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Graduation Project Brief



Appendix A: Interview plan with Company A

Interview plan with Company A

Intro

Hello, my name is Yu Chen and I am studying for a master's degree in Strategic Product Design at TU Delft.

I'm currently working on a project to develop a circular coffee cup system at Schipol Airport. The background of my project is based on the new regulation of disposable paper cups.

According to EU and Dutch government regulations, from 1 July 2023, customers must pay for disposable plastic cups and food packaging when they collect food or drinks or have them delivered, all merchants need to offer an alternative that can be reused

I will be working more on the design of a new coffee cup service system for the future from a business and strategic aspect

Ask for recording permission & Consent form

Before starting our interview, if you agree, during the interview, I would like to record the meeting for research purposes. Also, I would seek your consent through a Consent form. The data will be processed and analysed anonymously (without your name or other identifiable information). The video, and/or audio recordings will be used to support analysis of the current service system and may be used to support design strategies in publications and presentations about the project. I will send you a consent form after the meeting, which I would like you to sign and send to your email address if you have time.

If this is acceptable, we can proceed with our interview.

Interview questions

1. New regulations

- How will the new regulations impact your business?
- What are the main obstacles your business will be encountering due to the new regulations?
- Do obstacles differ between the different brands you are managing?
- Regarding the price suggestions given in the regulation, consumers need to pay more to use disposable paper cups. What do you think of this price suggestion? For pricing, Company A will suggest that all brands adopt the same pricing strategy, or let the brands decide how to charge? Global brands

if it's possible to have a global solution for all brands.

2. Current management situation

I know that in order to make travelers feel familiar and have a wonderful dining experience in unfamiliar places, Company A not only have its own restaurant brands but also cooperative brands. (role of Company A)

What impact does the company have on the brand?. It has impact on the product selection on the location and how much the brands are regulated and controlled and restricted by Company A and in which aspects of the whole brand are they restricted.

- Are there any differences in management regulations for proprietary brands and cooperative brands? If so, what are the main differences?
- Are there any specific regulations for the disposable paper cups currently supplied by different brands? (It can be considered from the three main processes of paper cup supply, sales and processing)
 - a. Paper cup supply: Are there any specific requirements for paper cups for hot drinks? For example, materials used, dimensions, logos that highlight the brand, etc.
 - b. Sales stage: I also made field observations at Schipol Airport before. I found that businesses prefer to provide disposable paper cups. I would like to ask what is the possible reasons to provide more disposable paper cups than reusable cup?
 - c. Disposal phase: Are there any specific requirements for the disposal of disposable paper cups? Because I found through observation that some businesses, have their own trash cans in the store. Are there any specific regulations on the disposal of waste such as paper cups?

3. Brand experience

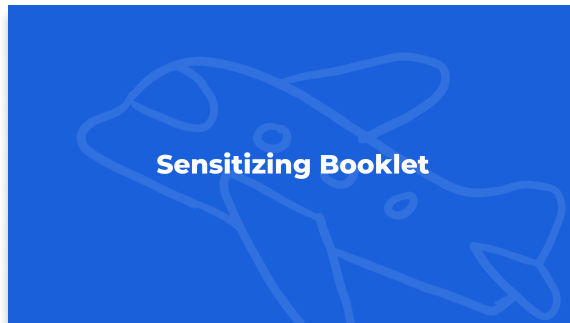
- What do you think are the strengths of your management in terms of brand experience?
- In regard to brand identity (Brand identity is the visible elements of a brand, such as color, design, and logo that identify and distinguish the brand in consumers' minds)
Is it more important to highlight the brand identity of Company A or the brand identity of different brands?

4. New service system

In response to the new regulations, a new service system for disposable paper cups may be implemented in the future to help businesses and guide consumers to better serve a sustainable society. What are your expectations or suggestions?



Wrap-up session

Appendix B: Sensitizing booklet setup



Thank you very much for your participation. Before the formal interview, I would like to provide you with this booklet to help you recall your last experience of having a beverage while waiting at Schiphol Airport.

If you encounter any problems, please do not hesitate to contact me!
Y.CHEN-103@student.tudelft.nl


Please recall your previous travel experience at Schiphol Airport

Your name _____



Your age _____

Your departure & arrival date _____


Your last trip destination _____





Pre-Preparation Phase
Select the luggage you prepared for your last trip

Circle the sticker that matches your mood at the time



Purchase Phase "Did you buy drinks at the airport?"
If you've ever bought a drink at Schiphol airport
Please sketch the scene of you purchasing beverage at the airport.
It mainly highlights what kind of beverage you bought and how the packaging looks like. The icons below are for your reference, you can also circle them

Circle the sticker that matches your mood at the time



Purchase Phase If you bought a hot beverage, then...

A. Circle the packaging for this drink



B. Circle if you used the following products



To help interviewees smoothly recall their beverage-drinking experiences at Schiphol Airport, the booklet follows a storyline that aligns with the passengers' journey, guiding them through a retrospective review. Initially, interviewees were invited to fill out personal information as well as details about their last flight.

The first stage is the **preparation phase**. Understanding what luggage the interviewees carried during their last trip helps collect data on passenger habits at the airport. The number of bags carried could be a significant factor affecting their beverage-drinking behavior.

During the **beverage-purchasing phase**, interviewees are offered a wide range of drink options to make their selection easier. For those who have consumed hot beverages at the airport, actual images were provided to understand their choice of cup and any additional products used.

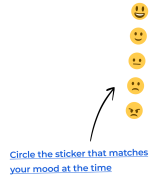
In the beverage-drinking phase, interviewees were encouraged to express, in their own way, any memorable aspects or information about the drinking process. The mode of expression is open-ended, and they were also asked to identify their emotions at the time. This feedback helps trigger a review of their drinking experience and identifies key factors that may have influenced it.



Drinking phase

Please sketch the scene of you drinking beverages at the airport.

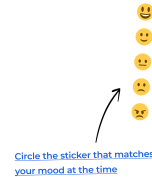
- Brand
- Surroundings
- Your action
- Your emotions
-



Disposing phase

The waste you left after finishing were ...

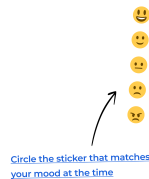
The icons below are for your reference, you can also circle them



Disposing phase

Please sketch the scene of you dealing with waste at the airport.

Where do you put your waste? What kind of trash bin? Whether to separate different waste? ...



Disposing phase

A. What issues do you think you pay more attention to when it comes to handling this type of waste at the airport?

Write down your ideas

B. Are you dissatisfied with the current recycling service & suggestions?

Feel free to write down your ideas



Future vision

In the future, the use of disposable paper cups will be gradually banned. Based on this background, tell us your expectations or advice

wow!

Thank you for your participation! I'm excited to engage in conversation with you. Please feel free to ask any questions or insights you'd like to discuss. Looking forward to our interview!



For the waste disposal phase, the first step is to understand what kind of waste the interviewees generated. They were offered a list of potential food waste items to choose from and are welcome to add any additional waste information. Questions were posed to guide their recollection of the disposal process, including which type of bin they used and whether they separated their waste. Finally, interviewees were invited to reflect on current waste management issues, considering what concerns them the most and offering suggestions for improving recycling services.

The last section proposes a **future vision**. Interviewees were informed that the use of disposable paper cups may be banned in the future, encouraging them to offer their expectations or suggestions.

Overall, the booklet's setup aligns well with the primary user journey of drinking beverages at the airport. It guides interviewees from a review of their own behavior to reflections on specific details, culminating in expectations for future services. This creates a comprehensive journey that also complements the subsequent user interview plan.

Appendix C: Interview plan with passengers who had visited Schiphol Airport in the past month

Schipol passenger Interview process set-up

Purpose of user interviews

- Understand users' perceptions of disposable coffee cup recycling
- Understand the current situation and reasons behind users' behaviour at the coffee use stage and disposal stage
- Understand users' expectations of the new coffee cup

system

Preparation:

Interview outline, Consent form, mobile phone (for audio and video recording), gifts.

Target users

Find someone who is possibly buying a drink. If there are no people available -> regular passengers. Do you have 8 minutes to answer some questions?

Semi-structured interview questions

	Questions	Aim
A	<u>Wrap-up session</u>	
Intro	Hello, I am a student from TUDelft and I am currently conducting research on airport coffee cups. I just saw that you have purchased coffee, you are my target user, and your feedback is quite important to my study. Would it be possible to take about ten minutes of your time for a brief interview?	State the purpose and length of the interview
Consent form	If you agree, during the interview, I would like to record the conversation using my phone and take a picture of the coffee cup you are currently holding (without capturing any faces) for research purposes. Of course, I would seek your consent through a Consent form. If this is acceptable, we can proceed with the formal interview.	Describe the consent form and request to record of the interview process
B	<u>In the scenario of waiting at the airport or for someone:</u>	Understand the current situation of airport

		passengers using coffee cups.
	Do you prefer to use disposable or reusable coffee cups at the airport? Why?	Understand passengers' propensity to use disposable coffee cups & why
	Do you use stirring sticks and lids when you enjoy your coffee and if so, what do you do with them when you throw them away? Why?	Understand passenger use and handling of stirring sticks and cup lids & why
	What are the obstacles or challenges for you to use reusable coffee cups?	Understand the obstacles faced by passengers when using reusable cups.
	What will you do with unwanted coffee cups?	Understand the current situation of passenger handling of coffee cups
	What do you think of the current disposal method?(Any inconvenience or suggestions)	Understand the issues and suggestions regarding the current process of disposing of paper cups.
Alternative questions	How do you feel about the culture of drinking coffee out of disposable paper cups but beer out of glass?	From a cultural perspective, understanding the reasons why passengers use disposable coffee cups.
	Do you notice which drink brand you are consuming? What elements during the beverage service process do you think can leave a strong impression of the brand on you?	Understand passengers' current perception of brands from a branding perspective, in order to provide insights for future brand value enhancement strategies.
	<i>Other questions are targeted according to the passenger's answers</i>	
C	<u>User Perception:</u>	
1	What do you know about the recyclability of disposable coffee cups?	Understand passengers' understanding of coffee cup recycling.
2	What do you know about the environmental impact of disposable coffee cups?	Understand passengers' level of knowledge about

		environmental sustainability.
	On a scale of 1 to 7, how much do you consider yourself to be sustainability-oriented? 1 not at all – 7 Fully aware of sustainability in my life.	The sustainability of the passengers themselves may be an influencing factor in user behaviour
D	<u>In everyday coffee-drinking scenarios:</u>	
	How often do you use disposable coffee cups in your daily life?	Understand the daily use of disposable coffee cups by users
	Under what circumstances do you choose to use disposable coffee cups?	
	Have you considered using reusable coffee cups? Are there things that hinder you?	Understand the scenarios in which users use sustainable coffee cups on a daily basis
Alternative questions	You have made different choices at home and at the airport, why?	Understand the reasons why passengers choose different options for different scenarios
E	<u>Views and expectations on the new legislation (optional, if there is enough time)</u>	
	How would you feel if policy makers decide to charge extra for the use of disposable coffee cups?	Understand passenger attitudes to the new policy
	What features do you think a new coffee cup recycling system needs to have?	Understand passengers' expectations for the design of new coffee cup systems.
Alternative questions	(If passengers find the surcharge for using disposable coffee cups unreasonable), what do you think would make you willing to use reusable coffee cups or alternatives	Understand passengers' suggestions for the design of new coffee cup systems.
	Have you seen any examples of paper cup recycling that are doing better?	Learn about the case studies
F	Wrap up, give a gift, express thanks. Ask respondents if they would like to leave their email for follow-up questionnaire research	

Appendix D: Harris profile evaluation analysis

Desirability evaluation analysis

		Concept 1				Concept 2				Concept 3			
		-2	-1	+1	+2	-2	-1	+1	+2	-2	-1	+1	+2
Desirability	Willing to use the cup												
	No worries about cleanliness of the cups												
	Cups are convenient to use												
	Satisfied with the cup service												
	Cup return rate												
	Willing to return the cup												
	Convenient to return the cup												
	Satisfied with the return service												
	Effectively Inform passengers of the change (new regulation or strategy)												
	Enable passengers to gain knowledge about sustainable choices												
	Enable passengers to gain knowledge of proper recycling / return												
	Provide a great brand experience for passengers												
	Enable passengers from different cultures to participate in the service system												

Willing to use the cup: Since all three concepts use cups made of PP material, they possess characteristics such as portability, insulation, etc. (chapter 2), and can generally meet the needs of airport passengers for using cups. Judging from the willingness to use, they are consistent

No worries about cleanliness : All three concepts use the same machine cleaning method, so there is no need to worry about cleanliness of the cups.

Cups are convenient to use: All three concepts use cups made of the same material, and there is no significant difference in their use.

Satisfied with the cup service: Concept 2, due to its gamified process and promotion through early touchpoints such as posters, allows consumers to more easily understand and become interested in the new cup system, resulting in relatively higher satisfaction

Cup return rate & Willingness to return the cup: Concept 1 may have the lowest user return willingness and cup return rate because it did not adopt a deposit system and did not provide incentives. Concepts 2 and 3 added reward and deposit systems, respectively, which may guide users to return.

Convenient to return the cup: Concept 1 only requires users to return, which is the most convenient. Both Concepts 2 and 3 require users to either scan a QR code or swipe a card in addition to returning the cup.

Satisfied with the return service: Concept 1 offers the simplest user operation. While Concepts 2 and 3 have more complex procedures, users in Concept 2 can receive gift vouchers, and in Concept 3, users can get their deposit refunded. Consequently, the user satisfaction levels for all three concepts are comparable.

Effectively Inform passengers of the change & Enable passengers to gain knowledge about sustainable choices & gain knowledge of proper recycling / return & Enable passengers from different cultures to participate in the service system: Concept 2 uses metaphoric and gamified methods of communication. This approach is more effective in helping consumers understand the current changes in the airport cup system and information related to sustainable cups. Additionally, a more comprehensible way of conveying information is beneficial for increasing user engagement and enthusiasm.

Feasibility & Viability evaluation analysis

		Concept 1				Concept 2				Concept 3			
		-2	-1	+1	+2	-2	-1	+1	+2	-2	-1	+1	+2
Feasibility	Extent of dependency on internal and external Infrastructure												
	Solve the problem of insufficient space for cleaning reusable cups.												
	Effective cleaning efficiency for cleaning companies												
	Easily accepted by various brands at the airport												
	Technically feasible to be implemented within six months.												
Viability	Financially sustainable.												
	Reduce cup loss and damage												

Easily accepted by various brands at the airport

All three concepts incorporate brand identification in the cup design, so their acceptance in terms of branding should be similar.

Extent of dependency on internal and external Infrastructure

Concept 1 is the most self-contained, relying solely on infrastructure within the airport for cleaning and distribution without the need for advanced technology. In contrast, Concept 2 necessitates both internal and external infrastructure, with cleaning outsourced to a third-party company outside the airport, introducing transportation logistics. Concept 3, while similar to Concept 1 in terms of cleaning, incorporates advanced return boxes equipped with RFID technology and payment systems. Among the three, Concept 1 requires the least infrastructure support, while Concept 2 demands the most due to its reliance on external facilities and transportation.

Solve the problem of insufficient space for cleaning reusable cups.

All three concepts address the issue of insufficient cleaning space in individual shops.

Effective cleaning efficiency for cleaning companies

Each concept employs a partitioned design for the return boxes, guiding users to separate the cup lids, cups, and cup sleeves, thereby enhancing the cleaning efficiency for cleaning companies.

Technically feasible to be implemented within six months

Concept 1 stands out as the most straightforward option, given its simplicity and reliance on existing infrastructure, making it likely the easiest to implement within the stipulated timeframe. Concept 2, with its barcode systems and external partnerships, might face challenges in ensuring timely implementation. Concept 3, despite its internal cleaning process mirroring Concept 1, introduces potential complexities with the integration of RFID and payment systems. As such, Concept 1 appears to be the most technically feasible,

Sustainability evaluation analysis

	Concept 1				Concept 2				Concept 3			
	-2	-1	+1	+2	-2	-1	+1	+2	-2	-1	+1	+2
Sustainability Use low-impact materials												
Use clean manufacturing for all the touchpoints												
Efficient distribution and packaging												
Use efficiency <i>Maximize energy conservation, minimize waste, and promote efficient use of materials</i>												
Extended use <i>long-term use through durability, easy maintenance, and prevention of premature obsolescence</i>												
Recovery for reuse <i>Optimize recovery by reuse, refurbishment, remanufacturing, and parts harvesting</i>												
End-of-life efficiency												
System-level sustainability												

Use low-impact materials

Concept 1 stands out as the most efficient, utilizing straightforward PP cups and bins, thereby consuming minimal resources. In contrast, Concept 3, which incorporates an additional RFID tag and a smart return box, is less efficient. The Life Cycle Assessment (LCA) results further highlight that the cups and smart return box in Concept 3 have a more pronounced environmental impact.

Use clean manufacturing for all the touchpoints

Concept 1 stands out as the most efficient because it simply utilizes PP cups without any added technology, reducing energy use and manufacturing complexity. On the other hand, Concept 3, with its RFID technology, demands more energy and sophisticated manufacturing processes, making it the least efficient from this perspective.

Efficient distribution and packaging

Concept 1: Using PP cups paired with a standard bin might be the optimal choice. This approach demands the least additional infrastructure and resources.

Concept 3: Incorporating PP cups with RFID tags, combined with an RFID technology and POS system, might be less favorable. The added complexities of this concept, such as embedding RFID tags into every cup and ensuring compatibility with the RFID technology and POS system at every distribution point, can escalate distribution challenges and associated costs.

Concept 2: The cups in this concept face the longest transit distances, leading to significant distribution challenges. As a result, they exhibit reduced distribution efficiency

Use efficiency

Among the three service design concepts for the airport's reusable cup system, Concept 1, utilizing standard PP cups and regular bins with in-house cleaning, stands out as the most efficient, minimizing both direct and indirect energy consumption. On the other hand, Concept 2, which incorporates barcodes, external cleaning, and a gift voucher system, is deemed the least efficient due to its increased logistical demands and potential overconsumption of resources. While Concept 3 introduces RFID technology and smart bins, its efficiency is somewhat balanced by retaining cleaning operations within the airport, though the electronic components could introduce minor power consumption concerns.

Extended use

Concept 3 shines brightest. The inclusion of RFID technology promotes reusability and durability by motivating users to return the cups. However, Concept 1, employing standard PP cups without any return incentive, ranks last, as it lacks specific mechanisms to ensure cup return and extended use, possibly leading to premature obsolescence.

Recovery for reuse

Among the three reusable cup system concepts for the airport, Concept 3 stands out as potentially the most efficient in terms of "Recovery for reuse" due to its RFID tracking and in-house cleaning, ensuring swift cup circulation. Concept 1, emphasizing direct reuse with in-house cleaning, offers a straightforward and close second in efficiency. Meanwhile, Concept 2, despite its tracking features like barcodes and IML, faces potential inefficiencies due to its reliance on external cleaning and reward systems, possibly making it the least efficient for rapid reuse.

End-of-life efficiency

Concept 1 emerges as the most efficient due to its straightforward design, making it highly amenable to mechanical recycling. In contrast, Concept 3, with its embedded RFID tags, might be the least efficient, introducing complexities in recycling. All concepts utilize PP cups, suitable for mechanical recycling. Concept 2, while using PP, integrates in-mould labels (IML) for barcodes, streamlining recycling by eliminating label separation but potentially introducing challenges due to varied materials or inks. Concept 3's RFID tags could necessitate removal or a shift towards more energy-intensive chemical recycling.

System-level sustainability

When assessing the three airport reusable cup system concepts from a system-level perspective, Concept 3 emerges as the most innovative, leveraging RFID technology to potentially enhance user engagement, streamline the return process, and promote sharing among users, leading to higher sustainability benefits. On the other hand, despite its simplicity, Concept 1 might be the least beneficial at the system level, especially considering its lowest cup return rate, which diminishes its overall sustainability impact. Concept 2, with its in-mould labels, offers an intermediate approach, consolidating tracking and identification into the cup, but without the broader system-level advantages that Concept 3 provides.

Appendix E: LCA calculation process

	Cup & lid Material	Cup add-ons	Cup return box	Cup Cleaning	Transportation
Concept 1	polypropylene (PP)	<ul style="list-style-type: none"> Normal cup Printed QR code cup sleeves with branded logos 	<ul style="list-style-type: none"> Normal return box Cup lid, cup, and residual liquid partition 	Machine cleaning	In-airport transport and distribution
Concept 2	polypropylene (PP)	<ul style="list-style-type: none"> Printed brand logos Cup sleeves (optional) Cup is affixed with In-Mold Label 	<ul style="list-style-type: none"> Smart return box with self-scan function Cup lid, cup, and residual liquid partition 	Machine cleaning	<ul style="list-style-type: none"> 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)	<ul style="list-style-type: none"> Printed QR code Cup sleeves with branded logos Cups tagged with RFID 	<ul style="list-style-type: none"> Smart return box with RFID reader hardware and EPS (Electronic payment system) Cup lid, cup, and residual liquid partition 	Machine cleaning	In-airport transport and distribution

Goal of the assessment

Compare the environmental impact of three service concepts, identify the one with the least environmental impact among the three, and based on the comparison results, propose environmentally favorable concept suggestions to provide insights for the creation of the optimal concept.

System boundaries of the analysis

The scope of work was a 'cradle to end of life' LCA, which includes the impacts of:

- Manufacturing the cups, lids, return box;
- Distributions;
- Washing and drying;
- End of life disposal and recycling.

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% (worst case scenario), the return rate of bins with scanning is 90%, and the return rate of bins 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.

• transportation

Concept 2 has the longest transportation and distribution distance, while Concepts 1 and 3 have consistent distances (assumption 3&4). Therefore, in terms of environmental impact arising from transportation distances (considering that all 3 concepts use the same external transportation methods), Concept 2 would certainly have the largest environmental impact. In the optimal solution, I can adopt the shortest transportation distances from Concepts 1 and 3. Therefore, 'transportation' in the system boundary analysis can be temporarily set aside

• Washing and drying

Assume the cups and lids in all three concepts are washed in the same dishwasher, washing and drying are not considered in the evaluation

Therefore, based on these assumptions and calculation objectives, the main focus is on comparing the production, use, and recycling of cups, as well as the production, use, and recycling of boxes among the three concepts.

Comparison of the environmental impact of 1 cup in the three concepts

Concept 1

1 normal cup		Total	
Cup	Polypropylene, granulate {GLO} market for APOS, U	0.53781	kg CO2-eq
	Printing ink, rotogravure, without solvent, in 55% toluene solution state {RER} market for printing ink, rotogravure,	0.002816	kg CO2-eq
	Chemical, organic {GLO} market for APOS, U	0.001077	kg CO2-eq
	Electricity, high voltage {NL} market for APOS, U	0.411589	kg CO2-eq
Lid	Polypropylene, granulate {GLO} market for APOS, U	0.009229	kg CO2-eq
	Printing ink, rotogravure, without solvent, in 55% toluene solution state {RER} market for printing ink, rotogravure, without solvent, in 55% toluene solution state APOS, U	0.002346	kg CO2-eq

Concept 2

1 IML cup		Total	
Cup	Polypropylene, granulate {GLO} market for APOS, U	0.57782	kg CO2-eq
	Printing ink, rotogravure, without solvent, in 55% toluene solution state {RER} market for printing ink, rotogravure,	0.11075	kg CO2-eq
	Chemical, organic {GLO} market for APOS, U	0.001077	kg CO2-eq
	Electricity, high voltage {NL} market for APOS, U	0.411589	kg CO2-eq
Lid	Polypropylene, granulate {GLO} market for APOS, U	0.009229	kg CO2-eq
	Printing ink, rotogravure, without solvent, in 55% toluene solution state {RER} market for printing ink, rotogravure, without solvent, in 55% toluene solution state APOS, U	0.002346	kg CO2-eq
In-mould label	Polypropylene, granulate {GLO} market for APOS, U	0.010255	kg CO2-eq
	Printing ink, rotogravure, without solvent, in 55% toluene	0.002086	kg CO2-eq
	Electricity, high voltage {NL} market for APOS, U	0.016464	kg CO2-eq
	Heat, from steam, in chemical industry {RER} market for heat, from steam, in chemical industry APOS, U	0.011204	kg CO2-eq

Concept 3

1 RFID tag cup		Total	
Cup	Polypropylene, granulate {GLO} market for APOS, U	0.53861	kg CO2-eq
	Printing ink, rotogravure, without solvent, in 55% toluene solution state {RER} market for printing ink, rotogravure,	0.11075	kg CO2-eq
	Chemical, organic {GLO} market for APOS, U	0.001077	kg CO2-eq
	Electricity, high voltage {NL} market for APOS, U	0.411589	kg CO2-eq
Lid	Polypropylene, granulate {GLO} market for APOS, U	0.009229	kg CO2-eq
	Printing ink, rotogravure, without solvent, in 55% toluene solution state {RER} market for printing ink, rotogravure, without solvent, in 55% toluene solution state APOS, U	0.002346	kg CO2-eq
RFID tag	Aluminium, wrought alloy {GLO} market for APOS, U	0.000421	kg CO2-eq
	Silicon, electronics grade {GLO} market for APOS, U	0.000385	kg CO2-eq
	Polypropylene, granulate {GLO} market for APOS, U	0.002188	kg CO2-eq
	Electricity, high voltage {NL} market for APOS, U	0.000152	kg CO2-eq

Since the three concepts formed in the ideation phase have not been actually produced, all judgments on raw materials are based on online information as well as related materials from Cupclub and student reports. The results may have some bias, but the analysis is only used for making a general assessment of sustainability.

Comparison of the environmental impact of 1 return box in the three concepts

Concept 1

1 normal return box			Total	116.09667	kg CO ₂ -eq
Steel, low-alloyed {GLO} market for APOS, U				20.059172	kg CO ₂ -eq
Electricity, high voltage {NL} market for APOS, U				96.037494	kg CO ₂ -eq

Concept 2

1 return box with scanning function			Total	150.72092	kg CO ₂ -eq
Steel, low-alloyed {GLO} market for APOS, U				20.059172	kg CO ₂ -eq
Polycarbonate {GLO} market for APOS, U				8.1768359	kg CO ₂ -eq
Silicon, electronics grade {GLO} market for APOS, U				38.520704	kg CO ₂ -eq
Electricity, high voltage {NL} market for APOS, U				46.646783	kg CO ₂ -eq
Electricity, high voltage {NL} market for APOS, U				3.0183212	kg CO ₂ -eq
Electricity, high voltage {NL} market for APOS, U				34.299105	kg CO ₂ -eq

Concept 3

1 return box with RFID reader hardware and POS system			Total	229.13831	kg CO ₂ -eq
Steel, low-alloyed {GLO} market for APOS, U				20.059172	kg CO ₂ -eq
Polycarbonate {GLO} market for APOS, U				12.265254	kg CO ₂ -eq
Silicon, electronics grade {GLO} market for APOS, U				77.041408	kg CO ₂ -eq
Electricity, high voltage {NL} market for APOS, U				46.646783	kg CO ₂ -eq
Electricity, high voltage {NL} market for APOS, U				4.5274818	kg CO ₂ -eq
Electricity, high voltage {NL} market for APOS, U				68.59821	kg CO ₂ -eq

Since the three concepts formed in the ideation phase have not been actually produced, all judgments on raw materials are based on online information as well as related materials from Cupclub and student reports. The results may have some bias, but the analysis is only used for making a general assessment of sustainability.

Comparison of the three concepts considering the return rate

Concept 1

Concept 1 (60% return rate, consider the worst-case scenario)	5378.12	kg CO2-eq
normal cup production	13445.19	kg CO2-eq
normal return box	0.04241	kg CO2-eq
Electricity, high voltage {NL} market for APOS, U	0.003007	kg CO2-eq
normal cup production	-8067.11	kg CO2-eq

In light of the absence of reliable data on cup return rates in standard return boxes, I've made a rough estimate of the return rate based on several factors. Concept 1 stands out for its visually appealing design and unique elements that captures the essence of Schiphol Airport. This increases the likelihood of passengers taking the cups as souvenirs. Moreover, Concept 1 lacks a deposit system, and given the high foot traffic at the airport, this could potentially result in a greater loss of cups. Taking all these factors into account, I've conservatively estimated a return rate of 60% for cups from Concept 1.

Concept 2

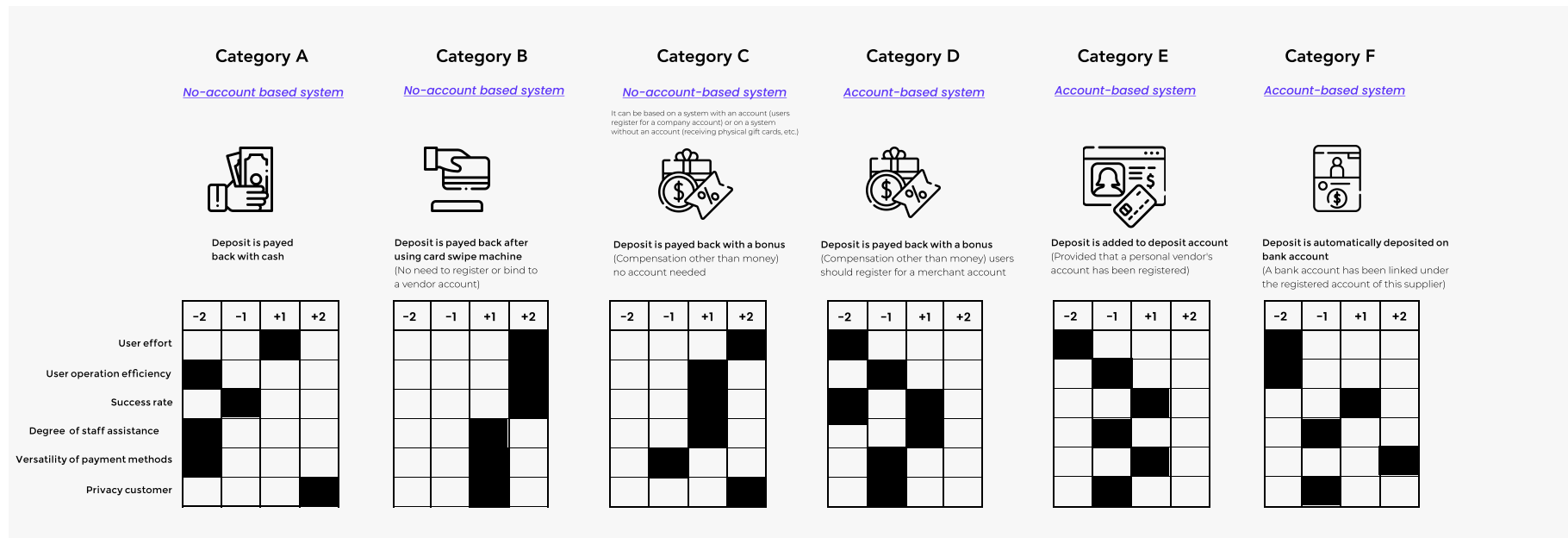
Concept 2 (90% return rate)	1444.66	kg CO2-eq
IML cup production	14445.39	kg CO2-eq
1 return box with RFID reader hardware and POS system	0.082587	kg CO2-eq
Electricity, high voltage {NL} market for APOS, U	0.027439	kg CO2-eq
Electricity, high voltage {NL} market for APOS, U	0.000752	kg CO2-eq
Electricity, high voltage {NL} market for APOS, U	0.001504	kg CO2-eq
IML cup production	-13000.9	kg CO2-eq

Concept 3

Concept 3 (95% return rate)	673.481	kg CO2-eq
RFID cup production	13465.18	kg CO2-eq
1 return box with RFID reader hardware and POS system	0.156944	kg CO2-eq
Electricity, high voltage {NL} market for APOS, U	0.054879	kg CO2-eq
Electricity, high voltage {NL} market for APOS, U	0.005638	kg CO2-eq
Electricity, high voltage {NL} market for APOS, U	0.00141	kg CO2-eq
Electricity, high voltage {NL} market for APOS, U	0.003759	kg CO2-eq
RFID cup production	-12791.9	kg CO2-eq

Since the three concepts formed in the ideation phase have not been actually produced, all judgments on raw materials are based on online information as well as related materials from Cupclub and student reports. The results may have some bias, but the analysis is only used for making a general assessment of sustainability.

Appendix F: Comparison of current deposit systems



Use effort

The no-account based system (Category B and C) requires less effort from users. Considering that returning a cash deposit might involve queuing or communicating with staff, the user effort increases. Given that airports primarily cater to occasional or one-time consumers, the account-based system (Category D, E, F) requires registering a new account, which demands the most user effort.

User operation efficiency

Category B performs the best. Firstly, for one-time consumers, a system without an account is more efficient than an account-based system, making Category D, E, F the least efficient. Secondly, using bonuses as a return might require additional steps like redemption, which adds an extra step compared to the automatic refund of Category B.

Success rate

Among the options, Category B stands out as the best, with auto-refunded deposits upon card swiping likely achieving a high success rate due to its automated processes. In contrast, Category C, which offers bonuses, might lag behind in success rates due to the complexity introduced by additional steps

Degree of staff assistance

Category B excels as the optimal choice, with its automated processes in systems that auto-refund deposits, minimizing the need for staff intervention. On the other hand, Category A, which involves cash returns, may be less efficient due to the potential need for staff involvement in handling cash or resolving related issues

Versatility of payment methods

For versatility in payment methods, Category E stands out as the best choice, with systems that enable deposits to be credited back to a registered merchant account, providing a range of payment options. In contrast, Category A, which relies on cash returns, offers limited flexibility in payment methods.

Privacy for Customers

Account-based deposit systems, such as Categories D, E, and F, are more susceptible to privacy breaches as they may require extensive personal information, including names, addresses, bank accounts, or credit card details. In contrast, methods that offer direct cash or bonus returns without the need for account registration are the most protective of user privacy.

Appendix G: Capacity analysis for smart return box

Key assumptions:

- Daily requirement: 25,000 reusable items (cups, lids, sleeves).
- Total collection points: 60-70 smart return boxes.
- For simplicity, consider an average of 65 boxes.
- For simplicity, consider the 12oz, 16oz, and 20oz cups each account for one-third of the total number.

Items per collection point:

- Daily items per box: $25,000 \text{ items} \div 65 \text{ boxes} = 384.6$, rounded up to 385 items.
- Items per box per collection (consider it's cleared twice a day): $385 \text{ items} \div 2 = 192.5$, rounded up to 193 items.

Breakdown by item type:

- **Cups, Lids, Sleeves: As previously calculated.**

Additional components:

- Residual liquid area: To account for leftover liquids, a separate compartment or a drainage system at the base of the box would be ideal. This could occupy around 10% of the total box volume, which is 5.53 liters.
- Electronic payment system: A compact electronic payment module, including a card reader and a cash dispenser, would be integrated. This might take up a volume of approximately 5 liters.
- RFID Reader Hardware: The hardware for reading RFID tags, given its compact nature, might occupy around 2 liters.

Adjusted volume requirement per box:

- Previously calculated volume: 55.27 liters.
- Additional components volume: 5.53 liters (liquid) + 5 liters (payment) + 2 liters (RFID) = 12.53 liters.
- Total volume: 55.27 liters + 12.53 liters = 67.8 liters.

Estimating cup size distribution based on beverage trends

It's difficult to give a precise breakdown of how the 193 cups were distributed without specific information on the actual usage patterns of each cup size. However, we can make a prediction based on widespread patterns:

- Perhaps the most typical serving size for regular coffee or tea is 12 oz (Marshall, 2023b).
- For larger servings or specialty drinks, the 16oz cups might be popular (Solutions, 2023).
- The 20oz cups may be used less frequently but are reserved for extremely large portions or iced drinks.

Based on these presumptions, a possible distribution might be:

- 12oz = 90 cups.
- 16 oz = 70 cups
- 20oz = 33 cups

Conclusion:

To meet the daily demand of 25,000 items at the airport, each of the 65 smart return boxes should ideally have a capacity of at least 67.8 liters, factoring in imperfect stacking, twice-daily clearing, residual liquid, electronic payment systems, and RFID reader hardware. Additionally, understanding the potential distribution of cup sizes is pivotal. A hypothetical breakdown [suggests that of the 193 cups per box, there might be 90 12oz cups, 70 16oz cups, and 33 20oz cups](#). This comprehensive design ensures efficient collection while catering to diverse beverage preferences and facilitating a user-friendly return and payment experience.

IDE Master Graduation

Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

! USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT

Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

STUDENT DATA & MASTER PROGRAMME

Save this form according the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy". Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1 !



family name _____
 initials _____ given name _____
 student number _____
 street & no. _____
 zipcode & city _____
 country _____
 phone _____
 email _____

Your master programme (only select the options that apply to you):

IDE master(s): IPD Dfl SPD

2nd non-IDE master: _____

individual programme: - - - (give date of approval)

honours programme:

specialisation / annotation:

SUPERVISORY TEAM **

Fill in the required data for the supervisory team members. Please check the instructions on the right !

** chair _____ dept. / section: _____
 ** mentor _____ dept. / section: _____
 2nd mentor _____
 organisation: _____
 city: _____ country: _____

comments
(optional)
 |
 |
 |

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v.



Second mentor only applies in case the assignment is hosted by an external organisation.



Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.

APPROVAL PROJECT BRIEF

To be filled in by the chair of the supervisory team.

chair _____ date ____ - ____ - ____ signature _____

CHECK STUDY PROGRESS

To be filled in by the SSC E&SA (Shared Service Center, Education & Student Affairs), after approval of the project brief by the Chair. The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total: _____ EC

YES all 1st year master courses passed

Of which, taking the conditional requirements into account, can be part of the exam programme _____ EC

NO missing 1st year master courses are:

List of electives obtained before the third semester without approval of the BoE

name _____ date ____ - ____ - ____ signature _____

FORMAL APPROVAL GRADUATION PROJECT

To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked **. Next, please assess, (dis)approve and sign this Project Brief, by using the criteria below.

- Does the project fit within the (MSc)-programme of the student (taking into account, if described, the activities done next to the obligatory MSc specific courses)?
- Is the level of the project challenging enough for a MSc IDE graduating student?
- Is the project expected to be doable within 100 working days/20 weeks ?
- Does the composition of the supervisory team comply with the regulations and fit the assignment ?

Content: APPROVED NOT APPROVED

Procedure: APPROVED NOT APPROVED

comments

name _____ date ____ - ____ - ____ signature _____

_____ project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date _____ end date _____

INTRODUCTION **

Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

space available for images / figures on next page

introduction (continued): space for images

image / figure 1: _____

image / figure 2: _____

PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

ASSIGNMENT **

State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date _____ - _____ end date _____

MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, Stick to no more than five ambitions.

FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.