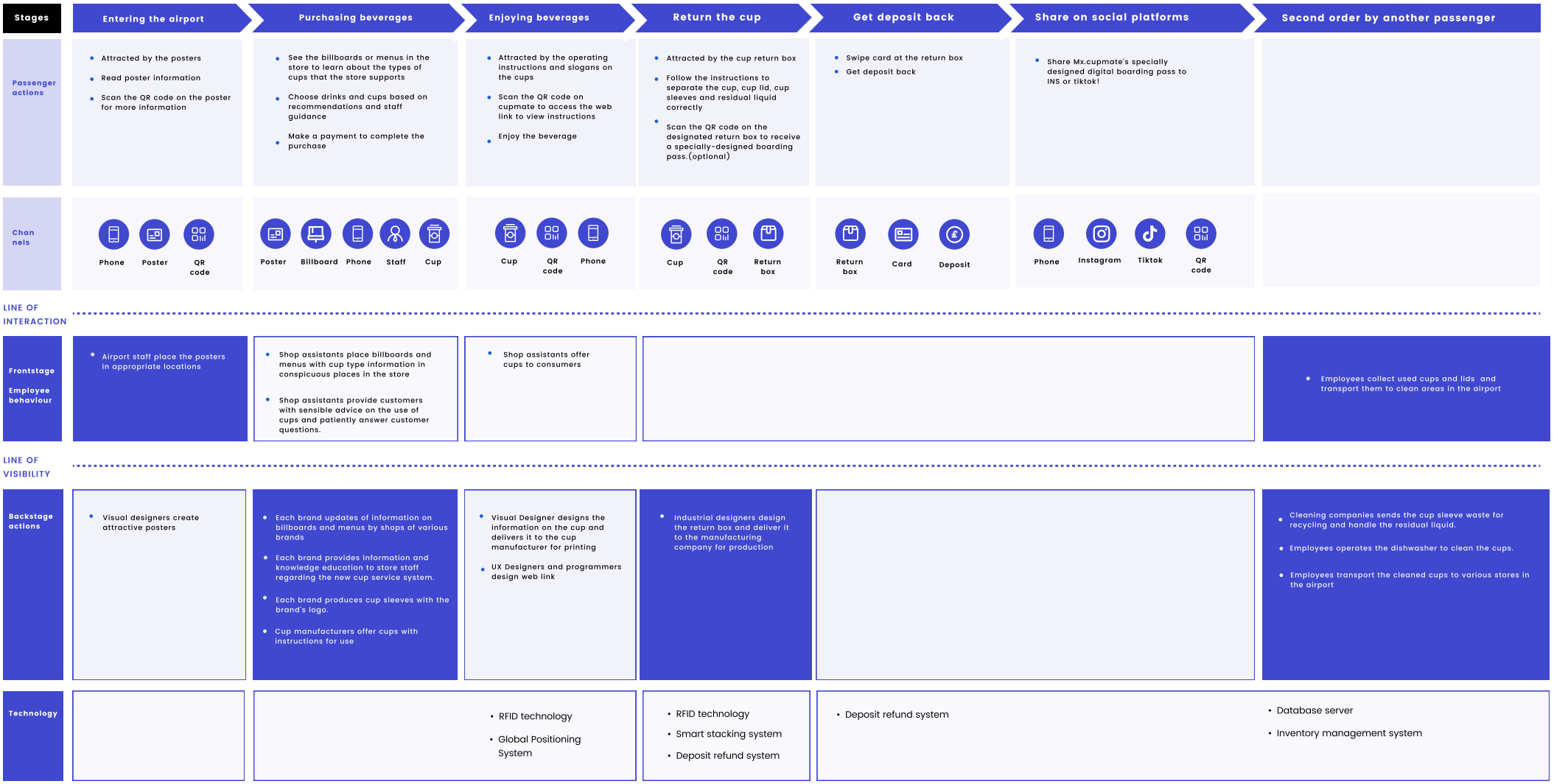


Figure 80. Service blueprint of Cupmates service, drawn by the author

6.3.2 Design intervention strategy

The Define stage applied the Com-B model for design intervention (chapter 3.4), and the specific design interventions in the final concept were shown in Figure 81.

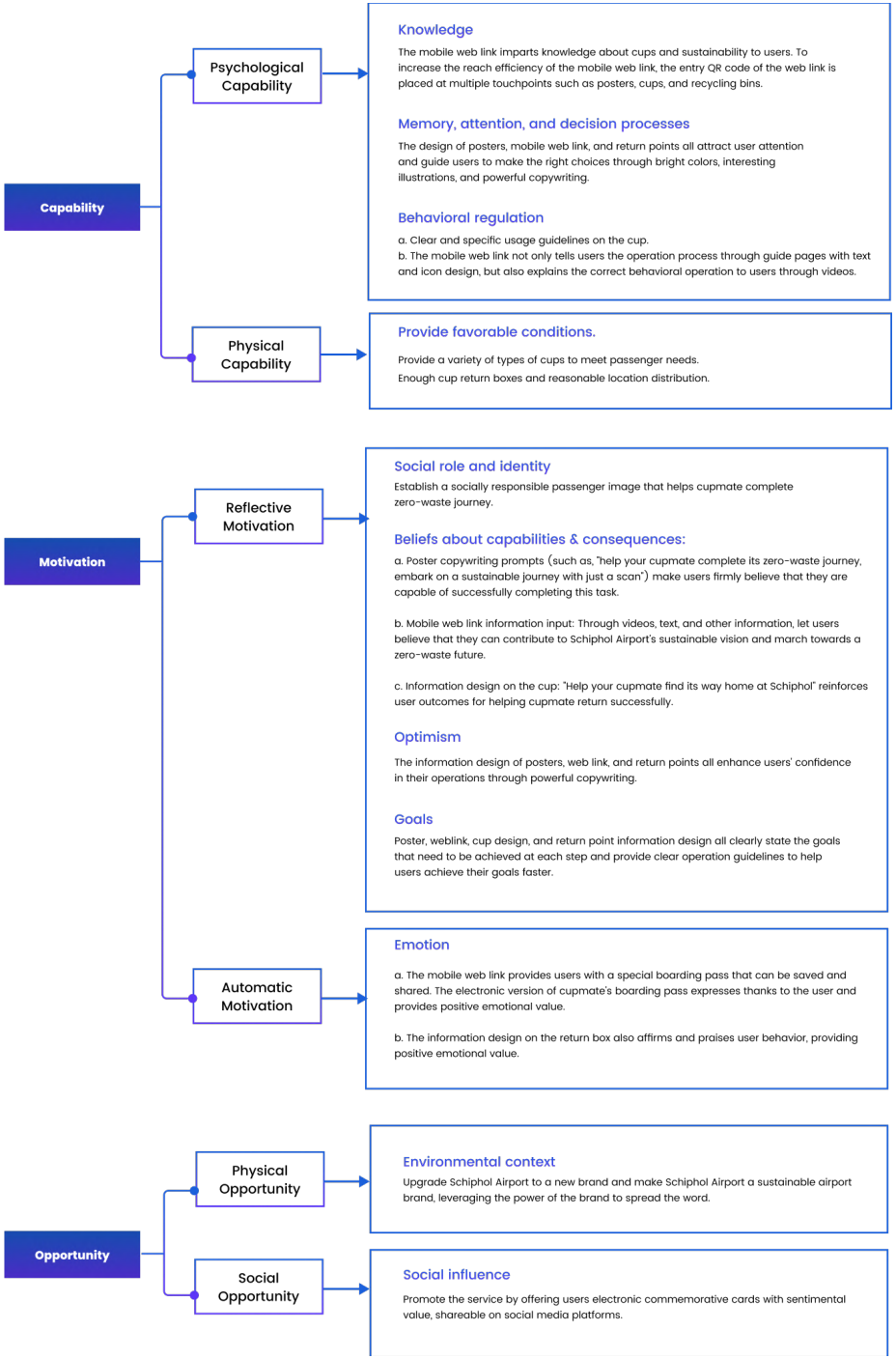


Figure 81. Design intervention strategy, drawn by the author

6.3.3 New stakeholder map and system map

The stakeholder map for Cupmates can be found in Figure 82. For a more comprehensive view, refer to the confidential Appendix. This map utilizes a four-quadrant matrix for classification.

In the second quadrant, stakeholders with both high influence and high interest are highlighted, necessitating close management. This includes food-service companies, Company A and Company B, as well as the Schiphol business, all responsible for coordinating and overseeing Cupmates' resources and services. Also situated in this quadrant are suppliers of products and services, the design and development team, and those involved with the new cups, lids, and sleeves—components vital to the passenger experience. The significance of smart return boxes cannot be understated; they are essential for tracking and ensuring the correct return and sorting of cups. Additionally, efficient dishwashers address hygiene concerns related to the cups. The design team plays a pivotal role, guiding project decisions and crafting key touchpoints that are integral to the project's success.

Consumers have been placed in the quadrant characterized by high influence but low interest. While the primary goal of Cupmates' service revolves around consumer satisfaction, underscoring their substantial influence, consumers typically prioritize their experience with the service over seeking detailed information about it, reflecting their low interest. On the other hand, businesses managed by Company A and Company B fall into the same quadrant of high influence but low interest. Their understanding and collaboration are vital, making their role in the Cupmates service process indispensable for its success.

The system map for Cupmates delineates the interconnections and dynamics among stakeholders, capturing the flow of materials, information, and finances (Fig.83).

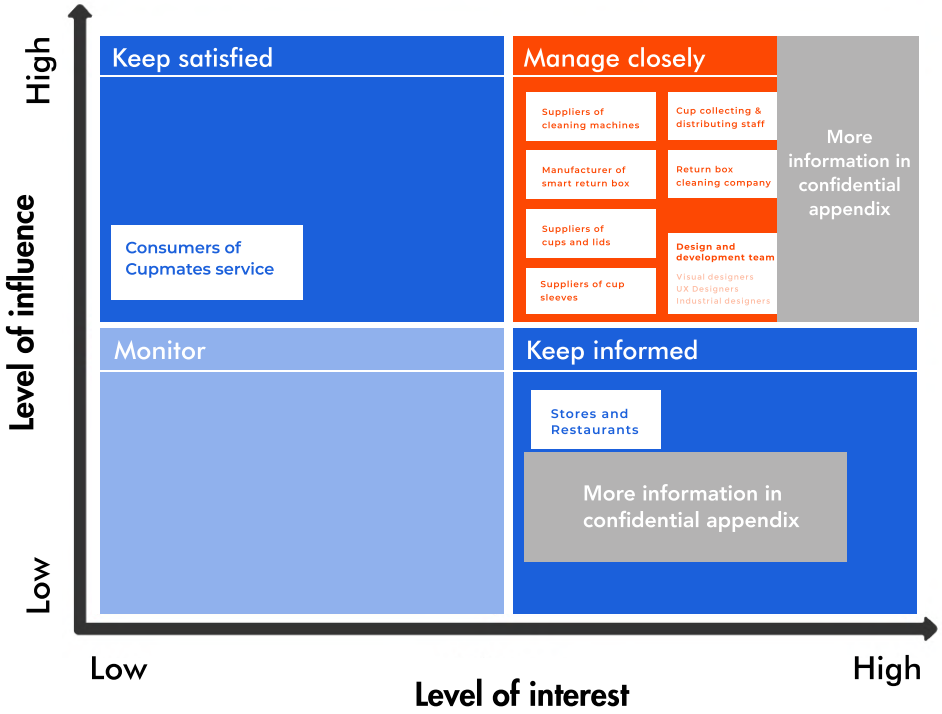


Figure 82. Stakeholder map of Cupmates service, drawn by the author

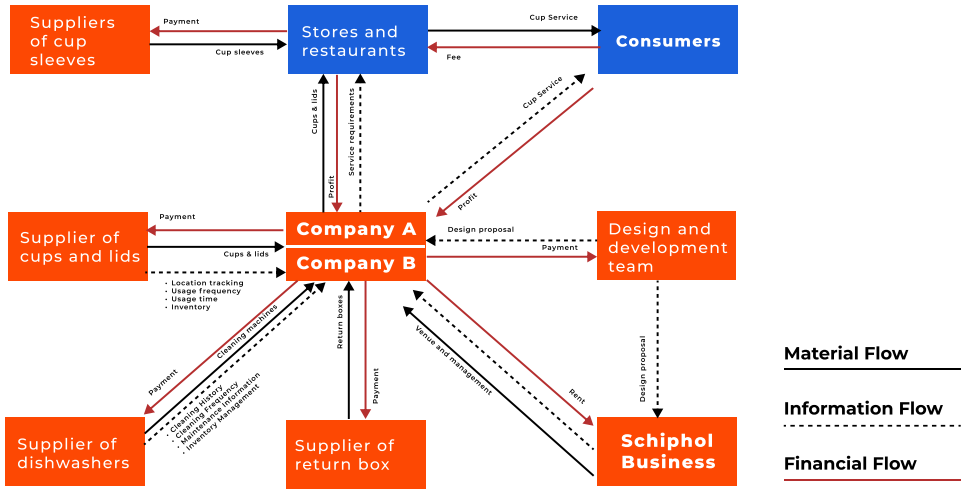


Figure 83. System map of Cupmates service, drawn by the author

6.3.4 Business Model Canvas

Value Proposition

Cupmates offers a reusable cup service infused with gamification to airport passengers, creating a seamless and engaging experience. Our user-friendly system ensures that passengers can easily enjoy their beverages, correctly return cups, and improve their airport experience. Beyond just a refreshing drink, passengers are empowered to actively champion sustainability and reduce waste at the airport

Cost Structure

The Cupmates service encompasses various expenses. Primary costs involve the purchase and operation of cleaning facilities, web link development, and the procurement and upkeep of cups, lids, and return boxes. Additionally, there are costs related to employee wages. However, the exact expenditures will depend on quotes from partnering companies and specific rental charges.

Revenue Streams

Revenue Streams for Cupmates are diversified and strategic. First of all, they encompass user deposits for the reusable cups, ensuring their return, for every direct engagement with the service.

Secondly, If other airports or establishments want to implement a similar system, they might pay a licensing fee to use the "Cupmates" branding, technology, or system model. This provides an additional revenue stream.

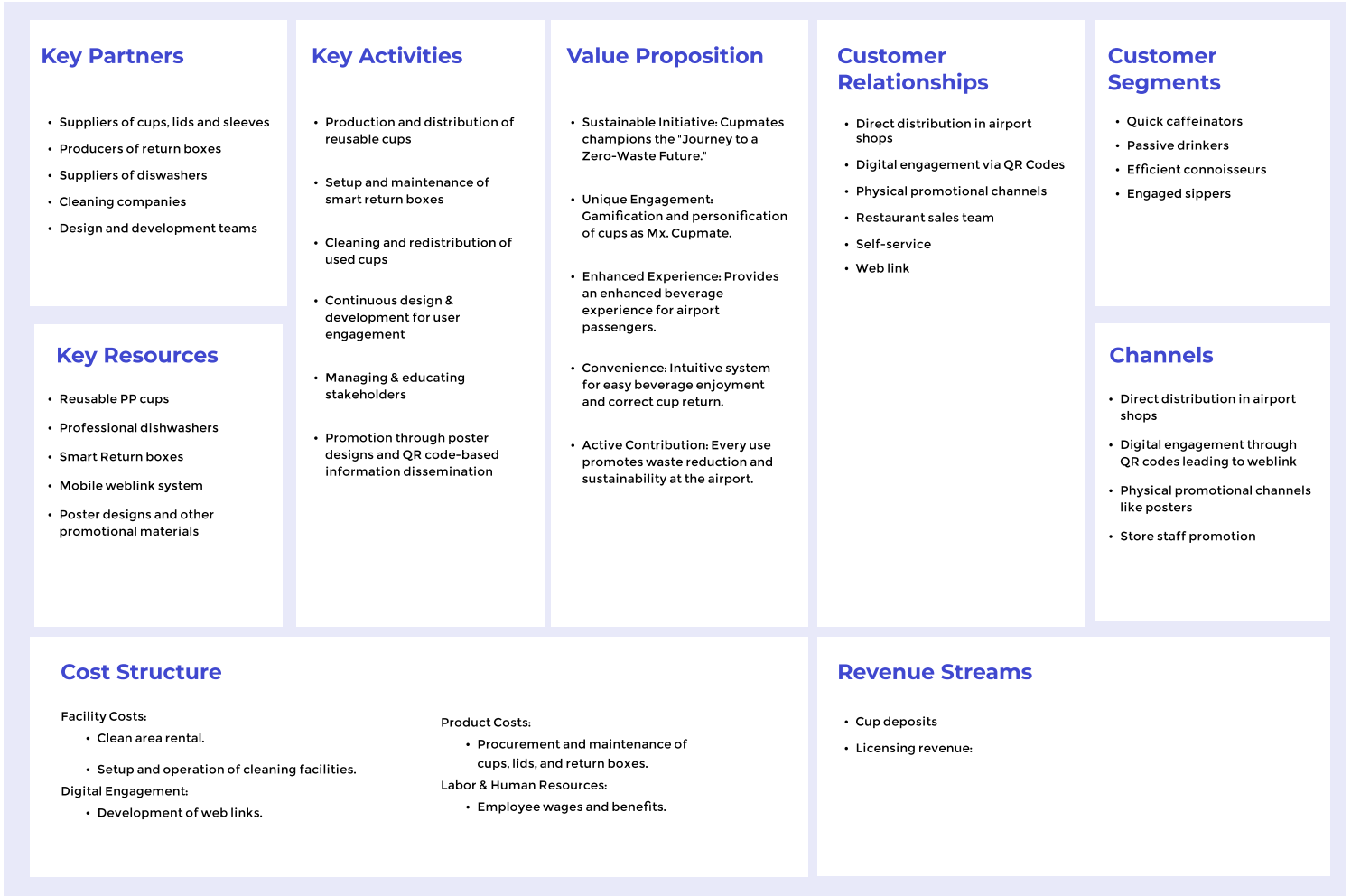


Figure 84. Business Model Canvas, drawn by the author

6.3.5 Implementation Strategy

Implementation roadmap

A phased implementation approach is required for the Cupmates service to be successfully deployed at Schiphol Airport. Based on feedback from Company A (chapter 5.2.3), the full system implementation is expected to take at least a year. By breaking up this year into distinct stages, the service will be able to better allocate resources, assess user feedback, and systematically improve its offerings. Each subsequent phase builds on the accomplishments of the previous one, resulting in a natural escalation in scope and complexity.

- *Initial Phase*

The foundational stage is about setting the scene. In these first three months, the primary focus is on introducing the service to the public. This involves producing the initial batch of reusable cups and smart return boxes, setting up them in strategic airport locations, integrating professional dishwasher system,and testing backend processes. Equally vital is the initial promotional push through posters and QR codes, which will raise awareness and kickstart the user adoption process.

- *Intermediate Phase*

In this phase, the service expands across more areas of the airport, moving from a trial to a broader rollout. Through updates to the mobile weblink and increased promotions. Both the backend processes and user interactions see notable improvements during this period.

- *Advanced Phase*

Having established a presence in the airport, this phase aims for a complete airport-wide rollout. There's a marked shift towards more sophisticated service features, including advanced gamification elements for enhanced user engagement. Maintenance becomes crucial, with regular reviews of the return boxes.

- *Continuous Improvement*

After the first year, this phase focuses on constant improvement and expansion. The service will adapt based on user feedback and anticipated needs. Regular discussions with stakeholders ensure alignment with the airport's vision. The goal is also to potentially introduce the Cupmates service to other locations beyond Schiphol, emphasizing a dedication to sustainable reusable cup solutions.

Initial Phase

Month 1-3

- Production and distribution of the first batch of reusable cups.
- Initial setup of smart return boxes at key locations.
- Integration of the professional dishwasher system.
- Start of regular cleaning and redistribution cycle.
- Pilot testing phase for backend processes.
- Initial promotion through posters and limited QR code dissemination.

Intermediate Phase

Month 4-6

- Roll out to more shops and areas within the airport.
- Enhancements to the mobile weblink system for better user engagement.
- Continuous design & development phase initiated.
- Expanded promotion and stakeholder engagement.

Advanced Phase

Month 7-12

- Complete airport-wide rollout.
- Regular review and maintenance of smart return boxes.
- Integration of advanced features and gamification for user engagement.
- Extensive stakeholder education and management.
- Broad-based promotion using a mix of posters, QR codes, and other channels.

Continuous Improvement

Beyond Year 1

- Continuous development and integration of additional functions.
- Periodic stakeholder feedback and education sessions.
- Refinement of backend processes based on operational feedback.
- Expansion of the Cupmates system beyond Schiphol Airport (if feasible).

Whole airport implementation

In the research phase, the focus was mainly on the areas after security checks (for specific reasons, see chapter 1.2.3). Considering Schiphol Airport also includes other areas, such as pre-security checks and office areas, the following suggestions are made for applying the Cupmates service throughout the entire airport.

In the areas before the security check, it's essential to strategically place return boxes not only in shops, dining zones, and main entrances and exits but also to consider the airport's connection with NS (Dutch Railways) (Wikipedia contributors, 2023). Given this connection, a collaboration with NS to install return boxes at train entrances and exits would be beneficial, preventing cups from being taken onto trains. While considering office areas, given the limited number and placement of return boxes, the primary service should cater to airport passengers. Airport staff are encouraged to bring their own cups.

Scalability of the system: Application across european airports

Preliminary assessment

Understanding the unique layout and dynamics of each airport is crucial. By conducting a thorough Airport Infrastructure Evaluation, we can pinpoint the most strategic locations for Cupmates stations and return points. Additionally, a Passenger Behavior Study will provide insights into the habits and preferences of travelers at each airport, ensuring that the Cupmates service aligns seamlessly with local needs.

Regulatory and partnership engagements

Before rolling out the Cupmates service, it's essential to liaise with local authorities. Local Authority Collaboration ensures that the service aligns with local environmental regulations and airport policies. Furthermore, Strategic Partnerships with existing airport vendors, cafes, and eco-initiatives will facilitate a smoother integration of the Cupmates system within the airport ecosystem

Service customization and cultural integration

Airports have diverse zones, each with its unique characteristics. Zone-Specific Deployment tailors the Cupmates service to these specific areas, ensuring maximum efficiency. Moreover, cultural nuances play a significant role in user adoption. Through Cultural Resonance, Cupmates branding, messaging, and even the "Mx. Cupmate" visual design can be adapted to resonate deeply with local audiences.

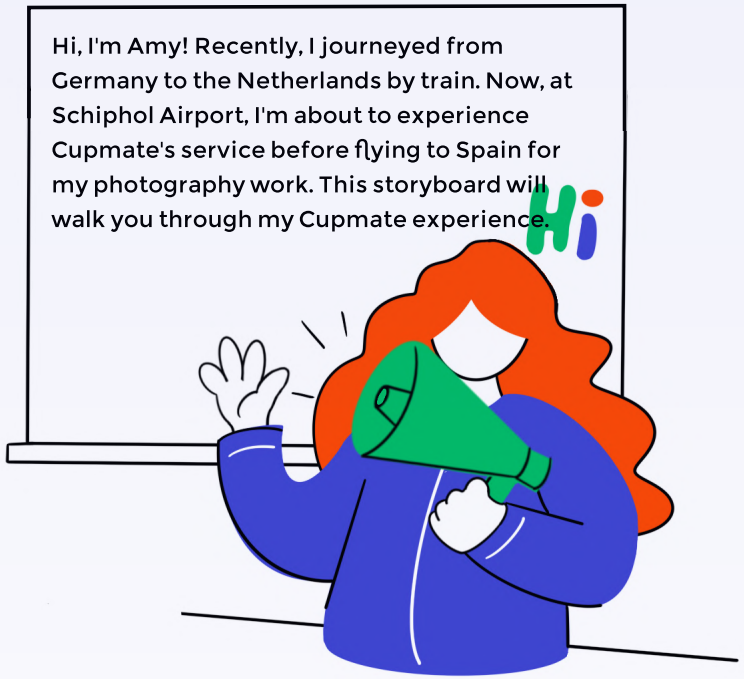
Collaboration with local enterprises

Partnering with local entities offers numerous advantages. Efficient Logistics means reduced international transportation costs and a lower carbon footprint. Swift Service Maintenance ensures that any disruptions are addressed promptly, maintaining service continuity. Lastly, Business Model Adaptability allows for the core concept of Cupmates to be consistently applied, while also permitting region-specific adaptations based on local collaborations.

Marketing and awareness

Promoting the Cupmates service effectively is key to its success. Localized Campaigns that emphasize the environmental benefits and user-friendliness of Cupmates will resonate with local audiences.

6.4 Passenger touchpoints



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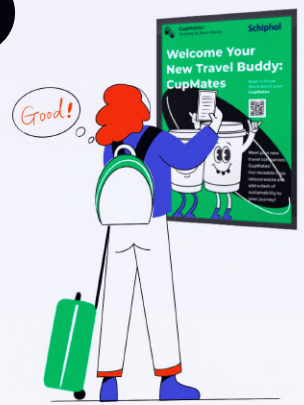


While at Schiphol Airport, Amy spotted posters announcing updates to the cup services. Intrigued, she scanned a QR code to learn more about Cupmates

2

After clearing security, Amy thought she'd grab a coffee to pass the time. She noticed the Cupmates service instructions right at the entrance of the coffee shop.

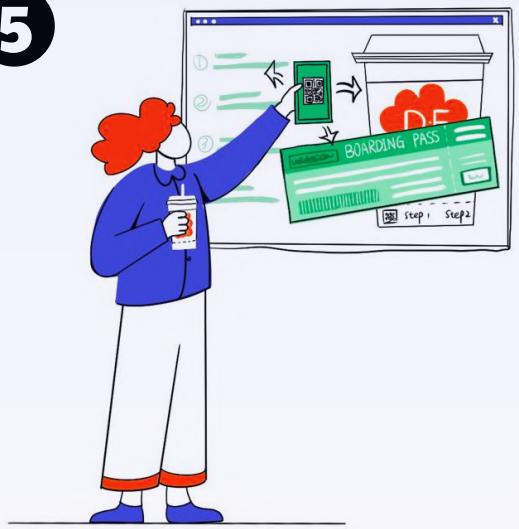
3

While waiting in line, Amy noticed counter billboards promoting the Cupmates service, along with recommendations for cups for both dine-in and takeaway. When she had questions about the service, the staff were quick to clarify. She chose a Cupmate cup and lid and paid for her order.

4

As Amy sipped her drink, she became curious about the graphics and QR code on the cup, which led her to scan it.

5



Scanning the QR code, Amy was directed to a web link detailing the cup service. She found all the information she needed, and even got a unique boarding pass, which she thought was pretty cool!

6

Once she finished her coffee, Amy set out to return the cup. She easily found the return box in Lounge 2, though she knew she could have used the map provided on the web link if necessary. Following the guidelines, she separated the cup, lid, sleeve, and any remaining liquid.

7

After properly returning, Amy followed the prompts to tap her bank card at the designated spot on the return box.

8

Once the screen confirmed that her card swipe was successful, Amy put her card away. Shortly after, she received a notification on her phone letting her know that her deposit had been refunded.

9

The return box also had a prompt encouraging Amy to scan a code for a special Cupmate boarding pass. After scanning it, she saved the unique boarding pass and posted it on social media platforms like Instagram, where it received a lot of likes.

Figure 85. Storyboard of Using the Cupmates Service

6.4.1 Touchpoint1：Poster design

Users at the airport can see a series of poster designs for the Cupmate service system. With vivid patterns and color designs, as well as clear and impactful headline designs, users can easily be attracted and informed about the current cup strategy changes at the airport. The posters also include QR codes with web links for mobile devices and guiding text to encourage users to scan the code and explore the link for in-depth understanding of the service system and sustainability-related knowledge.

The entire service system used metaphor, as the new Cupmate cups were designed as cartoon characters (Fig.86), with diverse expressions that made the cup image lively and relatable. A logo was also created for this service system, consisting of two cup graphics and a circular element. The circular shape represented not only the journey of Cupmate at the airport but also the recyclability of the cups. The service system utilized three colors, with orange as the primary color and green and blue as secondary colors. Orange served as the representative color of the Netherlands (Pim, 2023), symbolizing the proactive efforts of the Dutch government in promoting sustainable development. Green represented sustainability, while blue represented Schiphol Airport. The combination of these three colors signified that the Cupmate service system introduced by Schiphol Airport was dedicated to sustainable development under the influence of the Dutch government's policies.

Each poster in the series focuses on highlighting a specific aspect and maintains a cohesive message across the three posters. The first poster emphasizes bidding farewell to disposable paper cups and guides users unfamiliar with the changes to scan the QR code and access the link to learn about the airport's new cup strategy (Fig.87). The second poster primarily promotes the new cups, utilizing personified copywriting to encourage users to scan and discover more about Cupmates. The third poster serves as the main poster (Fig.87), with information design that guides users to use the new cup system and assists Cupmate in achieving a zero-waste journey. While each of these three posters has its specific focus, their content progresses in a logical sequence, enabling users to gain a comprehensive understanding of the current changes.

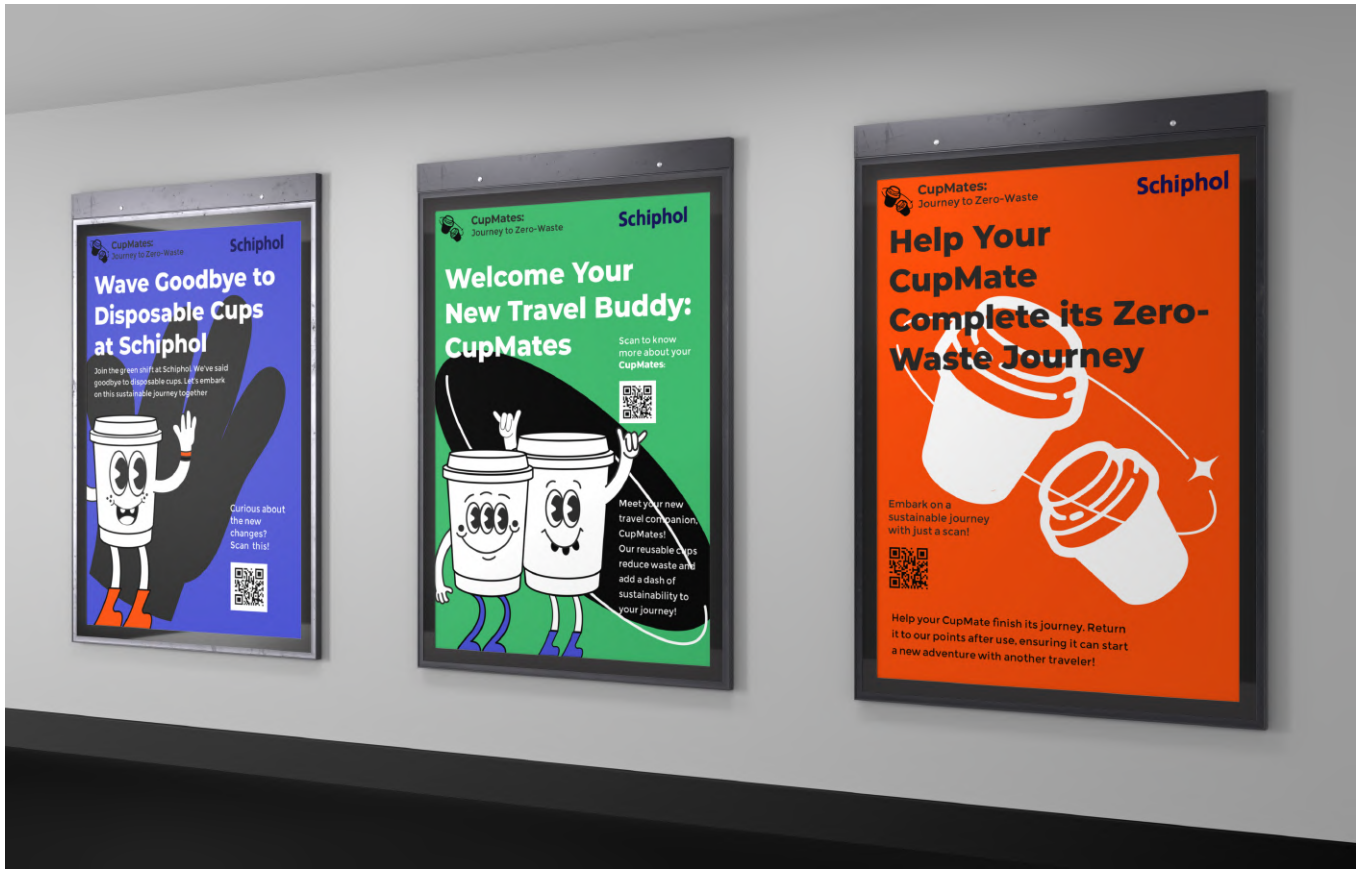


Figure 86. Visual representations of the promotional poster series

Poster Placement Recommendations for Cupmates at Schiphol Airport

Adhering to the principle of prioritizing commercial advertisements, the placement of cup promotional posters should not interfere with existing airport advertisements and marketing campaigns of various stores.To effectively promote the Cupmates service to both departing and arriving passengers at Schiphol Airport, key recommended poster placement areas include the main entrances and exits of each terminal, ensuring visibility as travellers begin and end their journeys. Strategic placements near security checkpoints, dining and retail zones, flight information display boards, and baggage claim areas within the airport would cater to both groups, capturing attention during critical touchpoints such as security checks, meal times, flight updates, and baggage collection.

It's also a good idea to rotate the posters every few months, updating the designs and messages to keep them interesting and to cater to frequent travellers who visit the airport several times a year.

Figure 87. Visual representations of the poster series

6.4.2 Touchpoint2：Standees

To enable consumers to quickly understand how to use the Cupmates service, stores will also provide standees with instructions (Fig.88), clearly informing users that they currently offer reusable cups based on a deposit system and the main steps for use.

Figure 88. Standees renderings

6.4.3 Touchpoint3：In-store billboards

At Schiphol airport, there are 82 diverse shops. Some shops focus solely on takeout options, others cater exclusively to dine-in customers, while establishments like coffee shop A offer both.

Cupmates cups have now completely replaced disposable paper cups. However, for those dining in, ceramic cups remain available. Additionally, customers are encouraged to bring their own cups. Prominent billboards at the counters convey the types of cups each shop offers, simplifying communication and enhancing

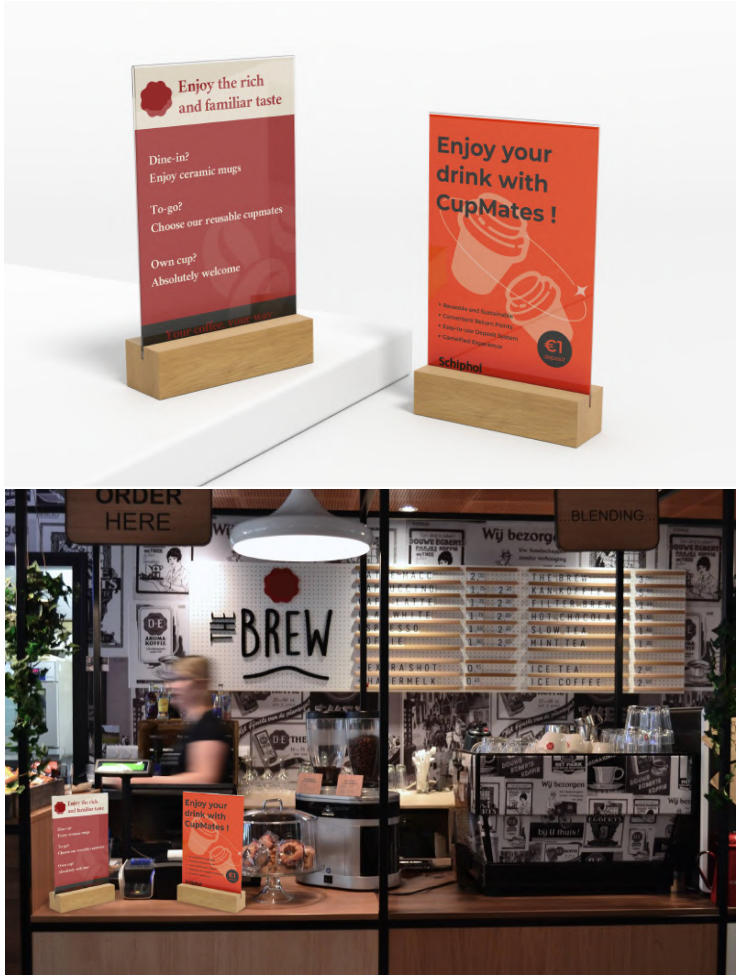


Figure 89. Billboards renderings

6.4.4 Touchpoint 4：Cupmates Cup

Cup design

Cups will serve as an easily accessible touchpoint during the beverage consumption process. When offering Cupmates cups, various brands will provide cups made of a standardized PP material. The cups will be designed with visual usage guidelines and slogans urging returns (Fig.90 and Fig. 91), directing user behavior. All cups and lids should be BPA free, NVWA approved. Cups are stackable and work for both hot and cold drinks.

Lid

According to passenger research detailed in chapter 2, customers are hesitant to walk with a cup containing a warm beverage due to fears of spilling. In the Netherlands, while the likelihood of a lawsuit related to spillage is low, it's advisable for businesses to offer lids optionally for hot drinks to prevent any spillage. This not only ensures safety for both domestic and international customers but also protects the business from any potential liabilities.

Cup sleeve for branding

To ensure users have a positive brand experience, each brand's logo is printed on the paper cup sleeves, as shown in Figure 92. Additionally, brands have the option to include their slogan on the sleeve, though the information to be printed is determined by the brand itself. These paper cup sleeves are provided to users alongside the cups.

Figure 90. Information design on the front and back of the cup.

Figure 91. Unified cup design

Figure 92. Cup with a branded sleeve (for illustration purposes only)

Size

Currently, there are many dining brands at Schiphol Airport, and the sizes of cups offered by each store vary (Fig.94). According to the cup size information from coffee shops in the market (Marshall, 2023), coffee shops provide a variety of cup sizes to accommodate various tastes and beverage options. The typical size of a coffee cup varies, but it typically weighs between 8 and 10 ounces. There isn't a single accepted standard, though. The sizes available at well-known coffee shops like Starbucks include Short (8 oz), Tall (12 oz), Grande (16 oz), Venti (20 oz), and Trenta (30 oz). The size of the cup can affect how consumers enjoy coffee; for instance, a larger espresso cup may dilute the crema, which would change the flavor and aroma (Marshall, 2023).

For Schiphol Airport, given its varied stores and the insights from the website (Marshall, 2023), it's recommended to introduce three distinct sizes: a Small (Tall) at 12 ounces, ideal for those seeking a swift caffeine hit; a Medium (Grande) at 16 ounces, which stands as the most favored size delivering a well-rounded coffee experience; and a Large (Venti) at 20 ounces, tailored for patrons desiring a more substantial beverage or an extended caffeine uplift. Implementing these sizes would cater to a wide range of preferences, ensuring a satisfying coffee experience for all travelers.

To ensure that the 12 oz, 16 oz, and 20 oz cups can be stacked together efficiently in the return box, the rim diameter of each smaller cup must be slightly narrower than the base diameter of the next larger size. This design ensures that the cups stack snugly and securely (Fig. 93).

Figure 94. Types of cups offered by different shops at the airport, photographed by the author at the airport

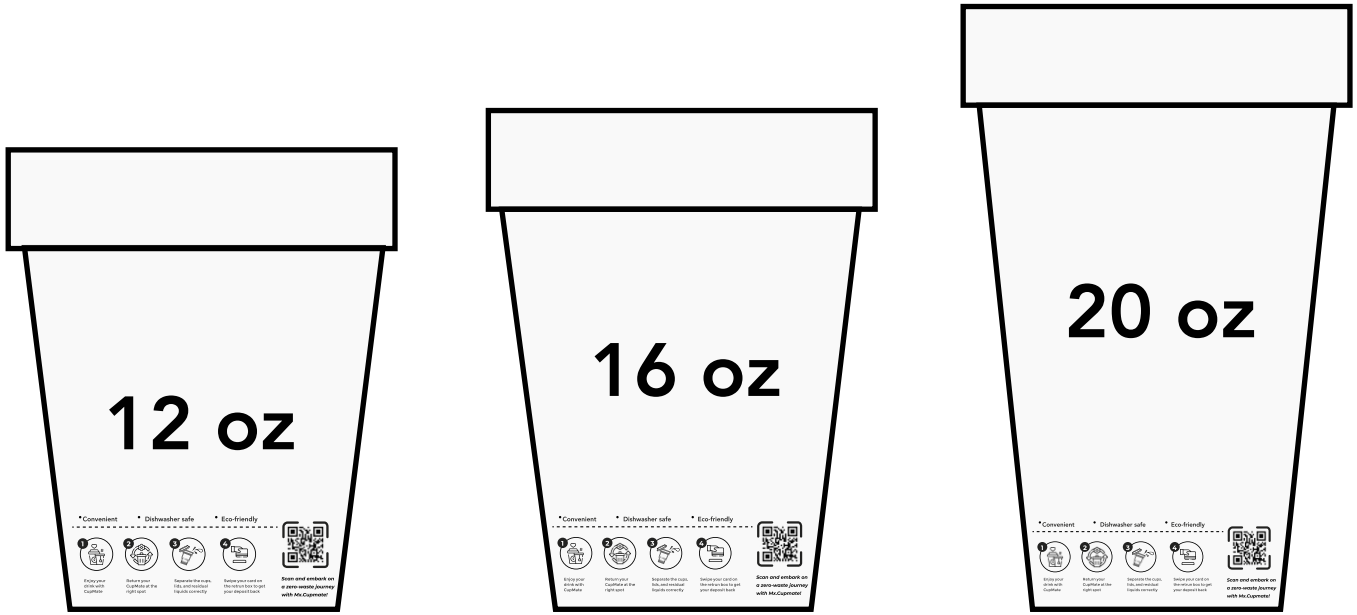


Figure 93. Multiple sizes of cups

Optimal quantity analysis for cups and lids

Ensuring a consistent supply of reusable cups is paramount for the seamless operation of airport services. Given the unique operational dynamics of airports, a two-day supply volume is recommended. The rationale behind this recommendation stems from the cleaning and redistribution cycle of the cups.

Daily consumption and cleaning cycle

Considering the daily disposable cup consumption of approximately 25,000 cups (based on the information provided by Company A) and a cleaning cycle of one day, airports should maintain a two-day supply to ensure uninterrupted service. After their use on Day 1, the used cups are all transported for cleaning. They undergo a thorough cleaning process and are typically ready for redistribution. This means that to maintain uninterrupted service, cups for Day 2 need to be already available at the airport while those from Day 1 are being cleaned.

Potential challenges

Even with a dedicated cleaning area within the airport, there are potential challenges to consider. Equipment malfunctions, especially with specialized dishwashers, can lead to delays in the cleaning process. Additionally, staffing issues or unexpected maintenance needs can disrupt the regular cleaning schedule. Furthermore, while the proximity of the cleaning area reduces transportation challenges, unexpected surges in passenger numbers can still strain the available cup supply. Having an extra day's supply on hand acts as a buffer against these uncertainties.

Financial implications and storage considerations

From a financial perspective, the initial investment for a two-day supply might seem substantial. However, this approach offers potential long-term savings. Consider the scenario where there's an unexpected delay due to dishwasher malfunctions or staffing issues in the cleaning area. The cost implications of such disruptions, combined with potential reputational damage, can be significant. Having an extra day's supply can mitigate these risks. Storage is another vital aspect to consider. While a two-day supply will undoubtedly require more storage space, the benefits of having a buffer outweigh the challenges. Airports should plan their storage facilities accordingly.

Recommended procurement strategy

In conclusion, considering the unique operational dynamics, potential logistical challenges, and financial factors, it's recommended for airports to maintain a two-day supply of reusable cups. Factoring in the daily consumption, cleaning turnaround, and a 10% anticipated loss rate, the ideal number of reusable PP cups (including lids) to procure stands at approximately 54,247. Adopting this strategy ensures uninterrupted service and positions the airport to adeptly handle unexpected situations with flexibility and efficiency

RFID Integration in cups: Enhanced tracking and management

Cupmates use cups embedded with Radio Frequency Identification (RFID) technology at their base offer advanced functionalities, enabling effortless tracking, identification, and return assurance of each cup (Ngai, Moon, Riggins, & Yi, 2008). The unique identification code on each RFID aids in monitoring a cup's cleaning history, ensuring adherence to hygiene protocols, and facilitates swift checks on its return status. This technology also allows organizations to gauge a cup's lifespan based on usage and cleaning frequency, flag it if damaged or unusable, and aids in inventory management by permitting quick checks for large-scale requirements. Underpinning these features is the electromagnetic field-based RFID technology, which can automatically identify and track tags without direct line-of-sight. (interview insights from Swapbox).

RFID tag on cups:

Role: Each polypropylene cup is embedded with an RFID tag that carries unique identification information.

Location: Fixed at the bottom of each cup.

Function: Once the cup is used and ready to be returned, it is placed inside a smart return box.

Smart return box with antenna dispenser and reader hardware:

Role: The box houses an antenna dispenser and reader hardware to detect and read the RFID tag of each returned cup.

Location: Inside the return box.

Function: When a user returns the cup and swipes their card, the system identifies the cup using the RFID tag, links it to the user's data, and processes the deposit refund to the user's bank card.

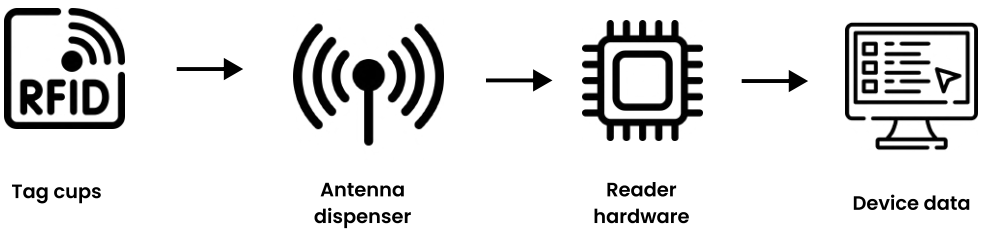


Figure 94. RFID tracking process

RFID reader on the dishwasher:

Role: To ensure cleanliness and hygiene for reused cups.

RFID Reader on the Dishwasher: The dishwasher is equipped with an RFID reader.

Function: Each time a cup is cleaned in the dishwasher, the reader detects the cup's RFID tag, and the cleaning event is recorded in a central database or cloud server. This allows for tracking the cleaning history of each cup, ensuring they are adequately cleaned before reuse.

Device data:

Role: This is essentially the central database or cloud server where all data related to cup usage, returns, and cleaning history is stored.

Function: After the cleaning process in the dishwasher, this system manages the redistribution of cleaned cups to various outlets. It also holds data necessary for automatic deposit refunds when users return cups.

Optimizing recycling practices for RFID-embedded PP Cups

While RFID tags in PP (polypropylene) cups present clear advantages for tracking and inventory management, they also introduce specific recycling challenges. To mitigate the potential contamination of the recycling stream by RFID materials, it's crucial to develop efficient tag removal processes before recycling – even if this introduces additional steps or costs (RFIDCARD, 2021). Collaborative efforts between RFID manufacturers and recycling facilities can also lead to innovative solutions. In essence, while the challenges are evident, with proactive measures and continuous innovation, the environmental impact of RFID-embedded PP cups can be minimized, ensuring a balance between operational efficiency and environmental responsibility.

6.4.5 Touchpoint 5：Web Link

The weblink has a simple structure, consisting of four main sections: zero-waste journey guide, view your boarding pass, view landing map, and about me (Fig.95). Zero-waste journey guide module educates users on the complete operational process through video instructions. Boarding pass for Mx. Cupmate module provides users with an electronic version of the Mx Cupmate boarding pass. This serves as both a gratitude gesture for users' contribution to the airport's sustainability efforts and a special memento that can be saved in photo albums or shared on social media. It will reinforce the users' sense of social identity and responsibility while indirectly promoting the sustainable service system of Schiphol Airport.

View landing map module offers users a map displaying the locations of cup collection points throughout the airport. Users can select different areas to view the cup collection points in those specific zones.Since we will provide a sufficient number of return boxes within the airport that are visually very easy to identify, this distribution map serves merely as an auxiliary tool. About me module consists of three parts: "What" introduces Cupmates (including Cupmates' material and usage advantages, as well as cup cleaning issues), "Why" explains the background of introducing the Cupmates service system (reasons for avoiding single-use paper cups, Dutch regulations, and the vision of Schiphol Airport), and "More knowledge" provides additional information and popularization of sustainability-related knowledge. The high-fidelity interface of the mobile web page link and the user flow is shown in Figure 95.

Figure 95. Weblink design

6.4.6 Touchpoint 6：Smart return box

Return box design

Visual design: The visual design of the return box aligns with the gamified style of the entire Cupmates service (Fig.96). The design serves a dual purpose: firstly, to ensure the return box is easily recognizable, enabling users to locate it quickly, and secondly, to guide users towards correct usage. Additionally, it prompts users to scan a QR code to access a commemorative Mx.cupmates boarding pass. Scanning the QR code directly leads to the Mx.cupmates boarding pass page.

Spatial partition design: The return box features three separate slots for disposing of cups, lids, and sleeves (Fig.97), with an additional internal compartment designed to collect residual liquid. As illustrated in Figure 5, the left slot is designated for lids, the central slot for cups, and the right slot for sleeves. To ensure users place the lids and sleeves in the correct compartments, arrows and informational cues are provided for guidance. To streamline the user experience, the optimized box design prompts users to invert their cups when return them. This allows any remaining liquid to drain directly into a storage box at the bottom, eliminating the need for users to pour it out in a separate step.

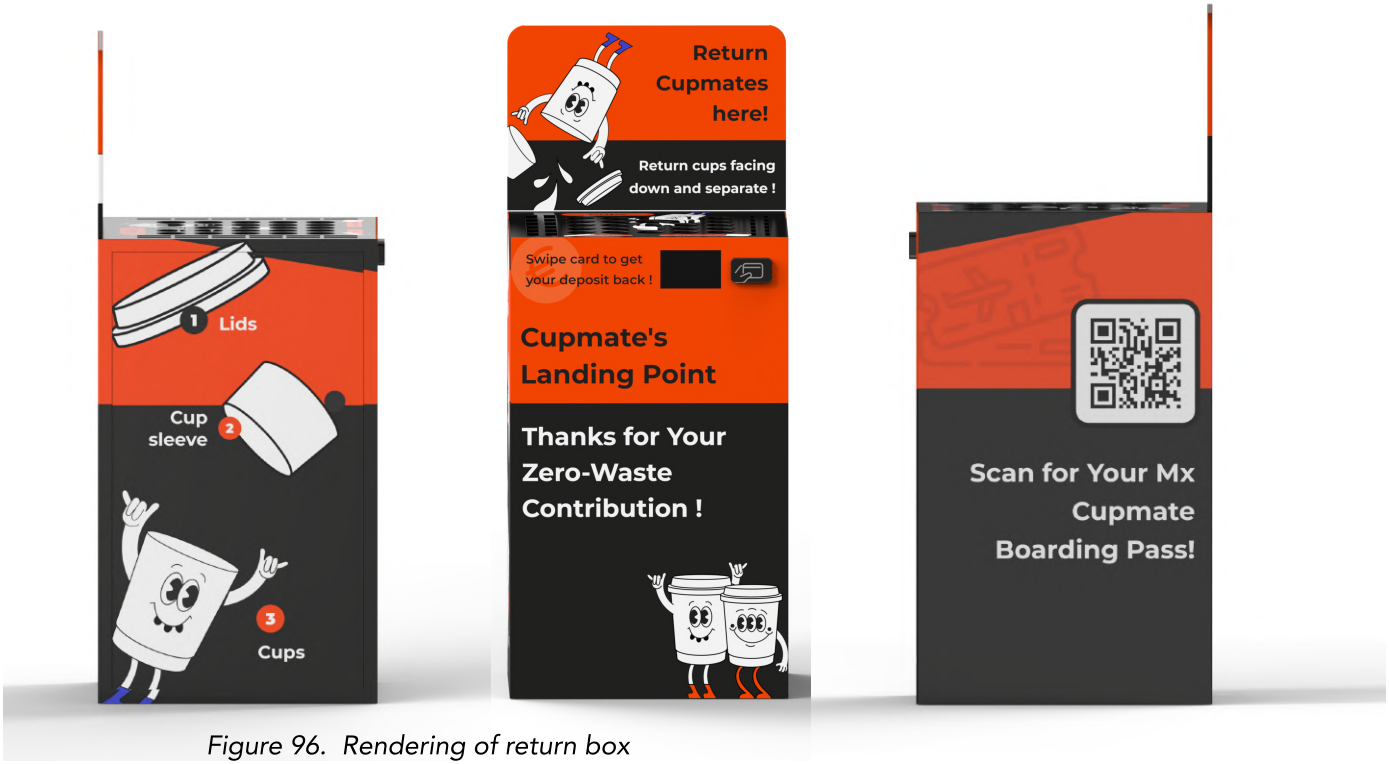


Figure 96. Rendering of return box

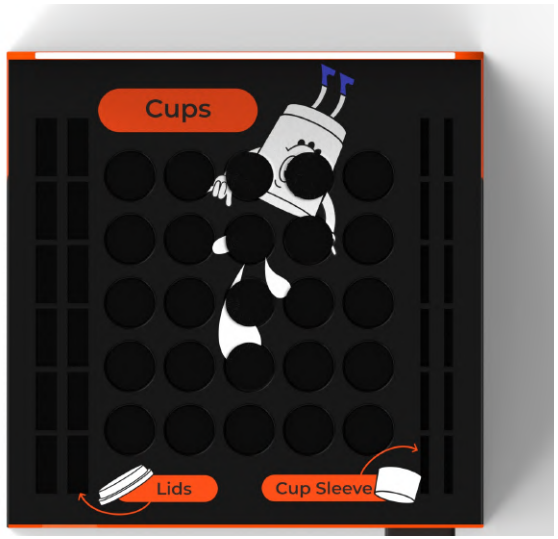


Figure 97. Spatial partition design

Internal structure

Cups: The design incorporates three sizes of cups: 12oz, 16oz, and 20oz, which are planned for efficient stacking within the return box (Fig.98). Each cup has a tapered shape, ensuring that the base of one cup fits snugly into the mouth of another, irrespective of its size. This design promotes a neat and stable stack, optimizing the space they occupy. Users can effortlessly deposit their used cups through a round entrance, which guides them into a cylindrical container. Notably, it's the base of this cylindrical container that has strategically placed holes. These holes are designed to allow any residual liquid from the cups to drain when they are returned upside down, collecting at the bottom of the recycling box in a designated residual liquid container. This design innovation eliminates the need for users to pour out leftover liquids separately, streamlining the disposal process and ensuring a cleaner and more efficient recycling experience.

Lids: Adjacent to the cup stacking area is a specialized compartment for cup lids. The lids are designed to stack within a cylindrical space (Fig.99), optimizing space efficiency. These lids are stored in a cylindrical container, ensuring that cups, lids, and sleeves can be collected separately. This design enhances the work efficiency of the cleaning staff by streamlining the collection process.

Cup sleeves: On the other side of the cup area is the space designated for placing cup sleeves (Fig.100). This section is designed to accommodate paper cup sleeves provided by different brands. The paper sleeves are stored in a sealed container. This design ensures that sleeves made of paper or cardboard remain dry and are not contaminated by residual liquids, thereby increasing the recycling rate of paper sleeves

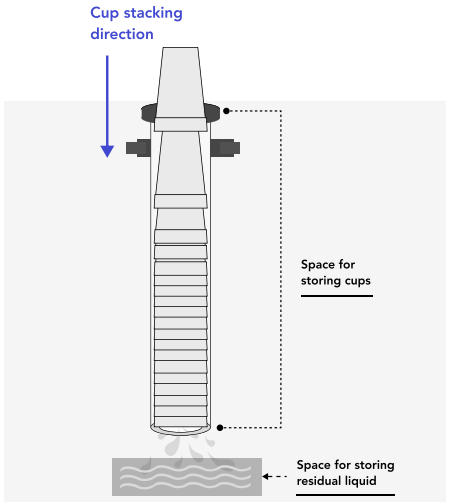


Figure 98. Stacking structure of cups

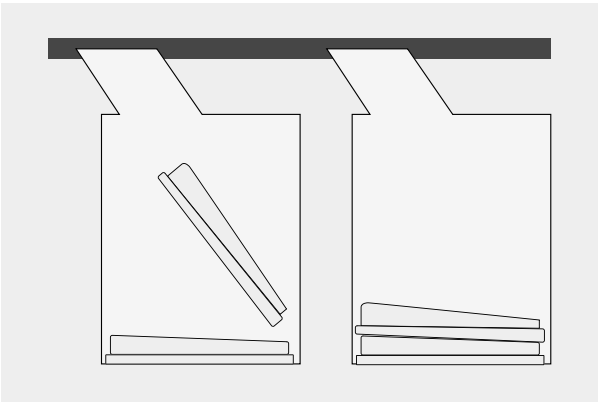


Figure 99. Stacking structure of lids

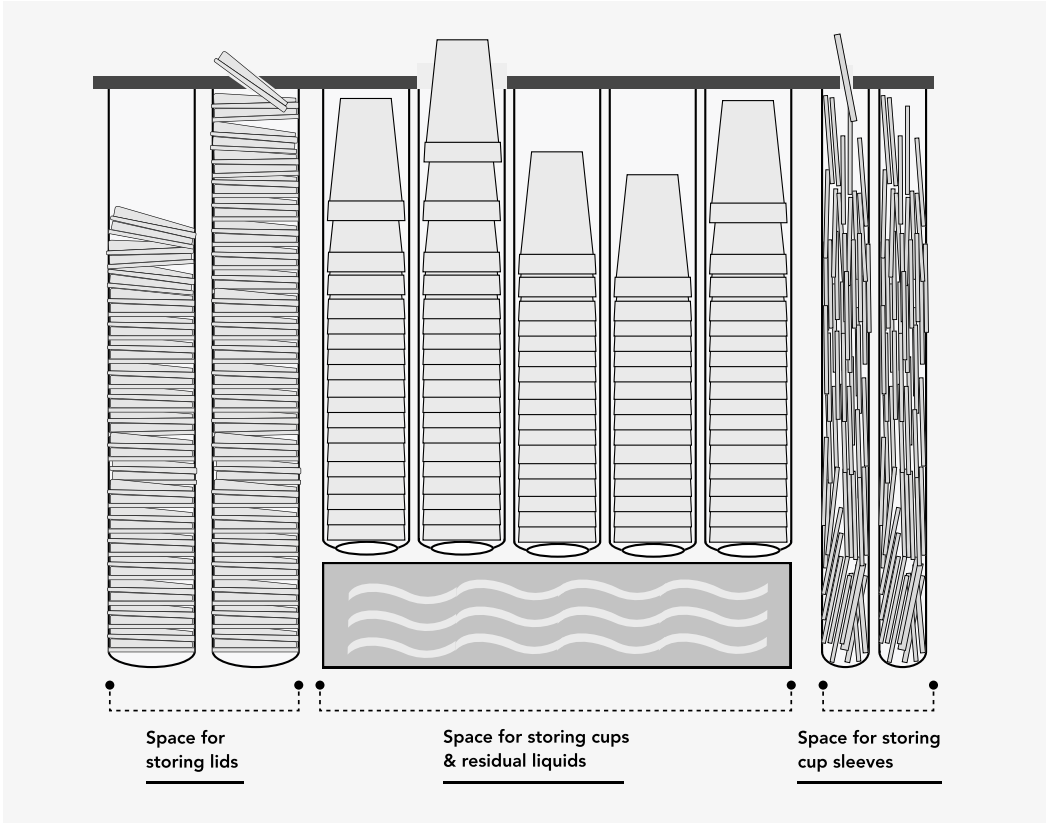


Figure 100. Return box internal structure: compartments for cups, lids, residual liquids, and sleeves

Cleaning staff operations

To facilitate the cleaning staff in collecting cups, lids, sleeves, and residual liquid, as well as cleaning the return boxes, a door has been installed on the left side of the return box. After opening the door, the cleaning staff can collect and clean various items (Fig.101).

Figure 101. Schematic of cleaning staff operating the return box

Size and capacity recommendation

To meet the daily demand for 25,000 cups, lids, and cup sleeves, and considering the potential distribution of cup sizes - approximately 90 12oz cups, 70 16oz cups, and 33 20oz cups per box - each of the smart return boxes should have a capacity of at least 67.8 liters. This takes into account factors such as imperfect stacking, twice-daily clearing, residual liquid, an electronic payment system, and RFID reader hardware. Consequently, each box should accommodate approximately 193 cups, lids, and sleeves respectively. For a detailed analysis, please refer to Appendix G.


Return Cupmates here!
Return cups facing down and separate !
Swipe card to get your deposit back !
Cupmate's Landing Point
Thanks for Your Zero-Waste Contribution !
Scan for Your Mx Cupmate Boarding Pass!

Recommended placement for return boxes

When determining the best locations for return boxes in an airport, it's essential to consider areas with high footfall and beverage consumption. Boarding gates, food courts, shops, and lounge areas are prime locations as passengers often finish their drinks in these zones. Additionally, security checkpoints, transit areas, and entrance/exit points are crucial as passengers might discard cups post-security or upon arriving or departing. Proximity to toilets, arrival areas, and car rental zones can also be beneficial, as travelers frequently dispose of finished drinks in these areas. Lastly, placing return boxes near trash bins can be effective, as passengers are already accustomed to disposing of waste in these spots.

Recommendations for Cupmates cup management

Cup retrieval: Considering the possibility that users might mistakenly dispose of the Cupmates cups in regular bins, leading to a loss of these cups, it's recommended to coordinate with the cleaning companies. They should be instructed to inspect the contents of the trash bins during their cleaning routines. If any Cupmates cups are found, they should be returned to the cleaning room.

Hygienic distribution: To ensure the cleanliness of the cups within the airport, after cleaning, the distribution of the cups from the cleaning room to various shops should be done using sealed containers or bags to maintain hygiene.

Maintenance and feedback: Furthermore, "maintenance" translates to ensuring that the cups are not only clean but also in good condition. Regular checks should be done to ensure that the cups are free from cracks, chips, or any other damages. Damaged cups should be removed from circulation and replaced. Additionally, the cleaning and distribution process itself should be reviewed periodically to ensure efficiency and effectiveness. Regular feedback from shops and users can provide insights into potential areas of improvement.

6.5 Key takeaways

- The final concept, "Cupmates Service," offers an engaging reusable cup service at airports. It personifies the cup as Mx.Cupmate on a zero-waste journey and incentivizes proper return behavior with a digital "boarding pass" that can be shared on social media to commemorate the user's eco-friendly experience at Schiphol Airport.

- The Cupmates system features branded sleeves on RFID-tagged PP cups, enables customers to make an initial deposit, and facilitates easy cup returns via smart boxes equipped with RFID readers and electronic payment systems for deposit refunds; the cups are then collected, cleaned, and redistributed across the airport.

- To ensure efficient backend operations, in addition to introducing professional dishwashers and establishing effective communication with various stakeholders, it's also crucial to consider factors such as the volume of cups purchased, the capacity of the return boxes, the stacking structure of the cups, and the frequency of collection and cleaning by the maintenance staff.

07

Discussion

Conclusion

This project addresses the urgent need for sustainable cup alternatives at Schiphol Airport, particularly in the context of upcoming Dutch regulations prohibiting disposable plastic cups for on-site consumption. Through research , the study proposed "Cupmates: Journey to a Zero-Waste Future" as a service solution. This system employs reusable polypropylene (PP) cups, outfitted with branded sleeves and RFID tags, along with smart return boxes and centralized in-airport cleaning facilities. This approach aims to provide a streamlined, environmentally experience for passengers, while also meeting the requirements of businesses and regulations .Feedback from potential users and key stakeholders indicates that the Cupmates system is both feasible for airport implementation and satisfactory for passengers. Therefore, this project provides Schiphol Airport with a possible solution for transitioning away from single-use plastics towards a more sustainable operational framework.

This research project initially aims to tackle the urgent issue of reducing disposable cup waste at Schiphol Airport, especially in light of forthcoming regulations that necessitate alternative solutions. Based on research findings, the following conclusions can be drawn:

- The use of reusable cups made from Polypropylene (PP) material can significantly reduce single-use plastic waste. These PP cups not only comply with Dutch government regulations but also offer cost-effectiveness and user-friendliness. They are convenient, sustainable, lightweight, and portable. Additionally, their recyclability makes them a preferred choice for passengers, businesses, and sustainability efforts.

In the Define phase, the problem statement formulated is: "Faced with new regulations, how can a feasible, viable, and sustainable cup system be developed at Schiphol Airport that not only complies with new regulations but also encourages passenger use and aligns with business interests?" Based on the evaluation and analysis of the Cupmates service system, the following conclusions can be drawn:

- The Cupmates service system is feasible. Feedback from key stakeholders indicates that the current service system is both feasible and viable, and aligns well with business expectations. Given the challenges stakeholders are about to face, the concept of on-site dishwasher cleaning effectively addresses the issue of limited kitchen space for washing reusable cups. Additionally, branded paper cup sleeves not only reflect brand identity but also improve the efficiency of cup distribution.

- From the perspective of potential users of the Cupmates service, passengers involved in the evaluation are generally willing to accept and are relatively satisfied with the service. Moreover, the service utilizes multiple strategies, anchored in the COM-B model, to encourage user behaviour. First, by establishing a responsible passenger image, they are encouraged to use the service. Second, a range of promotional media is used to build user confidence in transitioning to this new sustainable option. Third, the user experience is enhanced through gamified storytelling and the provision of a specially-designed digital boarding pass, serving as incentives to increase enjoyment and satisfaction, thereby encouraging use of the Cupmates service.

- In terms of the Cupmates service system's development, I've outlined an implementation strategy divided into four key phases: Initial Phase, Intermediate Phase, Advanced Phase, and Continuous Improvement. This strategy aims to ensure the effective and sustainable deployment of the Cupmates service at Schiphol Airport.

Limitations

Limited interview capabilities

Due to practical constraints that prevented on-site interviews at the airport, I was unable to conduct in-person user research. This might introduce some biases into the user research findings. Additionally, when selecting passengers with prior airport experience for interviews, it was challenging to reach older passengers who had visited Schiphol Airport within the past month. As a result, the age range of the interviewees was primarily between 22 to 35 years, which may not be fully representative.

Time constraints

Given the limited time frame for graduation and the extensive scope of the project, a significant amount of work had to be completed in a short period. This included extensive desktop research, user and stakeholder interviews, and iterative design and optimization of the proposed solutions. Due to these constraints, some areas might lack in-depth research, and certain design details might require further refinement.

Limited testing capabilities

The inability to test the service model at the airport and observe passenger behavior and feedback in a real-world setting means that the current design might still have areas that require continuous testing and optimization.

Reliance on theoretical basis

Owing to the time constraints, there was a heavier reliance on theoretical foundations to ensure timely completion. However, without extensive feedback and involvement from all stakeholders, the final design proposal might need adjustments based on real-world scenarios. It's essential to validate each touchpoint in the service process, communicate with all relevant stakeholders, and make necessary modifications for successful implementation.

Personal reflection

Enhancing interview skills with stakeholders and users

This project required extensive interviews and research with stakeholders and users. As a non-native English speaker, I initially faced significant challenges in effectively extracting valuable information from interviewees within a limited timeframe. However, under the guidance of my mentor, I refined the interview outlines, practiced them beforehand, and gradually honed my interviewing skills. I also came to realize that a successful stakeholder interview cannot be separated from thorough preparation beforehand. This includes gathering information about the stakeholders, preparing the interview plan, and, when necessary, recording the interview process after obtaining a consent form for later review. During the interview, it's also important to adjust the questions based on the interviewee's responses in order to obtain more useful information.

Applying critical thinking to Information analysis

The authenticity of many literature sources and online information is often difficult to verify. This is especially true in the study of material recycling, where I realized the pitfalls of taking some literature at face value. This led to discrepancies between the documented information and the actual scenario, highlighting the importance of critically evaluating every piece of information and cross-referencing it with multiple sources. I also became aware that when the authenticity of information is in question, it's essential to consult appropriate organizations or experts for repeated confirmation.

Gaining experience in service design for a large company

While I had previous experience with service design projects, they were mostly hypothetical and didn't require actual implementation. This project was my first exposure to a real-world, actionable service design initiative, revealing the myriad challenges and intricate relationships within a service system. Unlike past hypothetical projects, a real-world project demands thorough research and confirmation of every key detail within the system to ensure the design output is on the right track. Additionally, in my previous designs, I tended to focus solely on the user experience, often overlooking business considerations. This project was a comprehensive learning experience that extended beyond the user-centric focus I was accustomed to. It introduced me to the complexities of business design within a service system, encompassing various aspects such as business models, day-to-day operations, procurement strategies, and long-term maintenance plans. This holistic approach helped me realize that for a project to be successfully implemented in the real world, it's crucial to balance user needs with business viability.

08

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