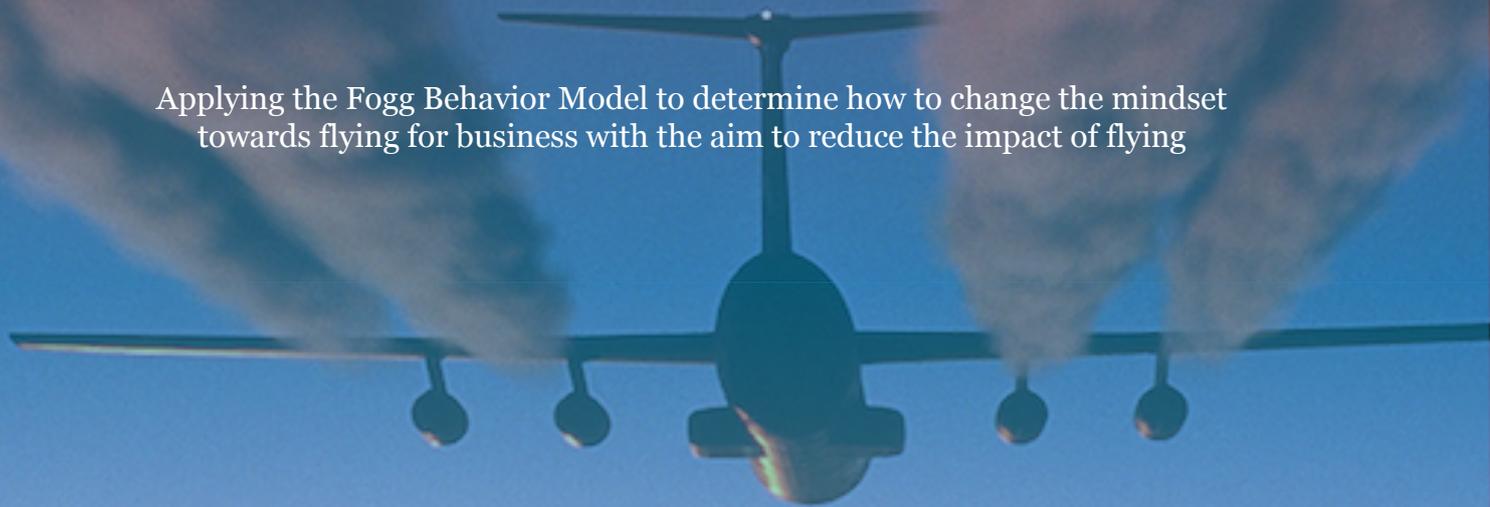# SUSTAINABLE BEHAVIOR CHANGE TOWARDS SHORT-HAUL FLIGHTS FOR BUSINESS TRIPS

Applying the Fogg Behavior Model to determine how to change the mindset towards flying for business with the aim to reduce the impact of flying

By Victor Hupe

SUSTAINABLE BEHAVIOR CHANGE TOWARDS SHORT-HAUL FLIGHTS FOR BUSINESS TRIPS

APPLYING THE FOGG BEHAVIOR MODEL TO DETERMINE HOW TO CHANGE THE MINDSET TOWARDS FLYING FOR BUSINESS WITH THE AIM TO REDUCE THE IMPACT OF FLYING

Author
Victor Hupe

Master Thesis - November 2022
MSc Strategic Product Design
Department of Industrial Design Engineering
Delft University of Technology
Delft, The Netherlands

Supervisory Team
Chair Giulia Calabretta
Mentor Ruud Balkenende
Irene Fernandez Villegas

TUDelft

Abstract

Companies let their employees take short-haul flights for business trips while there are alternative, more sustainable, modes of transport. Understanding the motivation of the company and their employees for flying is essential to create a design solution which could change their behavior. To reach the goal of a maximum global temperature rise of 1.5 degrees by 2050, we have to change our polluting behavior as much as possible. The data reported in this report is drawn from both a literature study and a series of qualitative, semi-structured interviews. The results of the research show that for the company the motivation to go on a business trip is driven by social motivators. The motivation of employees is driven by emotional motivators. Both the company and the employees experience physical motivators when choose to fly (compared to other modes of transport). The design solution is a seminar that helps creating awareness about the impact of short-haul flights in combination with a website, where users are guided in their decision to go on a business trip and in their choice for the best suited (sustainable) mode of transport.
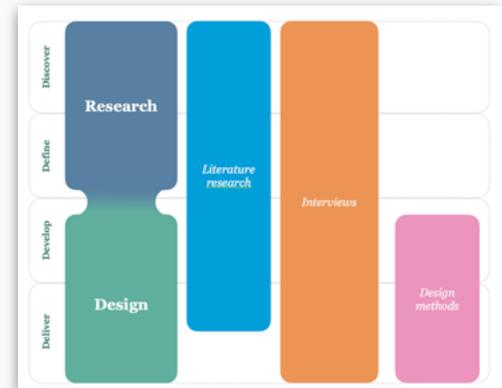
Summary

Companies let their employees take short-haul flights for business trips while there are alternative, more sustainable, modes of transport. Understanding the motivation of the company and their employees for flying is essential to create a design solution with which their behavior can be changed. To reach the goal of a maximum global temperature rise of 1.5 degrees by 2050, we have to change our polluting behavior as much as possible.

To find a possible solution the research question for this thesis the following: What are the motivators causing companies and their employees to go on business trips and choose flying as their mode of transport (when sustainable alternatives exist), and how can this knowledge be used to change the behavior to be more sustainable (following the Fogg Behavior Model)?

Figure 1, project approach according to the double diamond method and the use of different methods for each stage.
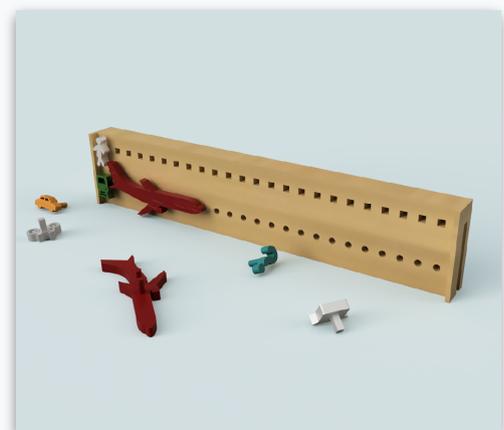
The project approach is based on the Double Diamond-method (figure 1 shows the different stages of this project and the used methods). The data reported in this report is drawn from both a literature study and a series of qualitative, semi-structured interviews. Also design methodes like How Might We, brainstorming and testing with the target group were used.

The results of the research show that for the company the motivation to go on a business trip is driven by social motivators, for employees this is because of emotional motivators. Both the company and the employees experience physical motivators when choose to fly (compared to other modes of transport).

The design solution is a seminar with the goal to create awareness about the impact of short-haul flights used for business trips. To achieve this goal I came up with an exercise where participants, through planning a business trip, become more aware of the pollution emitted by aircrafts and what feasible alternatives are for flying (figure 2 shows the board which represents a trip and the figures that can easily be attached). After the seminar, to ensure that the participant does not forget what was concluded in the seminar, several emails will be sent in the year after the seminar. The email will help the participant to less likely fall back into their "old" habit. The emails will be received after: one day, seven days, one month, three months, six months, nine months and one year. When the person responsible for arranging the trip is notified with the need for a business trip they can make use of a website. Through a serie of questions the website will present a personalized advise.

Figure 2, board and figures used during the seminar.

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Introduction

1.1 Motivation

Ever since I was a little boy, travelling and going on an adventure were my favorite things to do. I like to discover new places in the Netherlands but also abroad. I am fascinated by exploring new worlds, trying different foods and meeting new people. It inspires me to see how people all over the world find solutions for their problems. This does not only apply to people but also to animals and nature in general.

In my ideal world, people would live in symbiosis with nature in combination with technological advances. Our current way of living, however, is destroying our planet. Transport, and flying in particular is a significant contributor to this [1]. Transport accounts for more than one-fifth of global carbon dioxide (CO_2) emissions and one-fourth if we only consider Co_2-emissions from energy. This frustrates me. In order to create a world in which we can still explore and learn from other countries and cultures, we have to do something different.

With my background in design (through the bachelor Industrial Design Engineering and master Strategic Product Design) and biology (through my minor Biodiversity and Natural Environment), I want to try to find the right balance between human and nature. I would like people to pursue their dreams and travel around the word, without damaging nature.

With this thesis I try to tackle the problem of why companies let their employees take short-haul business flights while there are alternative, more sustainable, modes of transport. I will do this by understanding what motivates companies and their employees to go on a business trips. Based on this I will create a design solution that could help changing their behavior.

Even though my thesis is focussed on changing behavior, I thought I could be beneficial for my to apply for the sustainable aviation lab. Here, together with a team of 9 Leiden-Delft-Erasmus (LDE) universities students (with backgrounds in Aerospace engineering, Governance of Sustainability, Engineering and policy analysis, Industrial Ecology and Industrial Design Engineering) I worked on a sustainability challenge set by an external organization (NLR). During the lab I met guest speakers, relevant experts and commissioner(s), I followed workshops, joined a thesis group and created an interdisciplinary result together with the other students. More information can be found in Appendix A.

1.2 Problem statement

That flying is bad for the environment [2, 3], is nothing new. Flying is bad because the polluting gasses emitted during are directly emitted in the upper atmosphere. Here they can stay longer and can cause more damage [4]. These polluting gasses are not composed of CO_2 alone. They also consist of nitrogen oxide, soot and sulphate, nitrogen dioxide and water vapor. Because of this combination of substances, the negative effect on the atmosphere is two to four times as great compared to only emitting CO_2 [4]. CO_2 is the biggest contributor of these green-house gasses (GHG) emitted through flying (70% of the gasses emitted is CO_2, just under 30% is water vapor and less than 1% contains the other GHG's [4]).

The in-use phase of an aircraft (when it is used to fly) accounts for nearly all of an aircraft's life cycle environmental impacts. Fuel consumption is the biggest part [5, 6, 7]. This research will focus on the GHG's emitted in flight for short haul flights. As mentioned before, these GHG's consist for 70% out of CO_2. It is by far the biggest part of the GHG's [4, 8].

CO_2 includes also other greenhouse gasses (besides CO_2). As mentioned before, this combination of gasses results in a negative effect on the atmosphere which is two to four times as great (compared to only emitting CO_2). Therefore, in the scope of this research I will use CO_2 when comparing different modes of transport.

The aviation sector accounted for 3.8% of total CO_2-emissions and 13.9% of total GHG-emissions from transport in 2017 at EU-level [9, 10]. Between 1990 and 2012, the amount of CO_2-emissions from the aviation industry has increased by 75% [3, 11, 12]. According to the BBC, the total

passenger numbers are expected to double in the next twenty years [13]. Between 2013 and 2018 emissions from aircrafts have increased 32%. The United Nations Aviation Body estimates that the CO_2-emission emitted by aircrafts reached just over 900 million metric tons in 2018 and will be tripled by 2050 [10].

Development in the technology of, for example, fuel does result in lower emission per passenger but is not able to keep up with the rise in demand. The David Suzuki Foundation says that the improvements in efficiency only increase by 1 or 2% per year, while the aviation is growing up to 5% every year. Because other sectors are starting to reduce their emissions, it could be possible that in 2050 the aviation industry will take up 25% of the "carbon budget" that is set in order to limit the worlds temperature rise to 1.5 degrees celsius [10, 14]. Cumulative CO_2-emissions are kept within a budget by reducing global annual CO_2-emissions to net zero. This assessment suggests a remaining budget of about 420 $GtCO_2$ for a two-thirds chance of limiting warming to 1.5 degrees celsius, and of about 580 $GtCO_2$ for an even chance (medium confidence) [14].

"Aircrafts, for all intents and purposes, are becoming more fuel efficient. But we're seeing demand outstrip any of that. The climate challenge for aviation is worse than anyone expected." [14]

One of the contributors to this problem is the business passenger. While only 12% of all the travel passengers are people who travel for business, their trips result in more than 12% of the carbon emission [15]. The average business traveler takes around seven trips a year [16, 17].

Each trip takes on average only 3 days [16, 18]. Business trips are often short-haul flights within 1500 kilometer [19, 20]. And a lot of flights are short haul (more than 50% of the flights from Schiphol in 2019 were within 1000 kilometer, with almost 25% of the flight being within 500 kilometer) [21]. These short trips are less efficient (based on fuel consumption per passenger kilometer) compared to long haul trips, where a much higher proportion of the journey is in the relatively efficient cruise phase [22, 23]. Long-haul flights emit more GHG's in absolute numbers, but long-haul business trips are often longer (for 5-6 days which is twice the duration of a short-haul business trips) [16]. One reason for this is that airlines often use less fuel-efficient planes for shorter flights [18].

Studies have also found that business-class seats are responsible for up to five times as much CO2-emissions, because they take up more physical space in the airplane [24]. But, passengers who fly for business and buy an economy seat also add to the problem. Business passengers also fly more frequently compared to leisure passengers [25].

Even though business-class seats are responsible for more emission, passengers are not able to compensate an equal factor [26].

Business trips can also have a negative impact on the travelers [27]. Ivancevich et al. presents a stress model that shows the relationship between the business travel stress on the individual and organizational levels. They acknowledge that alternatives for business travel already exist, but that many activities which are business related depend on personal contact and communication between individuals. These trips, however, cause stress for the employee because of pre-, during-, and post-trip factors at the person level in combination with knowledge gaps (lack of familiarity with a market, technology or partner), government and political restrictions, or organizational resource constraints.

In short, these business trips have both a negative effect on the environment and on the travelers. This will only become more, since the demand for air travel keeps increasing [4]. Something has to change.

Research question
The research question that I try to answer in this thesis is the following: What are the motivators causing companies and their employees to go on business trips and choose flying as their mode of transport (when sustainable alternatives exist), and how can this knowledge be used to change the behavior to be more sustainable (following the Fogg Behavior Model)?

Design assignment
For the design assignment, I will use this research to present a design solution that makes it easier for companies and their employees to consider alternative modes of transport when they have to go on a business trip. This should be done through creating awareness. The awareness should be created by informing the employees what environmental impact flying has in combination with the advantages of alternative modes of transport. The user also needs to be guided in making their decision to go on a business trip and how.

1.3 Project approach

This project starts with research, from this conclusions are drawn which are then used to design a possible solution. It is important to understand the context to be able to identify the problem and the reason why the desired sustainable behavior is not performed currently. When this is identified, a solution to the problem should be proposed. The approach I used for this project is based on the Double Diamond-method [28]. The first half focuses on the problem space, with the goal of understanding the context and defining the challenge. This is the research phase. The second half focuses on the solution space, with the goal of creating a proposal that provides a solution to the defined challenge. This is the design phase. Figure 1.01 shows the different stages of this project and the used methods. In the next chapter I will describe each method more in-depth.
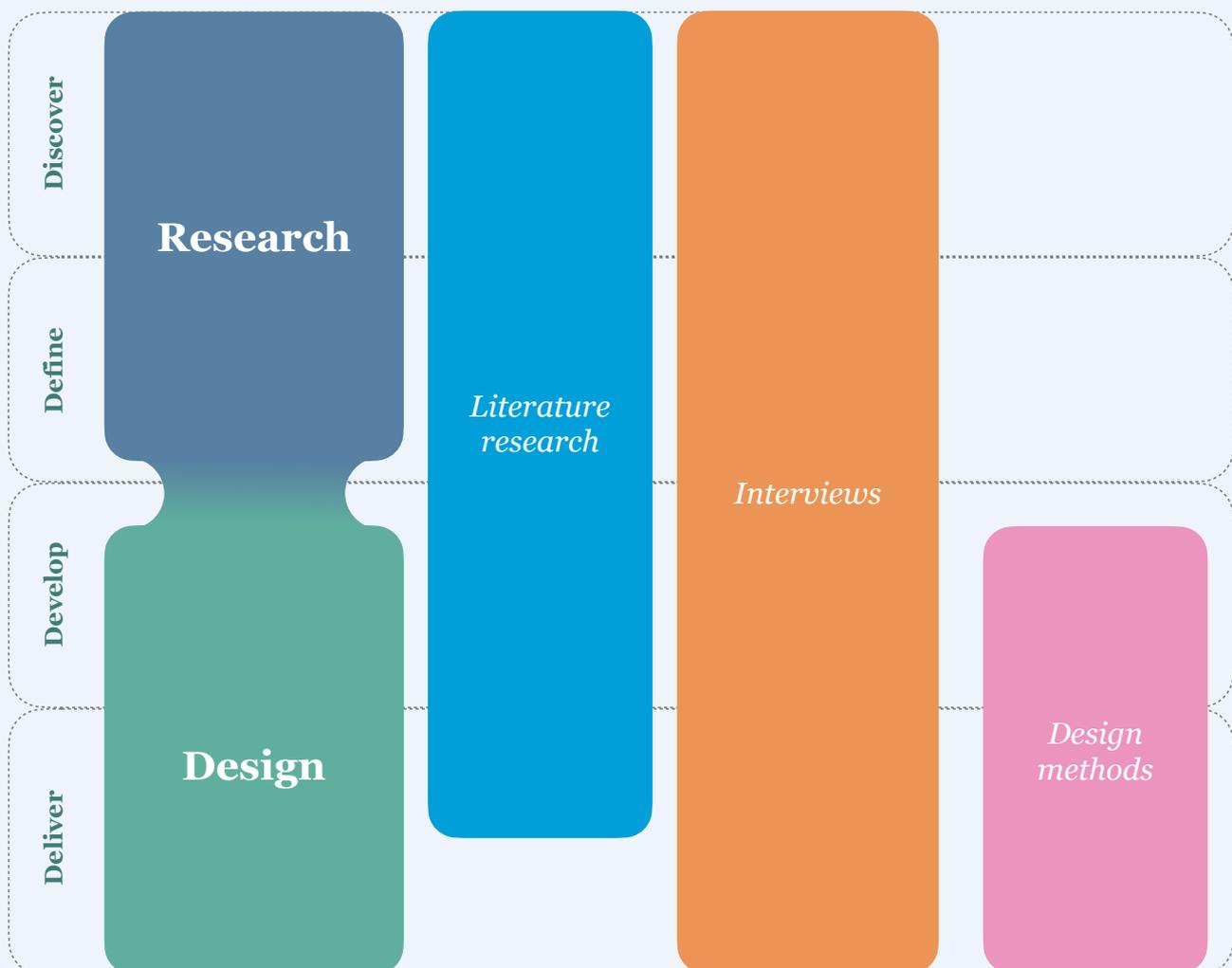
Figure 1.01, project approach according to the double diamond method and the use of different methods for each stage.

Methodology

In this chapter I will present the methods used in the research and the design phase. The data reported in this paper is drawn from both a literature research and interviews. In this chapter I will explain the variety of methods used to answer to my research question. I started with a literature research to better frame the core of the problem. During this literature study I conducted interviews to verify the information gathered from the literature research and to discover possible new insights.

The outcomes and conclusions from my research are the start of the design process. This allowed me to ensure that the choices made during designing had a strong argumentation based on research. In the design process, I used different methods conducted from the Delf Design Guide [29]. This chapter is divided in the sections Discover, Define, Develop and Deliver. Every subchapter describes which methods were used and why.

2.1 Discover: Context exploration

2.1.1. WWWWWH

I used the WWWWWH-method to discover the problem. By going over the What, Why, When, Where, Who and How of the problem, I have been able to identify the problem in its entirety. Through doing research I tried to answer all the different letters in this method. The conclusions were:

What
Determine the motivators causing companies (and their employees) to go on physical business trips and choose flying as their mode of transport (when sustainable alternatives exist), and find how this be used to change the behavior to be more sustainable (following the Fogg Behavior Model)?

Why
Short-haul flights have a major impact on the environment and there are often alternative ways of travel (in Europe) that are less polluting and can also have benefits for the company (such as cheaper or short-lived) and the employee (in the train does not have to wait for take-off before the passenger can do any work).

When
The problem is in full swing. The solution must come as soon as possible. Long-term developments can certainly be a good option, but there must be a world in which those solutions can be implemented. That is why it is perhaps more important to focus on short-term solutions (this is then a solution that is effective within 30 years).

Where
The problem is happening worldwide. In the parts of the world where many short flights are made (for whatever reason, this can be both the large amount of business and a rough habitat where alternatives are not a solution), the design solution will be able to make the most impact in the short term. The focus will first be on flights from the Netherlands to Europe, followed by Europe as a continent. After this, other continents where the majority of short flights take place will be looked at.

Who
The focus will be on short-haul business travellers. Short-haul flights are flight over a distance below 1500 km. The design solution can later be changed to also be applicable to leisure flights. The difference is mainly the motivation for the trip, where the business traveller wants to go as quick as possible from A to B, can for the leisure trip the journey already be part of the experience. Also for business trips their is also the often the opportunity to do things online, whereas the online option is not really feasible for leisure trips.

How
It would be most impactful if flying became illegal. However, this is not realistic. That's why it has to come from the demand for flying. The solution that should work in the short term will therefore probably best be found in changing the behavior of the passenger through awareness of the impact of flying and making the ability higher.

2.2 Define: Context defining

In order to be able to define the context fully, I have combined literature research with conducting interviews. At the end of the research I made a customer journey map to summarize my findings. From that I derived requirements which formed the base of the ideation-process.

2.2.1. Literature research

To collect data for this research I mainly used scientific papers. Other sources were reports, webpages and books.

The papers read for the literature research where placed in different thematic categories, to cover all relevant aspects of the problem definition. Every category was conceived with a different goal in mind. These are listed below with corresponding categories.

I. **The Fogg Model**
   - To understand how the behavior change model works.
   - To find out what causes behavioral change.
   - How this model can be used specific for this project.

II. **Behavioral change**
   - To understand which elements cause behavioral change.
   - How a designer can change behavior through their concept.

III. **Flying behavior**
   - To see what the current perception of flying is (with a focus on business flights)?
   - To find whether people are aware of the amount of emission of the aircraft they make use of.

IV. **Sustainable behavior**
   - To find, among other things, to what extent people are aware of their impact, from the pollution emitted during their flight, on the environment.

V. **(Developments in) Aviation**
   - To find what current developments are within the aviation sector.

VI. **(Developments in) Business trips**
   - To find what current developments are towards meeting for business.

2.2.2. Interviews

The interviews are a series of qualitative, semi-structured interviews with twelve Dutch employees who fly for business and work in different sectors. This approach was selected because one-on-one data collection is helpful when trying to obtain information about motivation and ability, since deeper interviews are possible [29]. This type of data collection can help finding the core of the motivation and ability.

In order to find individuals who fly for business, I reached out to different companies (from which I assumed they might fly for business) to find respondents. I used an approach similar to snowball sampling technique; I used the first participant to find new participants [30]. The participants were self-selected based on whether they fly for business themselves.

As mentioned in the introduction of this chapter, the aim of the interviews was to verify the information gathered from the literature research and possibly to discover new insights (which might be in line or contrary with the literature research). But also:

- Identifying the (current) motivators towards business trips and flying for these trips;
- Identifying the triggers for business trips;

- Finding out how aware people are of the impact of their flying;
- Determining how easy it is to choose flying as mode of transport.

During the interviews a distinction was made between the motivators from the perspective of the company and the motivators from employees themselves. The companies' perspective is formulated based on how the employees perceived this. People from different work sectors were interviewed, to see if there are overlapping motivators among different sectors. Different sectors were used to collect as many different perspectives as possible. The participants came from the following work sectors: aerospace, education, festival branch, insurance, maritime, the clothing industry and the steel industry.

Respondents were interviewed individually. The interview questions can be found in Appendix B. These are some questions that were asked:

- What is the purpose of the business trips (f.e. having a meeting)?
- Why do you want to go on a business trip?
- Why do you think your company wants you to go on this business trip?
- To what extent are you aware of the impact (on the environment) of flying
- In what situation have your opted not to fly?
- What do you perceive as a high priority when traveling?
- Which mode of transport is the best for your company's reputation?

These questions arose through the literature research, by looking at how other researchers had used the Fogg Behavior Model and how they formulated their questions [31, 32]. To find the ability I looked at the six factors which form the

ability. Each factor has a question that can be asked to find how high the ability is for that factor. These questions are deducted from other papers that also make use of the Fogg Behavior Model [31, 33, 34]. Some questions differ when asked to employers and employees respectively and were used in the interviews to gather information about each ability factor.

The classification of the triggers is based on the twenty-three types of nudges found in a paper by Caraban et al. [35].

As an example of coding, from the interview with the employee working at BOAL (Steel industry):

*"If a customer has a complaint we prefer to visit them to **show we take their complaint serious**, determine the problem and come up with a solution."*

Instigate empathy

Interviews were recorded, transcribed, and coded. Since not every interviewee agreed on being recorded, I also made notes which were later coded. Coding helped finding the differences and similarities between the respondents, within work sectors but also between work sectors.

In coding the transcripts/notes, I looked for surprising, outstanding or recurring topics. These became codes that I then tried to organize under themes. The themes are based on the categories of the motivators, the different factors for the ability and the three categories of triggers.

After coding, there could be doubts about allocating the codes into the right themes. In case this happend, the examples found in literature were used to give a decisive answer in the search for the most fitting category.

2.2.3. Customer journey map

Customer journey mapping is crucial since it is a strategic method for better understanding customer expectations [36]. It is also beneficial for improving consumer satisfaction. Mapping the customer journey helps to compare the expectations of the customer to their experience. The current experience will be the conclusion of my research. The customer journey also helps understand the differences between customer personas. The most significant advantage is that it allows me to better understand the customers. I can better personalize the customer experience if I understand their expectations. According to the Fogg Behavior Model, personalization is key in order to increase the ability, eventually resulting in behavior change [37].

2.3 Develop: Ideation

2.3.1. The analogies and metaphors

In this method I search for behavior change that has happend or is currently happening, which has a similar underlying thought (environmental impact). This method can help during the idea generation to see the problem through another perspective. I created multiple analogies, representing the first part (making the decision to have the meeting physically or not) and representing the second part (being aware you have to be somewhere physically) what could then result in the most sustainable mode of transport.

2.3.2. HMW / HOW - TOS

To generate different idea directions I did multiple HMW's (How Might We). With this method the question 'how might we …?' is asked. On the dots a subject can be placed for which the designer wants to come up with a lot of different ideas. An

example is how might we choose between two options (figure 2.01, see next page). This helped me discover new, less obvious ways of dealing with a decision.

2.3.3. Brainstorm

The brainstorm session was done together with a small group of four design students. Two students are now following the Design for Interaction master, one follows Integrated Product Design and the other Strategic Product Design therefor together the participants covered all the possible masters held at the Industrial Design Engineering faculty. During this brainstorm session I first presented the problem and then asked the participants to write down their first thoughts. After discussion and evaluating these thoughts, I presented multiple more specific questions. Following different masters resulted in interesting discussions. Another brainstorm session was held with two potential users. In a similar set-up, I first presented the problem after which I presented more in-depth questions. Again I asked them to write down their thoughts and ideas and share them with me and each other. This helped me to create something that really fits the need of the customer.

2.3.4. Datum Method

The Datum Method enables the designer to evaluate design alternatives using design criteria/design requirements. Done with at least two design concepts, one design concepts is the 'datum'. This is randomly chosen and represents by definition the neutral performance on each criterion/requirement. Each criterion is evaluated to determine which design concept is less effective (-), the same (S) or better than the datum (+).
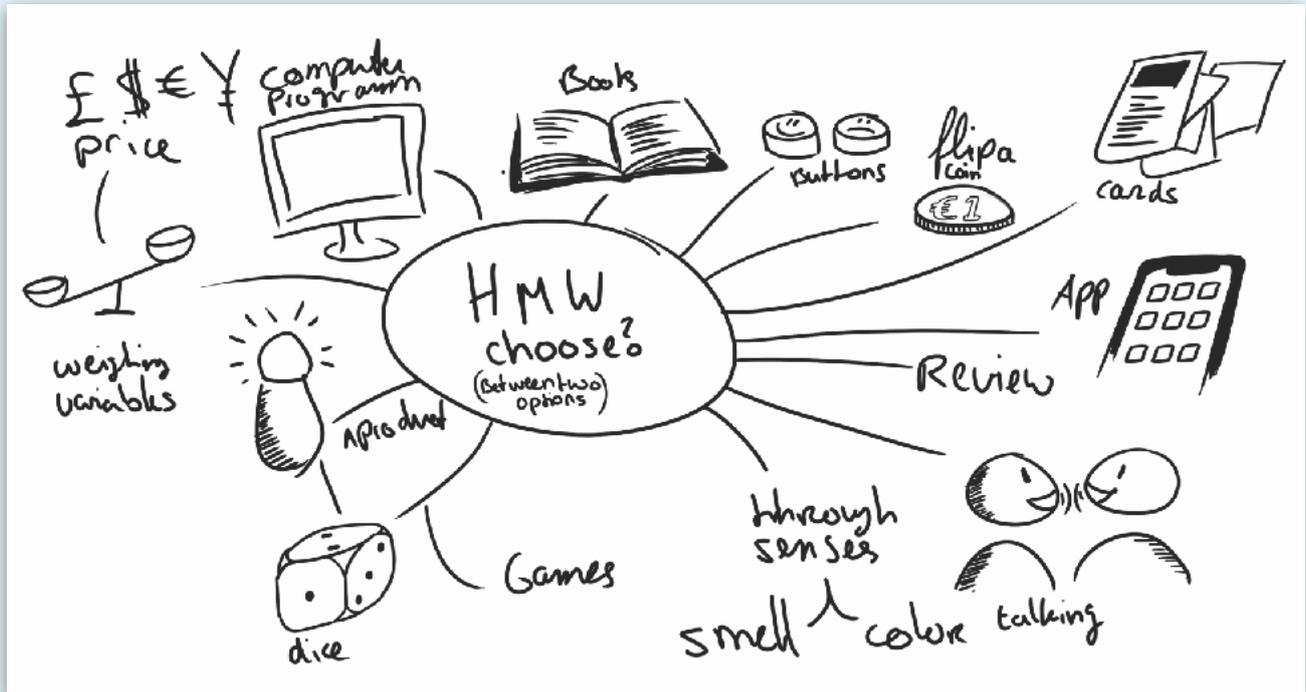
Figure 2.01, HMW choose (between two options).

2.4 Deliver: Conceptualizing

2.4.1. Testing with target group

Testing was done with the target group to see whether the future users will interact with my design solution in the way I intended, and to get feedback on the concept. I tested the complete possible design solution, from the seminar with reinforcement emails to the website helping and guiding users in their proces of deciding which mode of transport to choose for their next business trip.

Testing the seminar was done by creating a setting similar to what I had in mind for the final design solution. For the test I 3D-printed a board that could accommodate figures of different sizes (figure 2.02 presents a concept visual of the board with some figures). The size of the figure is determined by the emissions of that mode of transport. Information about the real impact of short-haul flights was given in the form of a lecture. The reinforcement emails were shown in a picture of how the final email would look like. The prototype website I made was using wix.com [38]. This is an user-friendly tool to create websites and it gave me the opportunity to see how participants would interact with the concept.

Figure 2.02, printed parts which can pinned on the board.

Literature research

In this chapter I will present, discuss and reflect on the information collected from my literature research. The main source of information for this thesis are scientific papers. Reports, websites, and books were also used as sources. The papers I have read for the literature research where divided into categories in order to address all important parts of the problem definition. Each category was conceived with a specific objective in mind. They are listed below.

I.   The Fogg Behavior Model
II. Behavioral change
III. Flying behavior
IV. Sustainable behavior
V.   (Developments in) Aviation
VI. (Developments in) Business trips

In this chapter I present the results and conclusions that I have been able to draw based on the literature. In the next chapter I will draw a line from theory to practice.

3.1 The Fogg Behavior Model

At the basis of this research stands the Fogg Behavior Model, proposed by Brian Jeffrey Fogg (specialisme in captology). In 2002 he studied the concept of persuasive technology [39]. In 2009 Fogg published a paper presenting his model.

The Fogg Behavior Model helps with identifying ability factors that influence whether and why certain behavior is being performed [40]. This knowledge can then be used in order to change the behavior. Fogg describes behavior as being constructed from three elements (figure 3.01): the motivation, the ability and triggers (prompts) [37]. Thus, to achieve a desired behavior, all three elements need to be taken into account [41].

Motivation

I.   Physical motivators
     a motivator related to sensation

II. Emotional motivators
     a motivator related to anticipation

III. Social motivators
     a motivator related to social cohesion

I.   Sensational motivation: we seek pleasure and avoid pain

II. Anticipatory motivation: our hopes and fears influence our emotions

III. Social cohesion: we seek social acceptance and avoid social rejection.

Ability

I.   Time
II. Money
III. Physical effort
IV. Brain cycles
V.   Social deviance
VI. (Non)-Routine

Trigger

I.   Facilitators
     used on individuals who are already highly motivated to offer ability

II. Signals
     a reminder for those who are already motivated and have the ability

III. Sparks
     used to motivate the individual who has high ability but low motivation

Figure 3.01, motivation, ability and trigger with each subcategory [33, 37, 41].

3.1.1. Motivators

The first element of Fogg's model is the motivator. Motivators can be defined as: What causes an individual to perform a certain behavior. Different types of motivators can be strategically used in order to change behavior (figure 3.02). Motivators can also be combined.

For example, if a company is cancelled (the phenomenon of being boycotted after being exposed to criticism in the publicity) this can result in both emotional and social motivators. Emotional motivators are the fear to loose potential or current clients due to negative branding. The fear of social rejection can be seen as a social motivator.

Motivation

I. Physical motivators
    a motivator related to sensation

II. Emotional motivators
    a motivator related to anticipation

III. Social motivators
    a motivator related to social cohesion

I. This motivator produces immediate results. Employees are reacting to what is happening right now.

II. Hope is the expectation of something good occurring. According to Fogg, hope is the most ethical and empowering motivator. Fear is the anticipation of something bad happening, most often loss.

III. Employees are motivated to do things in order to gain social acceptance and status. People are particularly motivated to avoid any negative consequences that could lead to social rejection.

Figure 3.02, motivators with explanations [33, 37].

3.1.2. Ability

The second element is the ability. The ability can be defined as: How well an individual is capable of performing a certain behavior. The ability is rooted in six variables. Each variable is explained in figure 3.03. According to the Fogg Model, time is the most influential variable and (non-) routine is the least [37].

The higher the ability of the individual, the easier the behavior is perceived and the lower the motivation is required to be in order to perform the behavior [40]. The ability is determinative in the sense that a behavior simply will not happen if an individual has no ability to perform it. It is however possible for an individual with a high motivation, to find meaning in preforming a specific task, and with that gain the ability [41]. In comparison to motivation, ability can be perceived as more important [31].

Ability

I.   Time → I.   If the behavior requires a significant amount of time, you are unlikely to engage in it.

II. Money → II. If you can not afford to engage in a certain behavior, you won't be able to engage in that behavior.

III. Physical effort → III. Any new behavior you try should not add to your cognitive load too much.

IV. Brain cycles → IV. The more physical effort a behavior requires, the less likely you are to perform it.

V.   Social deviance → V.   Behavior that is contrary to social norms is difficult accept and perform.

VI. (Non-)Routine → VI. If a new behavior is not incorporated into a routine, it will me more difficult to stick to it.

Figure 3.03, ability with examples [37].

3.1.3. Triggers

The last important element of behavior is the trigger. Triggers can be defined as: The (in)direct impuls causing the individual to perform a behavior. Without an appropriate trigger, behavior will not occur, even if the other elements are high. Depending on the amount of motivation and ability in an individual, different types of triggers are effective. This is presented in figure 3.04.

Triggers can occur in two ways. "Hot" triggers are triggers that instantly lead to a behavior. This could be a push-notifcation on your computer.

A "cold" trigger is a trigger that cannot be act upon immediately. For example, an advertisement on the radio while driving [31].

Where the elements of motivation and ability can be placed on a scale, triggers are either present or absent. That is why, regardless of whether an individual is highly motivated or highly able, a behavior cannot happen if no trigger occurs.
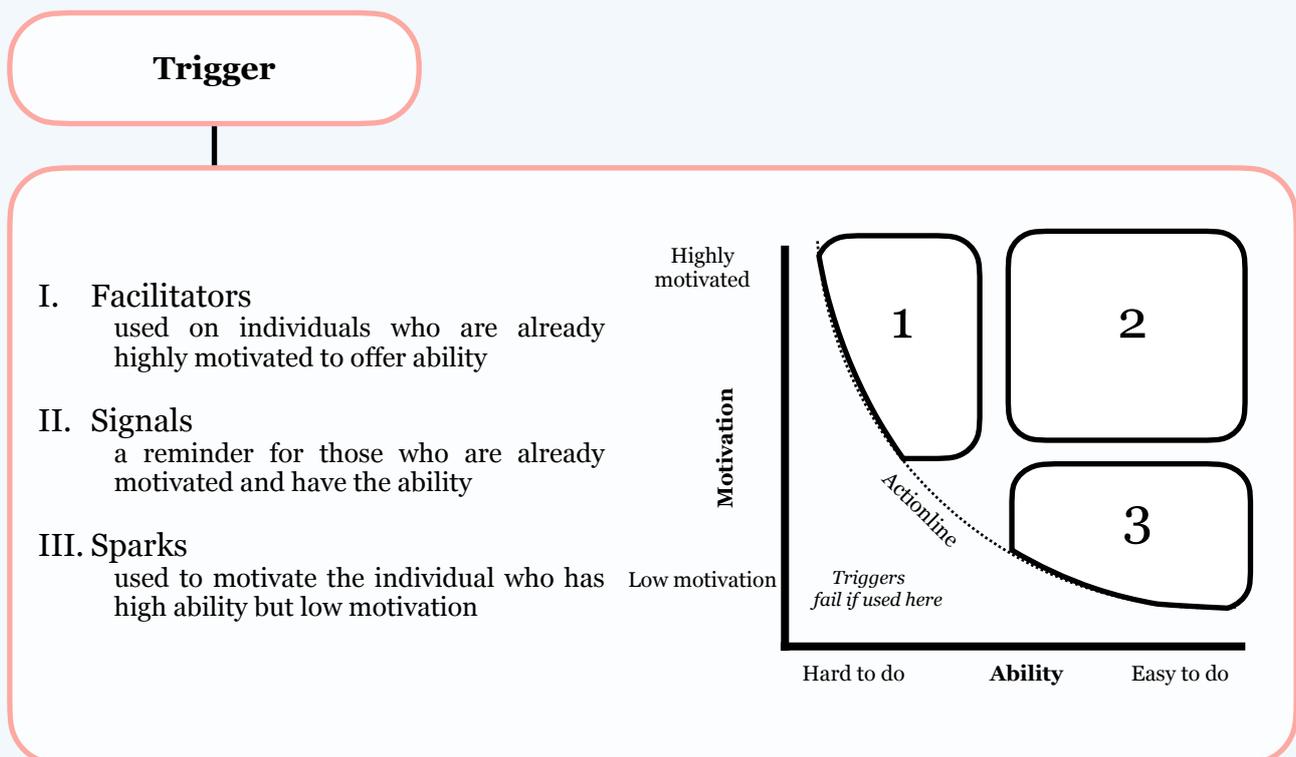
Figure 3.04, triggers and their location on the Fogg Behavior Model [41].

3.1.4. Action line

To increase the likeliness of an individual performing the desired behavior, you want to move individuals over the action line. The action line can be understood as the threshold for performing the behavior. However, simply crossing the action line (thus performing the behavior) does not always result in a pleasant experience for the individual. The most ideal area in the model is where both motivation and ability are high [37], as depicted in figure 3.05. If an individual has high motivation but low ability, they will experience frustration. In the same way, people can experience feelings of annoyance if they have to perform a simple task while feeling low motivation [31].

To avoid these areas of frustration and annoyance, the timing of the trigger is crucial [37]. When ability is low, a trigger can lead to frustration due to, for instance, the feeling that an opponent has an unfair advantage. When motivation is low, a trigger can lead to annoyance. An example of this is an advertisement for Valentine's Day presents in December.

An important and critical footnote on Fogg's model is that the initial targeted behavior change is small at best. It is possible to have more ambitious behavioral goals, but these can only be accomplished through the linking of multiple smaller goals [40]. The model can act as a helpful tool in designing individual parts of bigger behavior change programs. It is possible that users do not know what kind of steps they have to take to be able to attain their goals. They may need to be educated.
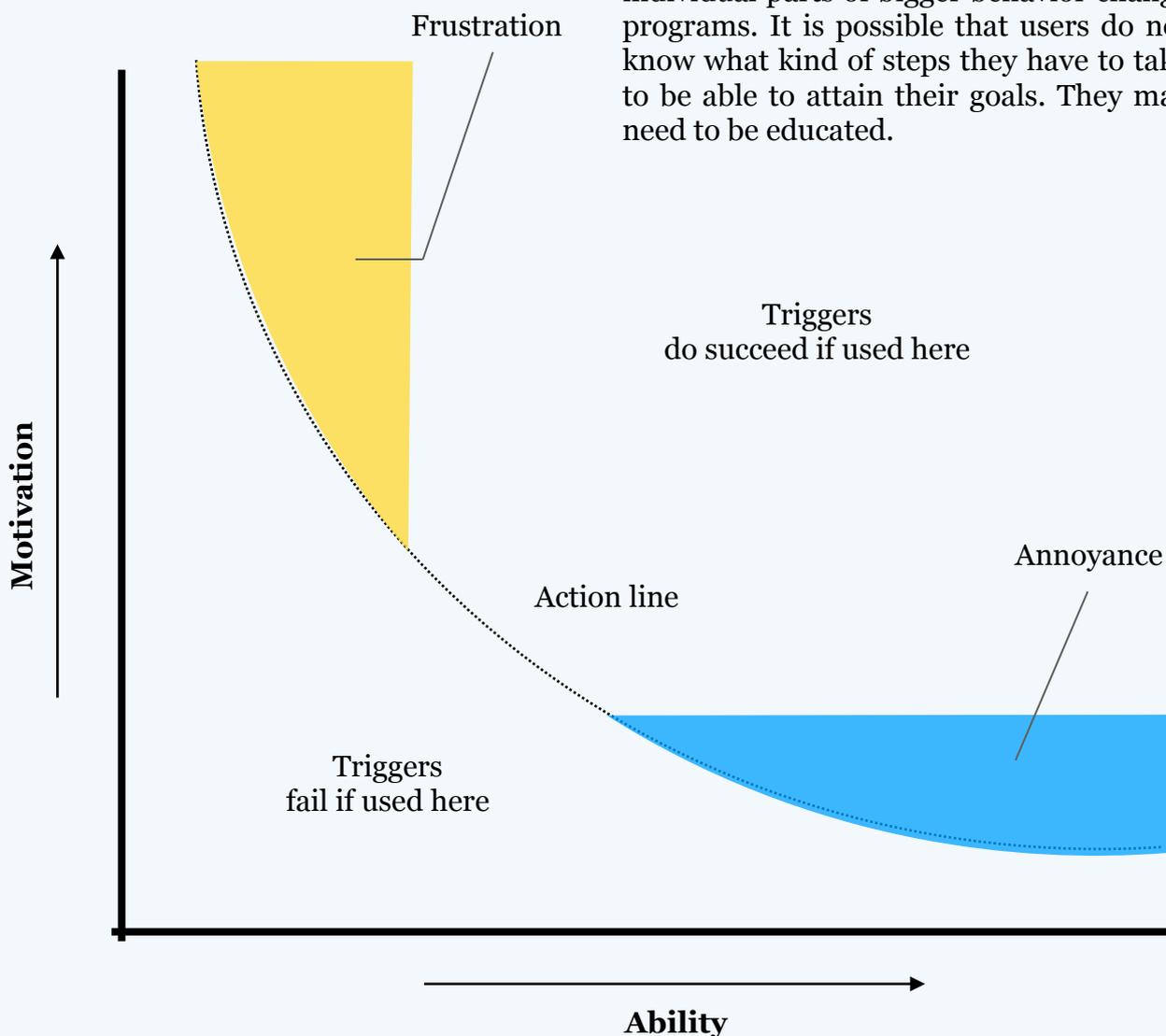
Figure 3.05, Fogg Behavior Model with areas for frustration and annoyance.

3.2 (Developments in) Aviation

This paragraph describes the alternatives for flying and current trends to make flying more sustainable. Reducing the emission released through flying can either be done through making flying more sustainable or fly less. Both directions offer multiple alternatives. I will only mentioned those directly related to my research question. More elaboration and other developments like alternative ways of propulsion can be found in Appendix C. Overviews of all the possibilities that reduce the impact of flying can be found in Appendix D.

3.2.1. More sustainable flying

Compensation for flying
Airlines like KLM offer the option for passengers to compensate for their emissions by choosing for Sustainable Aviation Fuel (SAF) as their fuel or pay extra for compensating their flights' emissions via reforestation. Reforestation however does not make flying more sustainable. It tries to solve the problem (too much CO_2 in the air resulting in environmental impact) by providing a solution rather than trying to get rid of what causes the problem.

The SAF that KLM uses will reduce CO_2-emissions by at least 75% compared to standard fossil fuels [42]. When KLM states their passengers can pay for compensation by choosing for 100% SAF, they pay for flying with 100% SAF, not for compensating all their CO_2-emissions. This results in a maximum of 75% reduction of emissions.

Choosing to fully compensate the impact by flying with SAF can be more than ten times more expensive than a 100% compensation through reforestation.

3.2.2. Less flying

The other possible direction is flying less. This could be done in two ways: either change the way people are travelling, or stop doing physical meetings.

Alternative ways of travelling
When people travel abroad there are multiple options of transport, most of them being more sustainable than flying. There are three main modes of transport: via air, land and water. There are also other modes of transport, such as space transport or transport which is not used for human transport like pipelines or cables. These are not taken into consideration for this research.

In the search for feasible alternatives we start with figure 3.06. The alternatives that have a higher relative emission than flying are considered not feasible. Other modes of transport like motorcycle are not feasible for a trip of 1500 kilometer due to the lack of space for luggage. Long-haul flights are not related to this research and therefore not taken into account.

In contrast to all the other modes of transport, the impact of the carbon footprint per passenger kilometer for a car can be brought down by traveling with more than one person (the more people in one car, the better). This research focusses on the individual traveller, which is why a medium car (both petrol and diesel) is not considered a feasible alternative. What is interesting to keep in mind in the design phase is the (petrol) car for two or more passengers. This mode of transport has lower emission per passenger kilometer resulting in a lower total emissions for the complete business trip.

We then end up with the green marked alternatives in figure 3.06, showing the original way of transport (marked grey). The feasible possibilities are going by bus, car (with multiple passengers) or train. The ferry is also a feasible mode of transport, however the locations of the harbors are often very specific. It can take a lot of effort and emissions to reach these.

Getting rid of physical meetings
The best solution to reducing the amount of CO2-emissions in aviation is not to fly. Alternatives for this do already exist. During the Covid 19-pandemic, people were not able to fly and therefore had to find other ways to communicate with each other. The already used concept of online meetings became renowned [43].

Online meetings via for instance Zoom, Skype, Teams, Miro or other special facilities seemed the perfect solution. These online meetings offer a place where people from all over the world could easily meet without having to leave their house. This obviously reduces any type of emission to zero.

Results from a research done by Manca et al. show that respondents may view virtual alternatives for business travel, such as video calls, online meetings and comparable software, as a temporary solution. They wish to resume travel as soon as it is safe to do so [44]. NOS recently published a news article in which is concluded that 'you can't close a deal via Zoom' [45].

It is clear that online meetings cannot completely replace physical meetings. There are, however, developments on the short and long term to improve online meeting experience (the Horizon Workrooms created by Meta [46]). This can help make it more similar to a physical meeting.
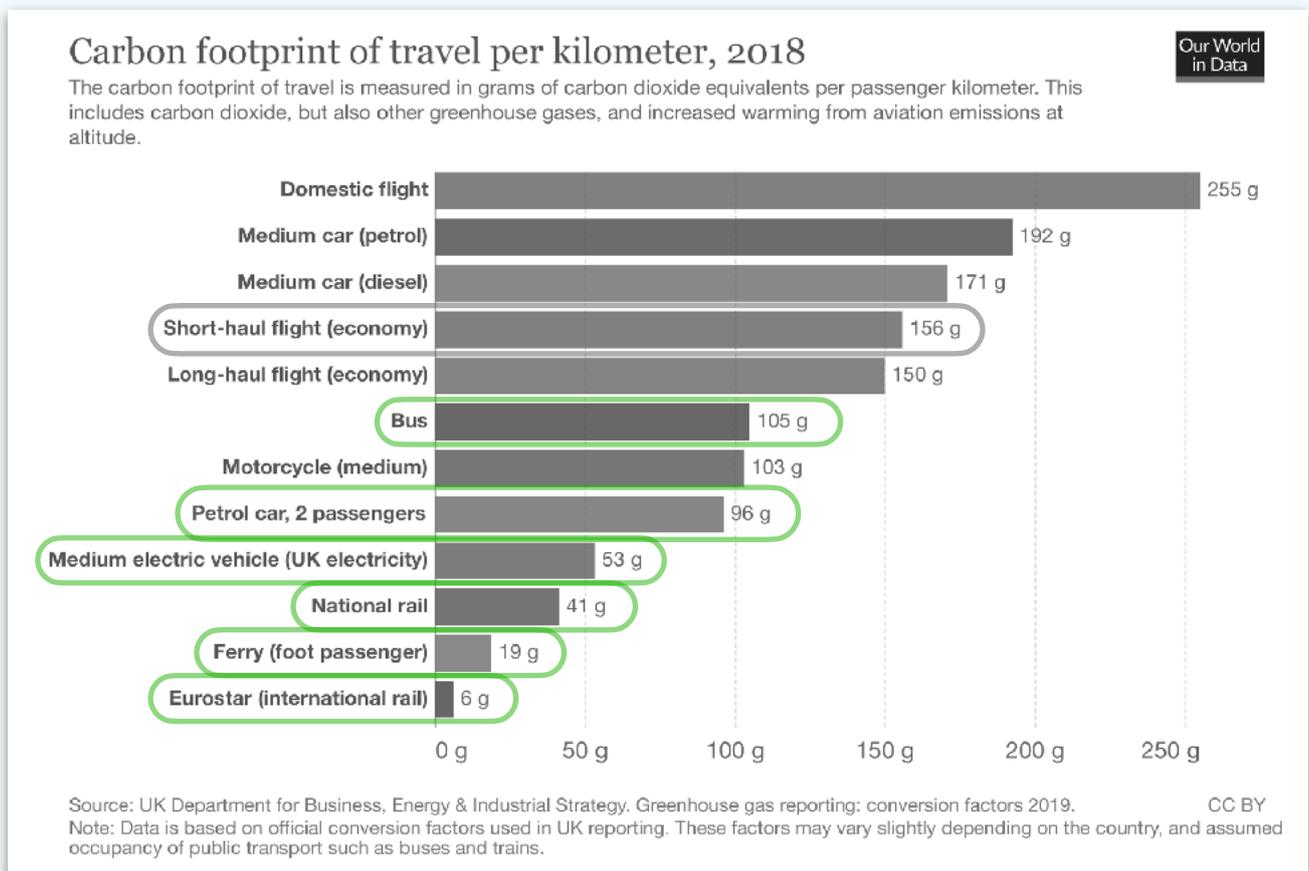
Figure 3.06, carbon-dioxide emissions per passenger kilometer of different transport options [47].

3.3 Applying the Fogg Behavior Model

3.3.1. Applying the Fogg Behavior Model to (non-)sustainable aviation behavior

Companies and their employees that fly show the behavior that is at the core of my research. I want to discourage that behavior. This will be in combination with encouraging the behavior of comparing and choosing alternatives for flying. This means that currently, their ability and/or motivation towards being more sustainable is too low.

To better understand why companies still make the decision to fly, this thesis first looks at the motivation for companies (from the employees perspective) to perform their current behavior. This in order to find pain points in the decision to fly and possible points of improvement for alternative modes of transport.
It is important for this desired behavior to stay out of the yellow and blue area. Points

of intervention can simplify the use of alternatives for flying. Fogg thinks it is most ideal when tasks are simplified. This in combination with increasing the ability and giving the right triggers at the right time, could make companies perform the desired behavior (which is choosing alternatives for flying when employees go on a meeting abroad).

3.3.2. The motivators

In chapter 3.1 I described the different categories of motivators. Fogg considers hope as the most ethical and empowering motivator [37]. Hope is part of the emotional motivators. However he does not describe one motivator as most important.

The motivators and demotivators are categorized into three main categories, these are explained in figure 3.07.

Motivator	Explanation	Example
Physical (de)motivators *a (de)motivator related to sensation*	This (de)motivator produces immediate results. It is a reaction to what is happening right now.	- The start of a new project - Physical meetings are more efficient - Price of a flight
Emotional (de)motivators *a (de)motivator related to anticipation*	Hope is the expectation of something good occurring. Fear is the anticipation of something bad happening, most often loss.	- Internal matters (e.g. the way the employee is perceived within the team or company) - Children and the future
Social (de)motivators a (de)motivator related to social cohesion	The motivation to do things in order to gain social acceptance and status. People are particularly motivated to avoid any negative consequences that could lead to social rejection.	- Maintaining current alliances - Brand image - Flight shame - The Public Debate and Role Models

Figure 3.07, categorization of the motivators with examples.

Motivators for business trips

Company	Employee
Social motivator	**Emotional motivator**
- New foreign alliances	- Internal matters (e.g. the way the employee is perceived within the team or company)
Physical motivator	**Physical motivator**
- Increasing sales	- Start of a new project
Physical demotivator	**Physical demotivator**
- Time spent on everything other than the reason for the business trip. - The costs of the trip without a direct return on investment.	- A business trip can result in tiredness - A business trip can result in a lot of stress.

Figure 3.08, the different motivators to go on a business trip found in literature [48, 49].

The literature research was used to determine the motivation of consumers for business trips where employees go by short-haul flights. In a quantitive study conducted in Australia, Massimiliano Tani (specialisme in economics) focusses on business trips from Australia to other countries, that can be reached by airplane or by boat [48].

The study aims to find the motivation for business trips, and tries to answer the question: Why do people make the choice for a physical meeting over an online meeting? The different motivators are presented in figure 3.08.

Motivators to choose flying (over alternatives)

Company

Physical motivator

- Flying is perceived a fast way to travel.
- Flying is perceived an easy way to travel.

- -

Social demotivator

- Brand image

Employee

Physical motivator

- Flying is perceived a fast way to travel.
- Flying is perceived a safe way to travel.

- -

Emotional demotivator

- Children and the future generation
- Bad conscience

Physical demotivator

- New knowledge on climate change
- The experience of climate change
- Alternative modes of transport

Social demotivator

- The social context / pressure
- Flight shame
- The public debate

Figure 3.09, the different motivators to fly found in literature [50, 51].

Flying is deemed more safe than other modes of transport. The chance of dying in an airplane crash is 1 in 9,821, while the chance of dying in a car crash is 1 in 114 for car drivers and 1 in 654 for car passengers. This is due to the many safety precautions and regulations an aircraft has to go through before it is able to take off [52, 53]. When comparing modes of transport based on deaths per distance travelled, commercial airplanes are the safest, followed by (in order) buses, trains, boats, cars. The least safe mode of transport are motorcycles [54].

In addition to these and other motivators, there are also demotivators. For the employee demotivators can be found in each category. From the company's point of view, this is only limited to the possible impact on the brand image.

3.3.3. The ability

According to Fogg, it is easier to increase the ability than to increase motivation [37]. When changing the ability, this could also impact the trigger chosen to reach the desired behavior. Triggers will be described in the next subchapter.

In this subchapter, I will describe the ability for a company and it's employees to go on a business trip. This is followed by a comparison between flying and other modes of transport.

The ability to go on a business trip
In this paragraph I describe the difference in ability between a company and its employees. The companies can, to some extend, create ability. They are in a position to use money and/or make the time for business trips. Companies have the power to set (financial) priorities for business trips. In other words, companies can increase their ability by focusing on the most influential factors.

This is different for an employee. They are unable to change the factors because, for example, it is not possible to free up time or money. The ability can therefor then not be increased by them, they are reliable on their company.

The ability to choose flying as mode of transport
As explained in chapter 3.1, there are six factors that determine whether behavior is in need of high or low ability. These factors are: time, money, physical effort, brain cycles, social deviance and non-routine. To determine the ability of flying for business trips, six factors of ability are evaluated. (non-)Routine was not considered, since this information is different for every company and is based on what they have done/experienced in their past.

In the search for ability it is important to compare flying to alternative modes of transport. On its own, it is not very interesting to know whether a mode of transport is easy (high ability) or difficult (low ability). What matters here is whether the ability of flying is higher or lower than its alternatives. In this research I use the train, car and online meeting as main alternatives, as they were most often mentioned in the interviews.

The ability factors are presented in figure 3.10, the calculations can be found in Appendix E. The values are based one a combination of my evaluations and existing data sources [21, 53, 55, 56].

Both the physical effort and brain cycles wil be different for each employee, which is why there is no fixed value. An overview with the explanation of the different peaks and valleys for different modes of transport can be found in Appendix F. Figure 3.10 seems to suggest that the train is the best option when it comes to a business trip and the online alternative could be considered the overall best option. However according to a research, the majority of the respondents stated that the train was not perceived as an alternative [57]. Arguments were:

- travel time was perceived as too long
- unreliability of the trains
- unfavorable departure times

There seems to be a lack of knowledge, since the travel time is not always longer as can be concluded from figure 3.10. Also research shows in 2018 around 79 percent of trains arrived on time (within Europe) [58]. Compared to around 43 percent of flights arriving on time or earlier than scheduled [59]. Here almost 10 percent had a delay of more than one hour.

And regarding the departure times it might be difficult to compare since the passenger has to arrive two hours prior to their flight at the airport in combination with the travel time to the airport, whereas the train requires the passenger to arrive 15 minutes before departure [60].

Delft Campus - London eye for a 3 day trip

	Aircraft	**Car**	**Train**	**Online**
Time *(duration of the mode of transport)*	5:58 hour	5:22 hour	4:35 hour	a few minutes (to start the meeting)
Money *(amount of money paid for a return trip)*	€62 - 76	€182	€136-380	Only the initial cost of a laptop and an internet-connection.
Physical effort *(when the employee has to perform physical effort in order to continue the trip)*				This only accounts for the time outside of the meeting. For online there is very limited physical effort needed to start the meeting.
Brain cycles *(when the employee has to perform mental effort in order to continue the trip)*				Depending on the skills of the employee there are very limited brain cycles needed to start the meeting.
Social deviance *(Environmental impact in CO2 in g/ passenger/kilometer)*	156 CO_2 g/passenger/kilometer	192 CO_2 g/passenger/kilometer (+ 6 CO_2 g/passenger/kilometer when the Eurotunnel is used or 441 CO_2 g/passenger/kilometer when the Ferry is used)	41 CO_2 g/passenger/kilometer	There will a negligible amount of CO2 emission emitted when setting up the application. There will only be indirect emissions from the electricity used during the meeting.

Figure 3.10, the different ability found in literature [21, 47, 55, 56].

3.3.4. The triggers

The trigger for the decision to go on a business trip is the same trigger as the decision to choose flying. In other words: flying is a result of the choice to go on a business trip. Therefore this research focusses on the triggers resulting in the need for a business trip.

The classification of the triggers is based on the twenty-three types of nudges found in a paper by Caraban et al. [35]. The codes presented in figure 3.11, were used to decide whether something is a facilitator, a signal or a spark.

Triggers can always have effect, however some triggers might have larger effect for particular combination of motivation and ability, this can be different for everybody.

Spark

Multiple viewpoints
Remind the consequences
Public commitment
Reduce the distance
Raising visibility of users' actions
Placebos
Reciprocity
Adding inferior alternatives
Throttling mindless activity
Make resources scarce
Biasing the memory of the experience
Deceptive visualizations
Enabling social comparisons

Facilitator

Defaults
Opt-out
Positioning
Hiding
Suggesting alternatives

Signal

Subliminal priming
Ambient feedback
Create friction
Instigating empathy
Just-in-time prompts

Figure 3.11, codes per category trigger.

3.4 Conclusion and discussion

When trying to change behavior, aiming for the top right section of the Fogg Behavior Model would be ideal. According to Fogg, it is most ideal when tasks are simplified. This can be used to make companies perform the desired behavior of choosing alternatives to flying, by increasing the ability and giving the right triggers at the right time.

When it comes to environmental impact in the form of CO_2-emission, online meetings and the intercity rail are the most sustainable alternatives for short haul flights. The design solution should therefore encourage these two sustainable alternatives. When presenting other alternatives, like the car for trips where the train might not be the most feasible option (e.g. when a location is very remote), it is important to stress that this option can only be more sustainable if multiple people travel in the same car. For other alternatives, it is important to educate employees about the advantages and disadvantages

The motivators
As for the motivation to go on a business trip, there is a difference between the employee and the company. The employee mentions an emotional motivator, this is however not mentioned for the company. Meaning the employee is motivated to do things based on the expectation of something good to occur. Which for example could be mean a raise in position or salary. Fear could also drive this motivator. Then the individual acts by the fear of something bad happening, which could for example be losing their job. The company can act according to social motivators, which is not mentioned for employees. Meaning they will do things in order to gain social acceptance and status. Which for example could help establish the position of their company within their branch. Both are motivated by physical motivators.

The company and the employee experience both physical demotivation when going on a business trip. Meaning their motivation is brought down by immediate results. A reaction to what is happening at that specific moment. There is a difference within the category of physical demotivator. The demotivator of the company for example, is the initial investment without direct profit or result. For the employee the examples are more related to the physical and mental effort they have to put in to the trip.

For the motivation to choose flying over alternative modes of transport, both the company and the employee are motivated by physical motivators. Both mention the fast way of travelling as a pro for flying. In other words, flying is chosen because it provides immediate (visible) results. This offers possibilities for other modes or transport. This is because the image that companies and employees now have, is a tunnel vision towards flying. Because flying is indeed fast, but not always the fastest when taking into account the complete journey.

There is, however, a big difference in demotivators. Where the company is only influenced by a social demotivator. The employee feels demotivated through all the different categories of demotivators. The demotivators mainly have impact on the employee's consciousness. The employee gets confronted with their wrong behavior resulting in a feeling of demotivation. The company seems to experiences a similar feeling but on another scale. Knowing to some extent that flying is the wrong behavior, a company can be demotivated by the fear for bad publicity. Since this could affect their brand image.

The ability

For the element of ability the conclusion can be drawn that companies have the resources to create their own ability. An employee has less resources and is therefore dependent on its companies' decisions. However, they do value the outcome as they are the ones who will go on the trip. When taking multiple ability factors into account (for example time and money), alternative modes of transport offer advantages over flying.

The triggers

The last element I have discussed is the trigger. I concluded that there is not one trigger that fits everybody. I also concluded that an individual can be trigger through multiple different triggers. In other words, someone does not have to be only triggered by triggers from one category.

It is always possible for a trigger to have impact on certain people, however, some triggers may have a greater effect for a specific ratio of motivation and ability; this might vary from individual to individual.

I made use of the Fogg Behavior Model because this model consists of concrete variables that shape behavior. The model can easily be translated into practical examples. Through elaborating on these variables, I can determine what the current behavior is and what needs to change to achieve the desire behavior.

In figure 3.12 I present the comparison between the different alternative modes of transport, based on Appendix G. The car is not included in this comparison, because the regulations surrounding cars will be zero emission for new cars by 2035 [61].
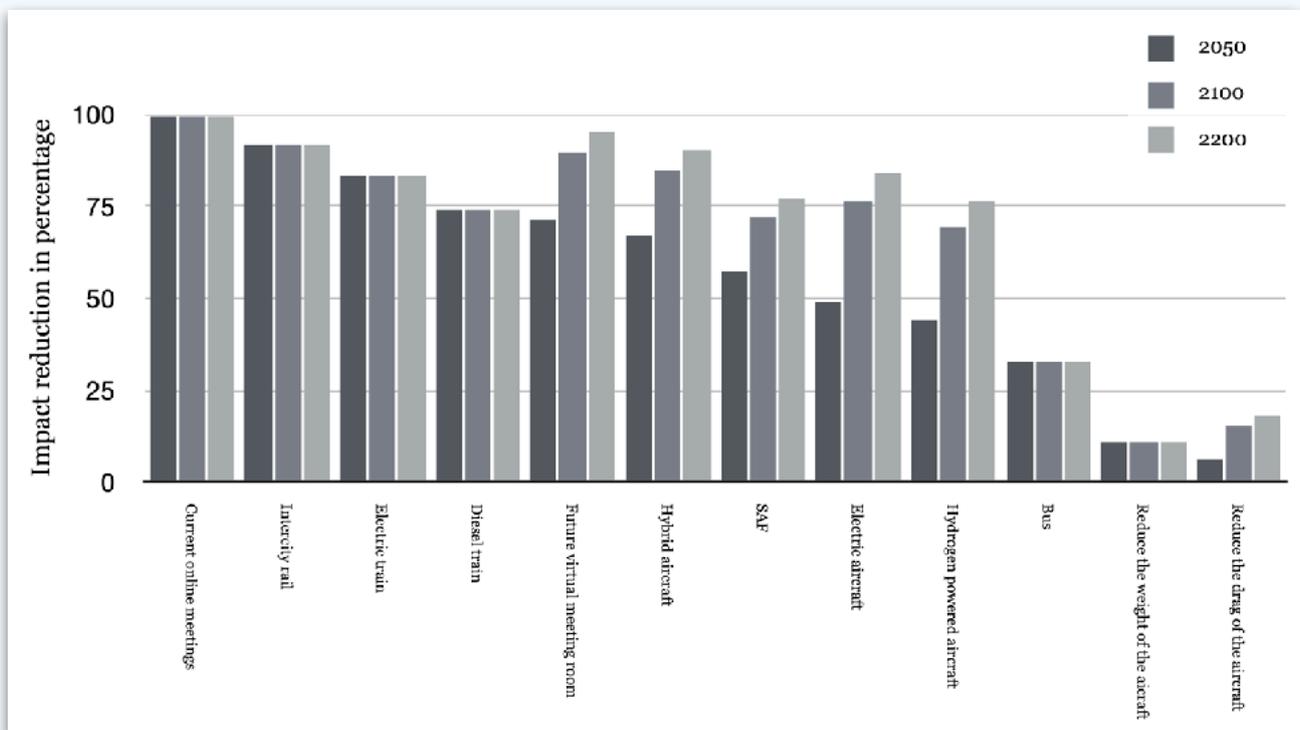
Figure 3.12, impact reduction until 2050, 2100 and 2200 in percentage compared to the inflight emission of CO2 of short haul flights per passenger kilometer [52, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75].

It will take some time before this will ensure zero emissions emitted by cars. It is difficult to determine what the impact of this will be in the various predictions.

For electric alternatives, the source of power is an important variable which is also taken into account. The emissions emitted by the electric alternatives (train, aircraft and online meetings) are dependent on the source of the power, whether this is renewable or non-renewable energy. Currently, energy production accounts for around three-quarters of global greenhouse gas emissions, from this around 28% is renewable energy [76]. The alternative needs to be adopted by companies before 2030 to be in line with the 2030 Agenda for Sustainable Development [77, 78]. It also needs to have impact before 2050 to contribute to minimizing the rise of earth's temperature. The estimated impact for electric alternatives and online meetings is presented in Appendix H.

It certainly makes sense to invest in long term solutions. However, we should also focus on what can be done in the nearer future. Solutions such as the change of propulsion, for example hydrogen or electrification, will only have an impact after 2050. These can, however, contribute to a large reduction in the impact of flying. SAF, hybrid aircrafts, hydrogen and electric aircrafts are also really promising alternatives, since they offer a reduction in CO2-emissions of 80% or more.

Figure 3.12 shows that there are solutions that deliver much higher reduction in long term, when compared to short term solutions. This also counts for solutions less related to this research but possibly impactful for the aviation (elaboration can be found in Appendix C and G).

The best solutions are presented on the left. These alternatives have the highest reduction, starting in the shortest amount of time. The most obvious solution is the online meeting. In the past few years this has proven to be a good alternative [79]. Unfortunately, however, online meetings also have multiple flaws e.g. people getting tired and loosing their concentration [80, 81, 82]. In 3.2, the conclusion was drawn that online meetings are not the perfect solution.

If an employee truly needs to meet in person, the best solution would be travelling by train (the intercity rail, electric train or diesel train). It is expected that over time the development of electrified and hydrogen powered aircraft will catch up with the intercity rail, and even may overtake the diesel train by 2050. Until then, we need to seek feasible alternatives.

The conclusion of the motivation is based on larger companies. This does not mean it applies to every company. For smaller companies, other motivators could play a role. When people work at a smaller company and therefore have a more important position within a company, it could for example be that they experience less fear for losing their job.

With regard to ability, the question can be asked to what extent a company listens to its employees or gives them a say in business trips at all.

When it comes to comparing different modes of transport, it may be that for some companies the factors of time and money are significantly more important than the other factors. For example, a startup is more likely to spend less money on a trip, what could result in reduced

comfort for the passenger. This is purely because they do not have the money. This results in difficulties when making a good comparison.

Concluding the triggers, the coding is based on the paper Caraban et al. [35], this ensures that there are clear guidelines for coding the interviews. These guidelines are reinforced by the examples mentioned in the paper. This helps create consistency in the coding process.

In this chapter I have set forth the state of affairs on the subject of behavior change and more sustainable (alternatives to) flying in previous research and theory. In the next chapter I will investigate what we can learn from current practice in order to make the desired change happen.

Results of the interviews

In this chapter I will present and discuss the results of the interviews I have conducted. I will also reflect on the similarities and differences between the interviews and the literature I have discussed in the previous chapter.

The interviews are a series of qualitative, semi-structured interviews with 12 Dutch employees who fly for business (from various sectors). The goal of the interviews was to confirm the information acquired from the literature research and maybe uncover new insights.

During the interviews, a difference was drawn between motivators from the companies' perspective, as perceived from the employees, and the motivators from employees. The company's viewpoint is formed based on how the experience of the employee.

Participants were drawn from different industries: aerospace, education, the festival industry, insurance, marine, the textile business, and the steel industry. Each respondent was inter-viewed individually. I interviewed people from different sectors to gather as many different points of view as possible.

4.1 Interviews results

This paragraph describes the outcomes of the interviews. Through asking what the motivators, ability and triggers are for employee and their companies to travel for business and choose flying as their mode of transport, I tried to find new insights and complement or disagree with my literature study. The latter I will discuss in 4.2.

4.1.1. The motivators

In subchapter 3.3.2. I gave examples for the three different category of motivators.

Figure 3.07 is summarized to recap, and presented as figure 4.01 presented below. It shows the three categories of motivator with explanation.

Motivator	Explanation
Physical (de)motivators *a (de)motivator related to sensation*	This (de)motivator produces immediate results. It is a reaction to what is happening right now.
Emotional (de)motivators *a (de)motivator related to anticipation*	Hope is the expectation of something good occurring. Fear is the anticipation of something bad happening, most often loss.
Social (de)motivators a (de)motivator related to social cohesion	The motivation to do things in order to gain social acceptance and status. People are particularly motivated to avoid any negative consequences that could lead to social rejection.

Figure 4.01, categorization of the motivators with examples.

Motivators for business trips

Company	Employee
Social motivator - Creating new alliances - Maintaining current alliances **Emotional motivator** - Internal matters -------- **Physical demotivator** - Employees also need to be compensated for when they are not working (e.g. the hotel their) - The employee can not be on both places so them leaving has impact on the team back home.	**Emotional motivator** - Interest in the company - The feeling of being part of the team - The feeling of respect by their team **Physical motivator** - Physical meeting is more efficient -------- **Physical demotivator** - The business trips results in a lot of pressure and stress, since you have to get the most out of the time you are there. - When travelling abroad you often also have to give up private time.

Figure 4.02, the different motivators to go on a business trip deducted from the interviews.

The following quotes are examples of motivators mentioned in the interviews and the motivator that was drawn from it:

"By physically going to the other company, we were able to create a better bond. We could open up to the culture from the employees of the other company. This strengthened the relationship between the companies."
(Employee working at Aegon)

⟶ **Social motivator**

"If there are questions about the new collection, it always works better if we go to the head office in Denmark to go through all options and comparing all the physical products."
(Employee working at Jack and Jones)

⟶ **Physical motivator**

"For the trip, on the way back, I could have spent some time working, but after the trip I felt really tired. I did not have any energy left."
(Employee working at Damen Shipyards Group)

⟶ **Physical demotivator**

The employees mentioned a far broader range of motivators in their interviews. For them, their interest in the informal side of the partner company (e.g. what employees do after work) was most often mentioned as being a motivator. The employees also thought that physical meetings result in more efficient working, since physical interaction provides better feedback on what the other person thinks as non-verbal communication can be observed. Other motivators where the feeling of being part of the team and the feeling of respect, because travelling would make the employee feel like an important and valuable asset.

Between the company and employee there seems to be overlapping motivators (e.g. internal matters). There are however differences within this motivator category which should not be overlooked. For example the physical motivator of the company are increasing sales while for the employee the physical motivator is new business and projects.

The motivators found in the literature and research are categorized following the Fogg Behavior Model, however there is some ambiguity. Also the literature research is limited to only one source due to lack of other material.

Concluding, for the employees, the emotional motivators mainly determined the motivation. Also physical motivators were mentioned. From a company's perspective, social motivators mainly determine the motivation. Also emotional motivators were mentioned. The demotivators are physical demotivators, for both employees and companies

Motivators to choose flying (over alternatives)

Company

Physical motivator

- Flying is considered as cheap mode of transport.
- Flying is perceived as accessible (regards purchasing a boarding pass).
- Flying is flexible (Airport offering multiple flights a day with their agenda)
- Flying is perceived a fast way to travel.

- -

Physical demotivator

- While flying the employee is not able to work much.

Employee

Emotional motivator

- Employees enjoy the feeling of flying, since it can give them a feeling of adventure.

Physical motivator

- The employees often have flown before contributing to a convenient experience.
- Flying is considered as cheap mode of transport.
- Flying is perceived as accessible (regards the well developed infrastructure for getting to the airport).
- Flying is flexible (Airport offering multiple flights a day, which can be aligned with their preferences)
- Flying is perceived a fast way to travel.

- -

Physical demotivator

- Convenience of the flight (expensive flights are not always approved by the company)
- Alternative modes of transport
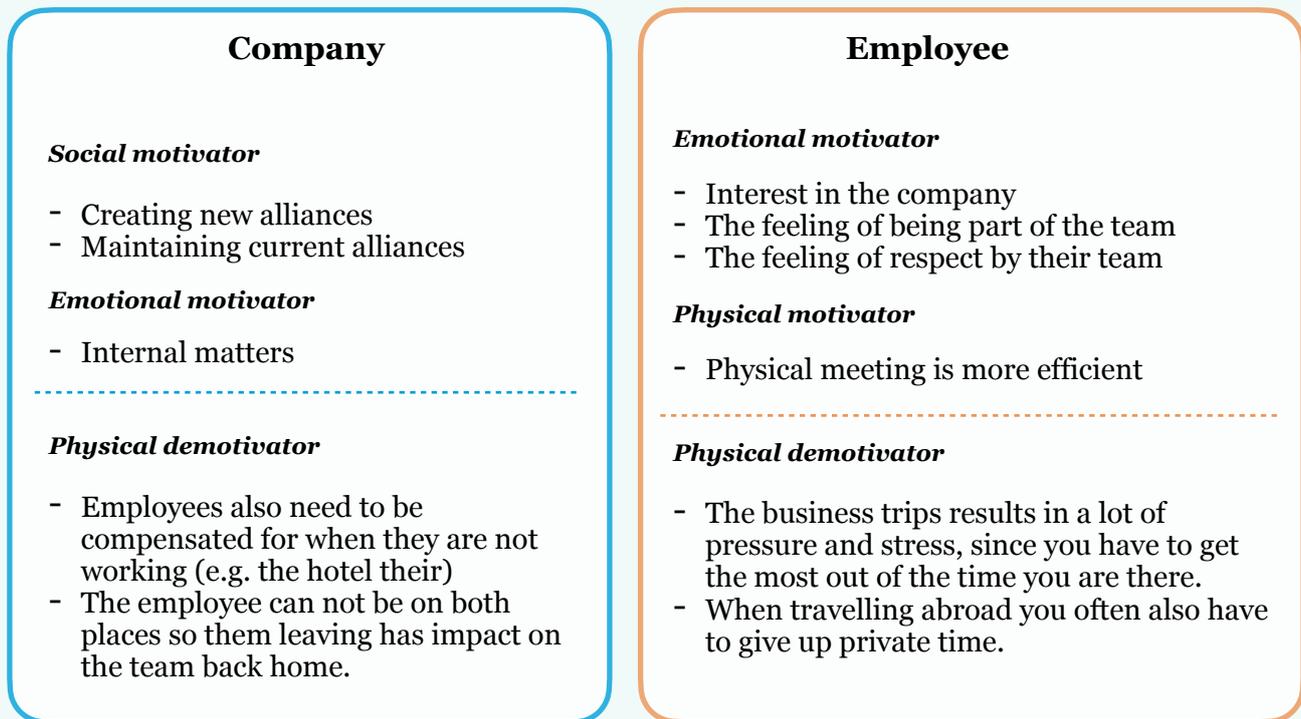
Emotional demotivator

- The future generation
- Bad conscience

Figure 4.03, the different motivator to fly deducted from the interviews.

The following quotes are examples of motivators mentioned in the interviews and the motivator that was drawn from it:

"Flying was often the cheapest and fastest way to go from A to B."
(Employee working at BOAL)

Physical motivator

"It feels easy and familiar to choose flying as mode of transportation."
(Professor working at the university)

Emotional motivator

From the interviews with the employers the following motivators were attributed to the companies' perspective: creating new alliances, maintaining current alliances (by showing respect and willing to put effort in the relationship) and internal matters (for example trying to solve a problem that occurred during a project, by using knowledge/experience from another company).

During the interviews only one participant mentioned they 'secretly' liked flying. All the other respondents did not mention their personal interest in flying. Most of the employees were mainly focussed on flying simply as a method of transport.

For the employee demotivators deducted from the research were found in all categories. For the company only one demotivator for choosing flying was deducted from the research.   Both the company and the employee had the same amount of motivator category. In the interviews more categories of motivators were found for the employee compared to the company's motivators.

Concluding, for the employees, the physical motivators mainly determined the motivation. Also emotional motivators were mentioned. For the company only physical motivators were mentioned. The demotivators for employees are physical demotivators and emotional demotivators. For the company physical demotivators where the only demotivators mentioned.

4.1.2. The ability

As explained in chapter 2 on the Fogg behavior model, there are six factors that determine whether behavior has a high or low ability. These factors are: time, money, physical effort, brain cycles, social deviance and non-routine.

During the interviews I went over each factor to determine both the ability to go on a business trip as well as choosing to fly compared to other modes of transport.

The ability for employees to go on a business trip
The questions presented in figure 4.04, as described in chapter 2.2.2., were deducted from the literature research.

The ability for employees to choose flying as mode of transport
After asking the questions described in figure 4.04 a follow-up question was asked: Does this factor influence the choice to fly over other modes or transport? And if so, how? The results are presented in figure 4.05. We see that both the company and the employee are mainly positive when it comes to flying. The employee were to some extent aware of alternatives and their advantages.

	Company		Employee	
	Question	**Answer**	**Question**	**Answer**
Time	What is the shortest time for the trip to obtain the necessary value?	*"Depends on the purpose, sometimes **one day** is already enough."*	What is a feasible length of the trip to obtain the necessary value?	*"The **longer the trip**, the **more intense** it is."* *"Sometimes I can **combine** it with **leisure**, resulting in a longer trip."*
Money	What do we financially gain from this trip (and what are the costs)?	*"There is often **not a direct financial advantage**, it is more about creating new or maintaining alliances."*	What are the financial benefits for your company (and what are the costs)?	*"A good **meeting** can be the start of a **long-term relationship** resulting in a **long-term cash flow** for my company."*
Physical effort	How much physical effort requires the trip for the employee?	*"They try to make the trip **as efficient as possible**, resulting in some quit intens days."*	Do you have to put in much physical effort to go on this trip?	*"With regard to the amount of work that needs to be done, in combination with **travelling** it can be **really intense**."*
Brain cycles	How much mental effort requires the trip for the employee?	*"The trip can cause a lot of **stress** but the company seems to **not** be **aware** of that."*	Do you have to put in much mental effort to go on this trip?	*"If I am able to **combine travelling** with **working** I can save time which I can use **later** to **relax**."*
Social deviance	Will there be more social acceptation if we go on this trip?	*"The **team** will probably get **closer** which might lead to better overall results."*	How will people react on you going on this trip (within and outside my company)?	*"**I felt honored** I was asked to join the trip."* *"Friends and family often think my work abroad is **pretty cool.**"*
Routine	Has there been a similar need before, did a business trip result in what we hoped?	*"The company prefers to use the **same things** like hotels or mode of transport for multiple trips, because we know the **quality** they offer."*	How much experience do you have with flying for business trips?	*"When travelling in the same way as previous trips, I have to put in **less effort** because I easily recognize everything."*

Figure 4.04, all the different motivators found in the interviews.

	Company		Employee	
	Question	*Answer*	*Question*	*Answer*
Time	Which mode of transport takes up the least amount of time?	*"**Flying** is **fast**, especially when crossing a sea."*	Which mode of transport gets you in the quickest way from door to door?	*"I think it is the **fastest way to travel**. Even with some delay it is faster than alternative modes of transport. **However**, which the current chaos I probably have to be at the airport **three to four hour before my flight**."*
Money	Which mode of transport is the most budget-friendly?	*"**The tickets are cheap**. Alternatives are often not even considered. If they are, not always a cheaper option is found."*	Which mode of transport is most affordable for your company?	*"Since ticket prices are varying in costs, my trip sometimes gets **cancelled** if I sent my request on a **short notice**."*
Physical effort	Which mode of transport requires the least amount of physical effort my employee?	*"The tickets can **easily be bought online**, resulting almost **no physical effort**."*	Which mode of transport provide you the least amount of physical effort?	*"**Flying** compared to alternatives provides the **least comfort**."* *"I have to go through all the security to end up in a small seat."*
Brain cycles	Which mode of transport results in the least mental effort?	*"It can take **some mental effort** if there is an important trip but it the company only knows it very short in advance. Then the consideration whether to fly / go can be difficult."*	For which mode of transport do you have to put in the least amount of mental energy?	*"When I am **on the plane** it is easy to **relax**, however when leaving the house until that moment I can experience **some stress**. Especially if the **traffic is busy** and I have to hurry."*
Social deviance	Which mode of transport is the best for my company's reputation?	*"The company **tries** to be **more sustainable** resulting in less trips. However if employee go on a business trip they almost always fly."*	Which mode of transport is the best for you reputation?	*"I do feel some **shame** when **flying**. But if I am honest I **also** kinda **like it**."*
Routine	Which mode of transport will be the best option not only for now but also next time?	*"The company prefers to fly with KLM since they **give frequent flyers advantages**. For example, when we fly regularly we can arrive only one hour prior to our flight to the airport. Resulting in the company having to pay less wages. "*	Which mode of transport will be the most convenient option for your next trip?	*"For me it is **always** easy when I **arrive** at the **airport**, I have flown often enough to know exactly where to go."*

Figure 4.05, all the different motivators found in the interviews.

4.1.3. The triggers

To identify triggers, I used insights from the interviews. I found eight different triggers (figure 4.06). These are again divided into three different categories: facilitator, signal and spark. The categorization was done based on two values: whether people were (highly or lowly) motivated after the trigger and whether the behavior occurring after the trigger was "easy" to perform (easy or hard). This was determined on the answers respondent gave to the questions: What triggers the business trip, what's the reason for the trip? Elaboration on the classification can be found in Appendix I. They were then placed on the Fogg Behavior Model and with the information from 3.1.3. I organized the triggers. This is presented in figure 4.06.

Triggers can always have effect, however as mentioned in the chapter 3, some triggers might have larger effect for particular combination of motivation and ability, this can be different for everybody.

In short, different branches are triggered in different ways. The differences between branches are significant (e.g. the education and maritime branch only having a trigger in the form of a signal), so there is not one trigger to reach everyone. Therefore I have to look at individual differences in order to respond more strategically to that company. In this way, the outcome of the design solution can be tailored even more.

		Aerospace	Festival branch	Clothing industry	Insurance agency	Steel industry	Education	Maritime
Facilitator	New business opportunities	■	■					
Facilitator	Direct sales revenue		■	■				
Facilitator	The start of a new project				■			
Facilitator	Maintaining relationships				■			
Signal	Periodic maintenance					■		
Signal	Specific organized meetings	■						
Signal	The need for knowledge						■	■
Spark	Customers request (or own request)	■				■		

Figure 4.06, the triggers mentioned during the interviews categorized.

4.2. Concluding results

In chapter 3 I described the relevant literature. In this chapter I presented the results of interviews I conducted. A comparison between these two results in the following conclusions:

The motivators

Based on the interviews I have concluded that the most important motivators for employees are emotional motivators. For companies, social motivators play the biggest role. This is in line with the conclusions from the literature research. This means the company is generally perceived as more driven to do things in order to gain social acceptance and status. The motivation of the employee is based of the expectation of something good occurring and the anticipation of something bad happening. In the literature, physical motivators were also important for companies. The interviews, however, did not affirm this.

The demotivators for both the company and the employee are physical motivators. This was also the conclusion mentioned in the conclusions in chapter 3. This means both the company and the employee are demotivated by immediate results, to what is happening at that moment.

This conclusion results in the following design requirements:

- The design solution should promote social acceptance of the company.
- The design solution should decrease the expectation of something bad happening as a result of the users behavior.
- The design solution should increase the travel experience resulting in less demotivation of immediate results.

According to the literature, the strongest motivators for the decision of flying are physical motivators, for both the company and the employee. The interviews present a similar result. So flying is mainly chosen because of physical motivation, the motivators that provide immediate results. As mentioned in chapter 3 this outcome offers possibilities for alternatives. Through informing both the company and the employee of the benefits of the alternatives, they can choose alternatives without becoming demotivated.

According to the interviews, the company and the employee share the physical demotivators. The employee is also affected by emotional demotivators. This is not in line with what the literature concluded. According to the literature, the company is mostly influenced by social demotivators. The interviews, however, show that physical demotivators are more important. For employees, physical and emotional demotivators are most important, based on the interviews. This in contrast to the literature, that deemed all three categories to be of significance for employees.

The conclusion can be drawn that the decision to choose flying creates more negative motivation for the employee than for their company. Another important result is that for employees, demotivators are a result from the direct impact of flying, while the company also focusses on whether the employee is able to work while travelling.

This results in the following design requirements:

- The design solution should decrease the motivation by increasing the motivation towards other modes of transport.
- The design solution should present clear reasons for the company why flying is not the best mode of transport.

- The design solution should inform both the company and the employee about the advantages of alternatives.

The ability

Based on the answers presented in figure 4.03, the company appears to be not aware of the impact a business trip can have on their employees. This account for both physical and mental impact. If the employee is able to reduce the impact of travelling, this could be through working or relaxing, this overall impact can be reduced.

This conclusion is in line with and adds to what was concluded in subchapter 3.3. There the conclusion was drawn that companies have the resources to create their own ability. An employee has less resources and is therefore dependent on its companies' decision. They do however value the outcome as they are the ones who will go on the trip. This is in line with the impact of the total trip, which will affect the employee, rather than the company.

This conclusion results in the following design requirements:
- The design solution should increase the ability of the company as well as the employee, but should mostly focus on the employee in this regard.

Based on the interviews, we can concludes that companies and their employees generally have a positive attitude towards flying. Employees were, to some extent, more aware of alternative modes of transport and their specific benefits than their employers. In chapter 3.3 I drew the conclusion that alternatives offer advantages over flying, when taking all ability factors into account.

The biggest problem then seems to be a lack of education. If both the company and its employees are able to compare flying to alternatives on all ability factors, they can make a more sustainable choice that is also better suited to their personal interests. This means that the design solution should not only focus on providing the fastest and or cheapest mode of transport but take different ability factors into account. This results in the following design requirements:

- The design solution should take all different ability factors into account when giving advise to the user.

The Triggers

Similar to the conclusion drawn in chapter 3, the interviews conclude that different branches are triggered in different ways. In order to respond more strategically to a specific company, I must consider individual differences. As a result, the outcome of the design solution could be customized, resulting in better triggering a company and its employees.

In order to understand which trigger suits which sector, more in-depth research must be carried out per sector. Figure 4.05 is a start presenting the differences between multiple sector, but it needs to be expanded further to draw a good conclusion (for each individual industry).

Research question

In chapter 1.2 I described the research question. This was:

What are the motivators resulting in companies and their employees to go on business trips and choose flying as their mode of transport (when sustainable alternatives exist),and how can this knowledge be used to change the behavior to be more sustainable (following the Fogg Behavior Model)?

Based on the conclusions I drawn the following answer is formulated.

The motivators causing companies and their employees to go on business trip are for employees emotional motivators. For companies, social motivators play the biggest role. This means the company is generally perceived as more driven to do things in order to gain social acceptance and status. The motivation of the employee is based of the expectation of something good occurring and the anticipation of something bad happening.

The motivators causing companies and their employees to choose flying as their mode of transport (when sustainable alternatives exist) are physical motivators, for both the company and the employee.

This knowledge can be used to change the behavior to be more sustainable (following the Fogg Behavior Model) through focussing on increasing the ability of the company and especially the employee.

In this chapter I tried to compared the conclusions from previous research and theory with the current practice. In the next chapter I will use the outcomes from this chapter to design a possible solution which helps companies and their employees shift their behavior.

Design

In this chapter I will describe the design process leading up to the design solution. For this process I used customer journey mapping. Mapping the customer journey allows a comparison between the customer's expectations and their experience. The customer journey also helps comprehending the distinctions between consumer personas. The most important benefit is to better understand my potential consumers. According to the Fogg Behavior Model, personalization is essential for increasing ability and behavior modification.

5.1 Research to design

5.1.1. Customer journey

In order to move from the conclusions as discussed in the previous chapters to the design in this chapter, I created a customer journey. I came up with three personas (see figure 5.01, an elaborate version can be found in Appendix J). They represent three of the interviewees from three different sectors. These personas are relevant because they help me determine the pain points for their current behavior. This information can be used to start ideation, to come up with solutions for those pain points.

The customer journey was made for a trip from Delft campus to the center of London. This trip was chosen because London Heathrow is the most popular short-haul flight departing from Schiphol [83]. If I would have chosen Amsterdam as place of departure for the entire trip, this would be unfair to all the employees having to travel to Schiphol from outside Amsterdam. Therefor I choose the location of my university.
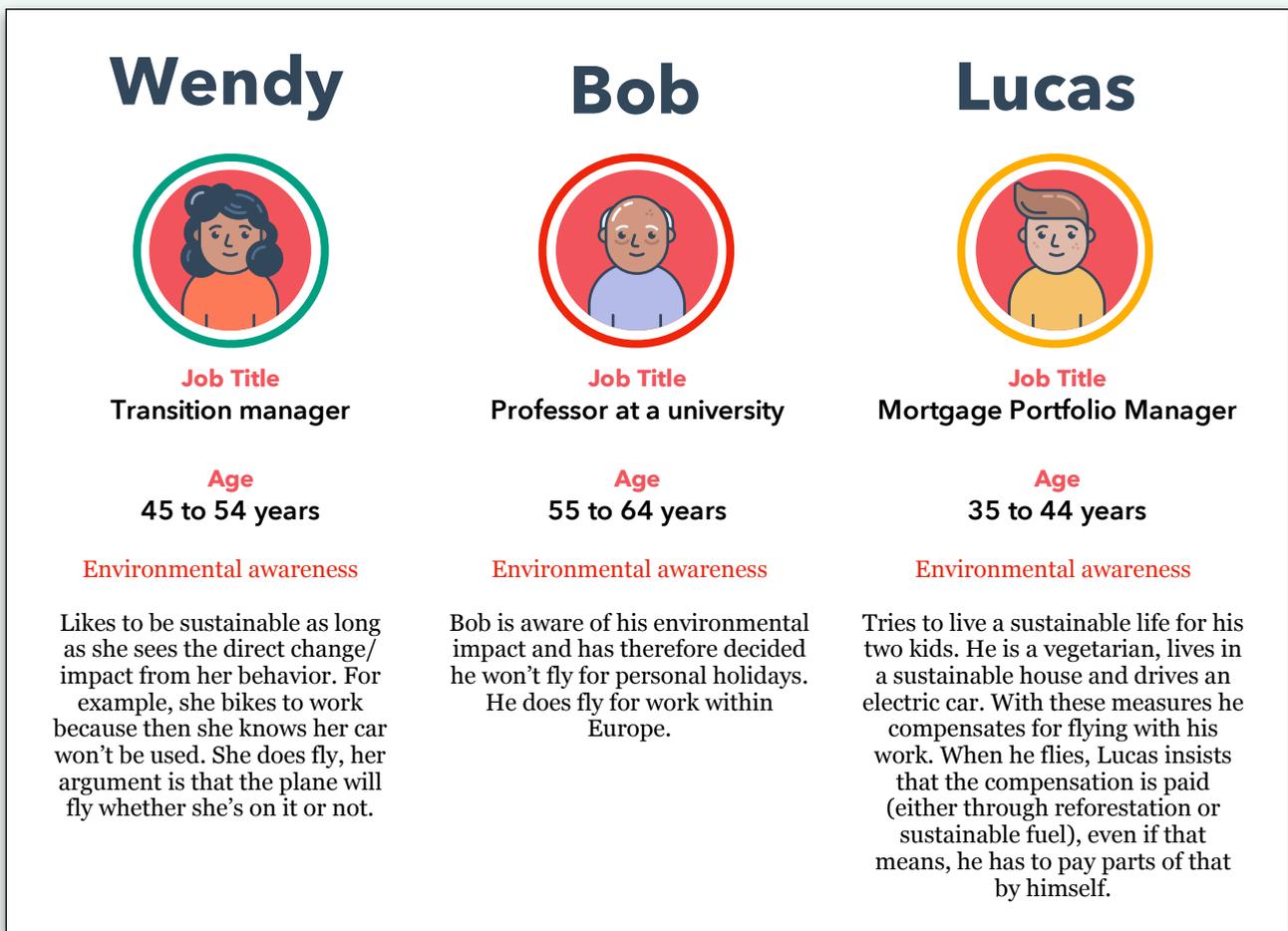
Wendy

Job Title
Transition manager

Age
45 to 54 years

Environmental awareness

Likes to be sustainable as long as she sees the direct change/ impact from her behavior. For example, she bikes to work because then she knows her car won't be used. She does fly, her argument is that the plane will fly whether she's on it or not.

Bob

Job Title
Professor at a university

Age
55 to 64 years

Environmental awareness

Bob is aware of his environmental impact and has therefore decided he won't fly for personal holidays. He does fly for work within Europe.

Lucas

Job Title
Mortgage Portfolio Manager

Age
35 to 44 years

Environmental awareness

Tries to live a sustainable life for his two kids. He is a vegetarian, lives in a sustainable house and drives an electric car. With these measures he compensates for flying with his work. When he flies, Lucas insists that the compensation is paid (either through reforestation or sustainable fuel), even if that means, he has to pay parts of that by himself.

Figure 5.01, personas used to create customer journey.

Figure 5.02 shows the three personas with the possible routes and the total emissions their choice will result in. The customer journey map starts with the initial trigger for the business trip, and ends with arriving at the meeting in London. In the customer journey map the decision to fly is a result from the initial decision for having a meeting.

Figure 5.03 describes the ability, motivation and demotivators per phase. Pain points were appointed based on the demotivators of both the company and the employee in combination with unpleasant experiences with flying. These experiences were deducted from the interviews. These pain points result in design requirements.
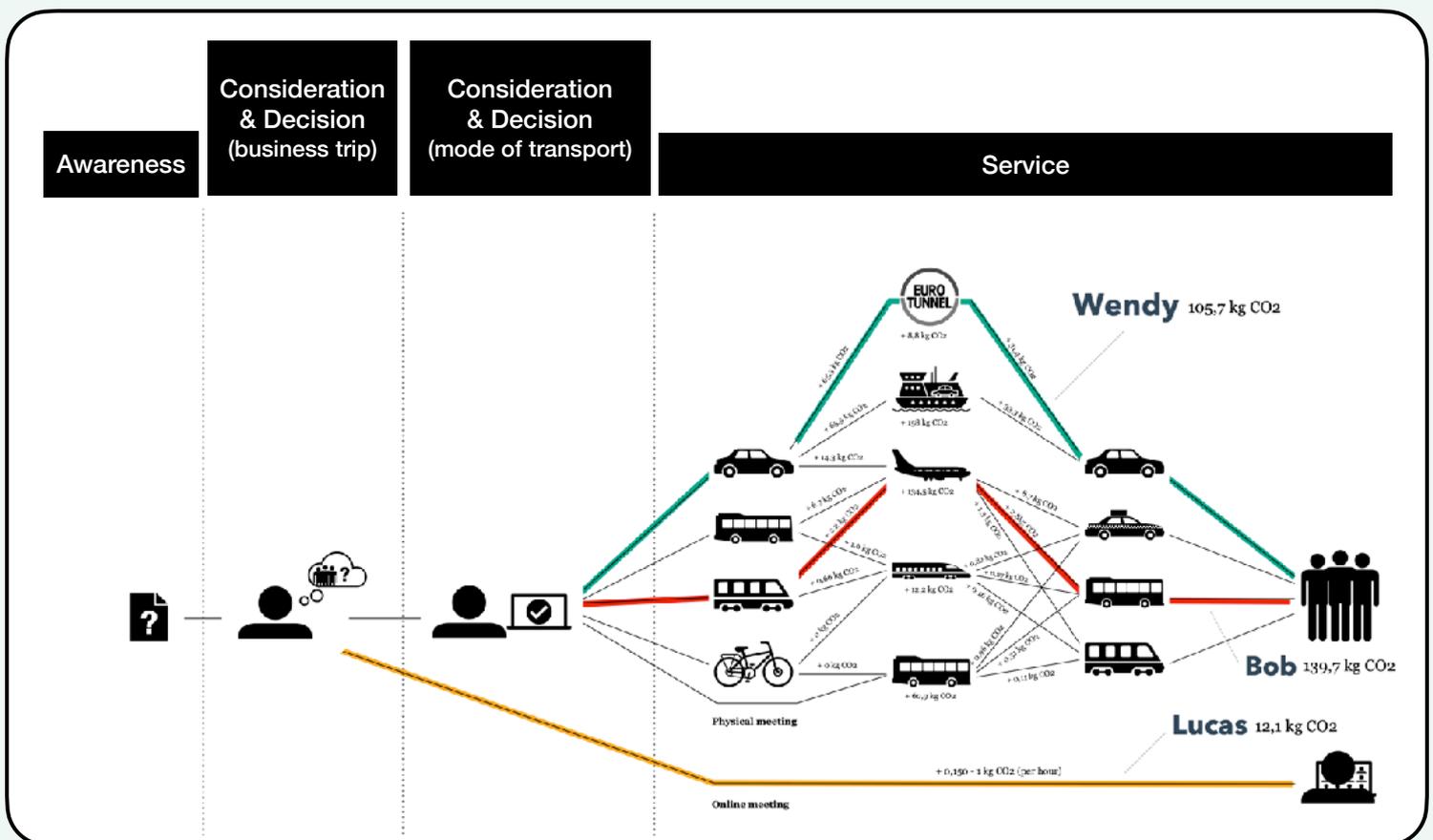

Figure 5.02, customer journey map for a meeting between Delft (campus) and London (London Eye) for one person [61, 84, 85, 86, 87, 88].

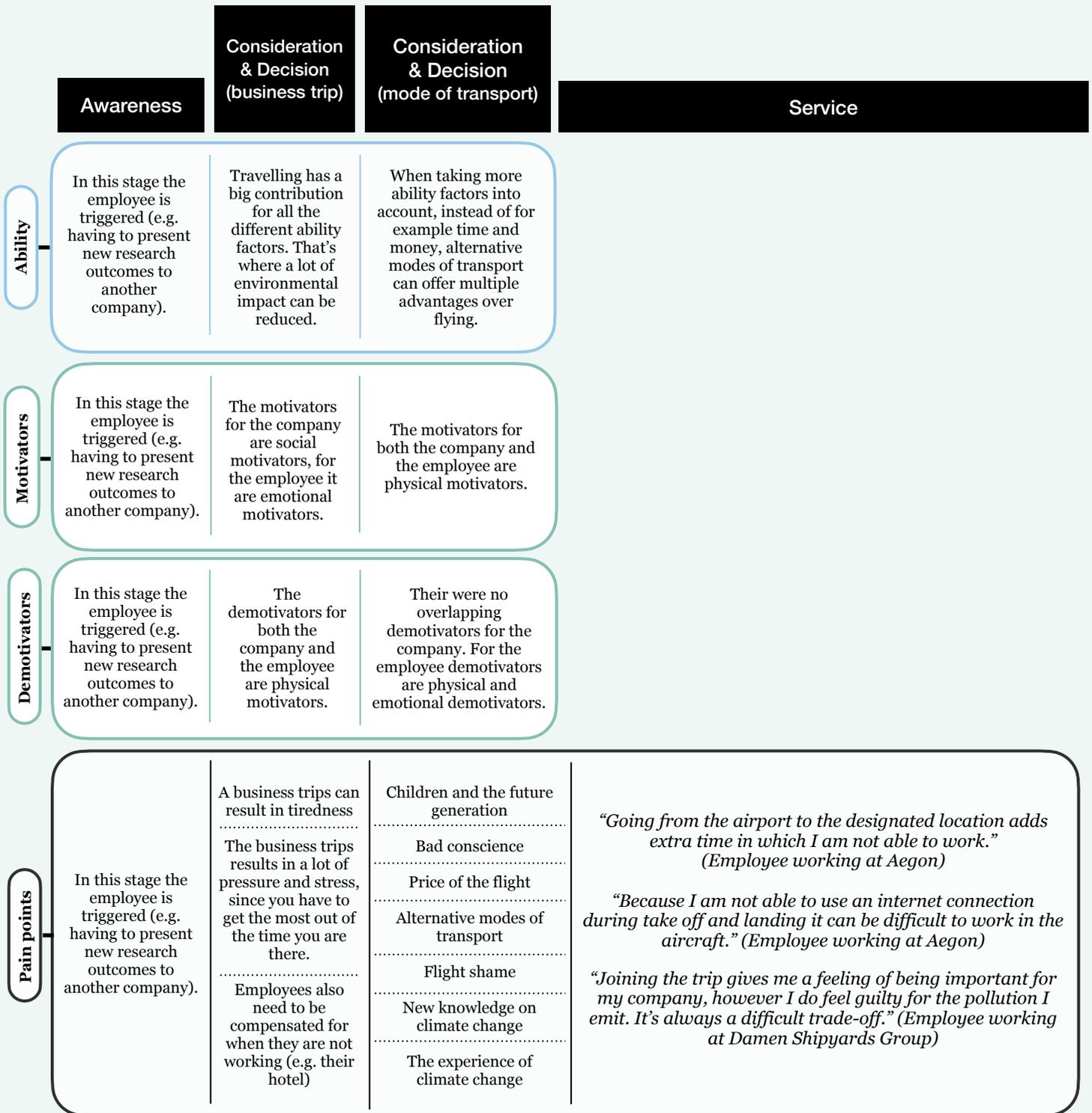|	Awareness	Consideration & Decision (business trip)	Consideration & Decision (mode of transport)	Service
Ability	In this stage the employee is triggered (e.g. having to present new research outcomes to another company).	Travelling has a big contribution for all the different ability factors. That's where a lot of environmental impact can be reduced.	When taking more ability factors into account, instead of for example time and money, alternative modes of transport can offer multiple advantages over flying.	
Motivators	In this stage the employee is triggered (e.g. having to present new research outcomes to another company).	The motivators for the company are social motivators, for the employee it are emotional motivators.	The motivators for both the company and the employee are physical motivators.	
Demotivators	In this stage the employee is triggered (e.g. having to present new research outcomes to another company).	The demotivators for both the company and the employee are physical motivators.	Their were no overlapping demotivators for the company. For the employee demotivators are physical and emotional demotivators.	
Pain points	In this stage the employee is triggered (e.g. having to present new research outcomes to another company).	A business trips can result in tiredness .... The business trips results in a lot of pressure and stress, since you have to get the most out of the time you are there. .... Employees also need to be compensated for when they are not working (e.g. their hotel)	Children and the future generation .... Bad conscience .... Price of the flight .... Alternative modes of transport .... Flight shame .... New knowledge on climate change .... The experience of climate change	*"Going from the airport to the designated location adds extra time in which I am not able to work." (Employee working at Aegon)* *"Because I am not able to use an internet connection during take off and landing it can be difficult to work in the aircraft." (Employee working at Aegon)* *"Joining the trip gives me a feeling of being important for my company, however I do feel guilty for the pollution I emit. It's always a difficult trade-off." (Employee working at Damen Shipyards Group)*

Figure 5.03, customer journey map including the ability, motivators, demotivators and pain points.

5.1.2. Design requirements

The requirements are determined based on the pain points deducted from the customer journey and the conclusions of the research. All the requirements are presented according to their source in figure 5.04 (on the next page).

5.1.3. Design focus

Design vision
The design vision is a result of the design assignment and formulated as follow.

To come up with a design solution increasing the awareness around the impact of short-haul flights while also guiding people in making a more sustainable decision (what), for employees who currently have business trips for which they fly and work at a company that want to increase it's sustainable awareness (who), by determining what the current motivators are for choosing a business trip and flying as mode of transport which lead to pain points that offer opportunities to design a solution presenting alternative modes of transport to be more attractive to use (how), thereby reducing the environmental impact employees and their companies have (why).

Target group
This design solution is targeted at the employees if companies that fly for business. While companies determines their policy, it is the employee who flies and gives feedback to the company. They are the ones who influence the initiation of a policy change. The companies themselves should not be forgotten, however, as they are the one paying for the design solution. Therefore there should also be some kind of advantage for them.

Design challenge
The demotivators which were most important for the employees were physical and emotional demotivators, as we saw in chapter 4. Short-term demotivators for going on the trip were personal issues like stress, tiredness and giving up private time. Long-term demotivators are the environmental impact of these business trips. This results in the first part of the design challenge: create environmental awareness with the design solution.

The demotivators for flying can almost all be related to the environmental impact of flying. Alternative modes of transport could provide an answer here. We saw that currently the ability is not high enough for employees and companies to consider alternative modes of transport. According to the Fogg Behavior Model, changing the ability is easier than changing the motivation. This results in the second part of the design challenge: create a design solution that makes it easier for companies and their employees to take alternatives into account when they have to go on a business trip.

		Requirements
Pain points from customer journey	Alternative modes of transport	The design solution has to provide different modes of transport.
	Children and the future generation / Flight shame	The modes of transport provided should be equal or more sustainable.
	Bad conscience / New knowledge on climate change	The solution must create awareness through education for the individual employee.
	A business trips can result in tiredness, a lot of pressure and stress	The solution should result in a more relaxed business trip experience for the employee.
Research results	The Fogg behavior model suggest that increasing the ability is easier than increasing the motivation.	The solution should guide the user through the process of deciding whether to go on a business trip or not and through the process of deciding which mode of transport to use if they have to go on a business trip.
	According to the Fogg model, personalization is key make the ability higher resulting in behavior change.	The solution must offer a personalized advise.
	Motivator conclusion for the decision to go on a business trip	The design solution should promote social acceptance of the company.
		The design solution should decrease the expectation of something bad happening as a result of the users behavior.
		The design solution should increase the travel experience resulting in less demotivation of immediate results.
	Motivator conclusion for the decision of flying	The design solution should decrease the motivation by increasing the motivation towards other modes of transport.
		The design solution should present clear reasons for the company why flying is not the best mode of transport.
		The design solution should inform both the company and the employee about the advantages of alternatives.
	Ability conclusion for the decision to go on a business trip	The design solution should increase the ability of the company as well as the employee, but should mostly focus on the employee in this regard.
	Ability conclusion for the decision of flying	The design solution must take all different ability factors into account when giving advise to the user.
Quote	*"There should be a common goal (for both the employee and the company) to reduce emissions from all trips within the company."*	The solution must create a goal for the business.

Figure 5.04, design requirements based on the customer journey, the research results and a quote.

5.3 Analogies

In the search for a solution, I tried to find inspiration in analogies. The analogies should give answer to similar question, how can people change their behavior to be more sustainable. This by asking themselves is what I think I have / do / use really necessary? or can I have / do / use something else reducing my environmental impact?

The first analogy should answer to the question: Is what I think I have / do / use really necessary? Similarities can be found in eating meat. More and more people become vegetarian or vegan [89, 90]. They change from eating meat to not eating anything made from or by animals. There are multiple reasons why this "movement" or sustainable behavior change has taken place. In figure 5.06 I mention the most common arguments to five of the six ability factors. For the factor of 'time', no argument was found, which is why it was not included.

Figure 5.05, campaign to stop eating meat by Peta [89]

The arguments all result in change. Some are encouraging new/desired behavior, others are discouraging the old behavior. With these reasons in mind people are eating less and less meat. A similar change could happen for business trips. Instead of eating different meat, why should you eat meat at all? For business trips this would result in, instead choosing which mode of transport, should the trip take place at all?

Money	- Meat is expensive.
Physical effort	- Eating animals increase your chances of getting a decease. - A plant-based diet is better for your health.
Brain cycles	- Feeling of guilt (an example is shown in figure 5.05).
Social deviance	- The meat business is one of the most polluting in the food industry. - Animal cruelty.
Routine	- Alternatives become more and more available.

Figure 5.06, arguments for changing from meat to becoming vegetarian/vegan linked to the six ability factors from the Fogg Behavior Model [91, 92, 93, 94, 95, 96, 97, 98].

Another transition of behavior is smoking. This second analogy gives answer to the same question: Is what I think I have / do / use really necessary? Over the last years smoking has declined [99]. People are changing their behavior by smoking less or quitting completely. This is due to multiple reason presented as arguments again linked to ability factors.

Similar to the first analogy, from figure 5.08, the conclusion can be drawn that for changing behavior when it comes to the category if something is really necessary, a combination of multiple if not all ability factors is needed.

Figure 5.07, anti-smoking campagne [100]

Time	- You save 720 hours a year when you stop smoking.
Money	- Smoking is expensive, you could save €3000 per year.
Physical effort	- There are eight direct risks to human health (cancer, autoimmune disorder, type 2 diabetes, premature deaths, lung disease, heart attack / stroke, complication for pregnant women and health dangers of second-hand smoke).
Brain cycles	- The thoughts of your behavior affecting you (and possibly people around you). The most often expressed thoughts are about the immediate impact of smoking (e.g., "I smell like cigarettes"). Smokers however expressed more severe worry over health-related thoughts.
Social deviance	- Deforestation. - Generation of toxic waste. - Air pollution through industrial production process and farming. - Air pollution through smoking the cigarette (figure 5.07). - Cigarette butts are 30 to 40 percent of all items collected in annual international coastal and urban cleanups.
Routine	- Smoke free zone / illegal to smoke at certain places.

Figure 5.08, arguments for quitting smoking linked to the six ability factors from the Fogg Behavior Model [101, 102, 103, 104, 105, 106].

The third analogy focuses on the behavior change from conventional petrol cars to electric cars. This answers the question can I have / do /use something else reducing my environmental impact? Even though it depends on the source of the energy, electric vehicles are more sustainable than non-electric vehicles (elaborated in sub-chapter 3.4). The argumentations are again presented in an overview where they are linked to the six ability factors.

Figure 5.06, 5.08 and 5.09 affirm that the solution to these problems can be found in the combination of multiple ability factors. This conclusion is in line with what was concluded in subchapter 4.2.

Time	- If people charge their car over night, they spend less time compared to a petrol car which needs to be filled at the petrol-station.
Money	- The in-use costs of an electric car is lower than a petrol car.
Physical effort	- A electric car never has transmissions. Causing the driver having to perform less physical effort.
Brain cycles	- A electric car does not have transmissions and therefore less mental effort while driving (only brake and gas instead of also different gears).
Social deviance	- Electric vehicles typically have a smaller carbon footprint than gasoline cars, even when accounting for the electricity used for charging. - The greenhouse gas emissions associated with an electric vehicle over its lifetime are typically lower than those from an average gasoline-powered vehicle, even when accounting for manufacturing.
Routine	- Some Dutch city centers have low-emission zones. Municipalities establish these zones to improve urban air quality. If a car is not allowed to enters these zones they will be fined (€100).

Figure 5.09, arguments for changing from gasoline to electric cars linked to the six ability factors from the Fogg Behavior Model [107, 108, 109, 110, 111, 112].

5.4 Ideation

5.4.1. Idea generation

To lay the foundation of the design solution I organized a creative session, to find different approaches to change behavior.

Aim of the session: To lay the foundation for the design solution, by answering the question: How to convert the outcome of the research to a design solution?

Sampling: Three participants with a bachelor degree in design.

Activities
The session started with introducing the problem. First the impact of the aviation followed by scoping into thesis focus, short-haul business flights. After this, the conclusion of the research was explained. After answering some question of the participants the brainstorm session started.

Each participant got the opportunity to share their first thoughts. These were written down. After all the participants had their turn, I asked them questions about their initial thoughts, to better understand their ideas. There were three rounds of ideation. During these rounds a lot of sketches were made.

Outcomes
The creative session resulted in the idea that the design solution should exist of multiple parts, each with a different goal. One part needs to create awareness, a requirement that was based on the research. This could be done through various ways: e.g. a workshop / seminar, a poster or a movie. There should also be a part that acts as a reminder and makes sure the awareness is not forgotten (this could act as a trigger). Multiple ideas were mentioned. One of them was a plant pot conveying a message/the goal of the awareness, this should be watered once every week resulting in a weekly reminder, see figure 5.10. A third part would be the execution of making the right choice. Here the user should be guided in their decision making. Ideas for this were a website, a telephone appointment with someone from greenbusiness or a flyer with a roadmap.
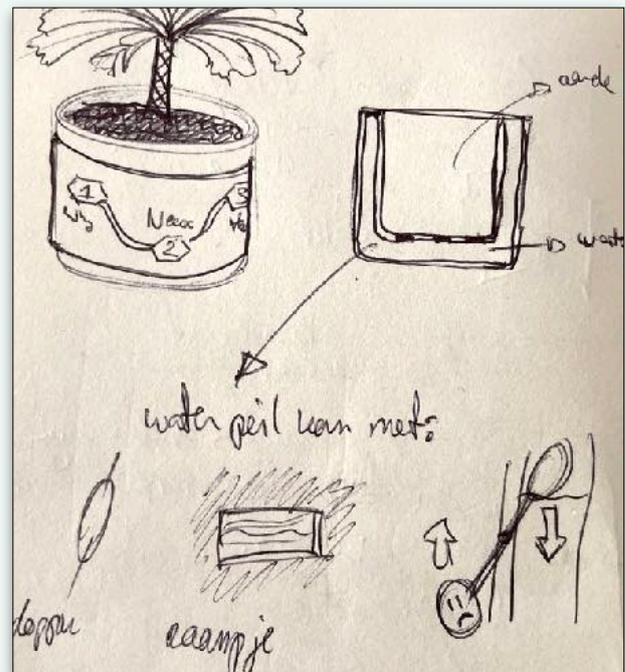
Figure 5.10, sketches made during the ideation.

With these outcomes I started my own ideation. I tried to further develop each of the three parts so that I could later use a design method to choose the best option.

Part 1 - awareness
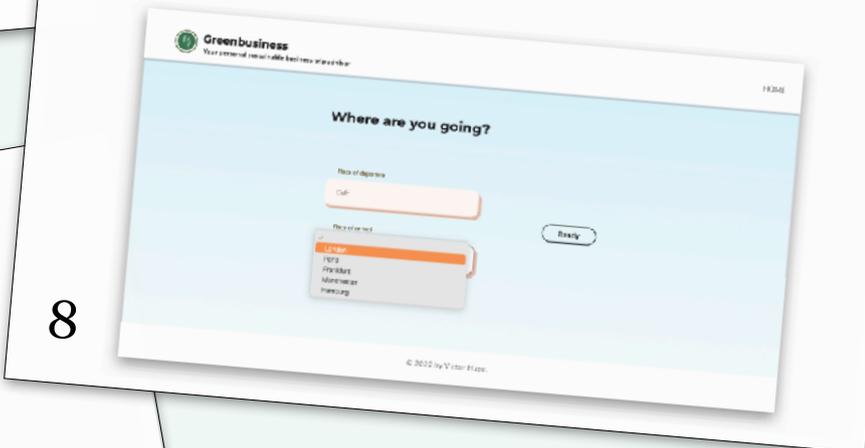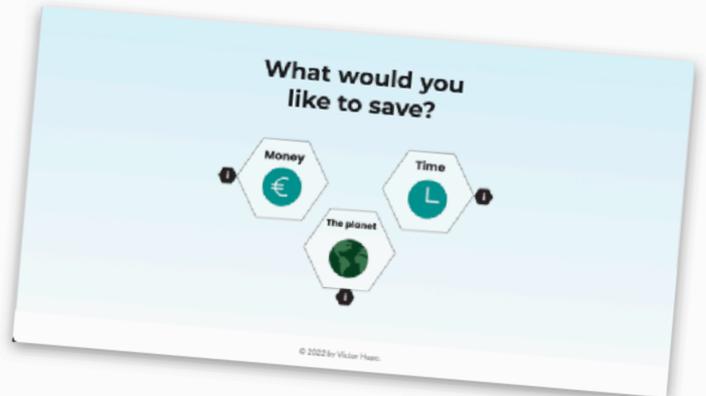A poster (1), interactive seminar (2) and movie (3).
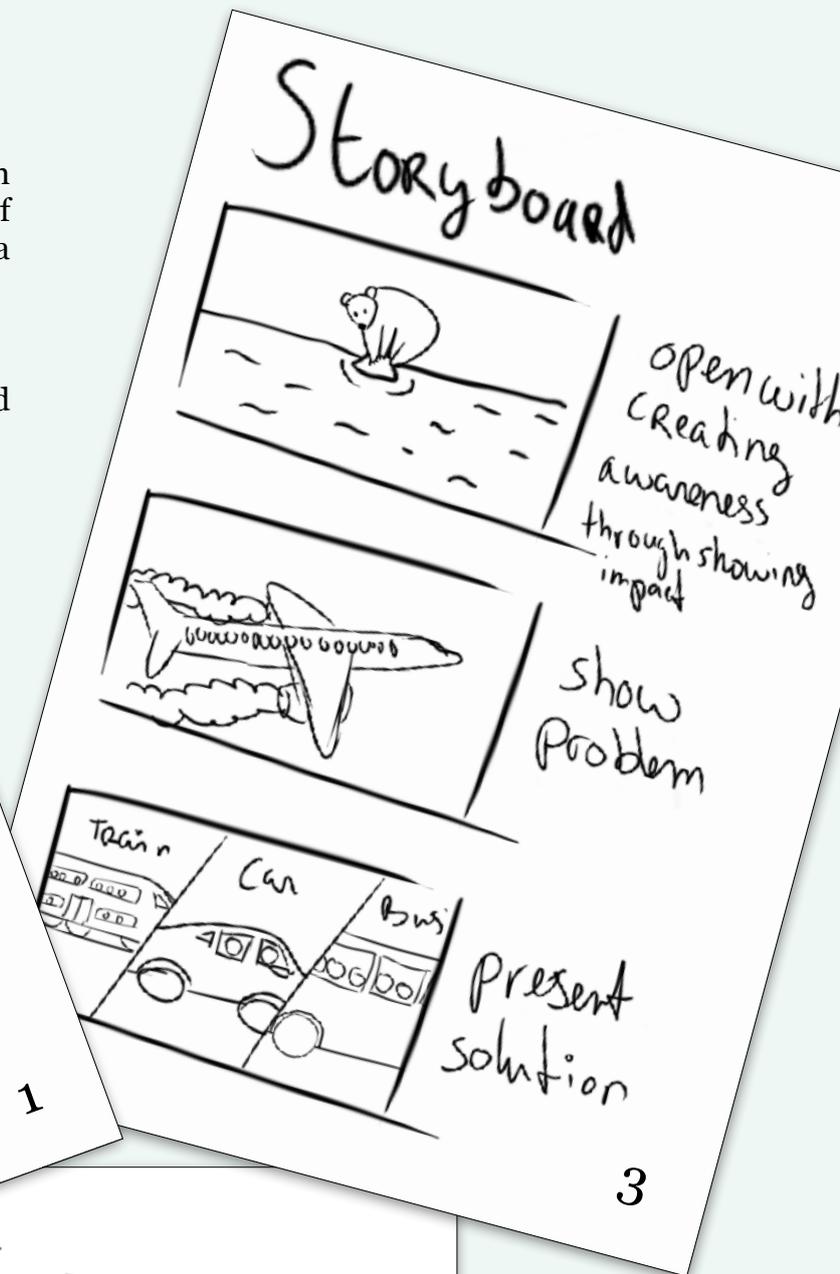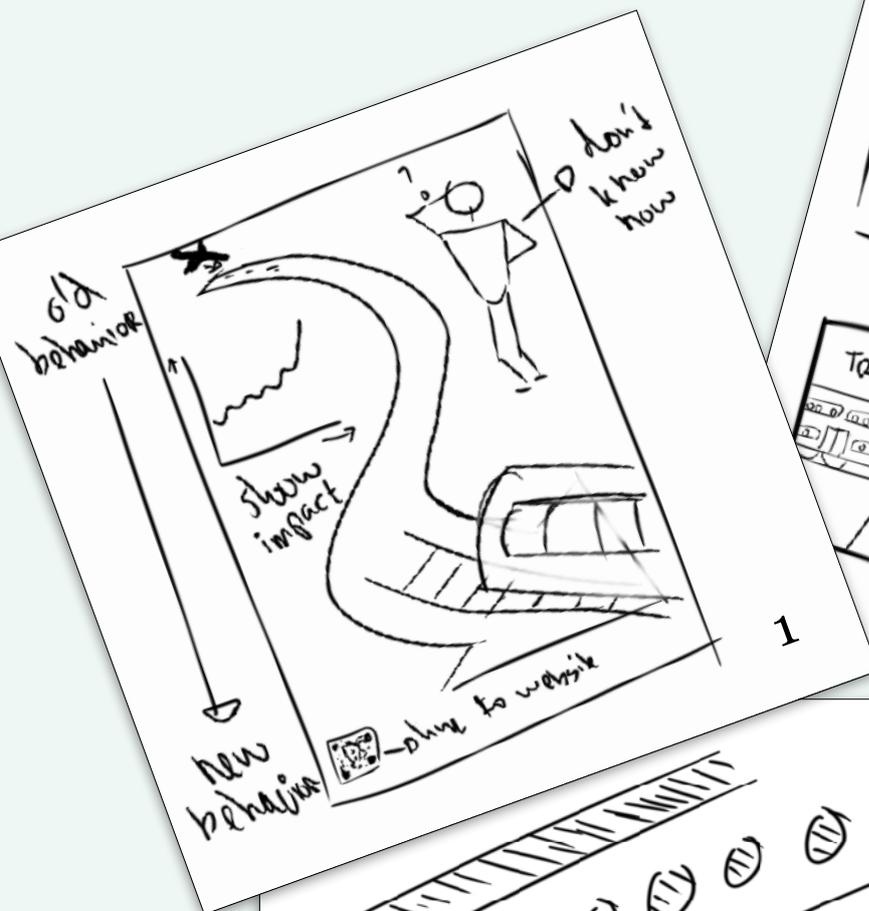
Part 2 - reinforcement
An email (4), mobile notification (5) and
plant pot (6).

Thanks for you participation / for
viewing the poster / movie!

4

5

6
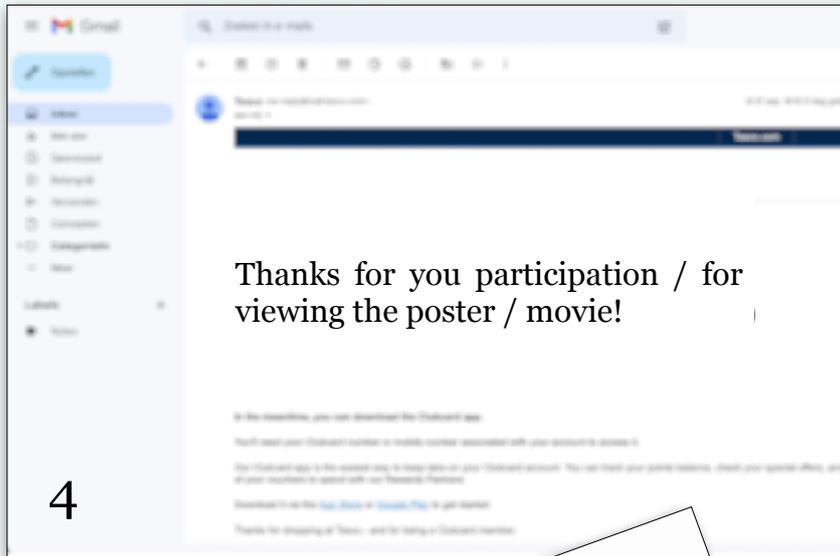
Part 3 - execution
A flyer (7), a website (8) and speaking to a greenbusiness employee (9).

7

8

9

Evaluation outcomes:

To find the best option for the first part (creating awareness) a datum method was conducted (figure 5.11). This method enables the designer to evaluate design concepts using design criteria (design requirements). I used the requirements related to creating awareness from the overview presented in 5.1.2. The most fruitful option is the workshop/seminar.

Requirements first part (awareness)	Workshop / seminar	Poster	Movie
The design solution should promote social acceptance of the company.	S	D	S
The design solution should increase the expectation of something good occurring.	+	A	+
The design solution should improve the travel experience resulting in less demotivation of immediate results.	+	T	+
The design solution should decrease the motivation by increasing the motivation towards other modes of transport.	S	U	S
The design solution should present clear reasons for the company why flying is not the best mode of transport.	S	M	S
The design solution should inform both the company and the employee about the advantages of alternatives.	+	.	-
Sum +	3	.	2
Sum -	0	.	1
	3	.	1

Figure 5.11, datum method for creating awareness.

To find the most suiting option for the second part (reinforcement), I presented different ideas in the next testing round. These ideas were a plant with a message on the plant pot, an email with a reminder or an app which sends notifications. After presenting the different ideas, I asked the following questions:

- Do you have any experience with one of the ideas? If yes, can you share that experience?
- Which idea would trigger what behavior?

The idea with a plant pot was never experienced before. The email and the notification would trigger the same behavior. Interviewees expected both of them to act as reminder. The plant pot, however, would not trigger the same behavior since it needs to be watered every week. It could easily become a routine. Due to the familiarity of the email (according to the interviews) and triggering the right behavior, the email is chosen as the best way of reinforcement.

The third goal is to guide the user in making the decision (execution). The different ideas from the ideation session are evaluated using the same method as for creating awareness. In the datum method, the ideas are validated for the requirements related to ability and the pain points. This is presented in figure 5.12.

The website turns out to be the best idea. It can be used at every moment of the day, requires less costs than the other options and the working is less effected by the amount of people looking for advise. Therefore the website is chosen as best option. This will be used for the next testing round.

Requirements third part (guiding user)	Flyer	Calling	Website
The solution must offer a personalized advise.	-	D	S
The design solution should take all different ability factors into account when giving advise to the user.	-	A	S
The design solution has to provide different modes of transport.	S	T	S
The design solution should increase both ability of the company as well as the employee. But put the emphasis on the employee.	S	U	S
The solution should result in a more relaxed business trip experience for the employee.	-	M	+
The solution should guide the user through the process of deciding which mode of transport to use if they have to go on a business trip.	-	.	S
The solution should guide the user through the process of deciding whether to go on a business trip or not.	-	.	-
The modes of transport provided should be equal or more sustainable.	S	.	S
The solution must create awareness through education for the individual employee.	-	.	+
Sum +	0	.	2
Sum -	6	.	1
	-6	.	+1

Figure 5.12, datum method for guiding the user.

5.4.2. First concept

With the feedback from the ideation session I came up with the following first concept.

Seminar
With the goal to create awareness, following from the datum method, designing a seminar would best fit the requirements. In this seminar the participant would get a case. They are asked to plan/map a short business trip with figures and a board (figure 5.13). When they are done, a short reflection takes place and the participant is shown that the same trip could also be made with alternative modes of transport. The participant is still able to go on their trip, but with a reduced impact.

Email
To be sure the participant will not forget the message of the seminar a reminder is needed. According to the design method the reinforcement should be done via email.

Website
For the execution a website was created (figure 5.14). This option was best suited according to the datum method. On this website the user will be guided in making their decision. This is done by asking questions like:

- Where they are going to?
- What the trigger is for the trip?
- Is the trip really necessary?

The complete website can be found in Appendix K.
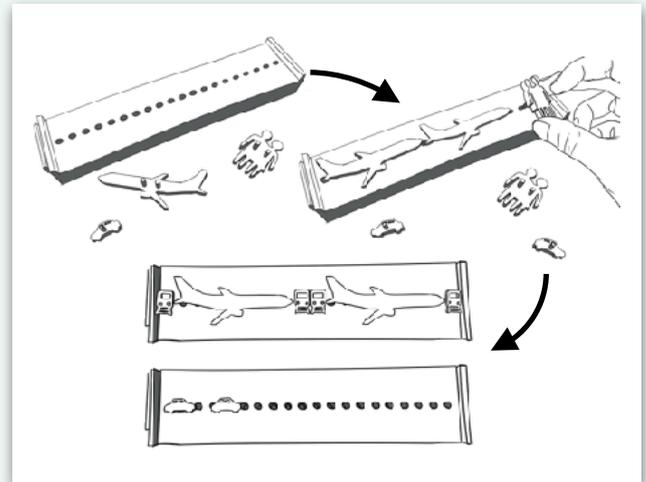
Figure 5.13, the attributes used in the case which is part of the seminar.
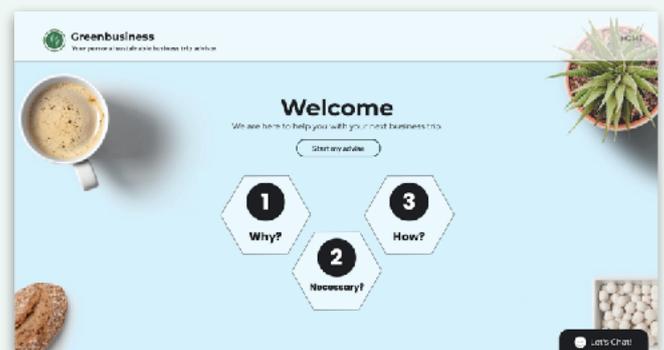
Figure 5.14, home page for test website.

5.4.3. Testing

I have tested this concept with people from my target group. I did three rounds of testing. The in-depth test result can be found in Appendix L. The first round was done with three participants from three different sectors (insurance, steel and clothing industry). The aim of this round was to verify the concept and to see whether it fits the needs of the target group.

The feedback was:

- The impact of personal life is not measured in the same unit as the modes of transport.
- The order of the seminar needs to be different (e.g. the lecture on the impact of short-haul flights should be after working on with the board and figures)
- Modes of transport such as the bicycle and walking were missing.
- It would help if different modes of transport have different colors, that represent the impact.
- What happens if people want to do this assignment but cannot physically get together?
- There should be a common goal for the employee and the company to reduce emissions from all trips within the company.
- The reinforcement should be done via email.

Implementation of the feedback from round one resulted in:
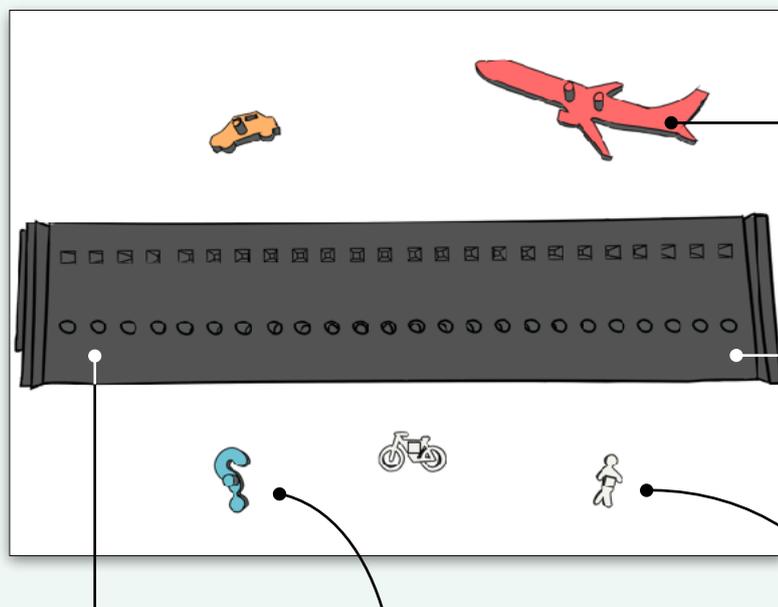
The figures received a color, green meaning less impactful until red being the most impactful.

An extra layer with rectangular openings is added, these are meant for transport with almost no emission and online.

There are 24 instead of 20 opening. This is equal to using the car (2 pins) to go to the airport, fly (8 pins) and get a taxi when you arrive (2 pins). And do the same on your way back. This is the maximum impact and is the current behavior. With this the board is full and every change will be an improvement.

White figures are added representing modes of transport with zero to none emissions.

The question mark is added representing modes of transport which are not included in the figures (e.g. Segway)

The second round was done with two participants, someone with a background in marketing and someone who is the head of a publicity agency. The aim was to verify whether these changes have the desired result. The feedback was:

- The case is not clear yet.
- The case is steering too much towards a business trip.
- The figure used for public transport is not clear.
- It is possible to turn the figure for public transport vertical which should be only used horizontal.

Implementation of the feedback from round two resulted in:
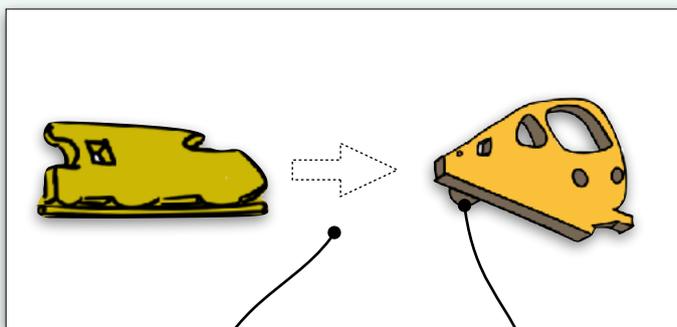
The figures used for public transport was changed.

The pin with which the figure could be 'clicked' in the board is changed from cilinder to a rectangular shape.
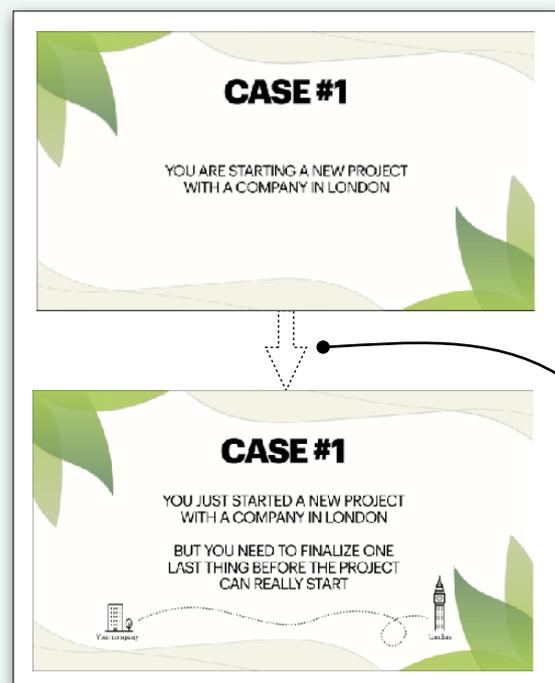
The case was changed to make also online meeting an option.

The third round was done with two participants, from the same company. The aim was to see how two participants who work together would react on each others board and how they would work together on the second case.

The feedback was:

- The case was still not clear, it was too logical to choose for the online option.
- The participant did not understand the case was about a return trip.
- The website was not fully working.
- The train symbol was now clear.

With this feedback in mind, I made the last iteration (on the right) which resulted in the final design concept.

Implementation of the feedback from round three resulted in:

The case was change to leave both options (physical meeting and online) open. The choice is really up to the participant.

To make sure the participant understands the case another slide is added with the final question, including a note mentioning the case is for a round trip (if you choose to travel).
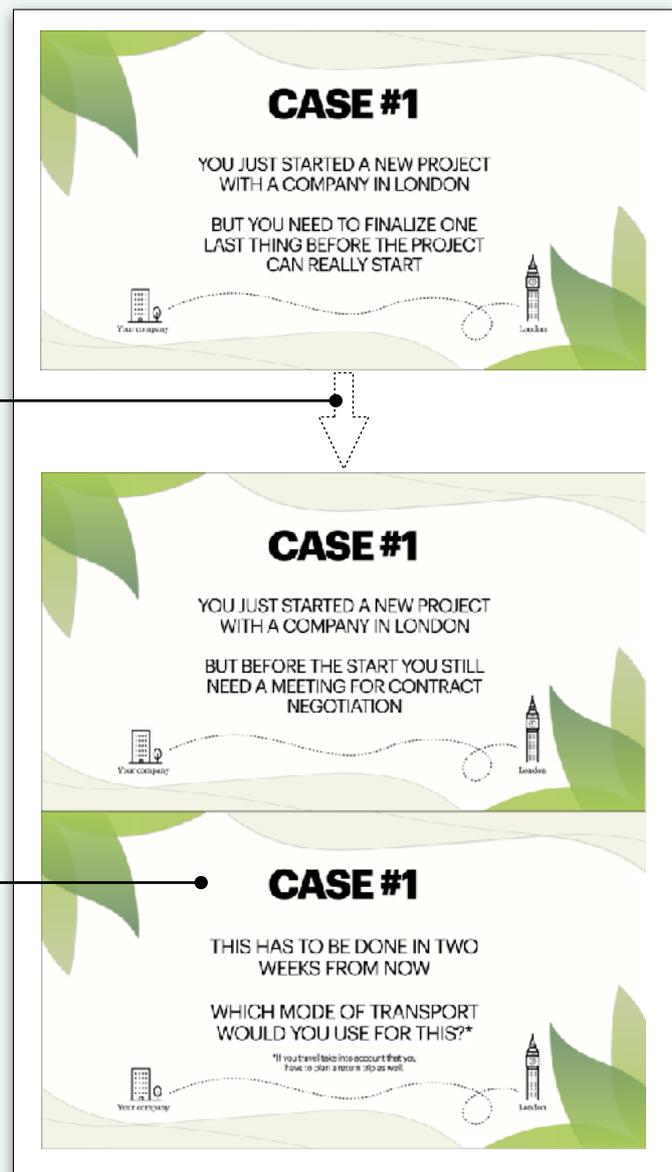
5.5 The design solution

In subchapter 3.1.4. we have seen that the Fogg Behavior Model is best suited for small behavior change. The final design therefore consists of three smaller goals: awareness, reinforcement and execution (figure 5.14). To create awareness I have designed an interactive seminar. To reinforce peoples behavior change, an email is sent after the seminar; one day, one week, one month and one year after the seminar. When employees have to partake in a business trip, they enter the execution phase. For this phase I have designed a website that can help and guide the user by giving personalized advise on the trip. The aim of this website is to increase the ability, which was key to behavior change according to the Fogg Behavior Model. In this advise the three most suitable modes of transport are presented. The user is also presented with a button that leads them to the place where they can either book a ticket (train, bus or aircraft) or find the route (when travelling by car).

The behavior change does not happen at one fixed moment. During the seminar there might be a moment of revelation. For employees who are already more aware of their impact on the environment this will have less impact. For them, the change in behavior may lie more in making it easier to search for options via the website. There is no guarantee employees will change their behavior, as they have to be willing to change to a certain extent. By focusing on personal argumentation for the behavior change I try to make it more appealing for employees to change.

Whenever a design requirement is met, this requirement is presented in box similar to the one presented below.

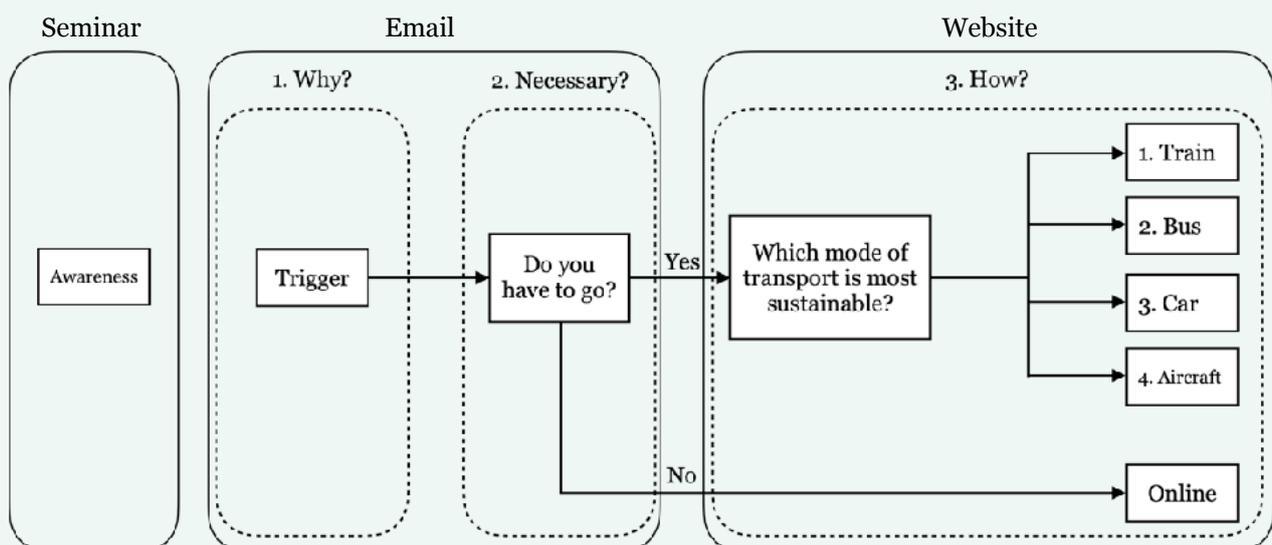> The solution must create awareness through education for the individual employee.

Figure 5.14, framework of the complete design solution.

5.5.1. Awareness

Motivators

I. **Physical motivators**
   a motivator related to sensation

→ I. Presenting alternatives helps seeking pleasure and avoid pain (causing by flying). *Motivator for the employee and company*

II. **Emotional motivators**
   a motivator related to anticipation

→ II. Creating awareness on the environmental impact of flying could cause fear, where alternatives could cause hope (for them and other people). *Motivator for the employee*

III. **Social motivators**
   a motivator related to social cohesion

→ III. Trying to reduce the amount of short-haul flights shows the world your company is working on sustainability. This can result in social acceptance. *Motivator of the company*

Figure 5.15, the motivators linked to different aspects of the design solution.

With the seminar my goal is to create awareness of the impact of short-haul flights used for business trips. To achieve this goal I try to activate the multiple motivators (figure 5.15). The seminar consist of three parts and will take approximately two hours. A complete time indication can be found in Appendix M.

The first part is a case. In this case (figure 5.16), ten boards are placed separately on the table (this example is based on 10 participants). Each board represents a business (round) trip. The assignment for the participants is to plan the ten return trips (each participant will work with one board and therefore one trip) using different figures representing modes of transport from their location to London. The only information they will receive is the different icons (figure 5.17) and what they represent (see Appendix N). The participants are given 5 minutes to plan their hypothetical trips.
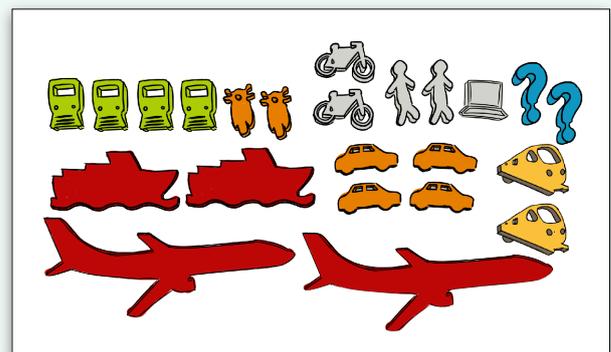

Figure 5.16, slide presenting the first case.

Figure 5.17, all the different figures available for each board.

After these 5 minutes, all business trips or all boards are clicked together and the group is asked if anything stands out (this could be the notable amount of red or bigger figures visible). Then, there is a short evaluation and reflection.

After this, there is a presentation in which an introduction is given on global warming and the contribution of the aviation industry to this problem (figure 5.18). The start of the presentation will be a short introduction the impact of flying on the environment. This is followed by the consequences (the change of the climate), the impact that is already visible today and what your impact can be as an individual.

After the focus on aviation as an industry, we will zoom in on short-haul flights (figure 5.19). It is made clear that there are good alternatives available for business trips. The online meeting is also discussed here. It shows why and when this is a good option and what one can do to improve this experience. Also the comparison is made with alternative modes of transport (figure 5.20). In this comparison the possible advantages of alternatives, both for the company and for the employee, are emphasized.

This will take about 50 minutes and ends with a break of about 15 minutes.

Figure 5.18, slide with the aviation's share of the global carbon budget.

Figure 5.19, slide with all the flights from Schiphol from 2019.

Figure 5.20, slide showing the comparison with alternatives.

The design solution should increase the travel experience resulting in less demotivation of immediate results.

The design solution should inform both the company and the employee about the advantages of alternatives.
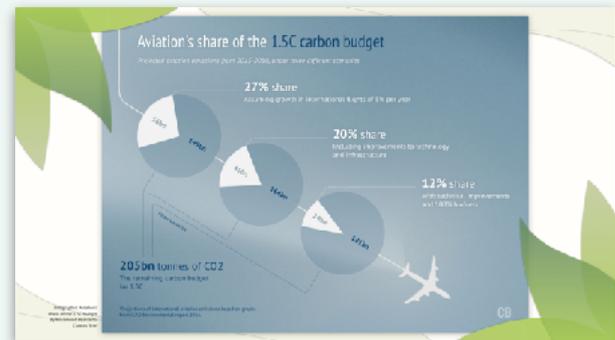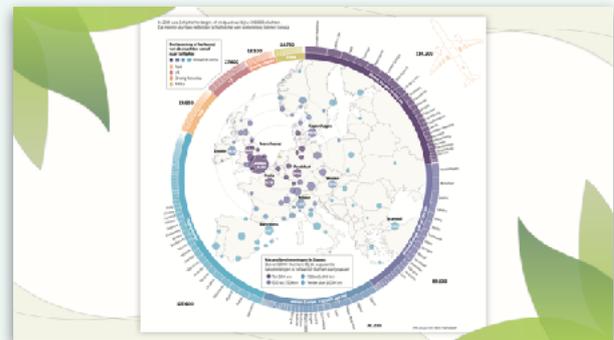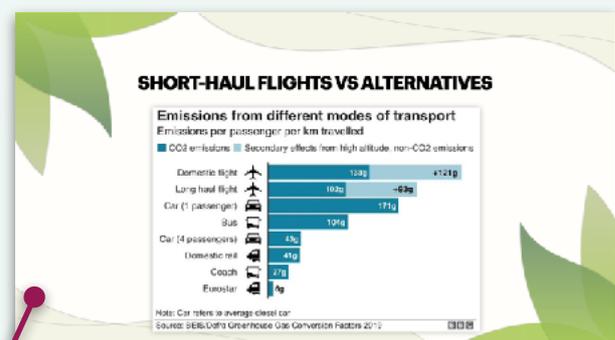
The second hour starts with another evaluation on their result of the first case, now the conclusion might be different or affirmative with the new knowledge learned gained from the presentation.
The group is now informed (if not already concluded) that the bigger the figure, the more impact is represents. Also the color of the figure means something, if the figure is green, it is the most sustainable option, the redder it gets, the worse the environmental impact is (white represents no emissions).

The participants are then instructed to plan ten return trips. They get the same case as the beginning of the seminar. However, now the participants will work together as a group, instead of individually. Therefor all boards will remain clicked together.

After 5 minutes, the goal is to see less red figures on the boards and thus represent less emission. The conclusion is the impact on the environment has been drastically reduced, while still having the possibility to travel.

Post-its will then be distributed. Each participant gets three post-its, followed by the question: Why is this change in mode of transport important or interesting to you? This question is asked because everyone has different goals. The participants are given a few minutes to write down their answers.

Then some participants are asked to paste their argument on a board with a few of the most common categories of arguments (their family, children, future, protecting

> The design solution should present clear reasons for the company why flying is not the best mode of transport.
>
> The design solution should decrease the motivation by increasing the motivation towards other modes of transport.

nature or a matter of conscience) for sustainable behavior. They can then give additional information if they are open to it. Bringing in a number of different people will show different people have different arguments.

After this, the group is asked to each stick their post-its to the category that they think fits their argument. During the evaluation of these arguments, the conclusion can be drawn that everybody has different personal arguments however different people might share arguments, resulting in them not helping themselves but also impacting other peoples live.

The last 15 minutes will be used to tell what will happen next. The website will be explained. It is also told that the company as a whole can earn a certificate. According to RTL Nieuws, companies are more attractive to new employees if they can prove they are becoming more sustainable [113]. With this certificate, a company can prove this.

> The solution must create awareness through education for the individual employee.

> The design solution should decrease the expectation of something bad happening as a result of the users behavior.

The amount of flights a company makes will be determined in advance. The amount of reduced flight results in a specific certificate (received after one year). The company receives a colorless certificate for participating in the seminar. The company is given a bronze certificate for a 10% reduction of short-haul flights, a silver certificate for 20%, a golden certificate (figure 5.21) for 30% reduction and a diamond certificate for reduction over 50%.

A certificate can be used by the company to provide internal feedback on what they have achieved. In addition, it can also be used to show applicants that sustainability is considered in their company.

The certificate is linked to the year in which it was obtained. It can be used to show the start of their shift in behavior resulting in becoming more sustainable as a company.

Figure 5.21, the gold certificate earned for a reduction of 30%.

The design solution should promote social acceptance of the company.

The solution must create a goal for the business.

Online version

If the participants cannot be physically present for the seminar, the seminar can also be held online. The setup is the same, only then the figures and the board are online. The participants go through the same principle, where the first case is individual (figure 5.22) and the second case will be done in groups (figure 5.23).
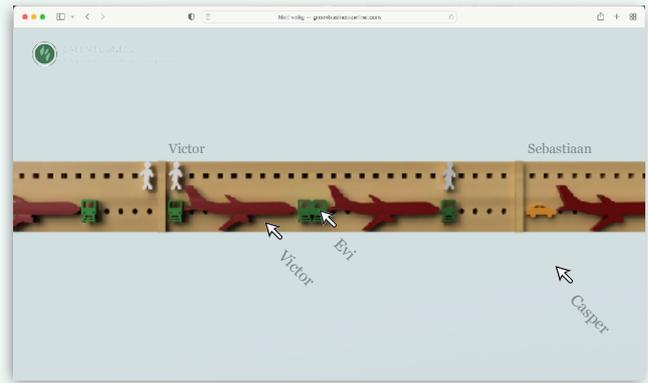

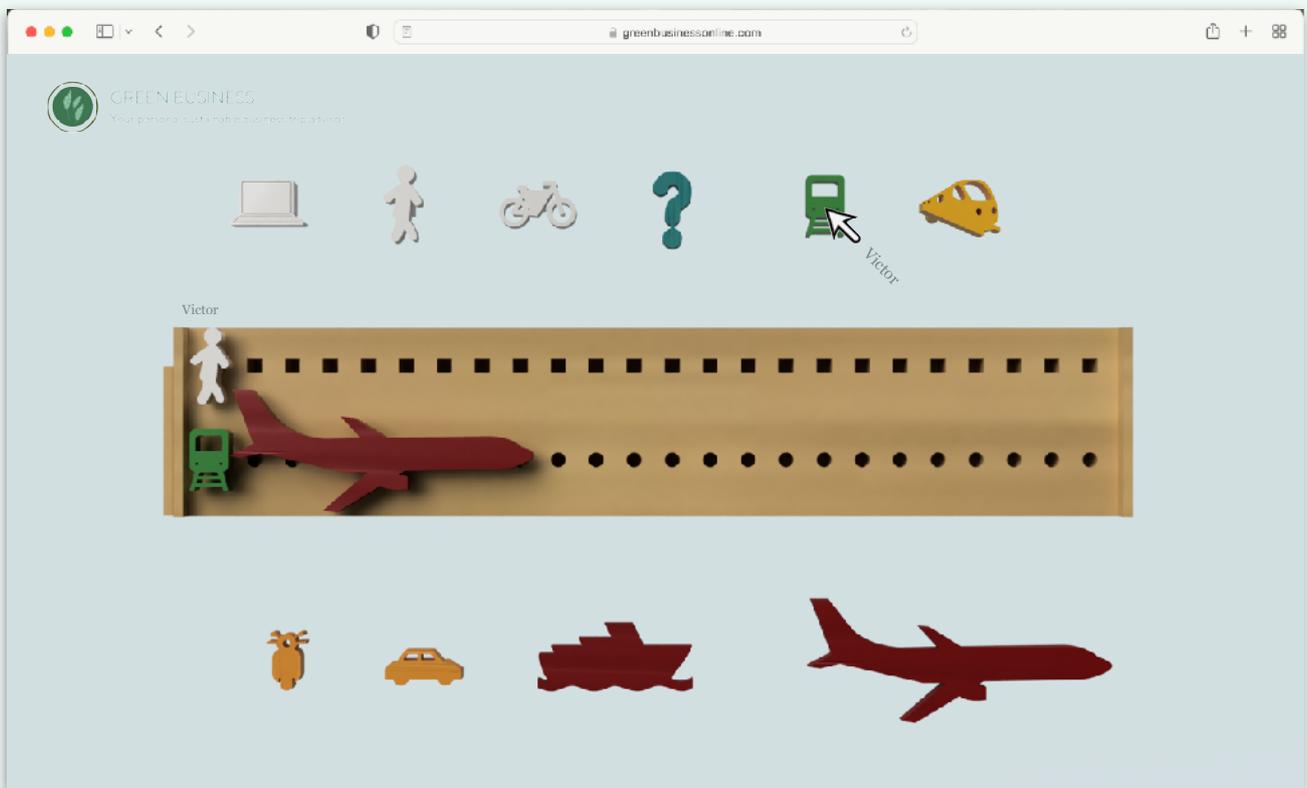*Figure 5.23, visualization of the participant comparing their planning with other (evaluating the first case) in an online setting.*

Figure 5.22, visualization of the participant planning the first business trip (the first case) in an online setting.

5.5.2. Reinforcement

To ensure that the participant does not forget the message of the seminar, several emails will be sent in the year after the seminar. The aim is that the participants are reminded of the seminar and thus less likely to fall back into their "old" habit.

The emails can tell you how much progress they have already made. The emails will contain jokes and facts to keep the information lighthearted and interesting to the received. Examples of the emails can be found in Appendix O.

The emails will be received after: one day (figure 5.24), seven days, one month, three months, six months, nine months and one year.

In terms of triggers, this could be seen as a cold trigger (as defined in paragraph 3.1.3.), since it does not directly push the receiver into performing the desired behavior. Regards the category, it can be seen as facilitator (explanation for this is giving in figure 5.25).

The email, as trigger, helps the receiver remember their argumentations for sustainable behavior change concluded in the seminar, the goal of their company and to use the website if they are in need for a business trip.
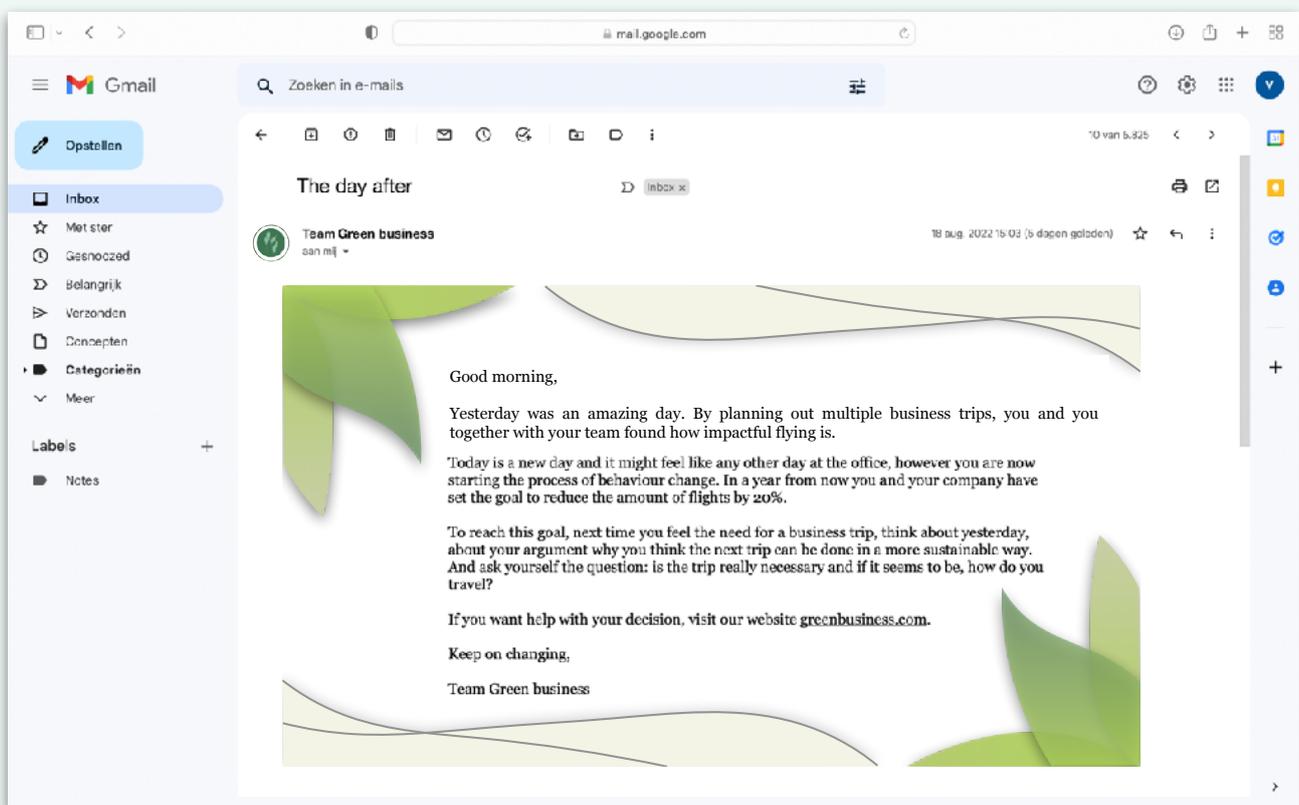

Figure 5.24, visual representation of what the email send one day after the seminar will look like.

Figure 5.25, the trigger linked to different aspects of the design solution.

5.5.3. Execution

With the website the goal is to guide the user during their decision if they have to go on business trip. If the answer yes, help them determine the best suitable (most sustainable) mode of transport. To achieve this goal I try to activate all the ability factors (see figure 5.26).

When the person responsible for arranging the trip is notified with the need for a business trip they can make use of a website. In the end the user will receive a personalized advise. This advise will be viable, it is not excluded that flying comes in second or even first place. It is however, quite unlikely due to the large relative amount of emissions for flights under 1000 kilometer and the amount of alternatives, but it could be possible. An example for this would be a trip between Delft and Oslo. According to Google Maps, driving by car would take between 14 and 18 hours. Going by bus/train will result in a 21 hour trip.

The website
When the user is in need of advise, they go to greenbusiness.com. Here they click on the header 'Advise' which will lead them to the part of the website where they are greeted by a new home page (figure 5.27). If the user scrolls down on the home page they will find an explanation on the three stages they will go through when using the website (figure 5.28). When the user clicks on the button 'start my advise', they are redirected to the next page asking them what they would like to save (figure 5.29). The advise will present the most environmental friendly mode of transport. However sometimes there can be differences in time and price for different modes of transport who have a similar environmental impact. If the both time and price are not relevant for the company they can choose to save the planet. This choice is offered to make the advise more personal. The following page asked for the destination (figure 5.30)

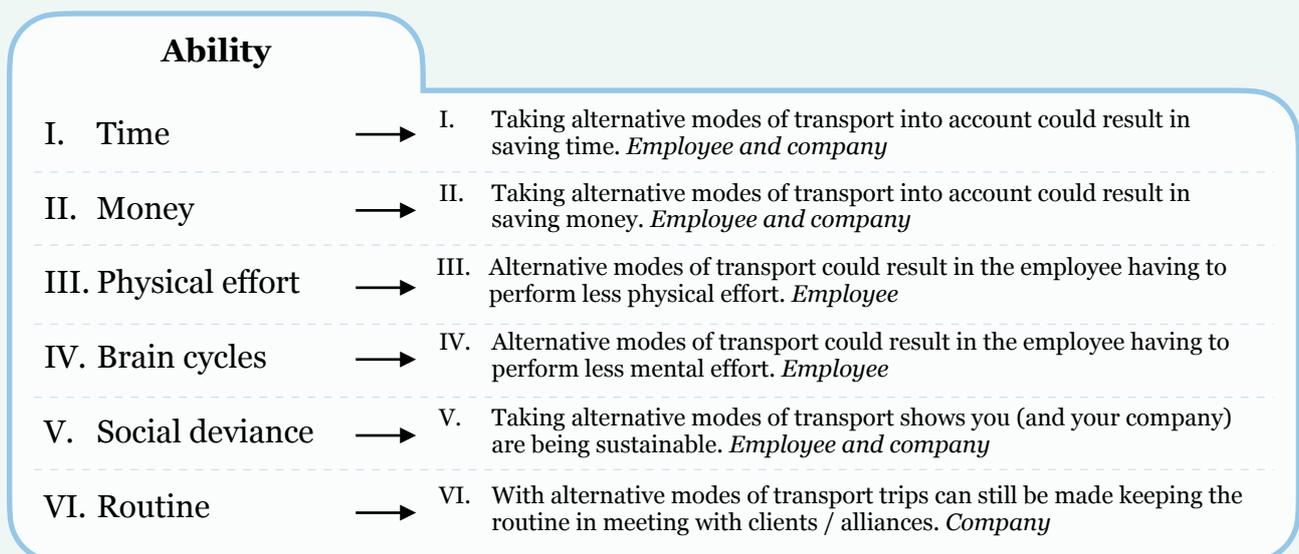| **Ability**	
I. Time $\longrightarrow$	I. Taking alternative modes of transport into account could result in saving time. *Employee and company*
II. Money $\longrightarrow$	II. Taking alternative modes of transport into account could result in saving money. *Employee and company*
III. Physical effort $\longrightarrow$	III. Alternative modes of transport could result in the employee having to perform less physical effort. *Employee*
IV. Brain cycles $\longrightarrow$	IV. Alternative modes of transport could result in the employee having to perform less mental effort. *Employee*
V. Social deviance $\longrightarrow$	V. Taking alternative modes of transport shows you (and your company) are being sustainable. *Employee and company*
VI. Routine $\longrightarrow$	VI. With alternative modes of transport trips can still be made keeping the routine in meeting with clients / alliances. *Company*

Figure 5.26, the ability factors linked to different aspects of the design solution, with aim shifted more towards increasing the ability of the employee.
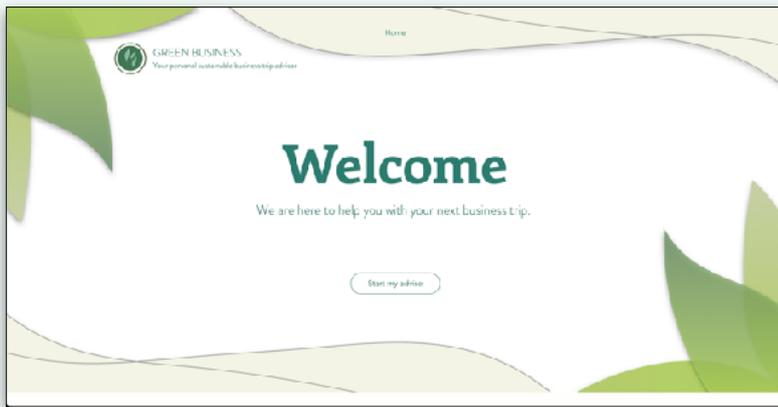
Figure 5.27, the home page voor advise section.

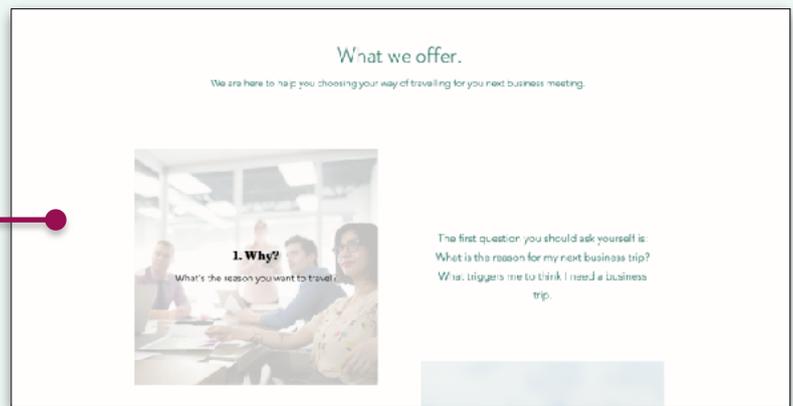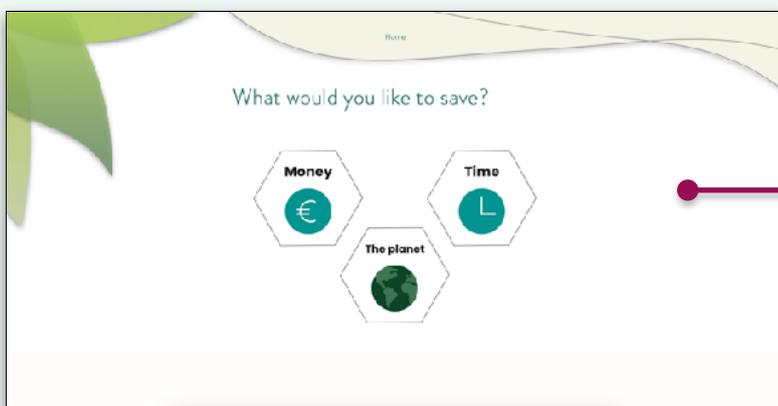The design solution should increase the ability of the company, but mostly the ability of the employee.

Figure 5.28, the explanation of the three different stages the user will go through.

The solution must offer a personalized advise.
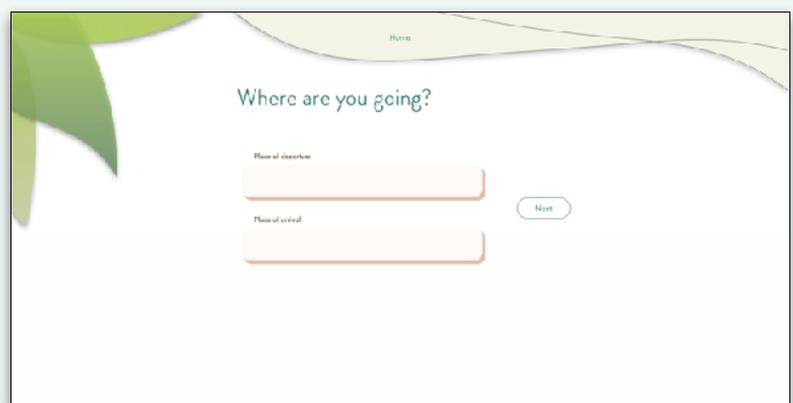
Figure 5.29, what is the user's goal?

Figure 5.30, where is the user going?

After selecting a goal and entering the place of departure and place of arrival, the user "enters" stage 1, Why? (figure 5.31) Here the question is asked: what is the trigger for the business trip? Each answer has a textbox with more information for that answer and examples that fall in that category.

The user is next presented with the question whether the business trip has to be offline or can also be done online. Employees will likely already have considered the online option before visiting the website. They then made the choice to go for a physical meeting. When using the website they are confronted with their impact. According to the third testing round, this could lead to doubt and it is possible that users will choose the online option at this point. This is why this question is included on the website. The aim of this page is to make online meetings more appealing. If the user decides it can also be online, they are redirected to the third stage, How? Here they receive tips on how to improve their online meetings (figure 5.34).

If the user indicates they have to do the meeting physically (figure 5.32) they are presented with the impact they have (figure 5.33), in order to raise awareness of what they could save if they do not travel. If they are aware of their impact but still want to travel, they enter the third stage, How? (figure 5.35). Here the website provides the top three options for the trip, including information to easily book the trip and/or find a route to the

The design solution should take all different ability factors into account when giving advise to the user.

place of destination (e.g. by being redirected to the right website from NS International). This advise is based on all the different ability factors and the alternatives presented are equal or more sustainable than flying.

The modes of transport provided should be equal or more sustainable.

The advise presented consists of multiple modes of transport. These options are determined keeping sustainability in mind. According to the second and third test round, this can result in a feeling of relief. Even though the trip is made, it is done in the most sustainable way.

The design solution should decrease the expectation of something bad happening as a result of the users behavior.

Since the website promotes the most sustainable mode of transport, which will often be the train, the employee can have a more relaxed business trip. The train offers a more comfortable space to work or relax while travelling, resulting in a better experience altogether. The employee can save time by working while travelling, which can result in more spare time while being at the location, which could be used to relax.

The solution should result in a more relaxed business trip experience for the employee.
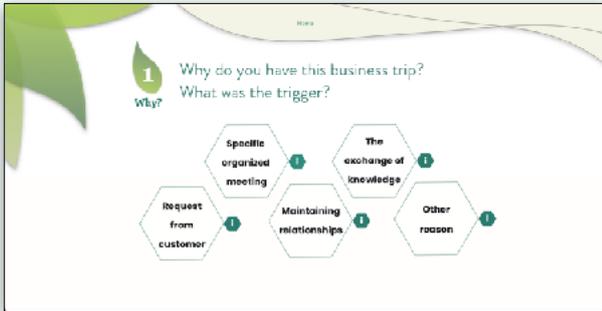
Figure 5.31, the first stage, Why?
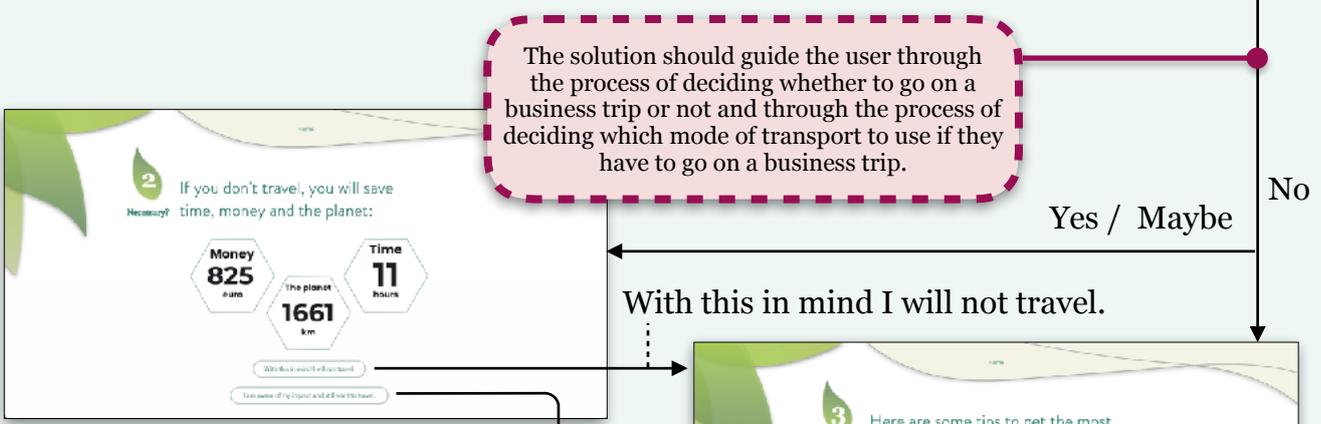

Figure 5.32, the second stage, Necessary?

The solution should guide the user through the process of deciding whether to go on a business trip or not and through the process of deciding which mode of transport to use if they have to go on a business trip.

Yes / Maybe

No

Figure 5.33, the second stage, if you don't travel, this is what you will save.

With this in mind I will not travel.

Figure 5.34, the third stage, How? If the user makes the decision to go for an online alternative.

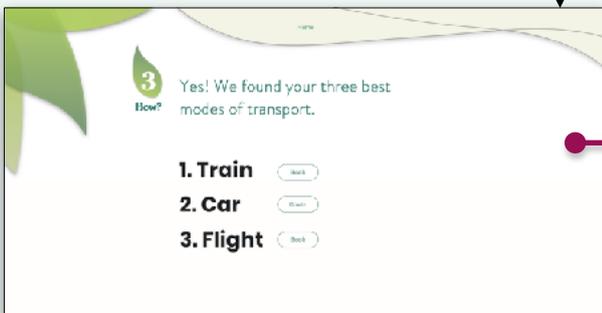I am aware of my impact and still want to travel.

Figure 5.35, the third stage, How?

The solution has to provide different modes of transport.

The solution must offer a personalized advise.

5.5.4. Testing final design

The final design went through one more test-round. This was done with one participant. The aim is to find possible improvement for future development. The feedback was:

- It is important in the second evaluation of the boards that it may be possible when looking at all the trips partly in the interest of the company, that the individual belief is set aside. There needs to come a good bridge between this evaluation and the post-its on which the participants can write down their arguments. This could be design by doing test with bigger groups.

- It might be easier if the post-it or pieces of paper have different colors. This allows for emphasis on the different individuals who, possibly unexpectedly, share their argumentation (of why they want to change their flying behavior).

- In addition to the certificate, information can also be shared on social media, with a focus on LinkedIn. This makes the company transparent and show the world what they working on. This can also motivate them to achieving their goal.

Besides this feedback there are also other accepts that can undergo further development. By testing, for example, more extensively how the trigger can better match the needs of different companies. As a result, the message of the seminar will have more impact and companies with their employees know better what to do to change their old behavior.

The certificate can also be further developed. An example of a certificate already developed is issued by B Corp (figure 5.36). This is an international certification that rewards companies when they contribute to improving the world in which we live. Companies that want to reconcile their pursuit of profit combined with a collective interest. Companies can make good use of this certificate to show that they are working on sustainability. As mentioned before, this can attract new applicants, but it can also help with change and new regulations regarding short flights. If a company already uses alternative modes or transport, they will be less impacted when regulations or laws are put through.

Figure 5.36, SPA presenting their status of being a B Corp-certified company [114].

5.6 Implementation of Greenbusiness

5.6.1. Value proposition

Greenbusiness increases awareness around the impact of short-haul flights, while also guiding people in making a more sustainable decision. This by giving a seminar (to create awareness), keeping in touch via email (reinforcement) and providing a website that gives advise on the most sustainable mode of transport. This is for companies and employees who currently have business trips for which they fly and work at a company that want to increase its sustainable awareness.

5.6.2. Implementation

Greenbusiness is a start-up. Within a company, different departments could be interested in purchasing the seminar (figure 5.37). If a company wants to be more sustainable, this seminar could be a good first step in the right direction. This seminar could fit in their 'training program' to change the employees and company's perspective towards short-haul flights.
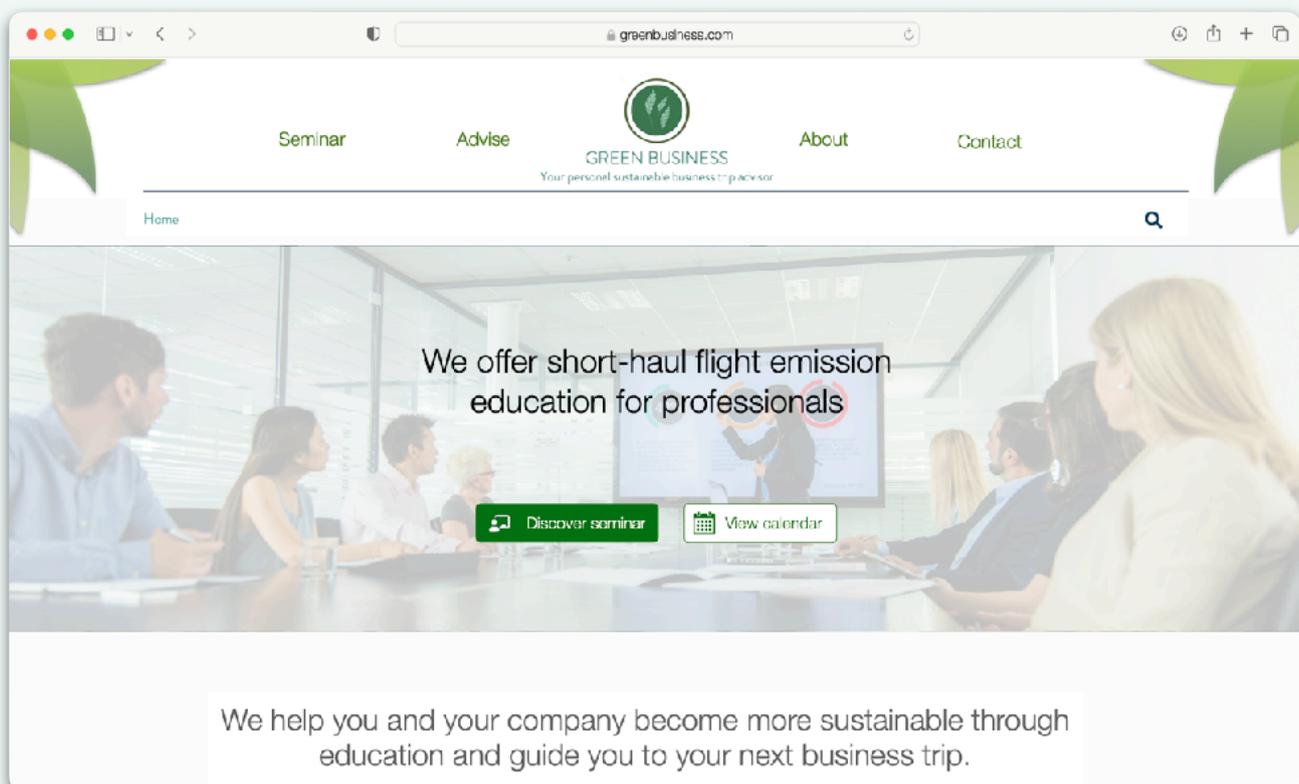

Figure 5.37, greenbusiness.com.

Participants of the seminar can be people from the different departments (figure 5.38).

I did interview to find out which departments are most often represented in seminar like mine. I asked someone working at DOB, a company that offers offshore education for professionals with a main focus lies on interactive courses, what kind of departments follow their seminars. He told me participants are not always from one department or can also be 'scouts' send by a company to see if the seminar is interesting enough. If they think more people would benefit from the seminar, they could come again with more employees.

When the company purchases the seminar, someone from greenbusiness comes to their location and gives the two hour seminar. This could be done in the morning or afternoon.
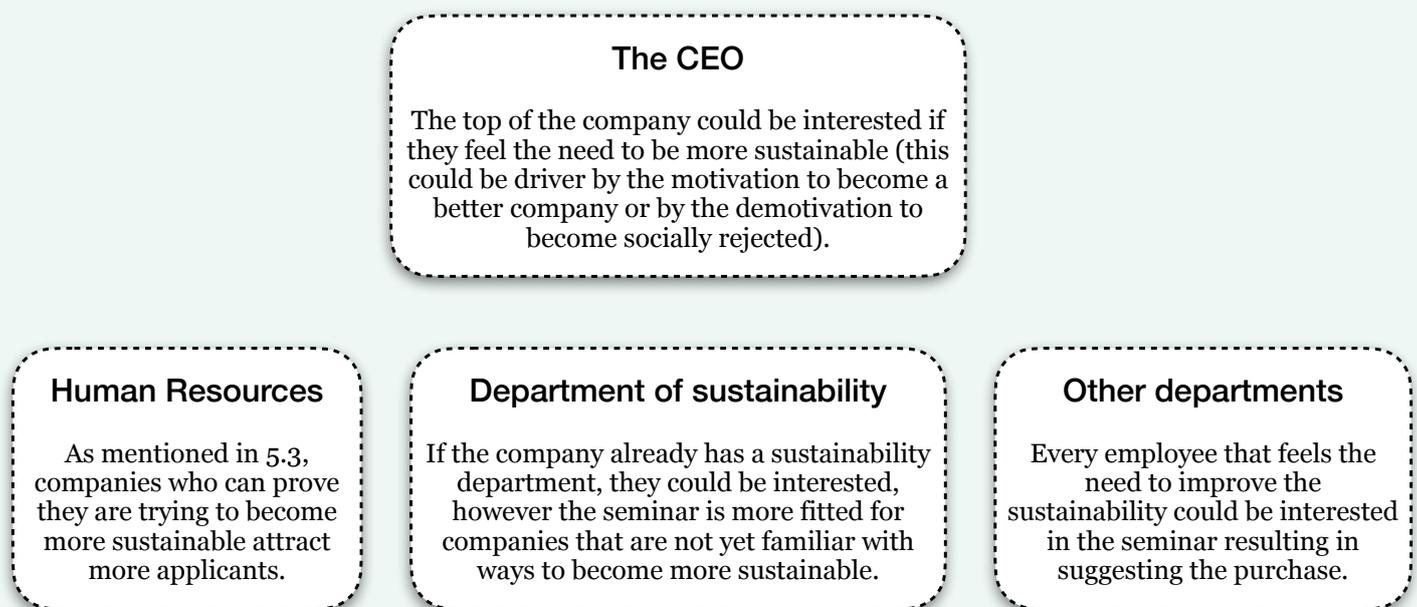
The CEO

The top of the company could be interested if they feel the need to be more sustainable (this could be driver by the motivation to become a better company or by the demotivation to become socially rejected).

Human Resources

As mentioned in 5.3, companies who can prove they are trying to become more sustainable attract more applicants.

Department of sustainability

If the company already has a sustainability department, they could be interested, however the seminar is more fitted for companies that are not yet familiar with ways to become more sustainable.

Other departments

Every employee that feels the need to improve the sustainability could be interested in the seminar resulting in suggesting the purchase.

Figure 5.38, how different departments could be interested in purchasing my design solution.

Discussion, future research and reflection.

6.1 Discussion

Attention for sustainability is often for the longer term. Major changes, such as electrification and the use of hydrogen still have years to develop before they can be applied on a large scale. Politically, the bar is often low, goals are often set far in the future, so that there is little need for change in the present. This is because the consequences of climate change will only become visible in the longer term, or with retroactive effect. This creates a dichotomy in the debate on sustainability. On the one hand, people can focus on long-term goals, which are expected to have a greater impact. On the other hand, also in order to actually achieve those goals in the longer term, it is important to immediately change our behavior now. This paper provides a starting point for this. Based on my research, I offer concrete tools for behavioral change, which can be use not only in the future, but also now.

Figure 6.01 presents the long term reduction of alternative modes of transport and developments compared to current flying emissions. An interesting example is the diesel train, in 2022 this is a good alternative and it is more sustainable than flying. However, in 2100 hybrid aircrafts will become more sustainable and in 2200 all alternatives of propulsion have overtaken the diesel train.

In conclusion, it certainly makes sense to develop for the future, however there must be a future in which it is possible to realize these investments. Therefore, the focus should primarily be on short-term solutions, but not without investing in different long-term solutions.
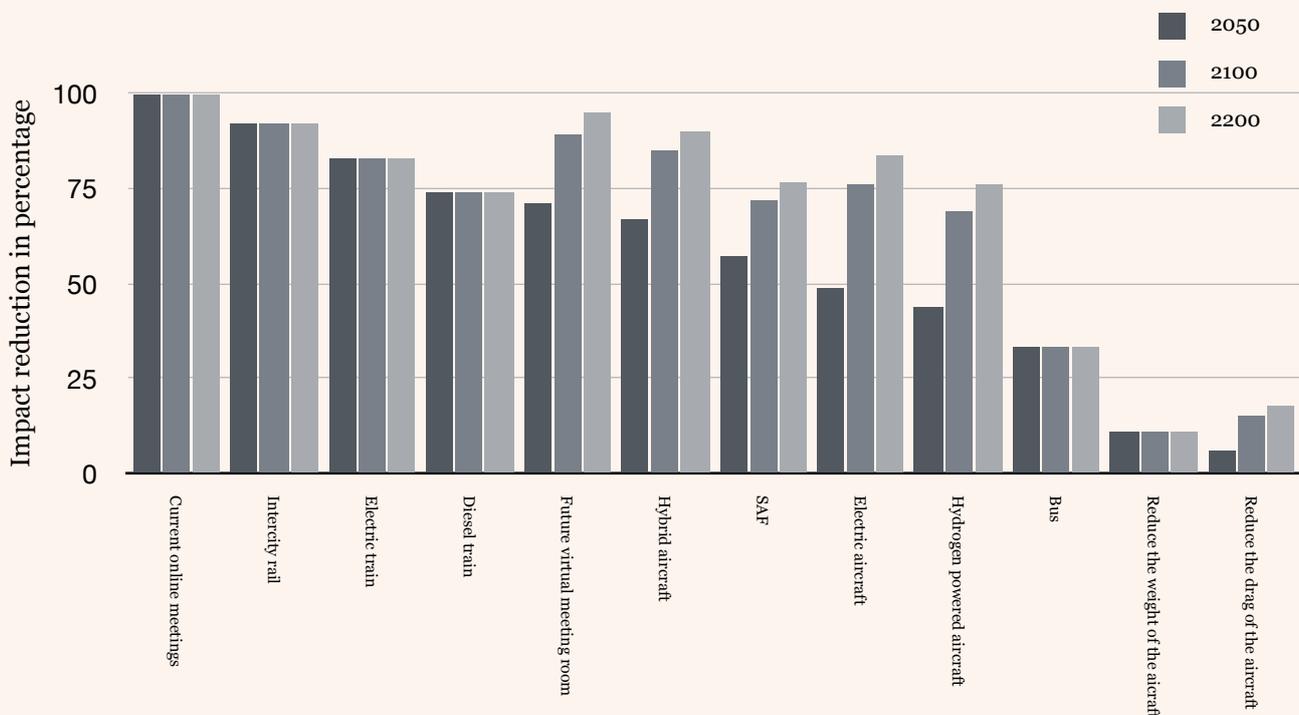

Figure 6.01, impact reduction until 2050, 2100 and 2200 in percentage compared to the inflight emission of CO$_2$ of short haul flights per passenger kilometer [52, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75].

6.2 Future research

Flying and sustainability are important themes in today's social debate. Due to the continuous developments of technology, these subjects are constantly evolving. This has quit some impact on, for example, new laws and regulations. It is expected that this will only increase in the future. After all, in order to meet climate targets, more regulations must be introduced, which then also must be implemented and executed. This is combined with our changing attitude towards flying. In short, new research questions and themes are constantly being added. Besides scaling up the current research through more qualitative and quantitative research and for example diving into what the perspective towards flying is in other countries, things worth investigating are: law, developments and leisure trips.

Law

There are multiple developments around short-haul flights within Europe, for example a growing number countries in the European Union have proposed bans on regional flights where a train route exists to reduce carbon emissions [152]. With these developments in the European field, the following questions / topics can serve as a basis for future research.

Developments

In Luxembourg public transport is free to use by everybody [153]. It might be interesting to do research on what would happen to the aviation industry and the overal emission by transport if public transport would be free or really cheap. It could also be interesting do to research on the economical impact it would have, since it would probably attract a lot of people to travel even more around Europe.

Another development is the increase in night trains throughout Europe. According to SchengenVisoInfo.com, a trans-European network of night trains, comprising of 40 international long-distance lines, will make a powerful comeback in urgent effort to combat climate change [193]. It will connect over 200 cities and regions across Europe by 2030. These night trains are designed to maximize passengers' comfort and privacy [194]. This can result in less costs in overnight stays while still remaining the value of the business trip. All with a significant lower environmental impact.

Leisure trips

Companies allow employees to build up frequent flyer miles and points and use these in their personal life, resulting in people getting more and more benefits when flying [26]. Therefore it also becomes more attractive for people to choose flying as their means of travel when going on a leisure trip.
Passengers that travel for leisure also contribute to the total carbon emission. This research is focussing on business travel because business passengers fly more frequent and have a relatively higher environmental impact However, in a future research the focus could lay on what people motivates when choosing to fly for leisure trips.

6.3 Reflection

In this chapter I reflect on what I have learned throughout the process of writing this thesis, and what improvements could be made in future research.

Before I mention the points of improvement, I want to mention that I've learned a lot. It sounds cheesy but I when I compare my work and with what I presented for my midterm meeting, I think I really made a lot of progress. Research is not where my strength lay, therefor I had to put in a lot of effort and resulted in a lot of things I had to find out. I am proud I did not give up and followed through staying passionate for the subject of this research. This mentality in combination with the points listed below is something I will bring with me the next time I do research.

To systematic reflect on my work, for every point of improvement I start with 'P', representing the problem of what can be improved. This is followed by 'H', where I explain how and what I should do to change and improve. I end with 'I', where I mention the impact this will have on the research. Starting with the macro level, I work down to the micro level.

Macro

- P: The overall plan and approach was not clear and concrete enough.
- H: Make a table of contents and determine in which chapter I want to answer what subresearch question.
- I: This helps me if I get stuck while performing the research. Then I can set a step back to overview the entire research and see where I have made the mistake.

- P: Not having a good understanding of what was expected as the end result.
- H: Through better research before the start of the project. Look into what others have done and what my supervisory team had in mind as result. I was under the assumption that I would make a framework, but this did not give me enough guidelines.
- I: This would keep me on track with my research. This would help create structure in my project.

- P: The planning I started with was too in-depth and lacked an overall structure.
- H: Creating a more global schedule with only detail on key points. This can be done, for example, through determining in advance when I will do interviews (or a questionnaire). Then I will know better when to think about what the purpose of that interview is and why I think it is good to gather information at that time.
- I: This will increase the quality of the research, since I will be more aware of what each key point contributes to the overall research.

- P: The transition from research to design was not good.
- H: Make a complete list of design requirements based on the conclusions from the research before I start designing.
- I: By drawing the right conclusions from the research, I can better ensure that my design is truly based on the conclusions from my research and not on the knowledge I have gained during the research.

- P: Not having one style resulting is sometimes spending too much on visualization.
- H: I could create this through choosing a font for headers and one the main text. This creates hierarchy while writing and helps me know at what "level" I am writing at a specific moment.
- I: This can help creating structure during the project.

Meso

- P: Not knowing enough what I want to get out of each method.
- H: I would like to determine in advance which methods I want to use, why I want to use it and what the goal of the method is.
- I: This will increase the quality of the research since I will then use the most optimal methods.

- P: Not knowing when to draw a conclusion.
- H: Determine in advance when to draw conclusions. This could be for example after every paper I read of after each page.
- I: If I write down a clear, well-founded conclusion from step 1 before I start step 2, I make sure that I can perform step 2 better.

- P: Not capturing enough moments when I ask myself whether the information is relevant to my research and what it contributes (besides when I draw a conclusion).
- H: I could do this by drawing a subconclusion more often. I can ask myself whether this helps with answering the subresearch question, and if not I have to ask myself whether

the information is useful for my research.
- I: As a result, I spend less time going into unnecessary depth on topics that do not directly contribute to answering my (sub)research questions.

- P: Determine a better guideline to know whether an argumentation/conclusion is in-depth enough. This was something I often struggled with now. I found it difficult to determine when I had collected enough information to substantiate my argument.
- H: By writing down the question or statement and asking myself whether I am really answering the question with that argument or conclusion. If not, then I can ask myself what is currently missing and use that to make the argumentation stronger.
- I: As a result, I will spend more time going in-depth into more important arguments instead of staying on a superficial level.

- P: Not knowing when I would have reached saturation during the literature research.
- H: In the future, I can better determine guidelines by, for example, asking myself whether I have already answered a sub-research question or looking at a minimum number of papers and then seeing whether I can already draw a conclusion instead of continuing until I think I've achieved saturation.
- I: I think I will have more in-depth results, if I considered in advance at what moment I expected to reach saturation.

Micro

- P: The organization of new information found in different sources.
- H: I would like to have a separate file for this in which I can keep track of this.
- I: This would save me time when searching for the right source, as it prevents ambiguities and unnecessary research later on.

- P: The story was sometimes lacking coherency.
- H: If I could have better determined at the macro level which chapters I wanted for my research, I could have created a file for each chapter at the micro level. This provides a better overview within the chapter and a more targeted answer to the (sub)research questions (which I would allocate to the right chapter).
- I: Then the research will be easier to read and better understandable. If the well-founded statements follow each other in the right order, I think that would positively effect the credibility of the research.

- P: Not writing good enough summaries after reading literature resulting in having to quickly reread that source.
- H: For my literature study I was glad that I created categories at the meso level in which I searched for information. However, I think there is some room for improvement at the micro level. I could have worked in a more structured way by better determining which papers I had already read, by writing a clear conclusion after reading.
- I: Save time when I need to find information. I can read the conclusions and find the right information more easily.

- P: There are also research insides that I missed. The interviews were not good enough because there were missing answers, since not all interviews consisted of the same questions.

- H: I can change this by knowing better what I want to get out of the interview and what I need at what time. I do not think the interviews have to answer all my subresearch questions, but I do think I need to have enough information to reach saturation.
- I: This will help create structure in my research.

- P: There was information lacking with regard to the motivators, after doing the interviews.
- H: For the motivators I should have thought of questions from which I obtain the motivation rather than literally asking what motivates people. I could look for the similarities between the different answers when coding, to determine what the motivation might be. When it comes to the ability I could have mentioned the different ability factors more clearly in my questions.
- I: As a result, I need less time during the processing of the interviews to find out what the level of ability is.

- P: There was information lacking with regard to the triggers, after doing the interviews.
- H: For the triggers, I should have listed the role of the triggers and the influence of different triggers better before I started my interviews. Then I would have been able to better determine during the interview what was the origin of making the decision.
- I: If I had more in-depth information and conclusions, I could have integrated those more in my design.

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Appendix

Appendix A - The interdisciplinair aviation lab

Together with a team of 9 Leiden-Delft-Erasmus (LDE) universities students (with backgrounds in Aerospace engineering, Governance of Sustainability, Engineering and policy analysis, Industrial Ecology, Ethics, and Industrial Design Engineering) I worked on a sustainability challenge set by an external organization. I followed a half year lab program. In 12 bi-weekly sessions I tried to gain insight into the interdisciplinary context of the challenge and how I could contribute to this challenge. During the lab I met commissioner(s), guest speakers and relevant experts, I followed workshops, joined a thesis group and created an interdisciplinary result together with the other students (after a two day pressure cooker were we combined al our insides in the form of LEGO builds, figure A1). The lab was supervised by an LDE-researcher.

Figure A1, end result of the two day pressure cooker.

External organization
The external organization of the aviation lab was the Netherlands Aerospace Centre (Nederlands Lucht- en Ruimtevaartcentrum, NLR). The NLR is the connecting link between science, industry and government for the aviation sector. It aims to make aerospace more sustainable, safer, more efficient and more effective. The challenges in aviation are always greater than the possibilities of today.

During the lab, there were two visits to the NLR. First to the NLR in Marknesse which is the location where most of the testing takes place (figure A2). The other visit was to the NLR in Amsterdam, this was to present the final interdisciplinary result.

Figure A2, excursion to the NLR in Marknesse.

Learning objectives
The main challenge in the lab was: "What can the circular economy mean for sustainable aviation?" Every student had their own approach and an individual research question. Some were focusing on the propulsion of the aircraft, while others focussed on the in-flight entertainment.

For me, these different perspectives on the same challenge were really interesting. By discussing different views, we really got to the core of the problem. Questions and discussions arose during lectures from experts. These ideas were discussed in a 'round table'. This was a meeting for which the students prepared different presentations about the main challenges, each focussing on our individual thesis. Four experts from different fields were invited to join in on the discussion. The round table, lecture and excursions helped me create more theoretical depth in my research. The aviation lab overall also helped creating structure in the process.

The final poster I created as part of the final presentation (figure A3) can be seen on the next page (figure A4), these were presented on A2 size for the audience to look at prior and after the presentation.

Figure A3, final presentation at the NLR in Amsterdam.

Figure A4, poster created for the final Aviation lab meeting at the NLR.

Appendix B - Interview

Briefing & consent

"

First of all, thank you for helping me with my research to find the motivation for business trips.
I would like to document the audio of this interview, do I have your consent for that?
I would like to discuss the content that I will be sharing with you as we go through it, and also ask you some questions afterwards.
For me, the aims for this session are: [session aims]

So by all means, please interrupt me at any point to react and share your thoughts on what I will be asking you; that is actually the whole point.
Please be honest, the interview will be anonymous, so don't be afraid to say things that pop up in your mind

"

Questions (semi-structured interview)

Introduction

1. How often did/do you fly on average (per month)?

2. Did/do you fly in business class?

3. Do you feel like you were productive on the plane?

4. How did purchasing a plane ticket go?
   - Was it planned short or far ahead?

5. Was something paid for compensating the aircrafts emissions?

6. If it were possible, would you have contributed something to reduce the impact of the trip?

7. Would it be possible for you to discuss something like compensation with people responsible for the business trip?

8. What is the purpose of the business trips (f.e. having a meeting or giving a workshop)?

9. Do you think you physically have to be there or could it also be done online?

Motivators

"Pleas answer the following questions from your company's perspective."

10. Why do you think your company wants to go on this business trip?
    - What was the motivation for having this business trip?

11. To what extent is the environment included in the decision go on a trip/to fly?

12. In what situation would your company not fly (and choose alternative modes of transport)?

"Pleas answer the following questions from your own perspective."

13. Why do you want to go on a business trip?

14. To what extent are you aware of the impact (on the environment) of flying?

15. To what extent are you aware of the impact of a business trip on you as an employee?

16. In what situation have your opted not to fly?

17. Is comfort a high priority when traveling?
    1. What do you perceive as a high priority when traveling?

Ability

"Pleas answer the following questions from your company's perspective."

18. What is the shortest time of the trip to obtain the necessary value?
19. Which mode of transport takes up the least amount of time?

20. What do we financially gain from this trip (and what are the costs)?
21. Which mode of transport is the most budget-friendly?

22. How much physical effort requires the trip for the employee?
23. Which mode of transport requires the least amount of physical effort my employee?

24. How much mental effort requires the trip for the employee?
25. Which mode of transport results in the least mental effort?

26. Will there be more social acceptation if we go on this trip?
27. Which mode of transport is the best for your company's reputation?

28. Has there been a similar need before, did a business trip result in what we hoped?
29. Which mode of transport will be the best option not only for now but also next time?

"Pleas answer the following questions from your own perspective."

30. What is a feasible length of the trip to obtain the necessary value?
31. Which mode of transport gets you in the quickest way from door to door?

32. What are the financial benefits for your company (and what are the costs)?
33. Which mode of transport is most affordable for your company?

34. Do you have to put in much physical effort to go on this trip?
35. Which mode of transport provide you the least amount of physical effort?

36. Do you have to put in much mental effort to go on this trip?
37. For which mode of transport do you have to put in the least amount of mental energy?

38. How will people react on you going on this trip (within and outside my company)?
39. Which mode of transport is the best for your reputation?

40. How much experience do you have with flying for business trips?
41. Which mode of transport will be the most convenient option for your next trip?

Triggers

42. What triggers the business trips?

Rounding up the interview

"

Thank you for participating and taking the time to answer these questions. Your answers are really valuable.

"

Appendix C - Alternatives to reduce the impact of flying

Alternative fuels

The in-use phase accounts for nearly all of a commercial aircraft's life cycle environmental impacts. Here fuel consumption is the most dominant variable (Parolin, G., Borges, A. T., Santos, L. C., & Borille, A. V. (2021). A tool for aircraft eco-design based on streamlined Life Cycle Assessment and Uncertainty Analysis. Procedia CIRP, 98, 565–570. https://doi.org/10.1016/j.procir.2021.01.152, Timmis, A. J., Hodzic, A., Koh, L., Bonner, M., Soutis, C., Schäfer, A. W., & Dray, L. (2014). Environmental impact assessment of aviation emission reduction through the implementation of composite materials. The International Journal of Life Cycle Assessment, 20(2), 233–243. https://doi.org/10.1007/s11367-014-0824-0, Scelsi, L., Bonner, M., Hodzic, A., Soutis, C., Wilson, C., Scaife, R., & Ridgway, K. (2011). Potential emissions savings of lightweight composite aircraft components evaluated through life cycle assessment. Express Polymer Letters, 5(3), 209–217. https://doi.org/10.3144/expresspolymlett.2011.20). Reducing the amount of emission coming burning the fuel would result in a lower total life cycle environmental impact. This can be done by making the fuel more sustainable. Sustainable Aviation Fuel (SAF) offer benefits comparative with traditional fuels as it alleviate environmental change, may improve the quality of the air, provide a steady energy supply, and may (when further developed) improve aircraft operations (because of higher performance properties) (Heyne, J., Rauch, B., le Clercq, P., & Colket, M. (2021). Sustainable aviation fuel prescreening tools and procedures. Fuel, 290, 120004. https://doi.org/10.1016/j.fuel.2020.120004).

SAF is fuel that meets all the similar requirements (both technical and safety) as fossil-based jet fuel (Heyne, J., Rauch, B., le Clercq, P., & Colket, M. (2021). Sustainable aviation fuel prescreening tools and procedures. Fuel, 290, 120004. https://doi.org/10.1016/j.fuel.2020.120004). SAF can be mixed with conventional fuel to contain similar hydrocarbons to fossil-based kerosene (Sustainable aviation fuel. (2022). KLM. https://www.klm.nl/en/information/sustainability/sustainable-aviation-fuel). However the difference is, the source where these hydrocarbons came from. SAF is in comparison more sustainable. Sources like waste oils of biological origin (like cooking fat) are used to make SAF (Sustainable aviation fuel. (2022). KLM. https://www.klm.nl/en/information/sustainability/sustainable-aviation-fuel). This causes (on the overal life cycle basis) a reduction of emissions when SAF is compared to fossil jet fuel (Where to find Sustainable Aviation Fuel. (2022). 4AIR. https://www.4air.aero/saf-map?gclid=CjoKCQjw-daUBhCIARIsALbkjSbhJMxK5ngG8Gq2ZcPqALIK9r-LCW2kDao_M7UOEtpjejhDn4KMANYaAvQ-EALw_wcB). SAF is cleaner, emits less and has a really low emissions of fine particles (this is important for air quality).

Compensation for flying

KLM offers 4 options, the first being a complete coverage by reforestation, followed by an option where around 97% of the compensating is done by reforestation and around 3% is done with SAF, the third option is around 94% reforestation in combination with 6% SAF and the last option being compensation only done through SAF. To show how much more people have to pay for reforestation versus SAF a graph (see figure C1) was made (based on the 8 most popular destinations within 750 km from Amsterdam (Benjamin, J., van Gameren, E., & Molijn, C. (2022, January 20). Is de internationale trein echt een redelijk alternatief voor korte vliegreizen? NRC. https://www.nrc.nl/nieuws/2022/01/20/is-de-internationale-trein-echt-een-redelijk-alternatief-voor-korte-vliegreizen-a4081166), presented with the amount of CO_2 emitted during the flight and the compensation can pay when they fly with KLM (Sustainable aviation fuel. (2022). KLM. https://www.klm.nl/en/information/sustainability/sustainable-aviation-fuel)).

The price seems to gradually increase, however the y-axe is logarithmic. If the graph was shown as a linear graph only the price of the 100% SAF would be visible (since this is around 45 times the price people pay for 100% compensation through reforestation).

The SAF that KLM will be using will reduce CO2 emissions by at least 75% compared to standard fossil fuels (Sustainable aviation fuel. (2022). KLM. https://www.klm.nl/en/information/sustainability/sustainable-aviation-fuel). So when KLM states their passengers can pay for compensation by choosing for 100% SAF, they are paid for flying with 100% SAF, not for compensating for all their CO_2 emissions.
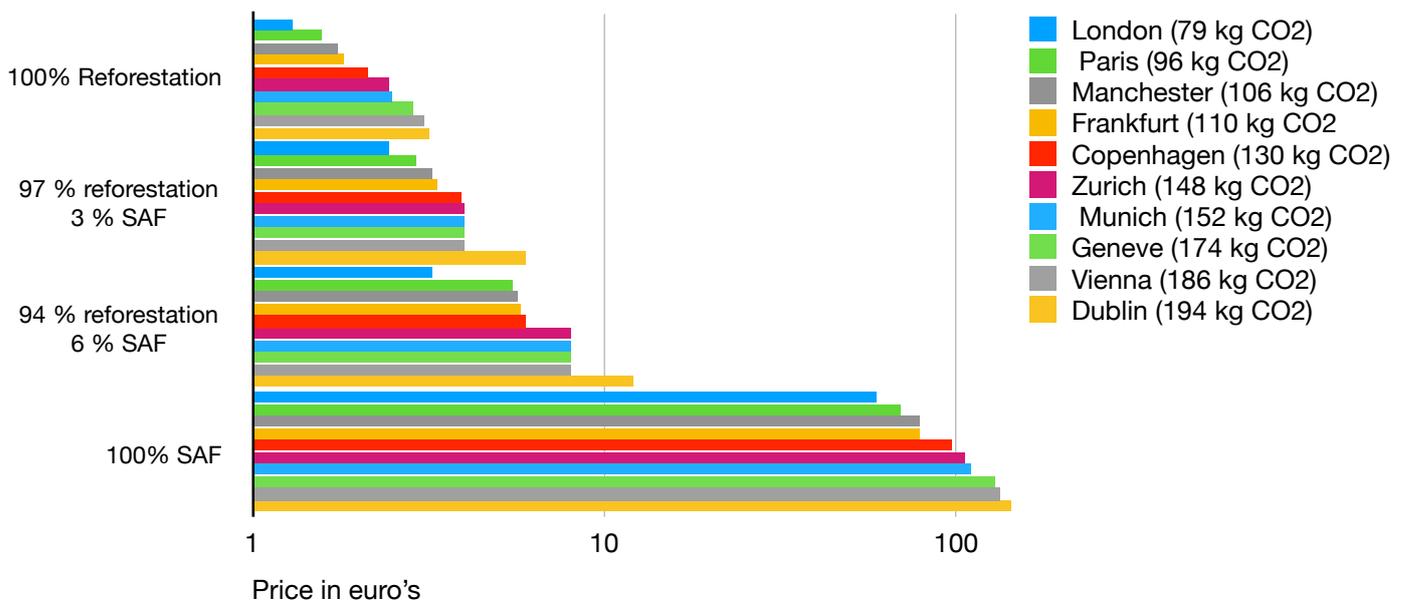
Figure C1, comparing 10 most popular destinations from Amsterdam and how much can be paid for compensation (Amsterdam's top destinations in 2018: London Heathrow and Dubai –. (2019, March 5). Business Traveller. https:// www.businesstraveller.com/business-travel/2019/03/05/amsterdams-top-destinations-in-2018-london-heathrow-and-dubai/).

KLM also presents the option to pay for reforestation as a way to compensate for the carbon emission. With their reforestation program passenger can compensate (part of) the impact of their flight on the environment. It will not affect the direct emissions of the flight itself, but the contribution will help restore forests that absorb CO_2 (Sustainable aviation fuel. (2022). KLM. https://www.klm.nl/en/information/sustainability/sustainable-aviation-fuel).

KLM works together with CO2OL Tropical Mix, which is a reforestation project in Panama (Sustainable aviation fuel. (2022). KLM. https://www.klm.nl/en/information/sustainability/sustainable-aviation-fuel). KLM claim they do not receive a share of the passengers donation; they say it is fully used to restore forests and promote sustainable development. There is an accountancy firm that checks the calculation method and whether the financial contribution is indeed used for the reforestation project in Panama.

Increase efficiency of the aircraft

As mentioned earlier, fuel consumption is the most impactful variable when it comes to the aircraft's life cycle environmental impact. As a result, a focus on fuel-saving measures, such as reducing the weight of the airframe (Zhu, L., Li, N., & Childs, P. (2018). Light-weighting in aerospace component and system design. Propulsion and Power Research, 7(2), 103–119. https://doi.org/10.1016/j.jppr.2018.04.001), makes sense. Since 1970, the operating empty weight (OEW) of aircraft has been steadily decreasing at a rate of 0.17% per year, this is in combination with a shift in the material composition of aircrafts (Cox, B., Jemiolo, W., & Mutel, C. (2018). Life cycle assessment of air transportation and the Swiss commercial air transport fleet. Transportation Research Part D: Transport and Environment, 58, 1–13. https://doi.org/10.1016/j.trd.2017.10.017).

Changing the weight of an aircraft can be done through the use of composites (also known as fiber reinforced polymer composites). Unidirectional carbon fibre reinforced polymers (CFRP) have a structural efficiency over twice that of aluminium alloys (Campbell, F. (2004). Introduction to Composite Materials and Processes: Unique Materials that Require Unique Processes. Manufacturing Processes for Advanced Composites, 1–37. https://doi.org/10.1016/b978-185617415-2/50002-2). However, because the direction of the fibers affect the mechanical properties of composites, components must have multiple laminates positioned in different directions (to account for a wide range of load cases) (Hale, J (2006). "787 From The Ground Up". In: Aero Magazine 4 (Sept. 2006)).

Even after accounting for this anisotropy (being dependent on the direction), the structural weight savings over aluminium alloy alternatives are significant. The Boeing 787 made extensive use of composites (particularly CFRP) now accounts for only 50% of its primary structural material weight (Hale, J (2006). "787 From The Ground Up". In: Aero Magazine 4 (Sept. 2006)). When compared to similar sized models employing aluminium alloys as the major materials, repeatedly resulted in a 20% lighter weight and a 10% - 12% reduction in fuel usage (Hale, J (2006). "787 From The Ground Up". In: Aero Magazine 4 (Sept. 2006), Marino M. and Sabatini R. (2014) "Advanced Lightweight Aircraft Design Configurations for Green Op- erations". In: Proceedings of the Practical Responses to Climate Change 2014 (Melbourne, Aus- tralia). Nov. 2014. DOI: 10.13140/2.1.4231.8405).

Airbus has gradually increased its use of composite materials, reaching 52% of the aircraft being composite with the A350 [75]. CFRP is used extensively in the empennage, wing, and fuselage of both the Airbus A350 and Boeing 787. Aircraft components must perform a variety of functions, for example, strength, fracture toughness, or corrosion resistance (Sustainable aviation fuel. (2022). KLM. https://www.klm.nl/en/information/sustainability/sustainable-aviation-fuel).

Natural fibres like as flax, hemp, and ramie, which can be produced regeneratively and allow for less intensive recycling procedures, are one option for minimizing aircraft's high production and manufacturing burden and poor potential for circularity (Bachmann, J., Hidalgo, C., & Bricout, S. (2017). Environmental analysis of innovative sustainable composites with potential use in aviation sector—A life cycle assessment review. Science China Technological Sciences, 60(9), 1301–1317. https://doi.org/10.1007/s11431-016-9094-y, Bachmann, J., Yi, X., Tserpes, K., Sguazzo, C., Barbu, L. G., Tse, B., Soutis, C., Ramón, E., Linuesa, H., & Bechtel, S. (2021). Towards a Circular Economy in the Aviation Sector Using Eco-Composites for Interior and Secondary Structures. Results and Recommendations from the EU/China Project ECO-COMPASS. Aerospace, 8(5), 131. https://doi.org/10.3390/aerospace8050131). The potential use of natural fibre composites in aviation has received substantial academic attention (Bachmann, J., Yi, X., Tserpes, K., Sguazzo, C., Barbu, L. G., Tse, B., Soutis, C., Ramón, E., Linuesa, H., & Bechtel, S. (2021). Towards a Circular Economy in the Aviation Sector Using Eco-Composites for Interior and Secondary Structures. Results and Recommendations from the EU/China Project ECO-COMPASS. Aerospace, 8(5), 131. https://doi.org/10.3390/aerospace8050131, Gomez-Campos, A., Vialle, C., Rouilly, A., Hamelin, L., Rogeon, A., Hardy, D., & Sablayrolles, C. (2021). Natural Fibre Polymer Composites - A game changer for the aviation sector? Journal of Cleaner Production, 286, 124986. https://doi.org/10.1016/j.jclepro.2020.124986). These bio-based composites have much reduced environmental impacts during manufacture and end-of-life (Bachmann, J., Yi, X., Tserpes, K., Sguazzo, C., Barbu, L. G., Tse, B., Soutis, C., Ramón, E., Linuesa, H., & Bechtel, S. (2021). Towards a Circular Economy in the Aviation Sector Using Eco-Composites for Interior and Secondary Structures. Results and Recommendations from the EU/China Project ECO-COMPASS. Aerospace, 8(5), 131. https://doi.org/10.3390/aerospace8050131, Gomez-Campos, A., Vialle, C., Rouilly, A., Hamelin, L., Rogeon, A., Hardy, D., & Sablayrolles, C. (2021). Natural Fibre Polymer Composites - A game changer for the aviation sector? Journal of Cleaner Production, 286, 124986. https://doi.org/10.1016/j.jclepro.2020.124986), however the consequences during the in-use period have way more impact.

Because natural fibre composites are far less structurally efficient than dominant fibre composites, their performance overall suffers (Gomez-Campos, A., Vialle, C., Rouilly, A., Hamelin, L., Rogeon, A., Hardy, D., & Sablayrolles, C. (2021). Natural Fibre Polymer Composites - A game changer for the aviation sector? Journal of Cleaner Production, 286, 124986. https://doi.org/10.1016/j.jclepro.2020.124986). This may improve with additional development (Bachmann, J., Yi, X., Tserpes, K., Sguazzo, C., Barbu, L. G., Tse, B., Soutis, C., Ramón, E., Linuesa, H., & Bechtel, S. (2021). Towards a Circular Economy in the Aviation Sector Using Eco-Composites for Interior and Secondary Structures. Results and Recommendations from the EU/China Project ECO-COMPASS. Aerospace, 8(5), 131. https://doi.org/10.3390/aerospace8050131, Gomez-Campos, A., Vialle, C., Rouilly, A., Hamelin, L., Rogeon, A., Hardy, D., & Sablayrolles, C. (2021). Natural Fibre Polymer Composites - A game changer for the aviation sector? Journal of Cleaner Production, 286, 124986. https://doi.org/10.1016/j.jclepro.2020.124986).

Besides the fuel, also the shape of the aircraft could contribute to a more sustainable travel. One development is the flying V. Created in a collaboration between the Delft University of Technology and KLM, the flying V has its passenger cabin, cargo deck and fuel tanks integrated in the wing (Flying-V. (2020). TU Delft. https://www.tudelft.nl/lr/flying-v). The design is shorter than an Airbus A350, but has the same wingspan. With this design, the Flying-V is able to make use of the current infrastructure at airports (think of gates and taxiways), without any need for adjustments). In the Flying-V a similar passengers can board (this is 314 in a standard configuration), this also accounts for the cargo.

The flying V is still fully in development. De developers are aiming to have a working plane in around 20 years.

Alternative ways of propulsion

Without having to change the complete shape of the aircraft, alternative ways of propulsion like flying hybrid or electric could also be an option to fly more sustainable (Zaporozhets, O., Isaienko, V., & Synylo, K. (2020). Trends on current and forecasted aircraft hybrid electric architectures and their impact on environment. Energy, 211, 118814. https://doi.org/10.1016/j.energy.2020.118814). The carbon produced through the burning of kerosene, which is generated from petroleum, adds to the disturbance of the carbon cycle (Arias P. et al. (2022) "Technical Summary". In: IPCC. Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Ed. by V. Masson-Delmotte et al. Cambridge University Press, 2021. ISBN: ISBN 978-92-9169-158-6. URL: www.ipcc.ch.). As mention earlier, there are alternative fuels used in the same way as fossil kerosene, except they use biomass as raw material rather than petroleum (Kolosz, B. W., Luo, Y., Xu, B., Maroto-Valer, M. M., & Andresen, J. M. (2020). Life cycle environmental analysis of 'drop in' alternative aviation fuels: a review. Sustainable Energy & Fuels, 4(7), 3229–3263. https://doi.org/10.1039/c9se00788a; Barke, A., Thies, C., Melo, S. P., Cerdas, F., Herrmann, C., & Spengler, T. S. (2022). Comparison of conventional and electric passenger aircraft for short-haul flights – A life cycle sustainability assessment. Procedia CIRP, 105, 464–469. https://doi.org/10.1016/j.procir.2022.02.077). But what if fuel, as we know it, is completely changed to an alternative way of power. Options like hybrid and all-electric engines may become a viable option for short haul commercial aircrafts. The power generating mix, like with any electrification solution, is critical to the sustainability of such alternatives, but has significant potential to minimise lifetime emissions (Kolosz, B. W., Luo, Y., Xu, B., Maroto-Valer, M. M., & Andresen, J. M. (2020). Life cycle environmental analysis of 'drop in' alternative aviation fuels: a review. Sustainable Energy & Fuels, 4(7), 3229–3263. https://doi.org/10.1039/c9se00788a; Barke, A., Thies, C., Melo, S. P., Cerdas, F., Herrmann, C., & Spengler, T. S. (2022). Comparison of conventional and electric passenger aircraft for short-haul flights – A life cycle sustainability assessment. Procedia CIRP, 105, 464–469. https://doi.org/10.1016/j.procir.2022.02.077; Markatos, D. N., & Pantelakis, S. G. (2022). Assessment of the Impact of Material Selection on Aviation Sustainability, from a Circular Economy Perspective. Aerospace, 9(2), 52. https://doi.org/10.3390/aerospace9020052). Besides that, electric engines emit no direct air pollutants, which is a significant advantage over currently use fuel, especially for the impact on health and the environmental (Kolosz, B. W., Luo, Y., Xu, B., Maroto-Valer, M. M., & Andresen, J. M. (2020). Life cycle environmental analysis of 'drop in' alternative aviation fuels: a review. Sustainable Energy & Fuels, 4(7), 3229–3263. https://doi.org/10.1039/c9se00788a; Barke, A., Thies, C., Melo, S. P., Cerdas, F., Herrmann, C., & Spengler, T. S. (2022). Comparison of conventional and electric passenger aircraft for short-haul flights – A life cycle sustainability assessment. Procedia CIRP, 105, 464–469. https://doi.org/10.1016/j.procir.2022.02.077). Unfortunately, the energy of todays modern batteries is insufficient from a technological viewpoint in unlocking these potentials. But even if it was then these aircrafts would not be commercially viable under today's market conditions (Schäfer, A. W., Barrett, S. R. H., Doyme, K., Dray, L. M., Gnadt, A. R., Self, R., O'Sullivan, A., Synodinos, A. P., & Torija, A. J. (2018). Technological, economic and environmental prospects of all-electric aircraft. Nature Energy, 4(2), 160–166. https://doi.org/10.1038/s41560-018-0294-x).

So on the short term electrified aircrafts seem not to be the best solution. This however is not the only alternative way of power. Given the larger energy shift, molecular hydrogen might be a clean energy carrier for future energy systems (with particular focus in the transportation sector) (Ball, M., & Weeda, M. (2015). The hydrogen economy – Vision or reality? 1 1This paper is also published as Chapter 11 'The hydrogen economy – vision or reality?' in Compendium of Hydrogen Energy Volume 4: Hydrogen Use, Safety and the Hydrogen Economy, Edited by Michael Ball, Angelo Basile and T. Nejat Veziroglu, published by Elsevier in 2015, ISBN: 978–1-78242-364-5. For further details see: http://www.elsevier.com/books/compendium-of-hydrogen-energy/ball/978-1-78242-364-5. International Journal of Hydrogen Energy, 40(25), 7903–7919. https://doi.org/10.1016/j.ijhydene.2015.04.032). In the same way this counts for the aviation industry. Long term, hydrogen combustion has been regarded as "the most likely energy carrier for the future energy economy" (Khandelwal, B., Karakurt, A., Sekaran, P. R., Sethi, V., & Singh, R. (2013). Hydrogen powered aircraft : The future of air transport. Progress in Aerospace Sciences, 60, 45–59. https://doi.org/10.1016/j.paerosci.2012.12.002). Hydrogen combustion has the potential to achieve a 90% reduction of the environmental effect of the in-use phase (Markatos, D. N., & Pantelakis, S. G. (2022). Assessment of the Impact of Material Selection on Aviation Sustainability, from a Circular Economy Perspective. Aerospace, 9(2), 52. https://doi.org/10.3390/aerospace9020052). It must be said that this only can become a reality if a larger hydrogen infrastructure is created (Baroutaji, A., Wilberforce, T., Ramadan, M., & Olabi, A. G. (2019). Comprehensive investigation on hydrogen and fuel cell technology in the aviation and aerospace sectors. Renewable and Sustainable Energy Reviews, 106, 31–40. https://doi.org/10.1016/j.rser.2019.02.022). This fuel cell technology might be interesting for aviation. It would be less useful, for reasons similar to batteries' restricted application, for propulsion on it own (Baroutaji, A., Wilberforce, T., Ramadan, M., & Olabi, A. G. (2019). Comprehensive investigation on hydrogen and fuel cell technology in the aviation and aerospace sectors. Renewable and Sustainable Energy Reviews, 106, 31–40. https://doi.org/10.1016/j.rser.2019.02.022; Hoelzen, J., Silberhorn, D., Zill, T., Bensmann, B., & Hanke-Rauschenbach, R. (2022). Hydrogen-powered aviation and its reliance on green hydrogen infrastructure – Review and research gaps. International Journal of Hydrogen Energy, 47(5), 3108–3130. https://doi.org/10.1016/j.ijhydene.2021.10.239).

Besides hydrogen being directly used as fuel, it can also be used to convert into electricity using fuel cells. This could help with generating the energy but does not change the capacity of the battery, which is the biggest hurdle that has to be overcome.

Alternative ways of travelling

When people travel abroad there are multiple options of transport with most of them being more sustainable than flying. There are three main modes of transport, air (f.e. aeroplane, hot air balloon, helicopter or blimp), land (f.e. car, public transport, bike, walking or truck) and water transport (f.e. cruise ship, submarine, sailboat or jetski).

There are also other modes of transport like space transport or transport which is not used for human transport like pipelines or cables. They are not taken into consideration for this research.

When it comes to finding alternative ways of still going abroad for business, there are a few option that are not realistic. For the air transport this would be for example the hot air balloon and the blimp. They simply go to slow (with a hot air balloon going at around 13-16 km/h [130] and a blimp going just a bit faster with 40 km/h [131]) and there is no good infrastructure build to make this feasible alternatives.

For land travel the option to go by foot and bike, are nowhere near feasible options. To put things in perspective, according to google maps, it would take you 88 to walk and 25 hours to cycle from Delft to Paris, while it only takes 5 hours by car and around 3 hours if you take the train.

And for the last category, travelling via water. A jet ski might seem to be a more feasible option since then you can reach speeds up to just under 100 km/h [132]). However the reach of a jet ski is at max 240 km which would not make it a feasible alternative. A cruise ship and submarine do have a longer range but travel at a significant lower speed resulting in way longer travel time (a cruise ship travels with a speed around 30 km/h and a submarine only goes about 15 km/h [133, 134]).

With this slower speed, you could argue, if the employee has a comfortable trip they could work and the company could subtract the time they are working from the total duration of the trip. However all water transport can be considered not feasible since the infrastructure is not their to support this kind of travel. It is just not possible to go from Delft to Paris by water transport. When compared to air travel people also have to travel to the airport but since the infrastructure has been created world wide, opens the opportunity to travel around the world. This research focusses on alternatives for short-haul flights, since for business trips often short-haul flights are chosen [135].

If you would consider a trip across the ocean (land transport would then obviously not be an option), and would compare going by aeroplane versus cruise-ship, you would find that, besides the cruise-ship travelling at a way lower speed (30 km/h in comparison, an average aeroplane flies with around 600 km/h [136]), going by cruise-ship emits more carbon emission than an aeroplane. Table 4.1 presents different modes of transport with the grams / CO_2 per passenger kilometer [137].

[130] Laakso, L., Grönholm, T., Kulmala, L., Haapanala, S., Hirsikko, A., Lovejoy, E. R., ... & Kulmala, M. (2007). Hot-air balloon as a platform for boundary layer profile measurements during particle formation.
[131] Blanc, T. V., Plant, W. J., & Keller, W. C. (1989). The Naval Research Laboratory's Air-Sea Interaction Blimp Experiment. Bulletin of the American Meteorological Society, 70(4), 354–365. https://doi.org/10.1175/1520-0477
[132] Hagerty, D., & Moeltner, K. (2005). Specification of Driving Costs in Models of Recreation Demand. Land Economics, 81(1), 127–143. https://doi.org/10.3368/le.81.1.127
[133] Webb, K. R., & Gende, S. M. (2015). Activity patterns and speeds of large cruise ships in Southeast Alaska. Coastal Management, 43(1), 67-83.
[134] Goodenough, L. R., & Greig, A. (2008). Hybrid nuclear/fuel-cell submarine. Journal of Naval Engineering, 44(3), 455-471.
[135] AirPlus. (2021, June 10). Short-haul accounted for larger share of business travel due to the pandemic – long-haul now catching up. AirPlus international. https://www.airplus.com/error_path/400.html?al_req_id=YppiQxzLCxA84gRqqQAv_QAAANg
[136] Ausubel, J., & Marchetti, C. (2001). The evolution of transport. Industrial Physicist, 7(2), 20-24.
[137] Chenoweth, J. (2009). Is tourism with a low impact on climate possible? Worldwide Hospitality and Tourism Themes, 1(3), 274–287. https://doi.org/10.1108/17554210910980611

If we take Table 4.1 and cross out the alternatives that have a higher grams of carbon dioxide per passenger kilometer than flying (Average car - single occupant and all the options for water transport), followed by crossing out the options that are not feasible. This can be because they just take too long (cycling) or are not related to this research (long-haul flight). And since not everybody has a new car or travels with four occupants (in this research we focus on the individual traveller) that option was also crossed out. The TGV is an electric French high speed train and therefor categorized as electric train instead of its own category of mode of transport. We then end up with the green marked alternatives in Table C2, showing the original way of transport (marked grey). The feasible possibilities are going by bus or different types of trains.

Mode of transport		Grams / CO_2 per passenger kilometre	Source(s)
Air travel	Short-haul flight	130	DEFRA (2007a)
	Long-haul flight	105	DEFRA (2007a)
Road	Average car – single occupant	206	DEFRA (2007a)
	New car – four occupants	41	European Environment Agency (2006)
	Bus	89	DEFRA (2007a)
	Cycling	9	NHS Direct (2008) & Wallén (2004)
Rail	Intercity rail	55	Transport Watch UK (2007)
	TGV	86	Transport Watch UK (2007)
	Electric train	54	Association of Train Operating Companies (2007)
	Diesel train	74	Association of Train Operating Companies (2007)
Water	Single occupant car passenger on ferry	1130	Carbon Tracking (2008)
	Foot passenger on ferry	141	Carbon Tracking (2008)
	Cruise liner passenger	342	Carnival Corporation (2008)

Table C2, Summary of carbon-dioxide emissions per passenger kilometer of different transport options [137].

A completely new way of travel is the Hyperloop. The Hyperloop is a high-speed transportation (land travel) idea that involves passenger pods moving at transonic speeds via a partly evacuated tube. The proposal was first offered in a white paper published by SpaceX in 2013 as an alternative to the current high-speed rail system being planned between Los Angeles and San Francisco, which has been considered excessively expensive and slow [138].

In research from Noland [139] the conclusion is drawn that the Hyperloop is well suited as replacement for the short-haul flight segment. A major weak point of the Hyperloop system technology appears to be its rather low transport capacity, mainly due to the low seating capacity of individual vehicles/capsules, which affects both the operational and the financial performance. Consequently, the investment costs of the Hyperloop infrastructure make up a large part of the total costs per seat-kilometre, raising the latter to a higher level than those of its counterparts (High Speed Rail and Air Passenger Transport). Hence, the break-even fares would also be higher, even if the load factor is relatively high [140]. For companies the higher price does not have to be a bad thing if they gain a lot in time.

[138] Opgenoord, M. M. J., & Caplan, P. C. (2018). Aerodynamic Design of the Hyperloop Concept. AIAA Journal, 56(11), 4261–4270. https://doi.org/10.2514/1.j057103
[139] Noland, J. K. (2021). Prospects and Challenges of the Hyperloop Transportation System: A Systematic Technology Review. IEEE Access, 9, 28439–28458. https://doi.org/10.1109/access.2021.3057788
[140] van Goeverden, K., Milakis, D., Janic, M., & Konings, R. (2018). Analysis and modelling of performances of the HL (Hyperloop) transport system. European Transport Research Review, 10(2). https://doi.org/10.1186/s12544-018-0312-x

However the Hyperloop technology is in its infancy and there are still many uncertainties around the system that need further exploration [140]. The combination of the many uncertainties and the fact that this way of travel needs a completely new infrastructure which has to be build from the ground up, resulted in this research not further considering this alternative as feasible.

Getting rid of physical meetings

The best solution to reducing the amount of carbon dioxide emissions in aviation is not to fly. Alternatives are already existing. Because of the covid pandemie people were not able to fly and therefor had to find other ways to communicate with each other. An already known concept called online meetings became really popular [141].

Online meetings via Zoom or Skype seemed to perfect solution. These online meetings offer a place where people from all over the world could easily meet without having to leave their house/room. This results in no traveling causing no emission. It almost sounds too good to be true.

This unfortunately is indeed not the perfect solution. Results from a research done by Manca et al. [142] shows that respondents may view virtual alternatives for business travel, such as video calls / meetings and comparable software, as a temporary solution, and will wish to resume travel as soon as it is safe to do so.

Also when comparing an online meeting with a physical meeting a few things stand out. To start with a few reasons why online meetings (f.e. via zoom) are more exhausting than physical meetings [143]. Starting with nonverbal cues such as facial expressions, tone of voice and pitch, movements, posture, and the space between communicators. These are used to transmit our sentiments and attitudes. People process these cues primarily automatically in a face-to-face encounter while still listening to the speaker. In an online meeting, people have to work harder to interpret nonverbal clues. It takes a lot of energy to pay attention. It is tiring to have dissonance, which leads individuals to have contradicting sentiments [143, 144, 145].

Also, people worry about their remote workspace and how they will handle occurrences that could make them seem terrible in front of their coworkers (f.e. if their Zoom background suddenly stops working, exposing their hoarding tendencies) [143, 144].

At work people often meet colleagues when walking to their meeting rooms. They then catch up on concerns or share their points of view before entering. This walk in combination with moving to a new room is energizing. Comparing this with home, people stay in one room without walking around and completing more before going into the Zoom meeting, often without pausing [143].

Another argument for real life conversations is the silence people use when talking. Silence is vital in real-life conversations because it provides a natural pace. Silence during an online meeting, on the other hand, makes people nervous about the technology. Besides that people perceived the individual speaking (in an online meeting) as less polite and focused as soon as after a 1.2 second delay in answering. Furthermore, impatience with people turning their mics on and off, poor connections, and background noise make the meeting go more slowly and taking up more time [143, 144].

[141] Mouratidis, K., & Papagiannakis, A. (2021). COVID-19, internet, and mobility: The rise of telework, telehealth, e-learning, and e-shopping. Sustainable Cities and Society, 74, 103182. https://doi.org/10.1016/j.scs.2021.103182

[142] Manca, F., Sivakumar, A., Pawlak, J., & Brodzinski, N. J. (2021). Will We Fly Again? Modeling Air Travel Demand in light of COVID-19 through a London Case Study. Transportation Research Record: Journal of the Transportation Research Board, 036119812110252. https://doi.org/10.1177/03611981211025287

[143] Sander L., Elizabeth & Baumann O. (2020). 5 Reasons Why Zoom meetings are so exhausting.

[144] Kaptelinin, V., Danielsson, K., Kaiser, N., Kuenen, C., & Nordin, M. (2021, October). Understanding the Interpersonal Space of Online Meetings: An Exploratory Study of "We-ness". In Companion Publication of the 2021 Conference on Computer Supported Cooperative Work and Social Computing (pp. 79-83).

[145] Kimura, S., Kunifuji, S., & Ito, T. (2020). A Comparative Study of the Effects of Clapping Hands Sounds and Gesture Presentation During Online Meetings.

Concluding we can say online meeting as they are now, are not the perfect solutions when it comes to replacing physical meetings. There are developments on the short term to improve online meetings (f.e. Microsoft adding the possibility to Teams to raise hands when people want to ask questions). There are also developments for a longer period of time like the Horizon Workrooms created by Meta [146].

In this research we take Horizon Workrooms as an example representing the future virtual meeting rooms. Meta presents their Workrooms as follow: Workrooms that allow individuals to collaborate in the same virtual space regardless of their actual location. It is designed to increase your team's capacity to interact, communicate, and connect remotely using the power of virtual reality. It works across both virtual reality and the web. I could help whether it is coming together to brainstorm on an idea, work on a project, get team updates, hang out and socialize, or just have better, more natural discussions [146, 147].

Meta thinks they can achieve this feeling of working together online (but with the same benefits of a physical meeting) by using features like mixed-reality desk and keyboard tracking, hand tracking, remote desktop streaming, video conferencing integration and spatial audio. Also creating avatars that look like the person they resemble, will contribute to the total experience and make it feel closer to a physical meeting [146, 147].

It is difficult to predict when and if we ever will sit behind our desk with VR goggles on our head, but because these developments seem to solve quit some problems of todays online meeting, it is worth thinking about. To make an estimation the Technology Acceptance Model (TAM) [148] was used (see figure C3). The theoretical basis of the TAM comes from the Theory of Reasoned Action (TRA) which was by Fishbein and Ajzen's int their 1975 research [150]. TAM aims to investigate how consumers' attitudes and beliefs influence their decision to adopt or reject Information and Communication technologies (ICTs) [151].
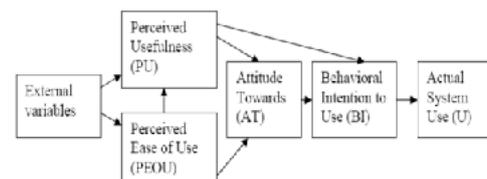
Figure C3, The TAM model [149]

This model suggest that the perceived ease of use and perceived usefulness is key for the attitude towards the product and the behavioral intentions to use the product. If the link is made to the FBM the perceived ease of use can be seem as the ability somebody has to perform a certain desired behavior. If the product is perceived as too difficult to use and/or somebody does not have the ability to use the project the behavior will not cross the action line [152].

Comparing these behavior models shows us if the users perceives the products useful enough and has the ability to use it, it is possible the desired behavior of using these more developed virtual meeting rooms will be actually performed. However since there are also external variables playing an important role it is difficult to say whether this will be 5 or 20 years from now. Because of this uncertainty it is not possible to consider this as the solution for reducing the flights taken for business purposes (since it can also take another 50 years for people to fully adopt this technology and we do not have that much time before we have to reach the deadline of the Paris Agreement [153]).

[146] Mora, C. E., Martín-Gutiérrez, J., Añorbe-Díaz, B., & González-Marrero, A. (2017). Virtual Technologies Trends in Education. EURASIA Journal of Mathematics, Science and Technology Education, 13(2). https://doi.org/10.12973/eurasia.2017.00626a
[147] Workrooms | VR for business meetings. (2022). Meta Quest. https://www.oculus.com/workrooms/?locale=nl_NL
[108] Lee, Y., Kozar, K. A., & Larsen, K. R. (2003). The Technology Acceptance Model: Past, Present, and Future. Communications of the Association for Information Systems, 12. https://doi.org/10.17705/1cais.01250
[149] Davis, F. (1989). 'Perceived usefulness, perceived ease of use, and User Acceptance of Information Technology', MIS Quarterly. Vol. 13, No. 3, pp. 318-339.
[150] Fishbein, M. and Ajzen, I. (1975). 'Belief, Attitude, Intentions and Behavior: An Introduction to Theory and Research', Boston: Addison-Wesley.
[151] Jaradat, M. I. R. M., & Mashaqba, A. M. A. (2014). Understanding the adoption and usage of mobile payment services by using TAM3. International Journal of Business Information Systems, 16(3), 271. https://doi.org/10.1504/ijbis.2014.063768
[152] Fogg, B. J. (2009, April). A behavior model for persuasive design. In Proceedings of the 4th international Conference on Persuasive Technology (pp. 1-7).
[153] Paris Agreement. (2015). European Commission. https://ec.europa.eu/clima/eu-action/international-action-climate-change/climate-negotiations/paris-agreement_en

Appendix D - Summary chapter 3.2

The seven different alternative directions are presented in the grey area outlined by the dotted line.
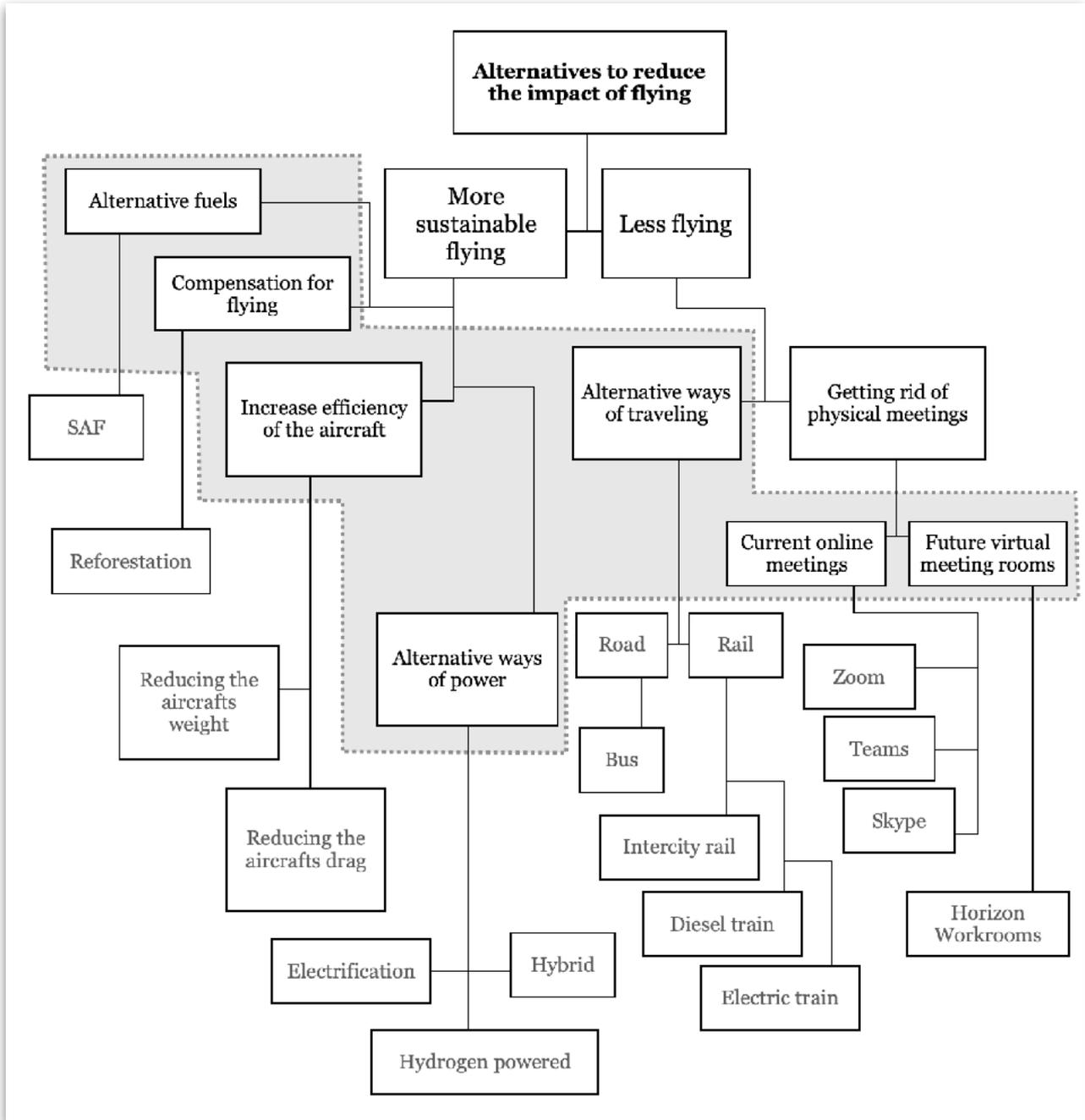
Appendix E - Estimated values ability for different modes of transport

Time
Aircraft
- Based on data provided by ecopassenger.org (*EcoPassenger*. (2022). EcoPassenger. http://ecopassenger.hafas.de/bin/query.exe/en?L=vs_uic&)

Train
- Based on data provided by ecopassenger.org (*EcoPassenger*. (2022). EcoPassenger. http://ecopassenger.hafas.de/bin/query.exe/en?L=vs_uic&)

Car
- Based on the outcome of Google Maps and the advised time of arrival found for the Eurotunnel (which is 1 hour) (Eurotunnel Le Shuttle. (2022). *Getting to –*. https://www.eurotunnel.com/uk/travelling-with-us/getting-to-eurotunnel-le-shuttle/)

Online
- Based on the interviews. *"For example when I have a online meeting it only takes 5 minutes to start my laptop and enter the meeting with someone on the other side of the world." (Employee working at Aegon)*

Money
Aircraft
- Based on the ticket price from Google Travel (*Google Travel*. (2022). Google Travel. https://www.google.com/travel/unsupported?
client=safari&rls=en&source=flun&uitype=cuA_&hl=nl&gl=nl&curr=EUR&tfs=CAEQARoZEgoyMDIyLTA4LTIwaqslAhIHL20vMGszcBoZEgoyMDIyLTA4LTI0cgslAhIHL20vMGszcHpkQ2pSSWRYQlVlSHBhVGtsMGNFRkJTamx2UmxGQ1J5MHRMUzB0TFMwdExYZHplblV4TTBGQIFVRkJSMHh5TTFKRIRGbERiRUZCRWdFd0dnb0kwQ2dRQWhvRFJWVlNPQU53c2lrPQ%3D%3D&ved=2ahUKEwjIt_nvt635AhVrQkEAHbAGBKgQlhd6BAgREAw&ucpp=CvICaHR0cHM6Ly93d3cuZ29vZ2xlLmNvbS9mbGlnaHRzP2NsaWVudD1zYWZhcmkmcmxzPWVuJnNvdXJjZjT1mbHVuJnVpdHlwZT1jdUFfJmhsPW5sJmdsPW5sJmN1cnI9RVVSJnRmcz1DQUVRQVJvWkVnb3lNREl5TFRBNExUSXdhZ3N3NJQWhJSEwyMHZNR3N6Y0JvWkVnb3lNREl5TFRBNExUSTBjZ3NJQWhJSEwyMHZNR3N6Y0hwa1EycFNTV1JZUWxWbFNIQmhWR3RzTUdORlJrSlRhbXgyVW14R1ExExSjVNSFJNVXpCMFRGVGXdkRXhZWkhwbGJsVjRUVEJHUWxGVlJrSlNNNSGg1VFRGS1JsUkdiRVJpUlVaQ1JXZEZkMGRuYjBrd1EyZFJRV2h2UkZKV1ZsTlBRVTUzYzJsclBRJ
TNEJTNEJnZIZD0yYWhVS0V3akl0X252dDYzNUFoVnJRa0VBSGJBR0JLZ1FsaGQ2QkFnUkVBdw)

Train
- Based on the ticket price from NS interantional (*NS International*. (2022). nsinternational. https://www.nsinternational.com/nl/treintickets-v3/#/search/NLASC/GBSPX/20220916?pax=A)

Car
- The average liter per km is 9.3L per 100 km (*M, L. (2022, January 17). What is good km per Litre? Reviews Wiki | Source #1 Des Informations, Tests, Chroniques, Avis et Nouveautés. https://reviews.tn/wiki/what-is-good-km-per-litre/*)
- The driving distance is 484 km according to Google maps
- This results in a use of 45,012 L
- With an average oil price of €2,022 per liter for the Netherlands, Belgium, France and the United Kingdom (*European Fuel Prices. (2022, August 1). Cargopedia. https://www.cargopedia.net/europe-fuel-prices*)
- This results in €91,01 one way

Brain cycles
- Based on the customer journey, elaborated in Appendix … - Determination brain cycles and physical effort for different modes of transport.

Social deviance
- Based on the customer journey, elaborated in Appendix … - Determination brain cycles and physical effort for different modes of transport.

Appendix F - Determination brain cycles and physical effort for different modes of transport

Brain cycles Aircraft

High

Low

Arriving to the airport and finding which gate.

Trying to find the gate.

In-flight.

Leaving the aircraft and find a way to go to your designated location.

Going through the security check.
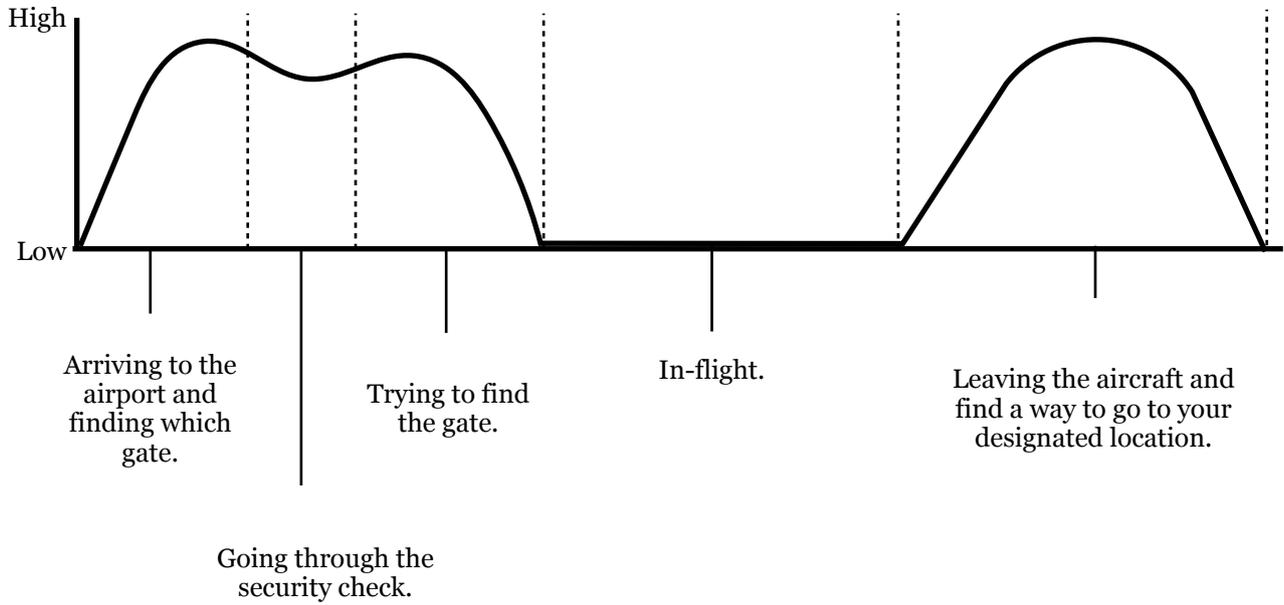
Physical effort Aircraft

High

Low

Arriving to the airport and finding which gate.

Trying to find the gate.

In-flight.

Leaving the aircraft and find a way to go to your designated location.

Going through the security check.

Brain cycles Car

High

Low
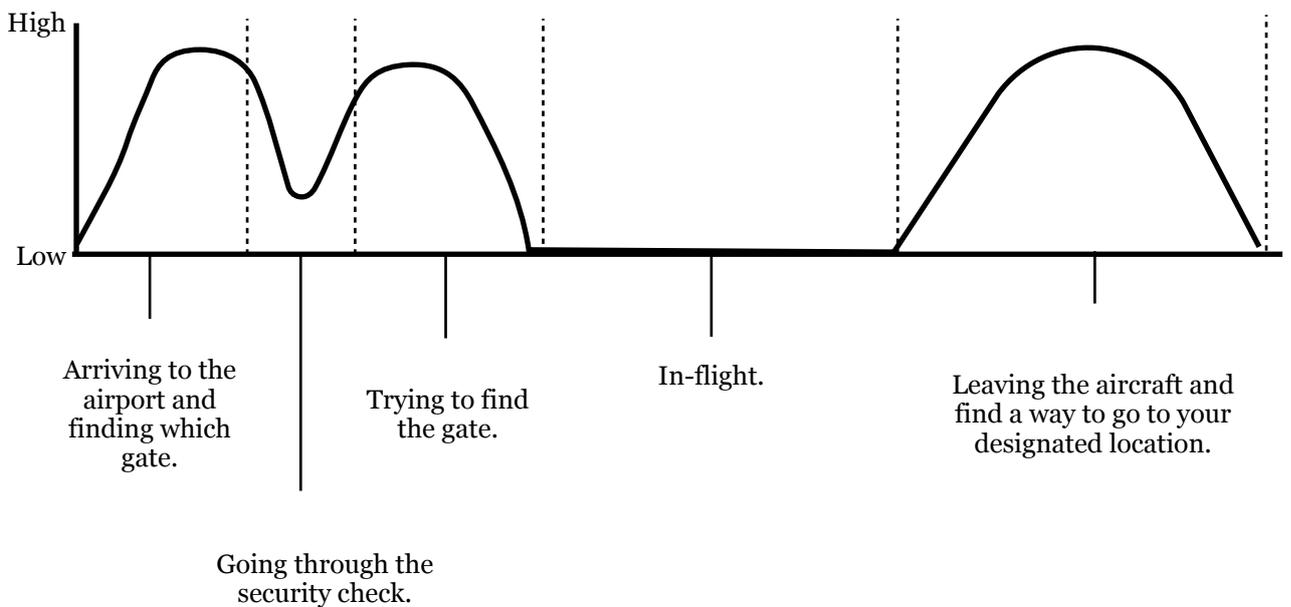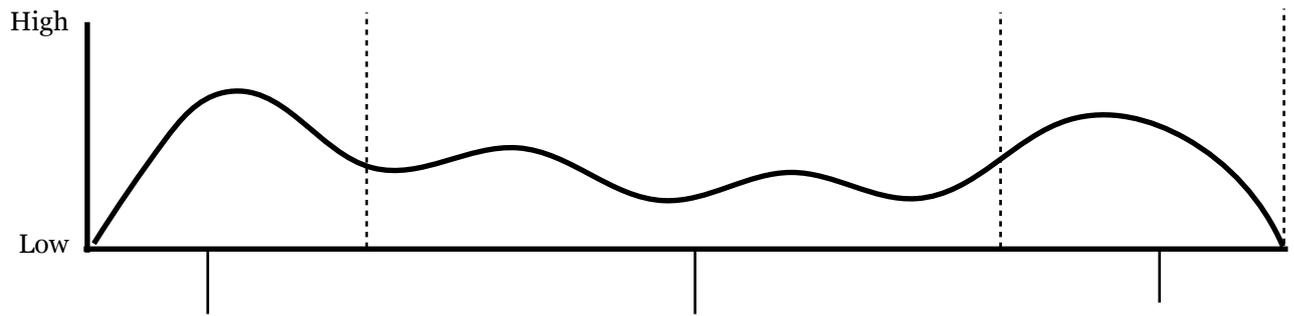
Entering the right
address and driving to
the highway.

During the ride there will be moments of a
higher energy level e.g. due to taking the
right exit.

Finding the right
address and where to
park the car.

Physical effort Car

High

Low
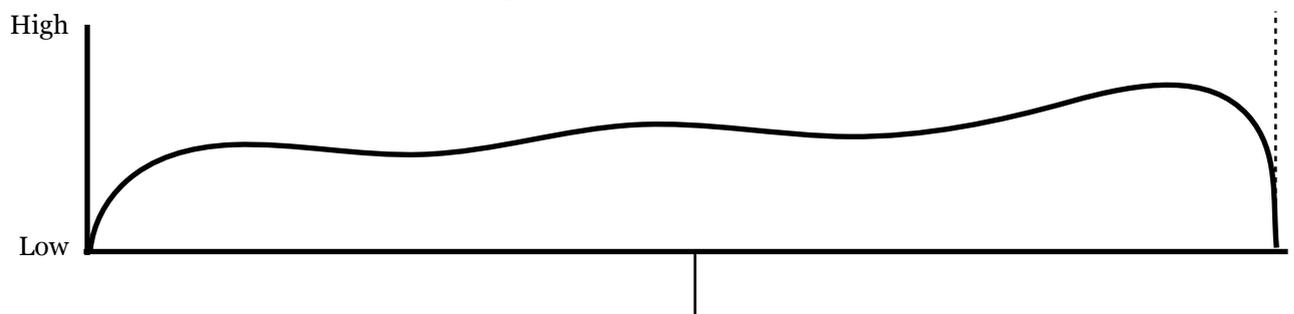
The amount of physical effort rise slightly
over time due to tiredness. It is not a perfect
straight line e.g. due to taking an exit where
the driver needs to slow down and brake.

Brain cycles Train

High

Low
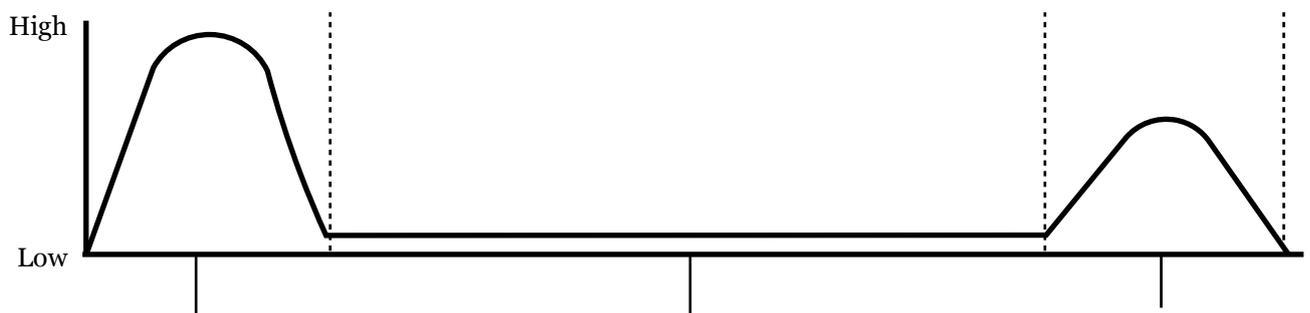
Arriving to the
translation and going to
the right train.

While sitting in
the train.

Leaving the train station
and find a way to go to
your designated location.

Physical effort Train

High

Low

Arriving to the
translation and going to
the right train.

Sitting in the
train.

Leaving the train station
and find a way to go to
your designated location.

Brain cycles Online

High

Low

Starting the program
and entering the right
meeting at the right
time.

During the meeting there is a constant level
op attention, this is not a straight line
because sometimes talking and other times
listening is required. This requires different
energy levels for different people.

Wrapping up the
meeting with the
conclusions and possible
agreement. This requires
a higher level of mental
awareness.

Physical effort Online

High

Low

Throughout the meeting there is no point
where someone needs to deliver high
physical effort.

Appendix G - Overview comparing the reduced carbon dioxide emissions of feasible alternatives to short-haul flights to determine the overall reduction

Alternatives to reduce the impact of flying		Grams of carbon dioxide equivalent per passenger kilometer	Reduction compared to short - haul flights (economy)	When will it reach this percent age?	Source(s)
	Short - haul flight	156	0	-	Statista. (2021, October 4). Carbon footprint of travel per kilometer 2018, by transport mode. https://www.statista.com/statistics/1185559/carbon-footprint-of-travel-per-kilometer-by-mode-of-transport/
Alternative fuels and compensation for flying	SAF	31	80	2030	Air bp. (2021, July). What is sustainable aviation fuel (SAF) and why is it important?	News and views. https://www.bp.com/en/global/air-bp/news-and-views/views/what-is-sustainable-aviation-fuel-saf-and-why-is-it-important.html
Changing the consumption of fuel in-flight	Making the aeroplane less heavy	139	11	2022	Hale, J (2006). "787 From The Ground Up". In: Aero Magazine 4 (Sept. 2006) Marino M. and Sabatini R. (2014) "Advanced Lightweight Aircraft Design Configurations for Green Op- erations". In: Proceedings of the Practical Responses to Climate Change 2014 (Melbourne, Aus- tralia). Nov. 2014. DOI: 10.13140/2.1.4231.8405
Change the exterieur of the aircraft	Different shape of the aeroplane	125	20	2041	The technology behind the Flying-V. (2020). TU Delft. https://www.tudelft.nl/lr/flying-v/technologie Euronews. (2021, December 13). Flying V: Meet the team of Dutch engineers behind the aircraft bidding to reshape air travel. https://www.euronews.com/next/2021/11/16/flying-v-meet-the-team-of-dutch-engineers-behind-the-aircraft-bidding-to-reshape-air-trave
Alternative ways of power	Electrification	0	100	2035	Kolosz, B. W., Luo, Y., Xu, B., Maroto-Valer, M. M., & Andresen, J. M. (2020). Life cycle environmental analysis of 'drop in' alternative aviation fuels: a review. Sustainable Energy & Fuels, 4(7), 3229–3263. https://doi.org/10.1039/c9se00788a Barke, A., Thies, C., Melo, S. P., Cerdas, F., Herrmann, C., & Spengler, T. S. (2022). Comparison of conventional and electric passenger aircraft for short-haul flights – A life cycle sustainability assessment. Procedia CIRP, 105, 464–469. https://doi.org/10.1016/j.procir.2022.02.077 [1Ribeiro, J., Afonso, F., Ribeiro, I., Ferreira, B., Policarpo, H., Peças, P., & Lau, F. (2020). Environmental assessment of hybrid-electric propulsion in conceptual aircraft design. Journal of Cleaner Production, 247, 119477. https://doi.org/10.1016/j.jclepro.2019.119477
	Hybrid	9	94	2030	HAV. (2022). Hybrid Air Vehicles. https://www.hybridairvehicles.com/our-aircraft/airlander-10/mobility/

	Hydrogen powered (fuel-cell propulsion)	27.3	83	2035	A fact-based study of hydrogen technology, economics, and climate impact by 2050. (2020, May). EU. *https://www.fch.europa.eu/sites/default/files/FCH%20Docs/20200507_Hydrogen%20Powered%20Aviation%20report_FINAL%20web%20%28ID%208706035%29.pdf*
Alternative ways of travelling	Bus	105	33	2022	Statista. (2021, October 4). Carbon footprint of travel per kilometer 2018, by transport mode. https://www.statista.com/statistics/1185559/carbon-footprint-of-travel-per-kilometer-by-mode-of-transport/
	Intercity rail	11.8	92	2022	Statista. (2021, October 4). Carbon footprint of travel per kilometer 2018, by transport mode. https://www.statista.com/statistics/1185559/carbon-footprint-of-travel-per-kilometer-by-mode-of-transport/
	Electric train	0	100	2022	Thomas, G. P. (2019, November 1). Are Electric Trains Eco-Friendly? AZoCleantech.Com. https://www.azocleantech.com/article.aspx?ArticleID=262
	Diesel train	41	74	2022	Statista. (2021, October 4). Carbon footprint of travel per kilometer 2018, by transport mode. https://www.statista.com/statistics/1185559/carbon-footprint-of-travel-per-kilometer-by-mode-of-transport/
	Car	127.6	18	2022	Average CO2 emissions from new cars and new vans increased again in 2019. (n.d.). European Environment Agency. Retrieved September 28, 2022, from https://www.eea.europa.eu/highlights/average-co2-emissions-from-new-cars-vans-2019
Getting rid of physical meetings	Current online meetings	0	100	2022	Mouratidis, K., & Papagiannakis, A. (2021). COVID-19, internet, and mobility: The rise of telework, telehealth, e-learning, and e-shopping. Sustainable Cities and Society, 74, 103182. https://doi.org/10.1016/j.scs.2021.103182
	Future virtual meeting rooms	0	100	2025-2030	Mora, C. E., Martín-Gutiérrez, J., Añorbe-Díaz, B., & González-Marrero, A. (2017). Virtual Technologies Trends in Education. EURASIA Journal of Mathematics, Science and Technology Education, 13(2). https://doi.org/10.12973/eurasia.2017.00626a Workrooms | VR for business meetings. (2022). Meta Quest. https://www.oculus.com/workrooms/?locale=nl_NL

Appendix H - Estimated impact electric alternatives and online meetings

Substantiations for estimated cost buildup

Online meetings:
- the average trip takes 3 days (*Releases Q3 Business Travel Trends Data. (2016, November 9). Travel Leaders Corporate. https://travelleaderscorporate.com/travel-leaders-corporate-releases-q3-business-travel-trends-data/; 25 Essential Business Travel Statistics [2022]: Facts About Business Travel In The U.S. – Zippia. (2022, June 7). Zippia. https://www.zippia.com/advice/business-travel-statistics/*)
- Professionals in an average week have 21.5 hours of meeting (this accounts for a 40-hour workweek) resulting in 12,9 hour of meeting (*Productivity Trends Report: One-on-One Meeting Statistics. (2021, October 2). Reclaimai. https://reclaim.ai/blog/productivity-report-one-on-one-meetings*). This is done completely online with the company abroad.
- The comparison is only made between the emission from the flight vs the emission from the online meeting, other pollution from f.e. lamps that are on, are not taken into account since they similar in both situations at both companies.
- 1 hour of meeting online => Two people spending an hour on Zoom at HD quality will generate around 0.0037kg of CO_2e (*Kingsley-Hughes, A. (2021, April 23). How much CO2 are your Zoom meetings generating? ZDNet. https://www.zdnet.com/article/how-much-co2-are-your-zoom-meetings-generating/*). Upgrade the video quality to 1080p, and that results in a four-fold increase in energy consumption.
- The most productive meetings are with 8 or less people (*The Most Productive Meetings Have Fewer Than 8 People. (2018, September 7). Harvard Business Review. https://hbr.org/2018/06/the-most-productive-meetings-have-fewer-than-8-people*). Slightly over half (54%) of meetings have 4-6 participants, roughly a quarter (27%) have 7-10, around (12%) have less than 3, and (7%) have 11-25 (*Turmel, L. (2017, September 18). Meeting statistics - stats on costs & time spent in meetings. Better Meetings. https://bettermeetings.expert/meeting-statistics/*). 6,4 participants is the average, so for this graph 6 participants is chosen

Electrified aircrafts
- Regardless of how far an e-VTOL travels, our analysis predicts takeoff and landing combined will require **between 8,000 and 10,000 watt-hours per trip**. (*Viswanathan, V., Sripad, S., & Leif, W. (2018, December 4). It's 2018 — why aren't there electric airplanes yet? | Greenbiz. GreenBiz. https://www.greenbiz.com/article/its-2018-why-arent-there-electric-airplanes-yet*) Averaging at 9 kWh
- e-VTOL that weighs 1,000 kilograms, including the passenger (*Viswanathan, V., Sripad, S., & Leif, W. (2018, December 4). It's 2018 — why aren't there electric airplanes yet? | Greenbiz. GreenBiz. https://www.greenbiz.com/article/its-2018-why-arent-there-electric-airplanes-yet*)
- 400 to 500 watt-hours per mile is equal to 250 - 312,5 watt-hours per kilometer (*Viswanathan, V., Sripad, S., & Leif, W. (2018, December 4). It's 2018 — why aren't there electric airplanes yet? | Greenbiz. GreenBiz. https://www.greenbiz.com/article/its-2018-why-arent-there-electric-airplanes-yet*).
- Distance from Amsterdam to London is approximately **380 kilometers**.
- Today the average carbon intensity of electricity generated is 475 gCO2/kWh, a 10% improvement on the intensity from 2010. (*Emissions – Global Energy & CO2 Status Report 2019 – Analysis. (2019). IEA. https://www.iea.org/reports/global-energy-co2-status-report-2019/emissions*)

Electrified train
- The Department for Transport (DfT) claims that carbon per passenger mile from an electric train is up to 35% less than that produced from a diesel train. (*Thomas, G. P. (2019, November 1). Are Electric Trains Eco-Friendly? AZoCleantech.Com. https://www.azocleantech.com/article.aspx?ArticleID=262*)

Appendix I - Trigger classification

Trigger	Motivation	Ability	Trigger
Request from customer (or own request)	High	Easy	Signal
New business opportunities	High	Hard	Facilitator
Specific organized meetings	High	Easy	Signal
Periodic maintenance	Low	Easy	Spark
Direct sales / revenue	High	Hard	Facilitator
The need for knowledge	High	Easy	Signal
Maintaining relationships	High	Easy	Signal
The start of a new project	High	Hard	Facilitator

Appendix J - Personas

Wendy

Job Responsibilities

Project management

Biggest Challenges

- Problem Solving & Decision Making
- Project Management & Disorganization
- Collaboration & Creativity

Gains Information By

Having online and physical meetings with partners.

Environmental awareness

Likes to be sustainable as long as she sees the direct change/impact from her behavior. For example, she bikes to work because then she knows her car won't be used. She does fly, her argument is that the plane will fly whether she's on it or not.

Hobbies

If she can take a day of, Wendy likes to go on a holiday with her husband. She likes to travel within Europe but tries to go once per year to somewhere outside Europe.

Goals in life

Wendy currently lives in the city but would like to buy a nice house in a rural area once she (and her husband) retire.

Bob

Job Title
Professor at a university

Age
55 to 64 years

Highest Level of Education
Professional degree (e.g. MD,

Job Responsibilities

Teaching students social science

Biggest Challenges

- Transferring knowledge to students
- Keeping the up to date with developments

Gains Information By

Reading books and (news) papers. And going to conferences to talk to other professors or to present his own works.

Environmental awareness

Bob is aware of his environmental impact and has therefore decided he won't fly for personal holidays. He does fly for work within Europe.

Hobbies

Likes to walk over the beach with his wife (and grandchildren). Also likes to visit other cities in his country by train (he does not have a drivers license).

Goals in life

To inspire students to make the right decisions in life by transferring knowledge on how to see things from different perspectives.

Lucas

Job Title
Mortgage Portfolio Manager

Age
35 to 44 years

Highest Level of Education
Bachelor's degree (e.g. BA, BS

Job Responsibilities

Portfolio management

Biggest Challenges

• Problem Solving & Decision Making
• Portfolio Management

Gain Information By

Having online and physical meetings with partners and clients. Also reads the newspaper every morning.

Environmental awareness

Tries to live a sustainable life for his two kids. He is a vegetarian, lives in a sustainable house (made from natural materials and has solar panels on his roof to produce his own electricity) and drives an electric car. Because of all these measurements he compensates for flying with his work. When he flies, Lucas insists that the compensation is paid (either through reforestation or sustainable fuel), even if that means, he has to pay parts of that by himself.

Hobbies

Lucas likes to spend every free minute with his wife and kids. He likes to play at home or go to the park.

Goals in life

Lucas wants to contribute to making the world a good place for his kids to grow up and become old.

Appendix K - Website setup for test with target group
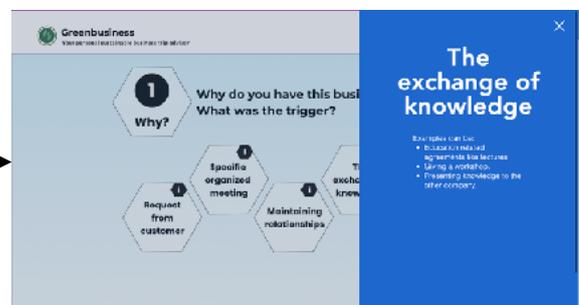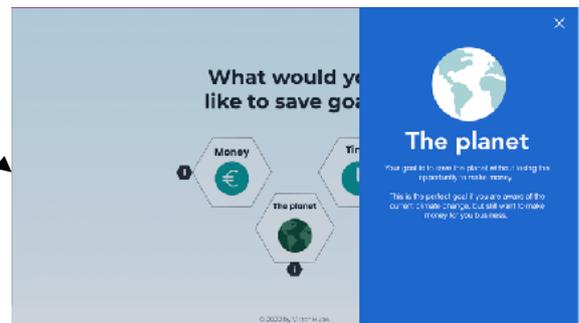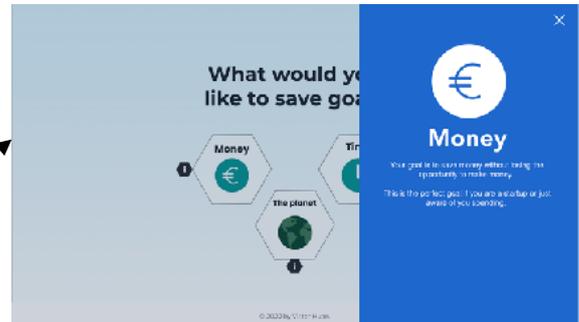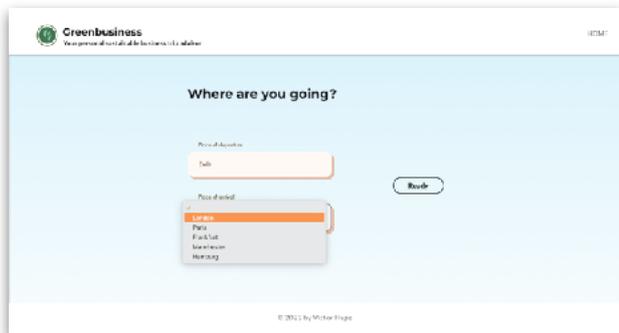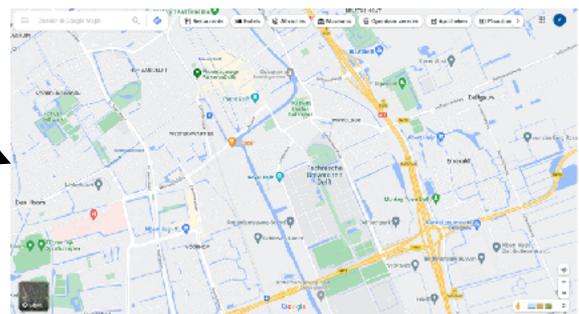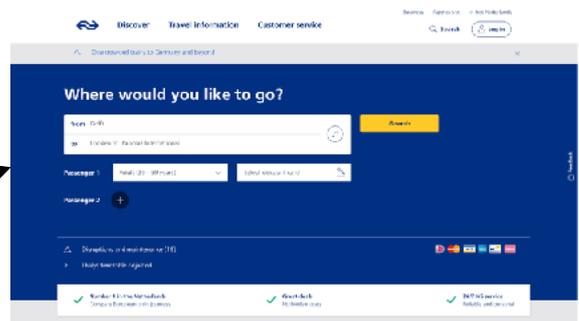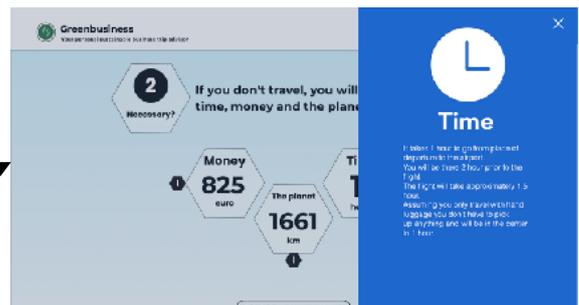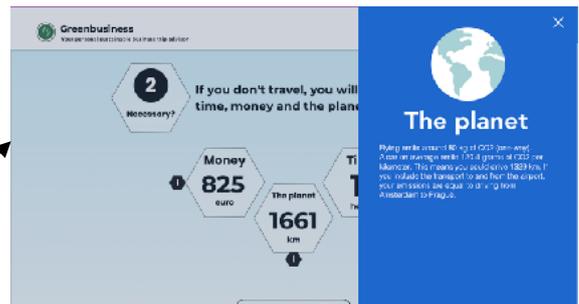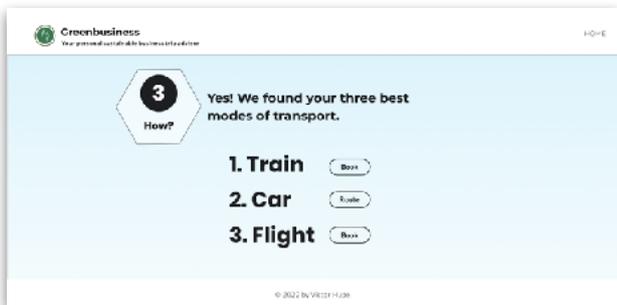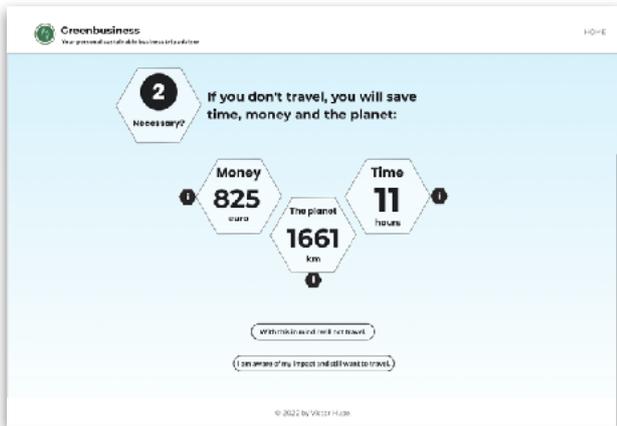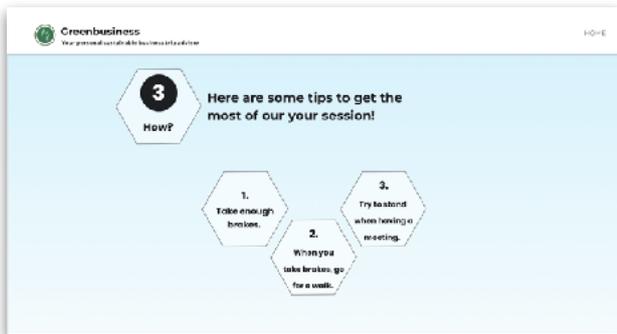
Appendix L - Testing with target group

Testing

After designing a first concept, I tested this with people in my target group.

Round 1

Aim of the session: To verify the concept and to see whether it fits the need of the target group.

Sampling: 3 participants from three different sectors (insurance, steel and clothing industry).

Activities: In preparation for this session I had printed the different parts (such as the board and the figures that can be pinned on it) with the 3d printer.

During the session there was an introduction in which it was explained that the aviation industry makes a significant contribution to climate change. Followed by the case that people got to plan a trip (by pinning the different modes or transport on the board). All boards were clicked together and everyone was asked to plan the transport for each board for the business trip (Figure 5.13).

When everyone had done this, it was explained that each board represents the maximum amount of CO_2 that the earth can process, also called the carbon budget. As a result, the planes were much larger than the car, they emit much more emissions. The question then was to place personal figures in the empty pins. This made it clear that by choosing the aircraft, very little is left for personal use. If one could replace the plane by the car or the train, the journey was still made but there is much less emissions.

Result: Based on the feedback the following conclusions were drawn:
- The impact of personal life is not measured in the same unit as transport. This is not correct, so something else has to be found such as adding a section that asks the participants to write down 3 things why they want the emissions of their business trips to decrease.
- The order must be different. For example, it is more fun to start with the cases, followed by the information about how bad aviation is, and then immediately apply the new knowledge and make a new planning of the trip (this but with less polluting modes or transport).
- Means of transport such as the bicycle and walking were missing. These provide no or minimal emissions (it can be calculated back to the emissions that are released when producing food that people consume and convert into energy). It might also be useful to have an extra kind of open
- It would help if different modes or transport have different colors that represent the impact (e.g. the redder the more emissions).
- What happens if people want to do this assignment but can't physically get together?
- Is it possible to have a common goal when it comes to reducing emissions from all trips within the company?
  - This could be done, for example, by issuing a certificate in which a ten percent reduction stands for a bronze certificate, twenty percent for silver and more than thirty percent for gold. This also helps the company attract new employees and

ensures that they can show the world (political but also the social world) that they are working on sustainable changes.

- The reinforcement should be done via email because when I asked the question, which of the following options would work for you as a reminder: a plant with a message on the pot that has to be watered every week and makes you think about the seminar, an email or a product that can also help during work, such as a laptop sleeve or a mouse pad. All 3 participants indicated that an email would work best. A plant is too far from the message I want to convey and is difficult to maintain for people who worked hybrid. The product that is more included in the workspace will after a while no longer stand out and no longer help you remember. That is why it was decided to use the email for reinforcement.

Round 2

Changes made from the first round are:

1.2. The figures received a color, green meaning less impactful until red being the most impactful.

1.1 There are 24 instead of 20 opening. This is equal to using the car (2 pins) to go to the airport, fly (8 pins) and get a taxi when you arrive (2 pins). And do the same on your way back. This is the maximum impact and is the current behavior. With this the board is full and every change will be an improvement.

1.3 An extra layer with rectangular openings is added, these are meant for transport with almost no emission and online.
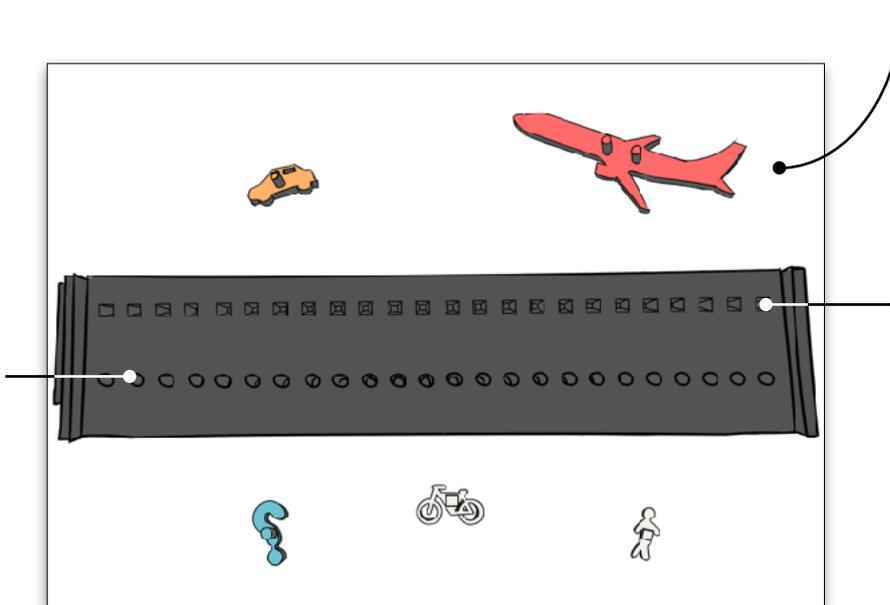
Figure 5.15, Iteration on round 1.

Change	Advantages	Disadvantages
1.1	More pins might give the participant the feeling they can use the aircraft or other pollution modes of travel since it all fits. This could then result in a bigger shock effect compared to a smaller board where some really pollution trips would already not fit resulting in making the trip already less pollution because of the limitations of the board.	If users do not choose the most polluting modes of transport, with the bigger board, it might be that a lot of the boards will be empty when linked to other boards. This might result in less of a shock effect because the impact might not be properly visible.

Change	Advantages	Disadvantages
1.2	The colors can contribute to a bigger shock effect since it will be easier to see how much red is there compared to no color and just seeing a lot of figures.	The colors might be distracting for the participants resulting in more focus on creating a business trip with the prettiest colors rather than how they would actually do it.
1.3	This extra layer gives the participant the option to add figures that represent modes of transport with no or almost no emission.	Is this really necessary? It might be too much without adding anything sufficient.
1.4	It might make the trip more complete with extra modes of transport.	Is this really necessary? It might be too much without adding anything sufficient.
1.5	It might make the trip more complete with extra modes of transport.	Is this really necessary? It might be too much without adding anything sufficient.

Aim of the session: To verify if the changes made have the desired result. Next to that find out if the group assignment works as I have in mind.

Sampling: 2 participants, someone with a background in marketing and someone who's the head of a publicity agency.

Activities: The seminar was organized in the way it will also be when company purchase it. Starting with a case where all the individual participants receive a board with figures. The case is as follow: How would you plan your next business trip to London? They received 2 minutes to figure out which modes of transport they want to use. When the participants were done, an individual evaluation took place. They received the question if something stood out. One of the reaction was the noticeable amount of red colour which was not perceived as a good thing. The boards were laid aside and a presentation was given. Here the participants were informed about the impact of flying. Starting with flying, followed by the aviation industry (and the urgentie this problem has), after which I scoped to short-haul business flights and finishing off with the comparison to alternative modes of transport. Here not only alternatives were gone over but also the other advantages for the company (e.g. saving time and money by choosing alternative modes of transport).

After a break the case started. This is the same as the first one, however now all the board are clicked together resulting in one big line of boards representing all the business trips. Now the participants have to work as group and project the new knowledge onto the configuration of their business trips. At the end (after 5 min) the new result is evaluated.

The next part is focussed on the advantages for the employees. Everybody received three post-its on which they should each write one reason or argument why shifting to a more sustainable behavior would have advantages for them. After 3 min these are share with the group showing that your arguments might be similar to those of different people among the group.

As last part of the seminar, the website was mentioned and a goal was set for in a year.

Result:
- The case is not clear yet.
- The case is too much steering to a physical business trip.

- The figure used for public transport is not clear.
- It is possible to turn the figure for train vertical which should be only used horizontal.

Round 3

Changes made from the first round are:
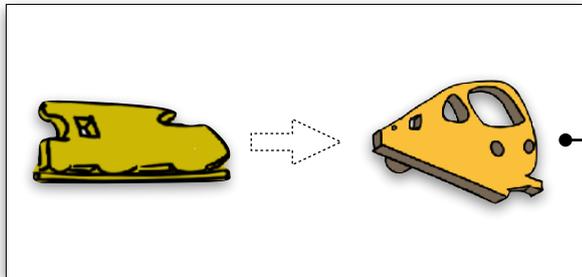
2.1 The figure representing the train was changed to a more recognizable figure.

Figure 5.10, Iteration on round 2.

Change	Advantages	Disadvantages
2.1	This figure might be better recognizable as a train.	It might still be difficult to perceive it as a train.

Aim of the session: To verify if the changes made have the desired result. Next to that find out if the group assignment works as I have in mind.

Sampling: 2 participants, someone with a background in marketing and someone who's the head of a publicity agency.

Activities: The seminar was organized in the way it will also be when company purchase it. Starting with a case where all the individual participants receive a board with figures. The case is as follow: You just started a new project with a company in London, but before the start you still need a meeting for contract negotiation. This has to be done in two weeks from now, which mode of transport would you use for this?

Result:
- The case was still not clear, it was too logical to choose for the online option.
- It was not clear it was about a round trip.
- The website was not working completely.
- The train was clear.

Appendix M - Time indication of the seminar

The seminar will be scheduled according to the timetable below.
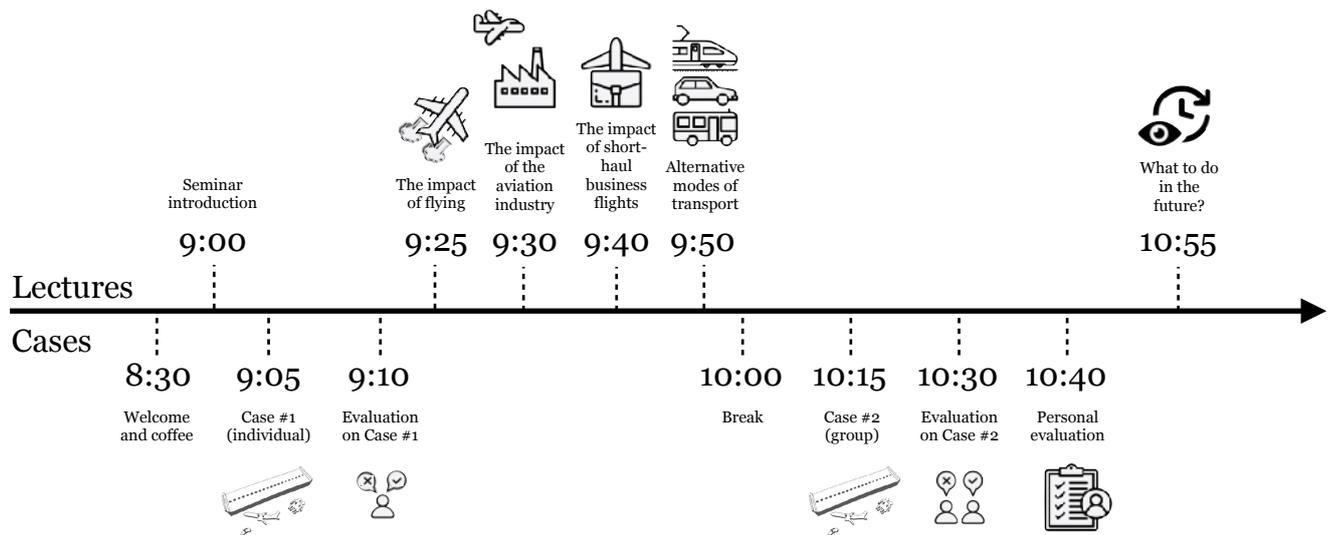
Figure 5.16, The gold certificate earned for a reduction of 30%.

Appendix N - Icon elaboration

A board is provided for each participant. The seminar has a maximum of 20 participants.
For each board there are the following figures:

Online

Train

Walk

Scooter

Bike

Car
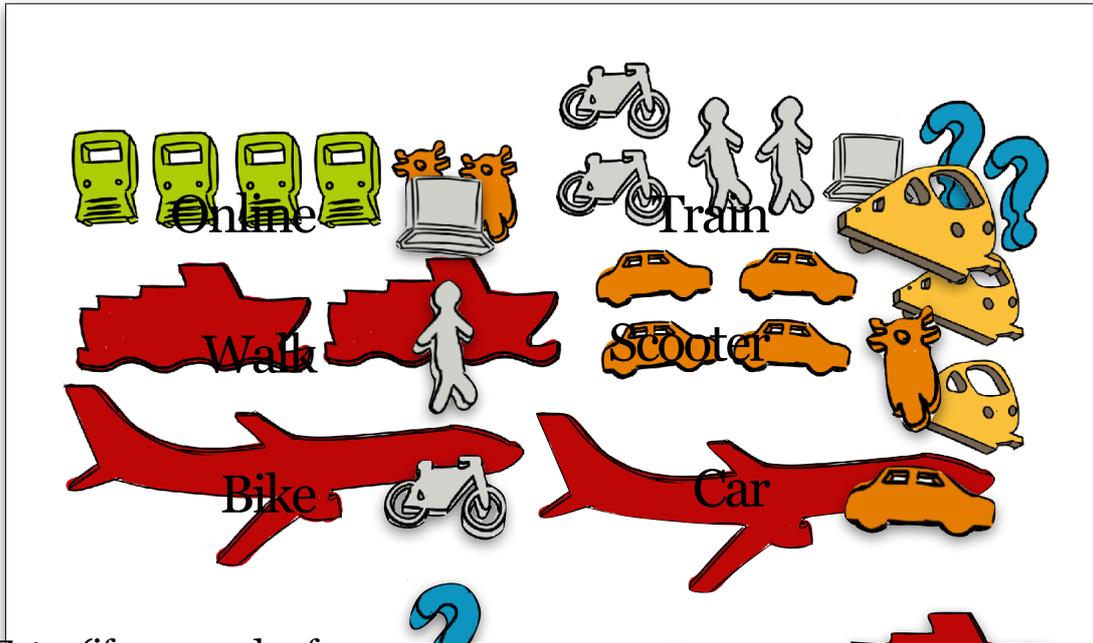
Extra (if your mode of
transport is not includes yet)

Figure 5.26, All the different figures Boat

Public transport

Aircraft

Appendix O - Different emails sent as reinforcement

- **1 day**

Good morning world changer,

Yesterday was an amazing day. By planning out multiple business trips, you together with your found out how bad flying is for the environment.

Today is a new day and it might feel like any other day at the office, however you are now starting the process of behaviour change. In a year from now you and your company have set the goal to reduce the amount of flights by 20%.

To reach this goal, next time you feel the need for a business trip, think about yesterday, about your argument why you think the next trip can be done in a more sustainable way. And ask yourself the question: is the trip really necessary and if it seems to be, how do you travel?

If you want help with your decision, you can always visit our website greenbusiness.com.

Keep on changing,

Team Green business

- **7 days**

Good morning world changer,

It us again from team Green business. Last week you were part of the seminar that will change the world and save the planet! Well, no that's maybe a bit too optimistic, but every contribution helps. It's not about trying to fix the complete problem with one solution but making small steps to reach bigger goals.

We hope you might already have taught about last weeks session and noticed all the aircrafts in the air or that you thought about it when you used your car / the train this morning. All these moments contribution to changing your view and to reach the goal of reducing 20% of the flights.

The next time we will contact you, we will inform you on the progress you have made by then. So good luck and as Benjamin Franklin once said, diligence is the mother of good luck!

And again, don't hesitate if you want help with your decision, you can always visit our website greenbusiness.com.

Keep on changing,

Team Greenbusiness

- **1 month**

Good morning world changer,

It has been a month since the seminar. And? Do you already consider yourself a climate activist. We hope you maybe already had the opportunity to put your new mentality into practice! And if this was not possible, since you still took a short haul flight, you might were more aware of your impact during that flight. This is also already a step in the right direction.

Since last time you and your company have reduced 2% of your initial impact. So you have already saved the equivalent of the emission emitted by a household for one week.
If you continue with this you will come just short of your goal to reach 20%. So keep on going and try to up the game just a little bit, we believe you can do it!

And again, don't hesitate if you want help with your decision, you can always visit our website greenbusiness.com.

Keep on changing,

Team Greenbusiness

- **3 months**

Good morning world changer,

Now after three months, things have shift a bit. The last time we on track to not reach your goal. However, you have done a wonderful job. Since last time you and your company have reduced 5% of your initial impact. This means you are again back on track, wel done!!

You and your company have now saved the equivalent of the emission emitted when doing the Trans Siberian express, which is a train ride for of almost 14000 km. Keep on going, we are looking forward to the next moment of measurement!

And again, don't hesitate if you want help with your decision, you can always visit our website greenbusiness.com.

Keep on changing,

Team Greenbusiness

- **9 months**

Good morning world changer,

Today is a special day, you will give birth to your baby. Oh no wait that's a different nine months. Well maybe it is not even that different, of course you won't give birth to a real baby but you might have given birth to a new version of yourself. Don't loose me here, it won't get any more spiritual than that, but now might be a good time to reflect on the past nine months. Have you done everything you wanted to do or change?

You have still three months left to reach the 20% goal. Your company is currently at a reduction of 17% (of the flights) which means you should be able to make it to at least 20%. Stay focussed and keep thinking of the arguments you wrote down at the seminar, why you want to travel more sustainable.

Good luck with the last three months and again, don't hesitate if you want help with your decision, you can always visit our website greenbusiness.com.

Keep on changing,

Team Greenbusiness

- **1 year**

Good morning world changer,

Yess!! You have made it. One year ago you and your colleges followed our seminar. The intention was to create awareness and open eyes when it comes to travelling for work. You did a fantastic job!

You and your company have reduced the impact with:

22%

For this wonderful percentage your company will receive a certificate proving you are real world changers. We, from Greenbusiness, hope you understand the importance of acting more sustainable and also that you don't have stop living live and stay at home all the time. You can visit other places for work, you will gain a lot from it, but just be aware of what you are doing and the impact it has.

Thanks for taking part in our journey to make the world a more sustainable place for everybody.

You can still visit our website greenbusiness.com if you want any personalized advise!

Thanks for you participation,

Team Greenbusiness

DESIGN FOR our future

TUDelft

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	Hupe	Your master programme (only select the options that apply to you):
initials	V given name Victor	IDE master(s): ( ) IPD ( ) DfI (★) SPD
student number	4533623	2nd non-IDE master: _____
		individual programme: _____ (give date of approval)
		honours programme: (Honours Programme Master)
		specialisation / annotation: (Medisign)
		(Tech. in Sustainable Design)
		(Entrepeneurship)

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

** chair	Giulia Calabretta	dept. / section: _____
** mentor	Ruud Balkenende	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.

Procedural Checks - IDE Master Graduation

APPROVAL PROJECT BRIEF
To be filled in by the chair of the supervisory team.

chair   Giulia Calabretta   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

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

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

( ) YES   all 1st year master courses passed

( ) NO   missing 1st year master courses are:

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 _____

Initials & Name _____   Student number _____

Title of Project _____

The best solution to reducing the amount of CO2 emissions in the aviation is not to fly. How can the amount of flights be reduced (and therefore the CO2 emissions)?

_____ 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 **23** - **03** - 2022   **15** - 07 - 2022 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, ...).

Travelling in general is bad for the environment. The carbon footprint of a domestic flight (flights less than 1,000 kilometres) had the highest of all transport modes (in 2018), with 225 grams of CO2 emitted per passenger kilometre. In comparison, a medium petrol powered vehicle's carbon footprint was 192 grams of CO2 per passenger kilometre.

Travelling for business is just 12% of the travel passengers but results in a bigger percentage of the carbon emission. How much exactly is difficult to say but business trips are often short or medium flights. These are up to 6 hours and have a disproportionately large carbon footprint. Besides that people who travel for work tend to have larger carbon footprints. This is not just because they fly more frequently. Studies have found that space consuming business-class seats are responsible for up to five times as many CO2 emissions as those in economy. However business travellers can on some flights produce 75% of the airline's revenues. This makes it difficult to try and reduce the amount of business flights.

The COVID pandemic made people aware that there are other options when it comes to meeting instead of flying. This resulted in a huge loss for the aviation industry. People found a way to connect without having to physically see each other. Before the pandemic there were around 200 thousand flights per week. When the pandemic hit, it dropped to around 25000. Currently is back at around 150 thousand flights a week. This is less than before the pandemic but it is a rising number.

Who is involved?
The stakeholders include: Airlines, the passengers who travel (for business), the airport and different other companies airline companies will work together with, when searching for a solution.

What do they value?
• The airline has the goal to make money. However, with a changing world, this money won't be earned by staying as they are. The world is changing to a more sustainable one. Airlines should be changing with this to be able to maintain their current status in the aviation industry.
• The passengers (who travel for business) want the fastest and most convenient way of travelling. A lower carbon footprint is a nice bonus but not a requirement.
• The airport would benefit from a solution in which it doesn't have to change anything (for example regarding infrastructure). Or if the airport has to make an investment that will benefit them financially.
• The different companies the airline will work together with when searching for a solution. They will probably value a collaboration with a big airline like KLM.

How do they currently operate within the given context?
Different airlines do different things. Airlines can't just stop flying their (business) passengers. KLM did already launch a campaign called fly responsibly (in 2019). This campaign is focussed on all their passengers and promotes less flying and other ways to reduce the carbon footprint of flying. This campaign is mainly focussed on flying with more sustainable fuel. In the end not flying would be the best option for the sustainability problem. But how can KLM strive for the lowest possible CO2 emission without losing their streams of income.

What are the main opportunities and limitations you are currently aware of?
The current solutions are tips for the passenger but not concrete solutions. Also, the solutions are focussed on every passenger where I think I'll be focussing on the biggest contributor to the carbon footprint, the business trips. For business trips there are other options for having a meeting. However these are not chosen, why not? How can this be changed?

space available for images / figures on next page

T̃UDelft

introduction (continued): space for images

TO PLACE YOUR IMAGE IN THIS AREA:
- **SAVE THIS DOCUMENT TO YOUR COMPUTER AND OPEN IT IN ADOBE READER**
- **CLICK AREA TO PLACE IMAGE / FIGURE**

PLEASE NOTE:
- **IMAGE WILL SCALE TO FIT AUTOMATICALLY**
- **NATIVE IMAGE RATIO IS 16:10**
- **IF YOU EXPERIENCE PROBLEMS IN UPLOADING, COVERT IMAGE TO PDF AND TRY AGAIN**
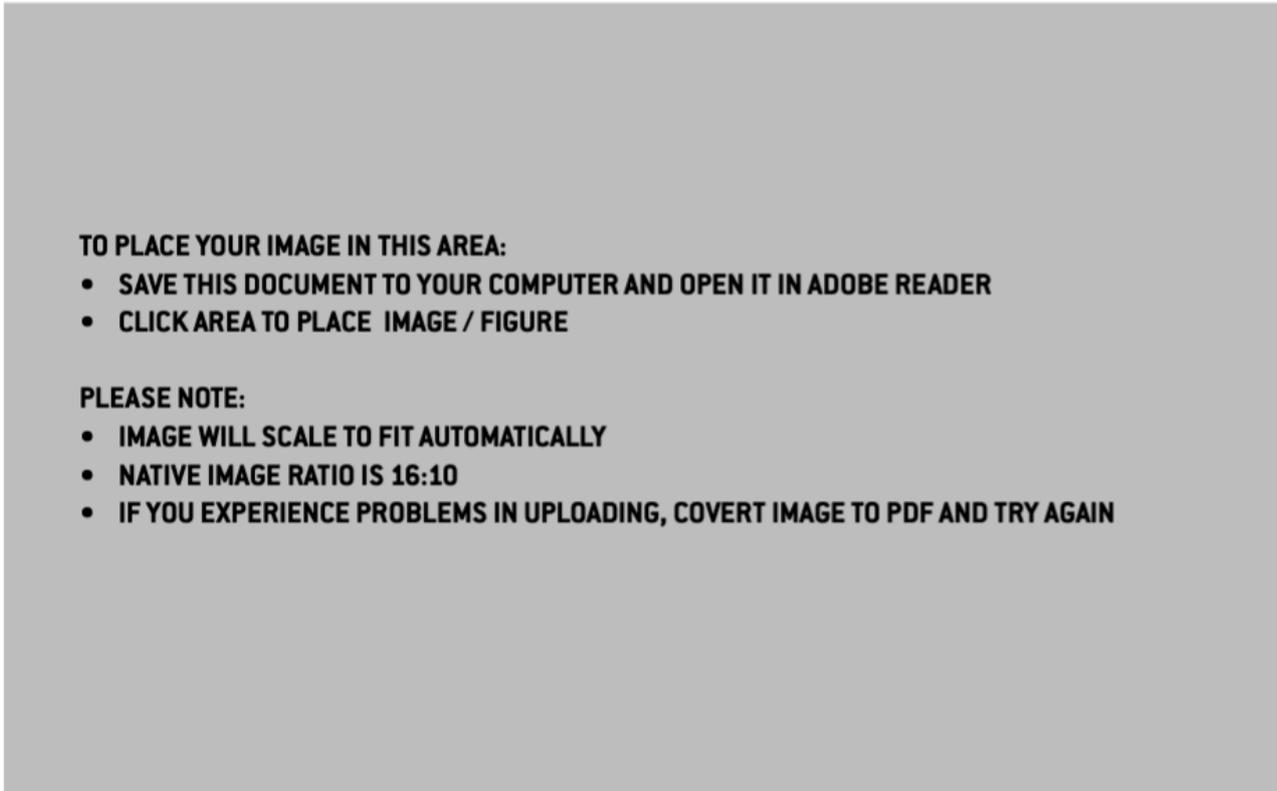
image / figure 1:   Overview of stakeholders

TO PLACE YOUR IMAGE IN THIS AREA:
- **SAVE THIS DOCUMENT TO YOUR COMPUTER AND OPEN IT IN ADOBE READER**
- **CLICK AREA TO PLACE IMAGE / FIGURE**

PLEASE NOTE:
- **IMAGE WILL SCALE TO FIT AUTOMATICALLY**
- **NATIVE IMAGE RATIO IS 16:10**
- **IF YOU EXPERIENCE PROBLEMS IN UPLOADING, COVERT IMAGE TO PDF AND TRY AGAIN**

image / figure 2: _____

Initials & Name _____   Student number _____

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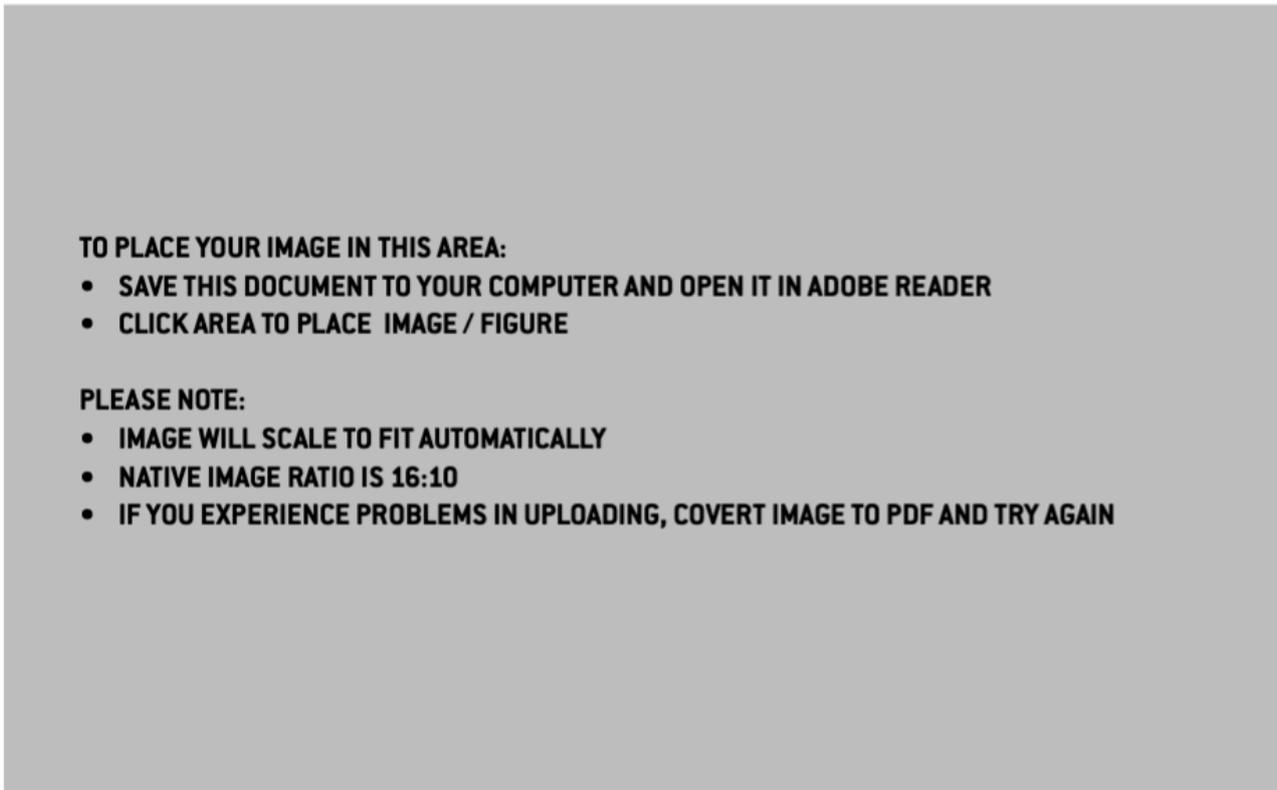
PROBLEM DEFINITION **
Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

Mindset of (business) passengers towards flying (resulting in too many (unnecessary) flights with a big impact on the environment). Passengers know flying is bad for the environment, however they still fly. Especially those who travel for business have alternatives, they can meet online. They don't choose this option. How can these passengers be stimulated to make another decision?

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.

I'll be designing a theoretical framework and a practical strategy for the aviation industry to affect the mindset of their business passengers in order to lower their carbon footprint. I will try and change this to a more environmentally friendly mindset. I am going to start with the complete ecosystem and later narrow my focus group down to those passengers who are contributing the most to the environmental problem, the passengers that are travelling for business.

In this project I'll be using a design approach. After doing literature research, I will be using the double diamond methode. Within this approach I will use KLM as data source. They are the biggest airline in the Netherlands and have a lot of data that is easy to acces.

The problem is bigger than just the mindset of the business passengers, however I think this is the core and therefore best to start with.

I want to look at other industries and see if there are companies who are experiencing a similar change in behaviour of users. My first thoughts go out to the automotive industry where there is also a change in fuel but also a change in behaviour towards driving (knowing it is bad for the environment).

My research question:
How can the mindset of passengers (who travel for work) towards flying be changed to a more sustainable one (to reduce the total carbon emission of flying)?

Sub-research questions:
- In what way will my strategy affect airlines?
- Who will play a role in executing my theoretical framework and practical strategy (will it be the airlines or the airport and in what way, or may other forms of transport => easy and fast solutions for travelling)?

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.

		Lab program meetings	Key-moments in graduation project	Different stages of graduation project	Regular tasks

	Calendar week	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	Project week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			17	18	19	20
1	**Research** Idea/Problem + Opportunity Identification																						
2	#4 In depth lecture: EOL of the aircraft																						
3	- Immerse myself in the current market => aviation, what is already being done with circularity.																						
4	- Find out what the needs are, where are points for improvement in the current market.																						
5	- Make an overview of other industries, these will different mobility industries.																						
6	- Look at what each industry has to offer and which frameworks/approaches/ practices have led to a success in this industry.																						
7	#5 In depth lecture: Policy in sustainable aviation																						
8	Perform a trend analysis.																						
9	Second meeting supervisors in week 3/4 - Clear overview of the problem and needs for KLM.																						
10	#6 Round Table																						
11	#7 Workshop 'Young leaders in sustainability transitoins'																						
12	**Feasible Concept/final solution** Design development => Redesign																						
13	Midterm evaluation																						
14	Third meeting supervisors in week 7 prior to the midterm evaluation => week 8 because of Mayholiday																						
15	*Part One of the double diamond* - Start creating a design solution with the information form the research - Concept Development (create a lot of different possible directions/solutions)																						
16	#8 In depth lecture: supply chain resilience and critical materials for aviation																						
17	*Part Two of the double diamond* - Concept Selection - Design Development (Narrow the possible directions/ solutions down) - Product Design Specifications																						
18	*Part Three of the double diamond* - Further Design Development (create with in that one or a few possible directions/solutions concepts) - Start prototyping - User testing																						
19	#9 Workshop 'Science communication'																						
20	*Part Four of the double diamond*																						
21	**Integration** Integrating the product in aviation industry																						
22	Make a plan for the launch of the product into the aviation industry																						
23	#10 In depth lecture: Complexity of stakeholder alignment (KLM)																						
24	Validate launch strategy with users																						
25	#11 Pressure Cooker of 2 days																						
20	Green light (80% of thesis)																						
21	#12 Final Presentations																						
22	Graduation																						

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.

My biggest passion is to travel. Especially outside of the Netherlands. To discover new worlds, try new and different food and meet new people. I think it's fascinating to see how people all over the world find solutions for sometimes the same problems. Besides traveling I crazy with nature. I actually did a minor in biology at the Leiden University. It was called biodiversity and natural environment. I really enjoyed. Unfortunately travelling and flying in particular is really bad for the environment. This frustrates me. I want to explore new places without having a negative impact on the world and its climate.

With the knowledge if gained during my SPD master, I think I'll be capable of creating a good strategy for the implementation and adaptation of circular design frameworks, approaches and practices to the aviation industry.

My personal learning ambitions are not really different from the learning objectives of the Graduation Project. My focus will be on the validation of my research. I want to substantiate my statements/arguments well. This might be easy but working with something as successful (which is not a fixed thing), might give me some problems.

FINAL COMMENTS

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

Initials & Name _____   Student number _____

Title of Project _____