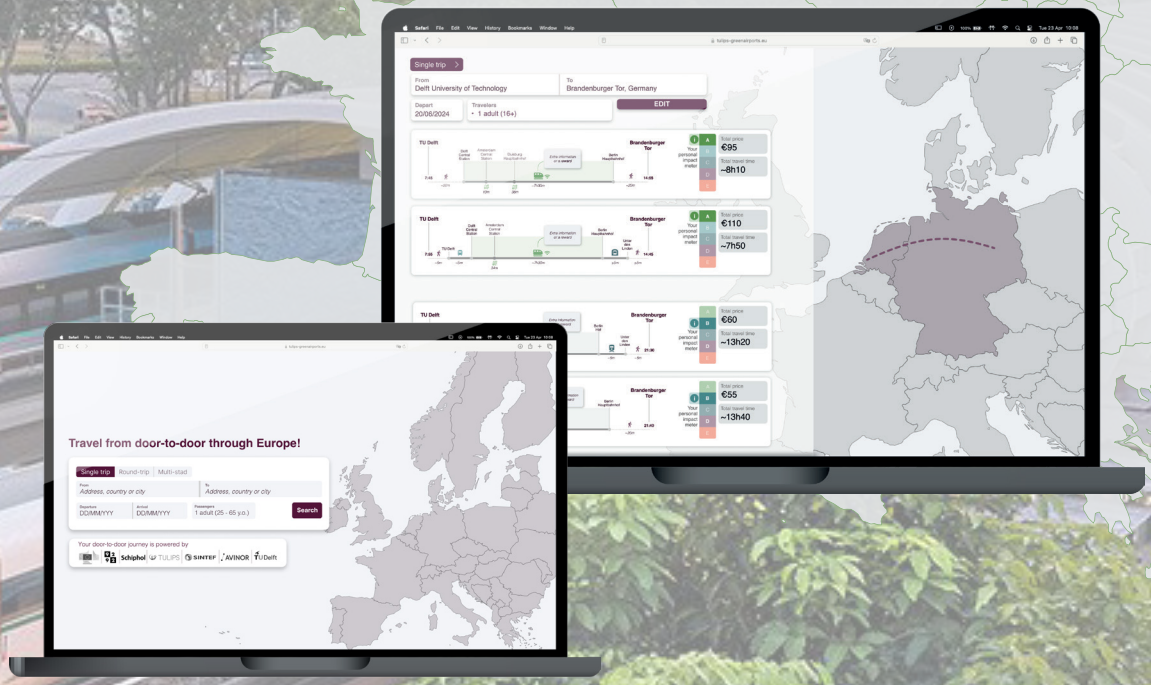
A multifaceted design strategy to encourage sustainable travel behaviour

Graduation report, July 2024

Seamless Personal Mobility Lab

Jenske Gosens

Faculty of Industrial Design Engineering



TU Delft

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Jenske Gosens

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Delft University of Technology
This report is part of the Seamless Personal Mobility Lab

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Author
Jenske Gosens

Project coordination
Dr.ir. S. Hiemstra-van Mastrigt

Academic supervisors
Dr.ir. S. Hiemstra-van Mastrigt

Prof. dr. ir. R. Mugge

C. Estrada Mejía, PhD

Project execution
Jenske Gosens

Project partners
TULIPS
SINTEF
European Commission*

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Image on front page (Siemens, 2016)

Hi!

Welcome to the report of my graduation project; *'Encouraging sustainable travel behaviour via a multimodal passenger platform, while sparking systemic change'*. I started with my project in February 2024, and I finished it in July 2024, thus receiving my Masters' degree in Strategic Product Design at the Faculty of Industrial Design Engineering at Delft University of Technology.

During the last five months I worked on a behavioural change strategy, implemented in a digital choice environment. Along the way, I got confronted with the complexity of the European passenger transport network, which is why I decided to design a roadmap as well. I really enjoyed working on this systemic challenge in the mobility sector. Which is why I decided to stay in the mobility/public transport field after finishing my thesis. Where I am hopefully able to continue improving the sector towards sustainable and seamless travel.

As I wrote in my project brief in February, my goal as a designer is to contribute to the societal problem of climate change. Designing for a change in travel behaviour towards a more sustainable one was a very interesting opportunity. During this project I gained experience in designing for sustainable consumer behavioural change and therefore designing for a better future.

I would like to thank my academic supervisors Suzanne and Ruth, thank you for your feedback, advice and keeping me on track when I was almost "drowning" in the complexity of the system. During my project, Catalina joined the TULIPS project team as a post-doctoral researcher and I felt like I could really rely on her while conducting the quantitative study, which I really appreciate.

I have learned a lot from all three of my academic supervisors, and I have found their supervision to be the perfect balance. Where I was guided with feedback when needed, but I also received positive support that inspired me to keep going and try harder.

In addition, I would like to thank Dag and Aleksandra, my main supervisors at SINTEF, even though you do not have a background in design or consumer behaviour, it has always been very insightful to get your perspective and to have the opportunity to be part of the TULIPS task team. The same goes for the other members of the task team that I frequently met with; Flemming, Leo & Eirik.

And, of course, a big thank you to the four experts I was able to interview during my research phase, the participants in my co-creation sessions, and everyone who filled out my online questionnaire. Without your input, this project would not have been as successful and fun!

Finally, a not so content-related round of thanks to my family, friends, and boyfriend, who listened to me when I needed to discuss, enthusiastically explain, or maybe whine a little ;)

Enjoy reading, and feel free to contact me if you ever want to discuss my thesis or discuss other ways to further improve the (multimodal) mobility- and public transport sector!

Executive summary.

Concerns about the environmental impact of the transport sector are increasing, particularly regarding the decarbonization of aviation and road transportation. The European Green Deal aims to reduce transport-related GHG emissions by 90% by 2050, but this sector remains one of the most challenging to decarbonize.

Despite the recognized need for shifting travel behaviour towards more sustainable modes, encouraging this shift remains a significant challenge, and a rise in unsustainable travel behavior and global greenhouse gas emissions is (still) visible. Multimodal digital mobility services are promising technologies that could enhance the environmental performance of transport and promote sustainable travel behavior. However, without a systemic shift towards a stabilized, innovative, and collaborative European passenger transport network, these innovative services, will struggle to survive. Therefore, this graduation project presents a multifaceted design strategy aimed at 1) designing a strategy for a multimodal passenger platform and 2) designing for the future of mobility towards seamless, multimodal travel.

Conducted within the Seamless Personal Mobility Lab and as part of the TULIPS consortium's task team 1.6, this graduation project aims to support the development of a multimodal passenger TRIP platform that targets a 1% reduction in CO2 emissions. Task team and project partners include SINTEF, AVINOR, and Schiphol Airport. The project's goal is to develop a multifaceted design strategy that encourages sustainable travel behaviour via a multimodal passenger platform while sparking systemic change in the European passenger transport network.

After extensive research, including literature review, market research, and expert interviews, it was clear how to design for behavioural change, who and what to design for, and what the desired outcomes of the project would be. Subsequently, in the design phase, multiple design sprints and co-creation sessions with fellow students and potential platform users led to four possible platform strategies. These strategies were quantitatively tested through an online questionnaire, the responses to which were analyzed using SPSS. Although many of the data analyses were not statistically significant (mostly due to a low number of respondents), the quantitative study set an example for further quantitative testing within the TULIPS task team, enabled one final iteration to finalize the design into one platform strategy;

The platform strategy addresses the challenges of lacking motivation and ability that lead to unsustainable travel behaviour. By creating a strategically designed choice environment, the platform strategy uses choice architecture to nudge travelers towards sustainable options, inform them about their climate impact, and make sustainable choices desirable and feasible through human-like support and seamless travel experiences.

Additionally, a design roadmap envisions a future mobility scenario for 2050, supported by enhanced stakeholder collaboration and digital and physical infrastructure improvements. This roadmap outlines four phases: 1) establishing a foundation and pre-development of the platform, 2) positioning the platform as a key player, 3) embracing competition and innovation till market saturation, and 4) ultimately achieving systemic change in a stabilized market, together.

List of abbreviations

API	Application Programming Interface
ANOVA	Analysis of Variance
ANCOVA	Analysis of CoVariance
CAS	Climate Awareness Scale
CC#1/2	Co-creative session 1 / 2
CV	Control Variable
DB	Deutsche Bahn
DS#1/2/3	Design sprint 1/2/3
DV	Dependent Variable
EEA	European Environment Agency
EU	European Union
FBM	Fogg Behavior Model
GHG	GreenHouse Gas
IV	Independent Variable
KiM	Kennisinstituut voor Mobiliteit
KPI	Key Performance Indicator
MaaS	Mobility as a Service
NS	Nederlandse Spoorwegen
OEM	Original Equipment Manufacturer
PT	Public Transport
SSMS	Sustainable and Smart Mobility Strategy
TEN-T	Trans-European Transport Network
TPB	Theory of Planned Behaviour
TRIP	Ticketing, Reservation, Information, Planning

List of definitions

Competitive routes
A competitive route in this report refers to a travel route where sustainable modes of transport are able to compete with unsustainable modes of transport. An example is: Amsterdam to Paris. On this route, the train is very attractive in comparison to airplanes and cars.

Consortium
An association, typically of several companies (TULIPS).

Door-to-door travel
Refers to a trip that begins at a specific point of origin (e.g., someone's home) and ends at a specific point of destination (e.g., someone's hotel), rather than at a central station or airport. Door-to-door travel includes the main modality as well as first and last mile modality.

First- and last mile transport
First- and last mile transport refers to the beginning of the travel journey (from door to main modality) and the final stretch of the transportation journey (from main modality to door).

Habit
A settled or regular tendency or practice, especially one that is hard to give up.

Iceberg model
A tool that allows you to shift your perspective and see beyond immediate events that everyone notices (Untools, n.d.)

Main modality
The main modality of an international travel journey refers to the main mode of transportation.

Mobility
The ability to move freely.

Modality
Mode of transportation, like an airplane, the train, or the bus.

Multimodal transport
Traveling from A to B via multiple modes of transport. In this specific report, it refers to a person traveling from A to B via multiple modes of transport. E.g., traveling to your work by bicycle, train, and finally the bus. Or more specifically within the scope of the project: a) traveling by train to an airport, b) by aircraft to another city, and c) by taxi (car) to the hotel you are staying.

Need
A need, goal, or requirement describes what the user (traveler) needs from the service or product (multimodal passenger platform).

Nudge
A purposeful change in the choice architecture.

Public Transport
Transportation according to a schedule with established stops and routes and that can be used by anyone (CBS, n.d.).

Stakeholder
An individual or organization that has interest or concern in something.

Sustainable travel behaviour
A person's effort to travel via eco-friendly modes of transport supporting the limitation of negative impacts of passenger transport, in terms of pollution, congestion, and climate change (Andersson et al., 2018). Effort can be separated into the intention to travel sustainably and the final choice of transport mode (behaviour).

Systemic change
An intentional process designed to alter the status quo by shifting the function or structure of an identified system with purposeful interventions (Taylor, 2016).

Travel
Going from one place to another.

Traveler
A person who is traveling or who often travels.

Want
A want, wish, describes what the user (traveler) wants from the service or product (multimodal passenger platform).

Table of contents

Introduction.

1

1.0 Introduction

This chapter provides insight into essential elements of this graduation project. These elements serve as the foundation for creating a thorough understanding of the project and its surrounding context.

The first section (1.1) elaborates on some general information, like the project topic, the project problem, goal and scope, the design approach and a reading guide.

Whereafter section 2, introduces the project context and -corresponding project partners (1.2).

1.1 General information

1.1.1
Topic background

Developments in sustainability and digitization are shaping the future of mobility. Mobility has become one of the hottest sectors, forming a competitive market with start-ups and traditional OEMs developing new transportation options and new technologies, with multimodal transport emerging as the new norm (Heineke et al., 2023) (Toet et al., 2022).

Environmental problems, caused by humans, are still an increasing societal problem (Gust, 2004). Despite a relatively high climate awareness in industrialized and European countries, lack of information, education, (financial) means and other influencing factors result in undesired unsustainable behaviour (Capaldi & Zelenski, 2016).

Concerns regarding the environmental impact of the aviation sector are increasing. According to the European Environment Agency (EEA) transport emissions represent around 25% of the EU's total GHG emissions (EEA, 2024). The European Green Deal aims to reduce transport-related GHG emissions by 90% by 2050, but the mobility and transport sector has proven to be one of the most difficult sectors to decarbonise. Statistics indicate a concerning rise in unsustainable travel behaviour and worldwide greenhouse gas emissions. Despite the recognized necessity of shifting travel behaviour to more sustainable modes, encouraging travelers remains a significant challenge (Howarth & Polyviou, 2012). According to the EEA, multimodal digital mobility services are one of nine digital technologies that could improve the environmental performance of transport (EEA, 2023).

Multimodal transport can be defined as an integration of different transport modes (see figure 1.1 on the next page) and services, combined in and by mobile applications and standardized payment systems. Multimodal passenger transport is an interesting prevailing innovation, however, there is a shortage of systemic academic research on the topic (Huang et al., 2023). Such multimodal transport technologies, if designed correctly, enable the promotion of alternative (public) travel modes, other than private cars and airplanes, while facilitating a door-to-door travel journey, and therefore forms an essential factor in encouraging sustainable transport behaviour (Huang et al., 2023).

The TULIPS consortium is working on a multimodal transport platform, aiming to support the traveler in traveling with whichever mode(s) of transport they prefer. The platform will present possible air-, rail- and road journeys, but due to the high pressure on the environment a focus on encouraging sustainable travel behaviour is desirable.

This graduation project ***aims to encourage sustainable travel behaviour***, via a multimodal passenger platform, complementing the ongoing TULIPS project. The project explores what is needed to shift the European traveler from international air- and road travel journeys towards rail- and PT travel journeys, shifting not only their choice of main modality, but also their first- and the last mile transport.

1.1.2
Problem statement

The following problem statement is addressed within this graduation project:

Despite the innovative nature of the mobility sector and an increasing climate change awareness, unsustainable travel behaviour is still rising. Existing barriers such as limited information, poor education, and limited financial resources, encourage unsustainable travel choices and unsustainable travel behaviour.

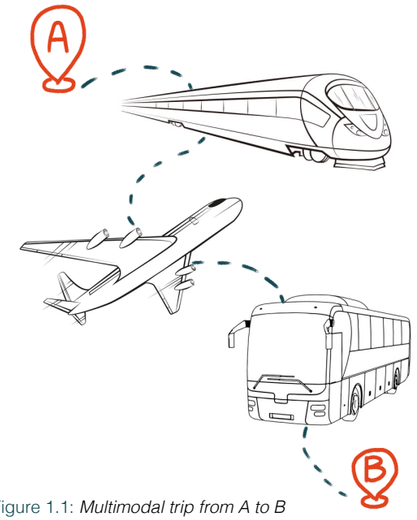


Figure 1.1: *Multimodal trip from A to B*

1.1.3
Project goal

The project started of with the following assignment:

Designing a strategy that (un)consciously encourages sustainable travel behaviour, via a multimodal passenger transport TRIP platform*.

The project brief is added in appendix A. In the Design Brief (section 2.6), an extended and complemented problem statement and a design goal have been developed and defined as a result of thorough research.

*Multimodal passenger platform (as defined by the TULIPS task team)
In order to keep an overview, the multimodal passenger transport TRIP platform will, from this point on, be referred to as the multimodal passenger platform.

The platform focuses on passenger transportation, and aims to maintain all four TRIP features (Ticketing, Reservation, Information, Planning). The platform will be available online via a website and an application for mobile phones. Ideally, the platform encourages sustainable travel behaviour, and contributes to a reduction of at least 1% of CO_2-emission of its users (and therefore travelers).

1.1.4
Scope

This project is scoped within the European passenger transport network, it is important to know that this project is executed from a mainly Dutch perspective.

Desired modal shift

There is a desired modal shift from air- and road-towards rail- and PT travel. The possible, and desired, shift options are summed up in table 1.1. Two main parameters are taken into account for desired shifts: “mode of transport”, segmented horizontally into sustainable and unsustainable modes of transport, and “leg of travel journey”, segmented vertically into the main modality and the first- and/or last mile.

Table 1.1: *possible passenger transport shifts*

	Unsustainable mode of transport	Sustainable mode of transport
Main modality (or partly in case of indirect flight)	Airplane	Train, Tour-bus
	Private car	Train, Tour-bus
First- and last mile	Private car	Train, local PT (metro, tram, bus)

Designing a strategy

The initial goal for this graduation report was to support TULIPS task team 1.6 in creating the multimodal passenger platform by designing a strategy to encourage sustainable travel behaviour. Allowing the traveler to stop.. and rethink the decision making (booking) process, making the sustainable journey salient and disrupting habitual behaviour (Granato et al., 2022).

Designing a detailed user interface and -interaction (both back- and/or front-end) has been excluded from the scope of this project, the importance lies with designing the behavioural change strategy and a visually coherent choice architecture/environment.

Expanding to the long term

During the research phase, it became evident that while there is an increasing demand for multimodal passenger services, the European passenger transport network is unable (or unwilling?) to meet this demand. Consequently, the goal and scope was expanded to include the design of a long-term strategy at an EU-wide level, making the platform more feasible and viable, and transforming it from an (too) ambitious concept into a possible and inspirational future scenario.

1.1.5
Approach

Within this graduation project a triple diamond approach has been followed. Where the first diamond; RESEARCH, contains literature- and market research, complemented with expert interviews concluded into a design brief.
The second diamond; DESIGN, aims to ideate and design the desired design strategy via multiple design sprints, individually and together with fellow students and the user-segment.
The final, and third diamond; OPTIMIZE & FINALIZE, focuses on quantitatively testing the platform and the designed strategy, to make sure the platform and its effect can be optimized and finalized.

Each phase lasted approximately 6 to 7 weeks.

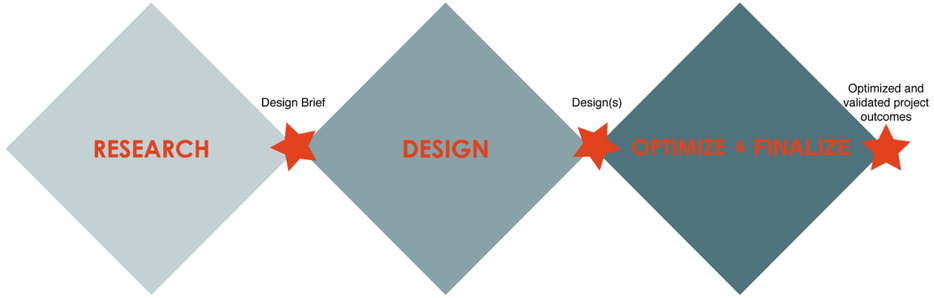


Figure 1.2: *Triple diamond design approach*

1.1.6
Reading guide

The report is divided into six main chapters; 1) Introduction, 2) Research, 3) Design, 4) Optimize, 5) Finalize and 6) Conclusion & 7) Discussion.

Chapters 2, 3, 4 & 5 elaborate on key project phases defined by the triple diamond approach. Each of these chapters will be introduced briefly and followed by information on the approach and/or applied methods.

Introduction
This chapter introduces the origin and context of this graduation project via the following main sections: 0) Introduction, 1) General information, 2) Project context.

Research
The research chapter elaborates on the research conducted to create a solid foundation of knowledge to design upon, the chapter is segmented into the following main sections: 0) introduction, 1) methodology, 2) literature research, 3) market research, 4) expert meetings & interviews, 5) systemic change and 6) the design brief.

Design
This chapter elaborates on the design of the strategy, the chapter is segmented into 4 main sections: 0) introduction, 1) design approach, 2) platform strategy and 3) integral strategy

Optimize
This chapter elaborates on a quantitative study that has been conducted to optimize the platform strategies designed in chapter 3, the content is segmented into 5 main sections: 0) introduction, 1) methodology, 2) hypotheses, 3) results and 4) conclusions and discussion. The quantitative study insights are translated into final iterations, which will be integrated into the platform strategy in chapter 5;

Validate
This chapter elaborates on finalizing the platform strategy, the chapter is divided into the following main sections 0) Introduction, 1) Final design iterations, 2) Final Platform Strategy and 3) Recommendations.

Conclusion & discussion
The final two chapters, Conclusion and Discussion, assess whether the design goal has been reached and if the problem statement has been significantly addressed with the design outcomes. Finally, research limitations are discussed, accompanied by recommendations to address these limitations and set the groundwork for future research.

1.2 Project Context

A diverse set of stakeholders has come together to work together towards the final goal of creating the multimodal passenger platform. This graduation project is part of the TULIPS consortium where a rich pool of stakeholders is working together, towards a greener aviation industry.

1.2.1
TULIPS

TULIPS brings together a competent and complementary consortium of 29 partners (see figure 1.3 on the next page) supported by an external advisory board to give an answer to the call for innovation and change in the aviation industry by the European Green Deal. The figure below shows an overview of participating partners and therefore active countries.

"TULIPS will develop innovations that facilitate the transition to low-carbon mobility and enhance sustainability at airports for the next four years, supported by the EU with €25 million in funding" (TULIPS, 2024).

The TULIPS project entails separate work packages, task projects, subprojects and therefore multiple (specific) objectives. All of these contribute to the main objective of accelerating aviation emission reduction and efficient resource use at airports.
This graduation project is part of objective 1, work package 1, task team 1.6 (working on demo 1.4).

Objective 1
Use federated IT platforms and data to improve multi-modal travel for passengers and freight to reduce traffic congestion and offer seamless green travel options.

Focus of work package 1
Intermodal services

Demo 1.4 (goal of task team 1.6)
International green travel - Use of an integrated digital TRIP platform based on decentralized distributed solutions integrating several stakeholders by a federated architecture.
The stakeholders (project partners) in task team 1.6 will be elaborated on in the following subsections.

1.2.2
SINTEF

The development of this platform is executed in collaboration with the Norwegian research organization SINTEF. SINTEF will contribute expertise and technological solutions. They act upon the opportunity to participate in testing and developing green solutions both at Amsterdam Airport and at Norwegian airports, which is in this case the development of the multimodal passenger platform (SINTEF, 2021).

Dag Kjenstad (Senior Research Scientist) and Aleksandra Glesaaen (Research Scientist), have been particularly involved with this graduation project on behalf of SINTEF. They are also team members of the TULIPS task team 1.6.

1.2.3
AVINOR & Schiphol

Both AVINOR and Schiphol Airport are part of TULIPS and the project task team. They contribute to the multimodal passenger platform by sharing flight data and expertise on multimodal options from their point of view as an airport operator (AVINOR) and airport and innovative mobility hub (Schiphol Airport).

Figure 1.3: *TULIPS partners*

Research.

2

2.0 Introduction

This chapter elaborates on all conducted research throughout the project, beginning with an overview of the research approach, followed by findings derived from literature, market research and expert interviews [n = 4], finally an additional (literature) research on how to design for systemic change is executed. Each section is finalized in main conclusions. The research phase enabled thorough understanding of the current situation, the problem and revealed design requirements and -opportunities, which are concluded into a design brief in the final section of this chapter.

2.1 Research approach

2.1.1
Literature research

To gain relevant insights and develop a deeper understanding of (travel) behaviour, behavioural change and (future) mobility a literature study was conducted. General theories on consumer behaviour and behavioural change have been examined and compared to more specific studies on travel behaviour, in order to understand how to design for travel behavioural change.

Since behavioural change, sustainability and mobility are popular research topics, substantial (qualitative) user research has already been executed in multiple studies and projects. Therefore, instead of executing qualitative user research, traveler segments are derived from existing research, projects and theories. Traveler segments are important in order to understand how and what to design for specific traveler wants and needs.

2.1.2
Market research

In order to gain knowledge and an understanding of the passenger transport sector, its stakeholders and its complexity, market research has been conducted.

A stakeholder- and system map have been developed to determine the most important stakeholders and key relationships and create a basic understanding of the system that ought to be designed for.

To understand competition between modes of transport, and to determine in what way sustainable modes are/will be able to compete with unsustainable modes, important influencing factors (like time, money and frequency) have been researched and determined.

Finally, since a new market player (the platform) is being developed, a competitor- and market analysis have been conducted. Existing services and service platforms have been examined and compared to determine differentiation strategies and seize market opportunities.

2.1.3
Expert interviews

To evaluate and complement literature- and market research four semi-structured expert interviews have been conducted (consultations with the project team excluded). These interviews have been transcribed, coded and clustered. These clusters could be concluded into a worldview by experts.

2.1.4
Systemic change

While researching literature and the market of European passenger transport, a need for systemic change occurred. Therefore, an additional literature study on how to design for systemic change is conducted and two theories have been combined into a desired systemic change approach for the European passenger transport network.

2.2 Literature research

Understanding how and what to design for travel behavioural change in a (future) mobility context.

This section includes:

2.2.1
(Travel) behaviour

This subsection revolves around four theories on consumer behaviour. The theories are translated to and placed into the travel behaviour context. At the end of this subsection these theories are concluded in a travel behaviour model.

Throughout the literature research, more than these four theories have been assessed. The final selection of contributing theories is based on their applicability to travel behaviour.

This section begins by introducing two widely recognized and acclaimed theories on consumer behaviour (change): the Fogg Behaviour Model and the Theory of Planned Behaviour.

Besides, two other theories are discussed: the attitude-behaviour gap and cognitive dissonance. These two theories are identified as important mental causations in unsustainable (travel) behaviour.

Fogg Behaviour Model

A widely recognized and acclaimed theory is the Fogg Behaviour Model (FBM) by dr. B.J. Fogg. The FBM provides insights into behaviour through three primary behavioural drivers; 1) **motivation**, 2) **ability** and 3) **triggers/prompts** (Fogg, 2009). Additionally, the FBM represents a model for behavioural change, utilizing the motivational and ability drivers towards the zone where behavioural triggers succeed (see figure 2.1). To give an example and apply the FBM on the travel behaviour context, the figure below, displays an average group of leisure travelers and business travelers on the FBM. Ideally, these two traveler segments lie within the trigger succeeding zone.

The leisure traveler is known to be relatively motivated to travel sustainably, but considers him-/herself unable to do so (Zijlstra & Uitbeijerse, 2023). The FBM suggests that the leisure traveler should be facilitated and enabled to travel sustainably. The main barrier for this travel segment is a low (perceived) ability, they perceive sustainable travel as a behaviour that is hard to do (see figure 2.1).

The business traveler is relatively able to travel sustainably, they e.g. have the financial means (offered by their employer) to travel sustainably, this travel segment could lack the right motivation to travel sustainably (see figure 2.1).

Figure 2.2 shows how motivators (e.g., social pressure) could steer the business traveler and facilitators (e.g., support) could steer the leisure traveler toward the right side of the trigger success line.

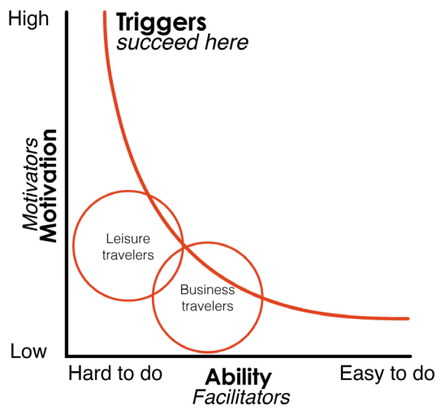


Figure 2.1: *Leisure traveler and business traveler on the FBM*

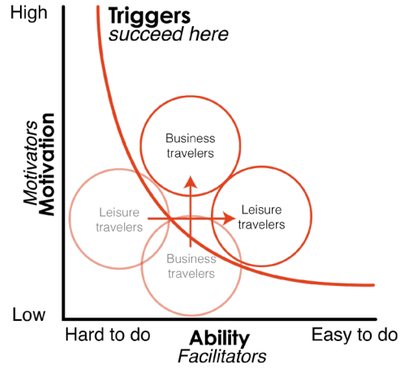


Figure 2.2: *Behavioural shift along FBM*

Theory of Planned Behaviour

The theory of planned behaviour (TPB) developed by Icek Ajzen (1991) elaborates on the influence of a persons' intentions and perceived behavioural control on behaviour. Where intentions are shaped by attitude (internal motivations), social norm (external motivation), and once again: perceived behavioural control. Figure 2.3 displays a graphical representation of the TPB.

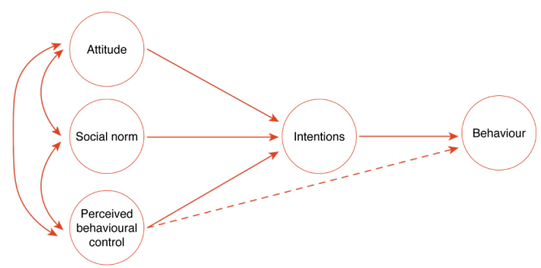


Figure 2.3: *Theory of planned behaviour*

When filling out the TPB from a travelers' point of view who intends to travel sustainably (by train); it will look like figure 2.4 below.

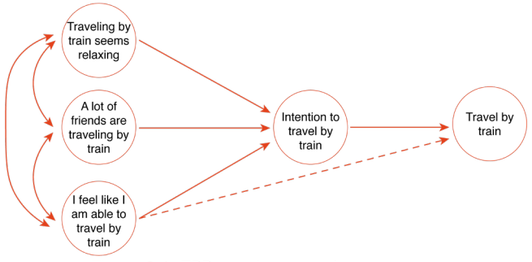


Figure 2.4: *TPB traveler example*

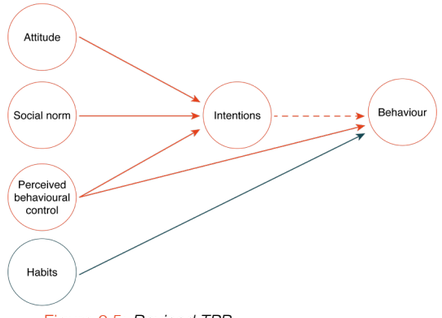


Figure 2.5: *Revised TPB*

According to the TPB, 1) a positive personal attitude, 2) the pressure of the social norm and a 2) high perceived behavioural control are important parameters in increasing the intention to travel sustainably and sustainable travel behaviour.

When comparing the TPB with the previously introduced FBM, an interesting similarity is found in the distinction between motivational factors (attitude & social norm) and ability (perceived behavioural control).

The TPB is an older theory, and lots of researchers have studied this behavioural model and adjusted it accordingly.

In 2011, Schoenau and Müller applied a quantitative research study on the predictability of mobility behaviour via the TPB. They confirmed that 1) attitude and the social norm influence a traveler's intentions to travel sustainably, but contradicted that 2) having the right intentions does not necessarily mean that the final travel behaviour will be sustainable. This phenomenon is backed by research into the "attitude-behaviour gap".

Schoenau and Müller also elaborate on the fact that travel behaviour is strongly habitual. Grigolon et al. (2010), confirm this, by explaining that initial preference for a specific mode of transport greatly influences travel behaviour. Where the preference for a specific transport mode is based on the general image of this transport mode and previous experiences.

Resulting in a revised version of the theory of planned behaviour, displayed in figure 2.5.

Attitude-behaviour gap

A Dutch quantitative research, on behalf of the KiM (Knowledge institute on Mobility Policy in the Netherlands) on leisure travel behaviour by Zijlstra & Uitbeijerse (2023) confirms the existence of an attitude-behaviour gap. This phenomenon refers to consumers that express concerns about climate change but fail to translate this into sustainable behaviour (Anable et al., 2006). This attitude-behaviour gap often results in mental tension, where consumers weigh their moral conscience with their actual, individual, wants and needs. An applicable example of such a mental tension is flight shame, flight shame often occurs when injunctive norms, like social pressure, clash with needs and wants of the individual self (Doran et al., 2022)(Zijlstra & Uitbeijerse, 2023).

The attitude-behaviour gap is an important mental aspect of travel behaviour, that should be taken into account when designing for behavioural change.

Cognitive dissonance theory

A better understanding of this mental tension can be developed through the cognitive dissonance theory from Leon Festinger (1957). The theory supposes a psychological discomfort when there is this inconsistency between a consumers' attitude and actual behaviour. This inconsistency is called dissonance, and the greater the dissonance the greater the need to act upon this psychological discomfort.

People respond to dissonance by 1) changing their beliefs, justifying their unsustainable behaviour or 2) by changing their behaviour to match their initial beliefs. The context of travel behaviour is highly relatable to this theory. Travelers are more likely to change their beliefs, to match and justify their unsustainable behaviour. A qualitative research study by Juvan & Dolnicar (2013), displays six coping beliefs (see figure 2.6).

Additionally, Kroesen et al. (2017) examined how attitude and behaviour influence each other in travel choices. They found that people's use of a travel mode and their attitude toward it are mutually reinforcing.

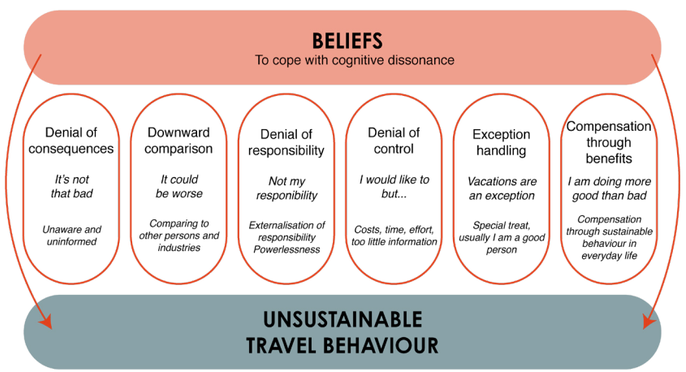


Figure 2.5: *Beliefs to cope with cognitive dissonance in travel context*

Those with inconsistent attitudes and behaviours are less stable. Interestingly, behaviour influences attitudes more than the other way around, meaning people are more likely to change their attitudes to fit their travel habits than to change their habits to fit their attitudes.

An opportunity lies in understanding and challenging these justifying beliefs; altering perspectives to make unsustainable travel behaviour harder to justify can increase the likelihood of travelers changing their behaviour rather than their attitude. Aiming to shift travelers from dissonant to consonant, aligning their behaviour with their true attitude and beliefs.

2.2.2
A travel behaviour model

Based on the previously introduced literature and additional studies into (travel) behaviour, a specified theoretical model for travel behaviour has been constructed to summarize and conclude all important and relevant findings into one travel behaviour model (figure 2.7).

This model has been created for this graduation project to serve as a theoretical foundation on travel behaviour to build upon in the following phase; the design phase.

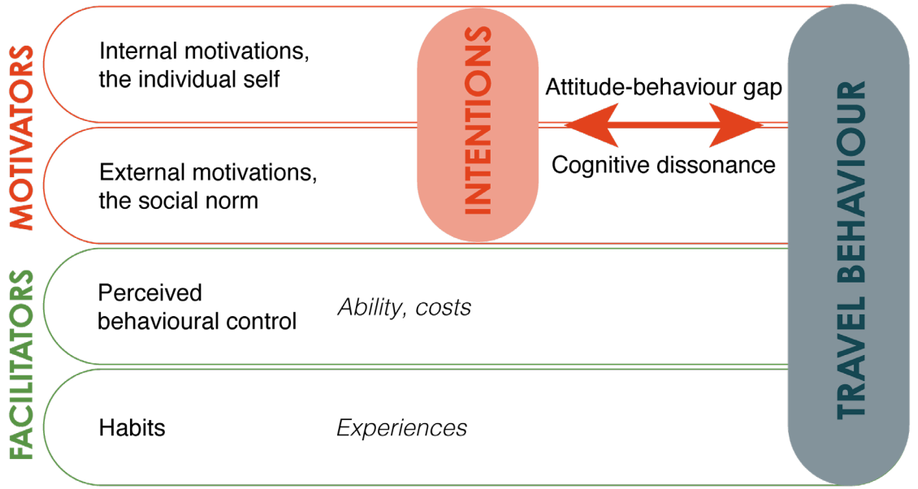


Figure 2.6: *Model of travel behaviour*

Key takeaways

The multimodal passenger platform should be **facilitating** and **motivating** its users in traveling sustainably. In fact, the platform should facilitate each travel option in such a way that motivation directly influences travel behaviour. Allowing both external- and internal motivations to encourage sustainable travel behaviour, rather than being limited by a disability (low perceived behavioural control, strong habits) to travel sustainably.

2.2.3 Designing for behavioural change

This subsection builds on the previously introduced travel behaviour model. This model already represents four parameters in behavioural change. These parameters are rotary knobs in the system of travel behaviour and can be strategically designed to control travel behaviour accordingly. In this subsection, concrete behavioural change strategy approaches and concrete examples of how to design for behavioural change are discussed. Appendix B includes a list of specific strategies and interventions found in the literature as a source of inspiration for the design phase.

In addition, this section includes a simplified overview of the average travel journey to explain how the platform can interact with travelers and strategically design interfaces to encourage sustainable travel behaviour.

Nudging

The human brain can be divided into the conscious and the unconscious decision making process. The conscious part of our brain makes slow and reflective decisions, while the unconscious part of our brain makes automatic and fast decisions (Ölander & Thøgerson, 2014).

The fast and automatic part can be steered by nudging, a nudge refers to a purposeful change in the choice architecture, to influence a persons' behaviour (Lehner et al., 2016). Choice architecture refers to the physical or informational structure of the environment in which choices are made (Thaler & Sunstein, 2008). Lehner et al. (2016), present four possible nudge tools: 1) simplification and framing of information, 2) changes in the physical environment, 3) changes in default policy and 4) use of social norms. Nudge tools 1, 3 & 4 could be of use for an online platform, like the multimodal passenger platform.

Thaler & Sunstein (2008) outline five conditions under which a nudging strategy can effectively influence behaviour. These conditions are listed in table 2.1, this table also provides insights into the conformity of each condition with the context of travel behaviour.

It can be concluded that nudging can be a useful tool in the travel behaviour context. However, the decision making process of booking an international travel journey is a relatively slow, conscious and reflective process. And theory states that this slow, conscious, decision making process is more likely to be influenced by informing strategies;

Informing

A way of integrating informing strategies is at the point of purchase, usually in the form of labels, or clear informative texts or via "decision-tree guidance". It is important to find the right load of information, because information strategies often become overwhelming and complex (Ölander & Thøgerson, 2014). This would decrease ability and negatively influence travel behaviour.

Even though the travel decision making process is considered relatively slow and conscious, habits have a strong influence on one's' travel behaviour (as concluded in the travel behaviour model).

To conclude, in a highly habitual, yet slow and conscious decision making process, a combination of both nudging and informing is optimal.

Table 2.1: *Nudge conditions (Thaler & Sunstein, 2008) in travel context*

Desired condition for positive nudging effect	Comparison to conditions of travel behaviour
When choices have delayed effect	*Corresponding* - there is no direct environmental effect noticeable from travel behaviour
When choices are difficult	*Semi corresponding* - difficulty differs per travel segment, travelers often make choices based on previous experiences, which makes it less difficult
When choices are infrequent	*Semi corresponding* - frequency differs per travel segment and per individual, the average Dutch person travels internationally for leisure 1,3 times a year (CBS, 2023), business travel would however, occur more frequently
When feedback is poor	*Corresponding* - there is currently little to none personal- or direct feedback on the impact of travel behaviour
When the relation between choice and outcome is ambiguous	*Corresponding* - there is no direct environmental effect/outcome noticeable from travel behaviour

SHIFT framework

The SHIFT framework developed by White et al. (2019) is a behavioural change framework. Five determined ways to shift consumer behaviour to be more sustainable are: applying social influence, stimulating- or breaking down habit formation, targeting the individual self, motivating via feelings and cognition and increasing tangibility. Figure 2.8 gives an overview of these behavioural change strategies including some concrete examples that refer to the travel behaviour context.

Figure 2.8: *Behavioural shift framework by White et al. (2019) in travel behaviour context*

Travel journey

See appendix C for a detailed version of the travel journey.

A clear distinction between short-term and long-term behavioural impact can be made (see figure 2.9, read = short-term, blue = long-term). A short-term shift can be encouraged by strategically designing the “investigating” and “booking” interfaces, while long-term behavioural change is often based on how the traveler experiences the travel and evaluates her/his travel journey. Eventually, the platform should not only contain a strategically designed choice environment (short-term effect), but holistically facilitate a pleasant experience with sustainable travel to encourage future sustainable travel (again), this can be supported by the TRIP service. Eleven possible, influencing, touchpoints and platform features have been uncovered, which can be divided into two categories; 1) short-term influencing user touch points that facilitate and motivate booking a sustainable trip (investigate & book) and 2) long-term influencing user touch points that ensure a smooth travel experience (prepare, travel & evaluate) (see table 2.2).

As introduced in the project scope the focus of this project lies with designing the choice environment. The other possible influencing touchpoints should however, not be neglected in further development of the platform.

Table 2.2 *Possible user-platform touchpoints*

Booking, short-term decision making	Experience, future decision making
1 - Welcoming interface, asking for door-to-door information	5 - Receiving a travel overview as a result of booking
2 - Choice environment, presentation of travel journeys	6 - Receive preparation tips and tricks
3 - Extra information and specifications	7 - Clear overview in the platform app
4 - Integrated ticketing/paying	8 - Rescheduled overview in case of disruption
	9 - Transfer information
	10 - App asks for feedback/experiences
	11 - Overview of final journey in app/mail

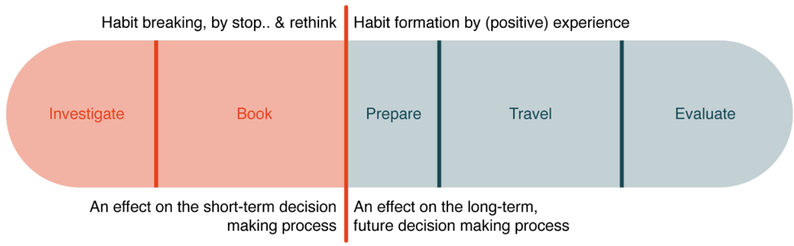


Figure 2.9: *Simplified travel journey*

Key takeaways

The platform should both **nudge** and **inform**, targeting the **individual self**, as well as applying the **social norm**. Additionally, nudging via the multimodal passenger platform can be done by **simplification and framing of information** and changes in **default policy**.

The platform should aim for **habit breaking**, by encouraging the traveler to **stop.. and rethink** their predetermined habitual decisions. It is key to communicate **tangible** types of information to allow understanding and increase the travelers' knowledge on how to travel sustainably.

The platform should both encourage sustainable travel behaviour by focusing on short-term decision-making and ensure a **positive travel experience** for future decisions and **habit formation**.

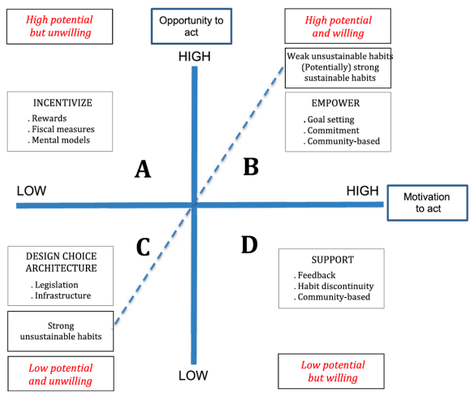


Figure 2.10: *Segmentation model of sustainable behaviour intentions (Verplanken, 2018)*

2.2.4
Theory based traveler segments

Travel behaviour and the decision making process is complex and different for every individual traveler. To be able to design for travelers and specified wants and needs, a clear understanding on frequently occurring travel behavioural patterns should be defined.

According to Verplanken (2018), sustainable behaviour intentions can be segmented as shown in figure 2.10 on the left.

Verplanken (2018) determined a difference in the opportunity to act and motivation to act, which aligns with the travel behaviour model and more specifically, the FBM.

Aligning this segmentation model with found travel behaviour; segment D (low potential/ ability but willing/motivated) fits travelers that experience flight shame and therefore demonstrate the attitude-behaviour gap. They are aware of the consequences of their travel behaviour, motivated to shift, but do not have the correct knowledge or means to travel sustainably. According to Verplanken (2018) the right strategy would be to support them, by e.g. giving feedback or by facilitating them in discontinuing habits. This aligns with previous research findings.

Four traveler segments have been developed, segmented on an axis of ability and on an axis of motivation (see figure 2.11). The framework below displays four traveler segments divided via the Segmentation model and the FBM.

To create a better understanding of each of these traveler segments, a brief overview for each traveler segment has been created and displayed on the next page in figure 2.12. The graduation projects by Rosa Hendrikx (2021) and Sarah van Coevorden (2024) have been used as a source of inspiration to define specific traveler wants and needs.

Figure 2.13 displays an iceberg model for each traveler segment to understand their mental models, wants and needs.

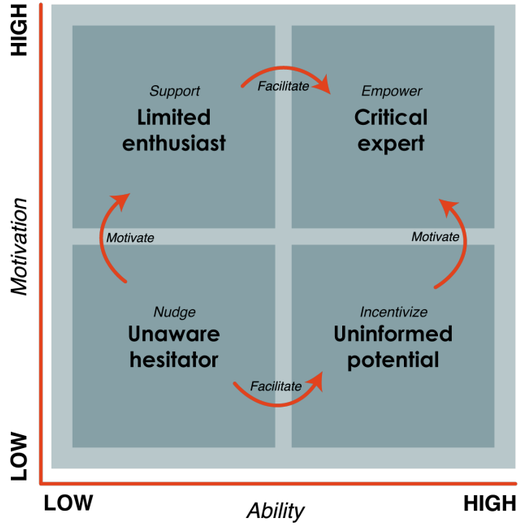


Figure 2.11: *Framework defining four traveler segments*

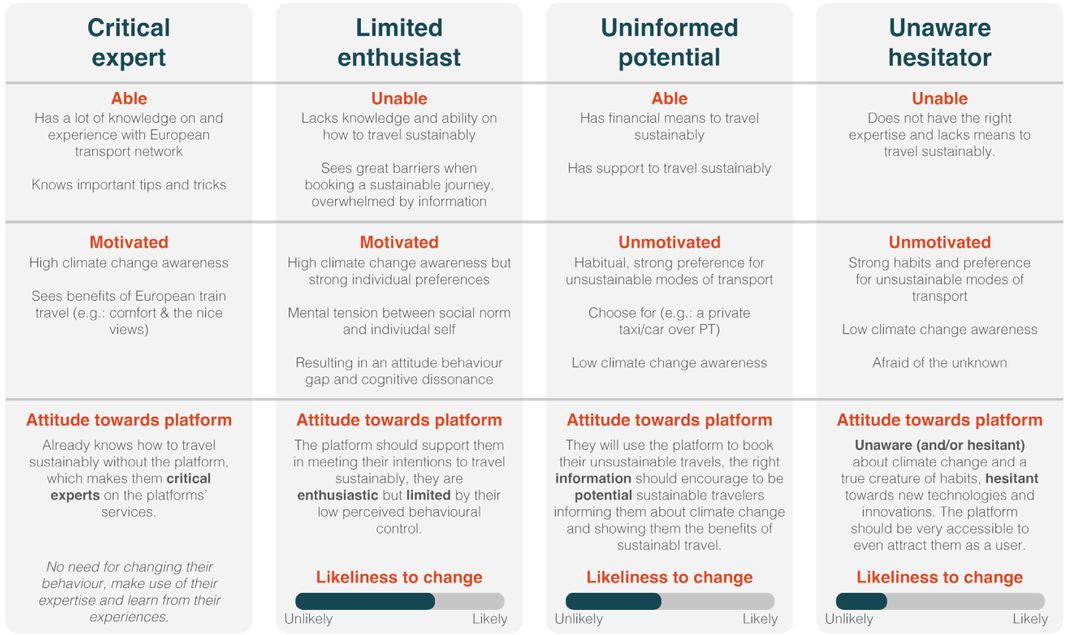


Figure 2.12: *Brief overview per traveler segment*

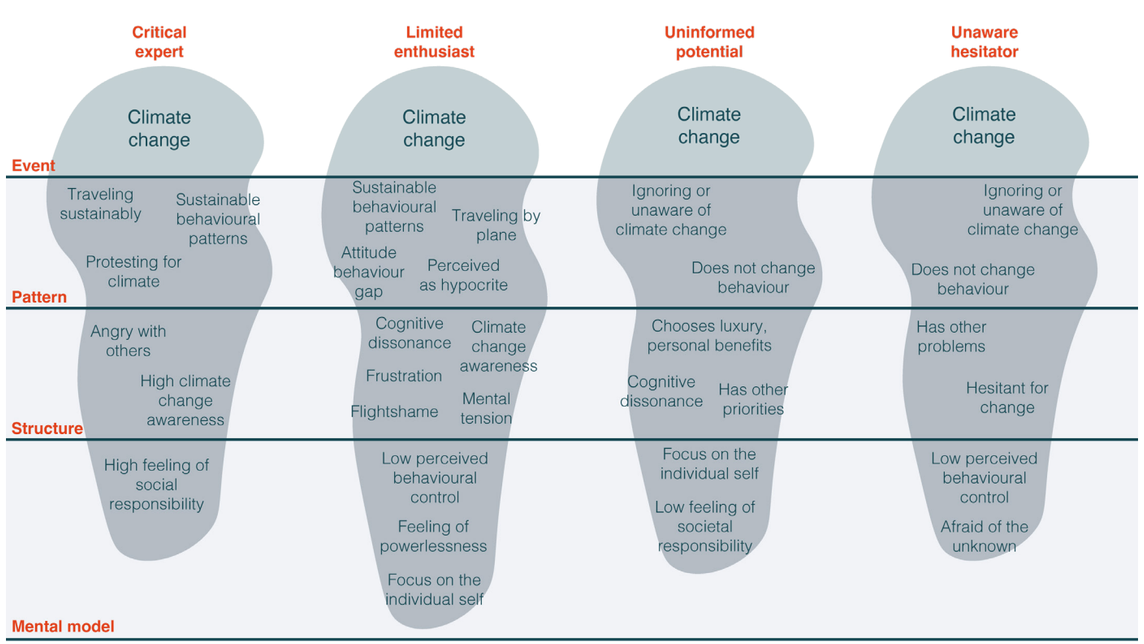


Figure 2.13: *Iceberg models for four traveler segments*

Limited Enthusiast

Although the ambition is to encourage every traveler to travel more sustainably, on a short-term basis, the limited enthusiast will be most likely to reform their travel behaviour as a result of the platform.

To better understand the limited enthusiast enthusiast, two personas and a customer travel journey have been developed specifically for this group (appendix D).

In short, the limited enthusiast is stuck in their habitual and often unsustainable travel behaviour due to a low perceived behaviour control, a feeling of powerlessness (despondent) and a focus on the individual self. However, they are considered relatively motivated to travel sustainably due to their high climate change awareness. They experience a high level of flight shame, because they are aware of the consequences of flying. They justify their unsustainable behaviour with a long list of beliefs (cognitive dissonance) to soften this mental tension.

In conclusion, the platform should be easily accessible, motivate limited enthusiasts by addressing the mental stress associated with flight shame, and simplify the choice of sustainable travel by eliminating obstacles and making it as effortless as possible.

Key takeaways

In order to shift every traveler towards sustainable travel behaviour, the platform should be designed to encourage all four traveler segments. The platform should be as **accessible** as possible to attract even the most hesitant travelers, and both facilitate and motivate.

A **long-term development plan** is needed, when the goal remains to target all four traveler segments. A behavioural shift amongst all travelers is only possible over the longer-term.

In order to target the limited enthusiast specifically (on the short-term), the platform should increase their level of **perceived behavioural control**, give them a **feeling of power** over their decisions and behaviour and **target the individual self**. Increase the **mental tension** that is known as flight shame and make it **impossible** to ignore or justify their impact on the environment.

2.2.5
(Future) Mobility concepts

A lot of governmental- and knowledge institutions sketch ambitious future mobility scenarios. Some of these concepts and ambitions that are considered relevant and a source of knowledge and inspiration for this graduation project are elaborated on below. The following section on market research (2.3) also touches upon some additional initiatives related to the future of mobility.

Sustainable and Smart Mobility Strategy

The Sustainable and Smart Mobility strategy (SSMS) set up and developed by the European Commission, Directorate-General for Mobility and Transport (2020) shows ambition within the European Commission to transform the European Transport system.

In short, the strategy communicates a future vision on sustainable and smart mobility. They claim that, in order to assure the success of the European Green Deal, the transport system should become sustainable, as a whole. The end goal for the SSMS is a 90% reduction in the transport sector's emissions by 2050.

The strategy confirms the need for more widely available sustainable alternatives, in order to enable sustainable modal choices. It poses the opportunity in changing mobility patterns and consumer behaviour and confirms a willingness in society to travel more sustainably.

The report indicates the importance of a future focus, specifically; 2050. 2050 is an important year due to the European Green Deal, which addresses 2050 as the year the EU should be climate neutral.

The SSMS indicates a positive and willing attitude by the EU, however, it appears that these ambitions are not enough to have a noticeable effect on the European passenger transport network. National governments and big transport providers hold a big part of the power and hamper systemic change, this challenge is addressed in the following section, on market research and confirmed in section 2.4 on expert interviews.

Mobility as a Service

Mobility as a Service, also known as MaaS is an emerging personal mobility concept with the ambition to connect all available transport and mobility services together in a one-stop-shop system and thus become a sustainable, agile and effective competitor to private cars, MaaS can also be customized according to the needs of its end users (Aapaoja et al., 2017). The objective of MaaS is to support and inspire a shift towards a more sustainable mobility paradigm (Alyavina et al., 2020). Which closely matches the goals for the multimodal passenger platform, developed within the TULIPS consortium.

TRIP

The goal for the multimodal passenger platform is to guarantee a TRIP service. A TRIP platform would be an online service platform which enables its users to 1) pay for the their ticket online (Ticketing), 2) reserve vehicles and/or a desired seating spot (Reservation), 3) get all desired and required information on beforehand and being updated during the trip (Information) and 4) to plan on beforehand and reschedule when it is needed (Planning). In short, a TRIP service is a holistic and supportive traveling service, and an example of Mobility as a Service (MaaS) where the user is enabled to book their travel wants and needs from door-to-door smoothly, via just one service provider (Veeneman et al., 2020). In the current transport platform market, there are no international, multimodal TRIP platforms yet, this indicates an opportunity to differentiate from competitors (see section 2.3.3).

Integrated ticketing

As explained, ticketing via the multimodal passenger platform is one of the TRIP services, and one of the objectives for the final version of the platform. Integrated ticketing is acknowledged by the European Commission, as a valuable asset in making multimodal transport attractive. However, the implementation of such services knows a lot of systematic barriers which are important to consider.

On behalf of the Directorate-General for Mobility and Transport of the European Commission, Frazzani et al. (2019) explain that implementing an integrated ticketing system requires seamless coordination across various stages of travel, from user inquiries to revenue sharing. Integrated ticketing relies on interoperability standards for combining information, schedules, pricing, and booking systems. Multiple stakeholders must collaborate, necessitating thousands of contracts, including technical, business, and political agreements, ensuring transparency in ticket pricing across all segments. Lacking stakeholder collaboration is one of the reasons integrated ticketing is yet impossible.

Seamless mobility

A desired outcome of the multimodal passenger platform is seamless personal mobility. Seamless mobility refers to systems in mobility that add to the well-being of people and the planet. It can be achieved through strategic interventions that integrate public and shared mobility using complimentary travel products (Seamless Personal Mobility Lab, 2021). Where seamless refers to a smooth, uninterrupted experience.

In 2013, Joppien et al., suggested that, in order to adopt a TRIP platform, a seamless experience across various mobility providers would be beneficial. Therefore, designing the TRIP platform to prioritize seamlessness is crucial, as it aligns with the broader objective of achieving seamless mobility. Seamless mobility is not only ensured via the right digital infrastructure, the physical infrastructure should be taken into account as well, allowing the digital multimodal passenger TRIP platform to support people in traveling from door-to-door, combining different transport modes (Veeneman et al., 2020).

Key takeaways

Innovations in the mobility sector take time due to its slow, bureaucratic nature. To address future challenges, a strategic roadmap with a vision for 2050 is essential. This should include concepts like TRIP, integrated MaaS, and Seamless Mobility, aligning with the platform and its broader context. The roadmap should include the development of the digital infrastructure of the multimodal passenger platform as well as the development of the physical infrastructure of the European transport network to ensure a seamless door-to-door multimodal travel experience.

2.2.6

Conclusions on literature

Understanding how and what to design for travel behavioural change in a (future) mobility context.

Designing for both the short- and the long-term is important within the mobility sector.

Short-term, because climate change is happening right now, and sustainable (behavioural) change is a short-term need. Secondly, there are already travelers (the limited enthusiasts) that are willing to shift their behaviour in the short-term, they are however limited in their ability. Thirdly, the TULIPS project only runs until 2025 and aims to book significant results in the following 1,5 years.

Long-term, because the innovation culture of the mobility sector is slow and bureaucratic, which is why significant change is only possible over a longer period of time. Developing the multimodal passenger platform is not enough, systemic change is needed to provide a true seamless, multimodal service.

Short-term

On a short-term notice, TULIPS task team 1.6, aims to design and develop a high-end prototype of the multimodal passenger platform. Three subgoals to achieve travel behavioural change have been exposed during the literature review:

1 The multimodal transport platform needs to be motivating its users to travel sustainably.

2 The multimodal transport platform needs to be facilitating its users to travel sustainably.

3 The multimodal transport platform needs to be accessible.

Defining such subgoals for the multimodal passenger platform creates clear guidelines for the later to be defined design brief (section 2.6).

A list of additional design requirements that support these subgoals and resulted from literature research are:

- The platform needs to apply nudging strategies
- The platform needs to target the individual self
- The platform needs apply the social norm (to drift away focus from the individual self)
- The platform needs to adjust the default settings
- The platform needs to apply informing strategies
- The platform needs to communicate tangible types of information
- The platform needs to be designed to break habits
- The platform needs to encourage the traveler to stop.. and rethink during the decision making process
- The platform needs to ensure a positive travel experience for future decisions and habit formation
- The platform needs to increase the level of perceived behavioural control
- The platform needs to provide a feeling of power/feeling of ownership
- The platform needs to a make the feeling of flight shame difficult to ignore

Long-term

In addition to developing the platform in the short-term to attract limited enthusiasts, a long-term strategy is essential for continuous improvement and iteration, ultimately aiming to serve all four traveler segments.

Furthermore, designing a future-proof multimodal passenger platform requires a long-term strategy. This strategy should include a vision for the future of the mobility sector, emphasizing seamless, multimodal passenger transport and other integral services, such as integrated ticketing and the TRIP concept. Developing a long-term strategy for the development of a multimodal passenger platform can be comprehended into a design roadmap.

To achieve this long-term systemic shift towards seamless, multimodal travel, comprehensive market research and an understanding of the mobility sector and its European market are crucial. The next section on market research will elaborate on this topic.

2.3 Market research

Understanding how to design a relevant platform and strategy in the European passenger transport market

This section includes:

2.3.1
Stakeholder network(s)

Within the scope of this graduation project, the European passenger transport network includes all stakeholders that contribute to transporting persons. This subsection elaborates on the European passenger transport network, and tries to simplify it optimally, to allow understanding while aiming for potential intervention of the system.

A national stakeholder system

To elaborate on the complexity of the system, the stakeholder map in figure 2.14 shows an elaborate overview of all stakeholders, on a national level. This map is still simplified, since it does not specify transport providers or infrastructure operators like KLM, NS or pro-rail. However, it gives a rough idea of the complexity of the network and its relationships.

Layers

The stakeholder map has three layers: demand, supply, and research & policy. Front-end services include demanding stakeholders, while back-end services, including suppliers and research & policy, provide data and travel options to front-end stakeholders.

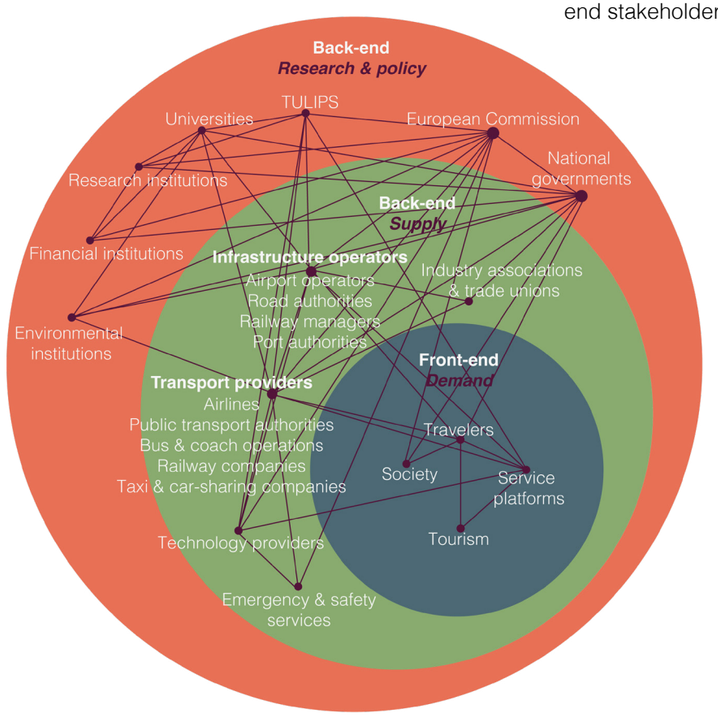


Figure 2.14: *Layered stakeholder map of national transport network (no specific country)*

Scoped down national stakeholder system

The stakeholder network in figure 2.14 is complex and difficult to comprehend, challenge or intervene within the time-span of a graduation project. The most important (powerful) stakeholders and their relationships within the network are displayed in the simplified stakeholder system in figure 2.15.

Since this projects' goal is to encourage sustainable travel behaviour, travelers are a key stakeholder.

Governmental institutions are related to all other stakeholders. Governmental institutions have the power to regulate all other stakeholders, and form alliances and bonds with other countries and their national governmental institutions. Therefore, this stakeholder "bubble" includes both the EU and national governments, and represents the collaboration within and between countries.

The most powerful supplying stakeholders are transport providers and infrastructure operators. Transport providers are in direct contact with travelers, and infrastructure operators play a significant role in supply (confirmed by multiple experts). Infrastructure operators include e.g. railway operators, airports and road authorities. Transport providers include e.g. airlines, public transport companies and railway companies.
Competition between transport providers has been taken into account since it drives important innovations and pricing strategies (section 2.3.2)

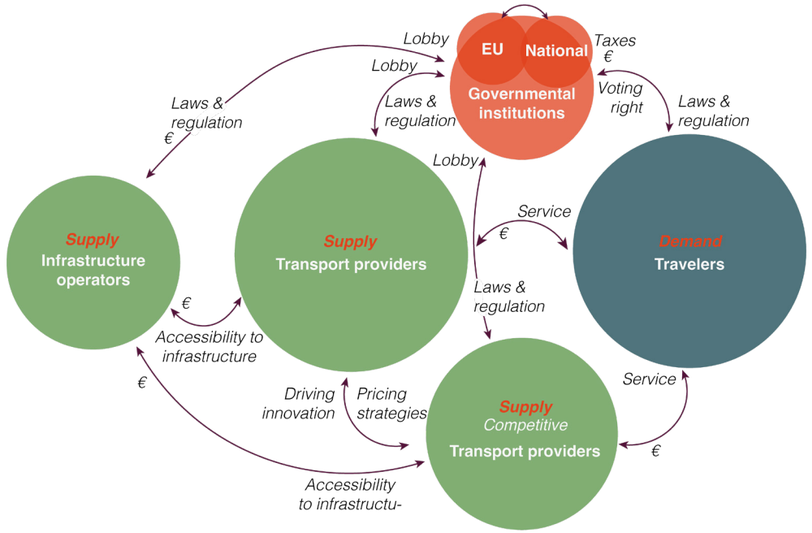


Figure 2.15: *Simplified system map European passenger transport network*

Scoped down European stakeholder system

To be able to comprehend the European passenger transport market and its dynamics, the national passenger transport network (figure 2.15) has undergone further simplification. It now focuses on the key relationships among three main stakeholder groups: supply, demand and governmental institutions (see figure 2.16).

Each European country has their own national passenger transportation network, resulting in the simplified European Stakeholder Network shown in figure 2.17. A distinction between EU-countries and non-EU-countries has been made.

A seamless international travel experience depends on the national governments and national transport providers/infrastructure operators of the countries the traveler travels through.

Figure 2.16: *Further simplified national passenger transport network*

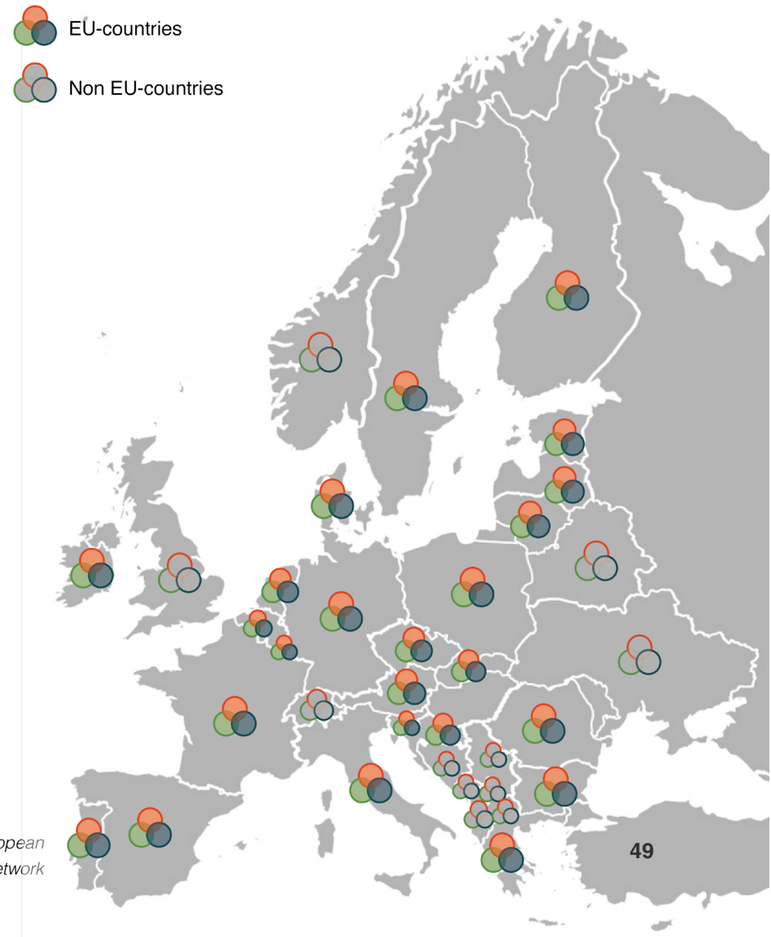


Figure 2.17: *Simplified European Passenger Transport network*

Integrating the multimodal passenger platform

National stakeholder network

The platform relies on data and information from the supplying stakeholders, requires (financial) support from governmental institutions and depends on an active engagement with travelers (see figure 2.18). Ticketing data from multiple suppliers can be translated and combined via the right API's (Application Programming Interface), while traveler/user engagement, travel decisions and behavioural change can be tracked via KPI's (Key Performance Indicators).
Without stakeholder collaboration, and a willingness to participate in this innovation, the platform will not succeed in facilitating seamless sustainable travel behaviour. Enabling a smooth collaboration is key and only possible in the long-term.

European stakeholder network

On a European level, the primary objective of the platform is to offer the digital infrastructure for multimodal travel connections between European countries and facilitate a seamless multimodal travel experience.

The objective of achieving such seamless collaboration between European countries is (maybe too) ambitious. The long-term strategy should take the complexity of the system into account. The long-term aim is to ignite European collaboration, spark change and showcase the possibilities that the multimodal passenger platform can offer.

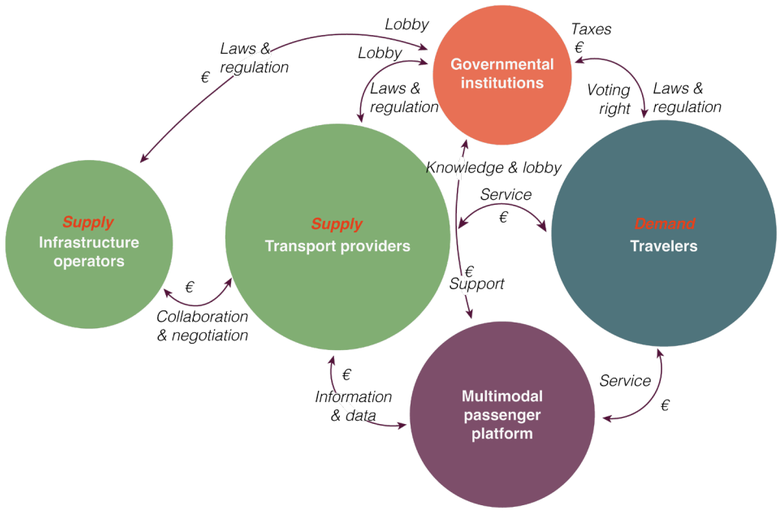


Figure 2.18: *National stakeholder network including platform*

Integrating the multimodal passenger platform

To understand the steps already taken or planned towards a seamlessly connected EU, several key initiatives, including policies and EU-wide agreements, have been explored. The previously introduced Sustainable and Smart Mobility Strategy (SSMS) by the European Commission is one of these initiatives. Additionally, this subsection elaborates on the European Green Deal and the TEN-T policy.

European Green Deal

The European Green Deal aims for a climate neutral EU in 2050 and distinguishes concrete subgoals in 2030 and 2040. These subgoals are key milestones in the following 25 years that should be taken into account when designing the long-term strategy.

In 2030, the EU aims to achieve a 55% reduction in GreenHouse Gas (GHG) emissions compared to 1990 levels. The EU has outlined several proposals to reach this goal, summarized in the "Fit for 55" package (European Commission, 2020). Over the following ten years, up to 2040, the plan is to quadruple the electrification of the transport sector, introduce market-ready zero-emission aircraft, and ensure that only CO2-neutral cars are available. By 2040, the EU aims for a 90% reduction in GHG emissions compared to 1990 and to establish an interconnected multimodal transport system that contributes to an 80% reduction in GHG emissions compared to 2015 (European Commission, Directorate-General for Climate Action, 2024). By 2050, the EU's goals include achieving climate neutrality and tripling the high-speed rail infrastructure (European Commission, Directorate-General for Mobility and Transport, 2020).

TEN-T policy

The European Green Deal itself does not elaborate much on multimodal- or train passenger travel, it mostly focuses on decarbonizing the road- and aviation sectors. They do however refer to the TEN-T policy (Trans-European Transport Network). The TEN-T policy is a key instrument for developing an efficient, coherent, multimodal, and high-quality transport infrastructure throughout the EU (European Commission, Transport and Mobility, n.d.).

Two major goals within the TEN-T policy are the completion of the Core Network in 2030 and the completion of the Comprehensive Network in 2050. The Core Network focuses on the most important trans-European connections and hubs, connecting the 27 EU Countries. The Comprehensive Network focuses on integrating interconnecting the Core Network (Rete Ferroviaria Italiana (RFI), n.d.).

The TEN-T policy displays great ambitions the EU has for the European railway infrastructure; construction of new rails and exchanging existing rails for high speed rails.

The policy is however, strongly infrastructurally focused. It does not elaborate on multimodal services or an improved collaboration between stakeholders and/or transport providers. The multimodal passenger platform aims to fill this gap and build upon infrastructural plans in the TEN-T policy by connecting Europe systemically but also digitally.

Key takeaways

Achieving travel behavioural change requires national and international stakeholder collaboration. The roadmap should address the roles and collaborations of the four key stakeholders. Governmental institutions have overarching power, which the platform can use in order to bring together all key stakeholders to achieve a travel behavioural shift. Besides encouraging the traveler to travel sustainably the platform should stimulate collaboration while pushing the networks' boundaries towards systemic change.

There is a need for a deeper understanding of how to design for systemic change. This need arose while examining the European passenger transport market, listing necessary systemic changes to enable a societally wide travel behavioural shift (section 2.5).

2.3.2
Competing modes of transport

Transport providers do not only compete with similar transport modes (e.g.: airline vs. airline), they also compete with other modes of transport (e.g.: airline vs. railway operator). Since the passenger platform is multimodal and aims for an increased usage of sustainable modalities (currently: rail), this competition between transport modes should be taken into account. There are six competing relationships, displayed in figure 2.19.

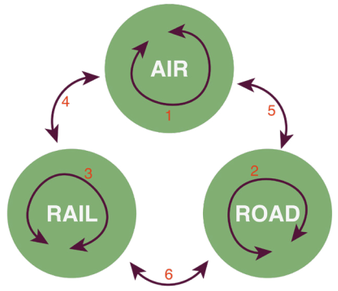


Figure 2.19: *Competing relationships between modalities*

National aviation- and road infrastructures are internationally accessible for other airlines and everyone who owns a private car (for some highways, travelers need to pay taxes). National railway infrastructures are (often) not accessible for other (international) train operators. This is partly due to technical problems, like different gauge, signaling and electrification systems, which makes running trains cross-border complicated and less desirable than running trains on a national level (Worth, 2022). The national focus of railway operators and train providers is a key problem in the European railway system. More about these nationally oriented railway systems and its consequences became clear after conducting expert interviews (section 2.4: Expert interviews).

Partly due to this national focus, railway journeys are often unable to compete with air- and road journeys. However, there are some shorter-distanced rail journeys that are already able to compete with air- and road travel. Based on desk research via multiple trip planners (Skyskanner, Cheaptickets, Trainline, NS International, Google Maps & viaMichelin) competitive routes could be determined (see appendix E).

Train journeys between the Netherlands (Amsterdam and Rotterdam Central Station) and closeby cities like Paris and Brussels are highly competitive, while somewhat farther away cities like Berlin, Vienna, Prague and London are semi competitive with air and road journeys. However, this high competitiveness, combined with a national railway focus, results in high demand and low supply. For example, the Eurostar to London or Paris is often very expensive compared to flying.

Key takeaways

In the short term, the platform should actively encourage railway journeys that are already competing with air- and road journeys.

In the long term, the platform should encourage the European passenger transport market to allow more rail journeys to compete with air and road journeys.

2.3.3
Competing transport services

This subsection elaborates on the possible market position of- and offers differentiation strategies for the multimodal passenger platform. It also evaluates possible collaborations with existing travel planning platforms. Two types of competitors have been evaluated; 1) other generalized service platforms and 2) private, train travel booking services.

Generalized service platforms

Generalized service platforms refer to online platforms that automatically generate travel journeys based on some specifics and preferences filled out by the user. The multimodal passenger platform, generated by the TULIPS initiative will also be a generalized service platform.

The two matrices below (figure 2.20 and 2.21) show two different ways of comparing these competing platforms to define the unique selling points of- and set up differentiation strategies for the TULIPS multimodal passenger platform on the market of generalized travel service platforms.

NS international (TRIP) and TUI (TRP) are identified as two key competitors on an international level. 9292 (TRIP) is a key competitor on a national level. Google maps (IP) serves as an informing and planning tool, rather than a booking and reserving tool, but for determining first- and last mile transport, is considered a competitor.

To conclude, developing the TRIP service offers a unique differentiation strategy especially when combined with an international and multimodal focus, unmatched by any existing platform. Allowing the platform to enter the market as a new and innovative player, filling a gap and offering a travel service that is seeked by travelers.

This gap of travel services is a result of constraints within the European stakeholder network. Therefore, enhancing stakeholder collaboration is as crucial as developing the platform itself. With the EU recognizing the potential of multimodal travel, similar platforms may emerge as competitors during the following years and while developing the TULIPS multimodal passenger platform itself.

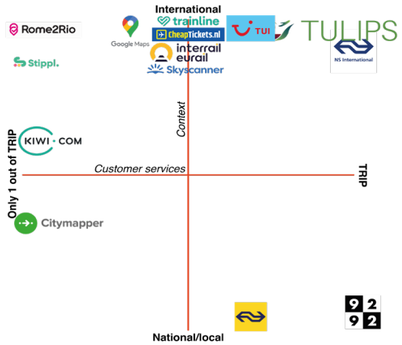


Figure 2.20: *Competitor matrix A*

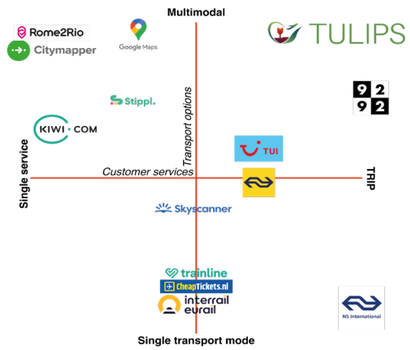


Figure 2.21: *Competitor matrix B*

Private train booking services

In the subsequent section (Section 2.4), interviews with several experts are examined. Among these experts (n=4), three were employed at private train travel booking services.

These booking services provide personal assistance and support in booking railway journeys, leveraging their expertise to ensure seamless train travel across Europe. Their 24/7 support addresses potential disruptions, offering peace of mind to travelers. This comprehensive service competes with the multimodal passenger platform by providing personalized, trustworthy assistance that enhances comfort and ease.

However, these travel services can be limited in accessibility due to a smaller selection of travel options and additional fees in exchange for service. It is expected that their customer base primarily consists of Critical Experts. Furthermore, the TULIPS platform differentiates itself by combining multiple modes of transportation, offering a more inclusive and multifaceted travel solution from door to door.

Collaboration strategies

Competing existing transportation services also have the potential to become valuable allies. This is particularly true for (partly) state-owned platforms such as NS, which operate under the influence of national and European governmental institutions. Here, governmental institutions could encourage providers to cooperate. Ideally, however, such platforms would cooperate willingly, driven by a shared vision and benefits for all parties involved.

Key takeaways

Developing an international, multimodal TRIP passenger platform sets the platform apart from existing online booking services. However, collaborating with competitors is essential for achieving the future vision of seamless, sustainable European travel. While differentiation is important, future efforts should prioritize collaboration to achieve this future vision. The long-term strategy should aim for a balance between the platforms' individual success and sparking systemic change through inspiration and improved stakeholder collaboration.

2.3.4
Conclusions on market research

Understanding how to design for a long-term shift in the European passenger transport market.

Market research has allowed exploration of the complex network of stakeholders involved in the European passenger transport sector. Key stakeholders include governmental institutions, transport providers, infrastructure operators, and travelers, each playing a crucial part in shaping the European passenger transport network.

Governmental initiatives such as the European Green Deal and the TEN-T policy have been pointed out as drivers of innovation and change. These initiatives aim to transform the transport sector by promoting sustainable practices and enhancing infrastructure. It is important to take these initiatives and their impact on the network into consideration. However, these policies primarily emphasize physical infrastructural development, leaving a gap for digital service oriented infrastructures.

The multimodal passenger platform aims to bridge this gap by offering seamless multimodal travel connections across European countries. The platform's success depends on effective stakeholder collaboration and the willingness of all parties to participate in this innovative solution. Ideally, the platform must differentiate itself from existing generalized service platforms and private, personalized booking services but also foster collaboration with governmental institutions and transport providers.

The transport sector is characterized by competition not only within similar modes of transport but also between different modes (e.g., airlines vs. railways). By focusing initially on routes where rail travel already competes with air and road travel, the platform can in the short-term encourage the use of sustainable transport options.

2.4 Expert Interviews

Evaluating and complementing the previous literature- and market findings, forming a comprehensive understanding of the European passenger transport network.

This section includes:

2.4.1
Introduction

Four experts in total, have been contacted by e-mail and recruited based on their expertise within the European mobility/train field. They position themselves professionally as "train- and/or mobility specialists". All participants identified as male and were aged between 30 and 50 years, employed by organizations or companies based in the Netherlands.

The primary goal of these expert meetings was to gain comprehensive insights into the Dutch and/or European passenger transport network.

Originally an (specified) interview guide has been made for all separate meetings/interviews, but because of the enthusiasm of the participants, the meetings often turned out to be lively and friendly conversations.

A general version of the interview guide and the shared consent form has been added in appendix F. All experts consented to a recording and transcription of the interview, and to quoting interesting phrases, anonymously.

2.4.2

Cluster system

After transcribing the interviews, the transcripts have been coded into brief codes existing out of an concluded assumption and a supporting quote. These codes have been clustered into main insights. These clusters have been mapped and connected in a cluster system. The system represents the main conclusions that can be drawn based on the expert interviews, and these conclusions are drawn and supported by quotes in the following subsection. The cluster system is shown in figure 2.22.

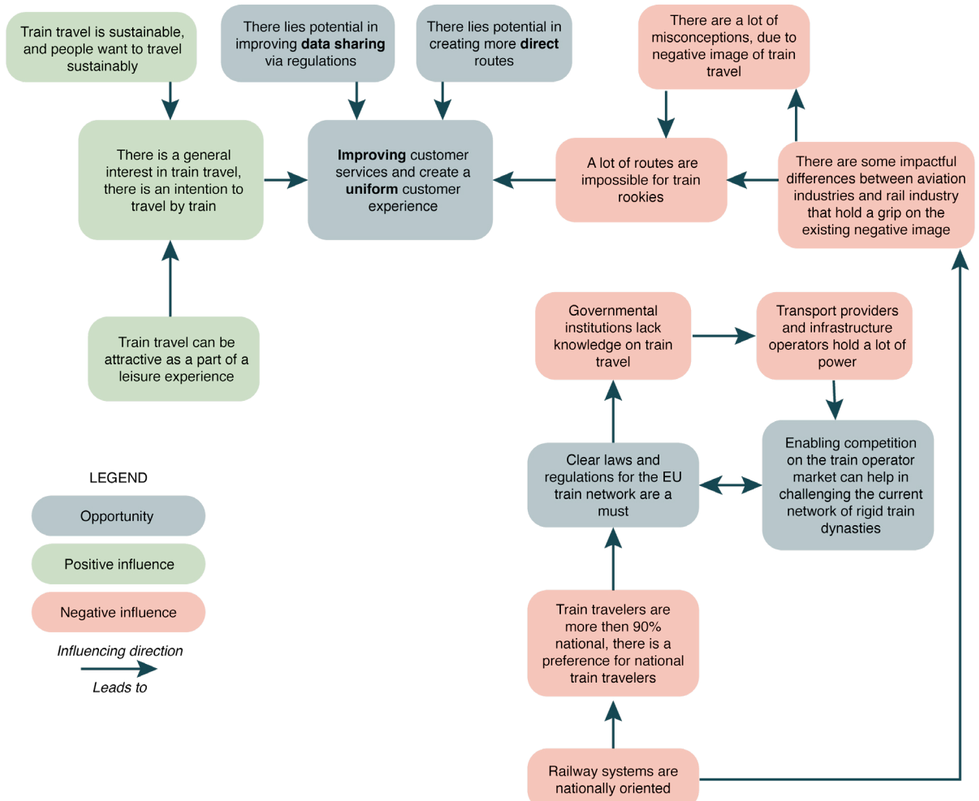


Figure 2.22: *Clustered system from expert interviews*

2.4.3

Expert worldview

This cluster system can be concluded and summarized in the following textual worldview, the definitions in bold are elaborated on and supported by quotes on the following pages:

Interest in sustainable travel is rising and there are a lot of options when you have the right **expertise and/or means**.

Customer services are lacking, and vary per country or provider. Railway systems are **nationally oriented** and national stakeholders are lacking communication and collaboration, which leads to unnecessary difficulties and an unjust negative image.

Governmental institutions have **power**, but they have **too little knowledge** and experience to put it to good use, which is why a big portion of the power lies with transport providers and infrastructure operators.

Interest

The experts that have been interviewed notice an increase in interest for train travel, mainly due to sustainability reasons. There is also a pool of travelers that enjoys the train ride due to a high level of comfort and because they consider traveling via train as a complementing aspect to their travel experience.

"I noticed that my website with information on international train travel got very popular very fast"
- Expert 2

"Our customer base exists out of all types of age-groups, as well leisure as business"
- Expert 4

Expertise and/or means

The experts elaborate on a needed amount of expertise and experience on train travel. With the right expertise on the railway system and other European public transport systems you can get from door to door. Some of the experts that have been interviewed even have their own service platform where they book the desired travel journey in exchange for an added fee. Therefore, it is concluded that you can travel sustainably with the right amount of knowledge on the system, but also if you have the financial means to pay for such a booking service.

"To be an expert, you need to be aware of a lot of possible connections, this enables you in calculating possible delay and optimal transfer times, and you are aware of your options in case of drop out or a delay"
- Expert 2

"But yeah, traveling by train to Spain is just a lot of hassle, which is why they are willing to pay our organization extra to plan their journey and to support them"
- Expert 1

Customer services

According to the experts, customer services are lacking, there is no uniformity. Improving customer services and creating uniformity is the low hanging fruit. Creating the multimodal passenger platform and facilitating integrated ticketing could e.g. help in acting upon this opportunity and fill this service gap.

"The low hanging fruit is in creating better customer services, creating uniformity"
- Expert 1

This lacking customer service is a result of lacking stakeholder cooperation and unclear laws and regulations.

"But yeah, the SB says "it is not our strike", but the transport provider (SB) that strands, officially needs to finance shelter or facilitate another travel option, it is just so unclear who holds responsibility"
- Expert 2

Negative experiences as a result of these lacking services on their account decrease the rising interest, resulting in unsustainable habit formation. People tell other people about their bad experiences, and assumptions about railway travel are made and/or strengthened.

"People make a lot of assumptions, but they actually have no idea because they've never tried or experienced it"
- Expert 4

National focus

According to all four experts, the national focus of most railway providers is one of the key problems behind the lacking stakeholder network. Especially expert 3 and expert 4, elaborated on this subject.

"There is a very high national interest, because organizations rather invest their money on e.g. national railway systems then internationally"
- Expert 3

"More than 90% of train travelers in NS trains, travel nationally, that explains that national focus"
- Expert 4

Power but too little knowledge

Power officially lies with governmental institutions but in practice it lies with providing stakeholders and infrastructure operators. Because the power of the transport system lies with the organizations that have knowledge and own data. Therefore, providers and operators are able to lobby and influence governmental institutions to their liking. Which is how they, among other things, maintain a national focus, and do not feel the need to improve international services or create uniform customer communication and services.

"I would have hope, if national governments wake up, and start being more compelling, but that's gonna be a very long breath, take the Intercity to Brussels e.g…"
- Expert 3

"The main issue is that stakeholders lack communication skills to sit around the table together and get to a solution, together"
- Expert 4

2.5 Systemic Change

Understanding how to design for systemic change

From the previously conducted research there has been concluded that the European passenger transport market is in need of a multileveled shift towards seamless, sustainable and multimodal European travel, Europe is in need of a transport shift.

There is a need for shifting from nationally oriented towards internationally oriented railway systems, an improved and increased level of stakeholder collaboration and a behavioural shift among all four traveler segments; the market is in need of systemic change.

Additionally, without such systemic change, in the current system of European passenger transport, the multimodal passenger platform is unable to offer key features like TRIP and integrated ticketing, which all contribute to a seamless travel experience and an increased level of sustainable travel behaviour resulting in lowered GHG emissions.

To understand how systemic change can be initiated and encouraged by a design intervention (like the multimodal passenger platform), two theories have been researched and will be referred to when designing the desired transport shift as a part of the design roadmap.

Systems-shifting design is one of these theories. As Mieke van der Bijl-Brouwer explains in her blog post (2022), systems-shifting design aims to shift systems into a desired direction. Changing the system is rather difficult, and striving for an expansion in the system is more viable.

Systems-shifting design starts off with the design/determination of a vision, which represents the directionality in which we want the complex system (the European passenger transport system) to change. The multimodal passenger platform should become a key leverage point in the system of European passenger transport (stakeholder network). Leverage points are places in the system, where a small shift can produce big changes over time (Meadows, 1997).

Secondly, the **multilevel perspective framework** by Frank Geels provides insight into how a so-called niche innovation (the platform e.g.) can eventually influence the regime in a landscape (system). Geels (2010) explains that niche innovations can influence the regime if they gain enough momentum, supported by successful experimentation, learning processes and the creation of supportive networks. Four phases of systemic transition that should be kept in mind are 1) predevelopment, 2) take-off, 3) acceleration and 4) stabilization.

To illustrate the applicability of these two theories, the figure below visually depicts how the multimodal passenger platform could

intervene in the system and transform the socio-technical landscape of European passenger transportation, supported by both the system-shifting design and the multilevel perspective framework. The development of a multimodal passenger platform could expand the network towards systemic change. A similar way of visualizing systemic change will be used for and in the design roadmap.

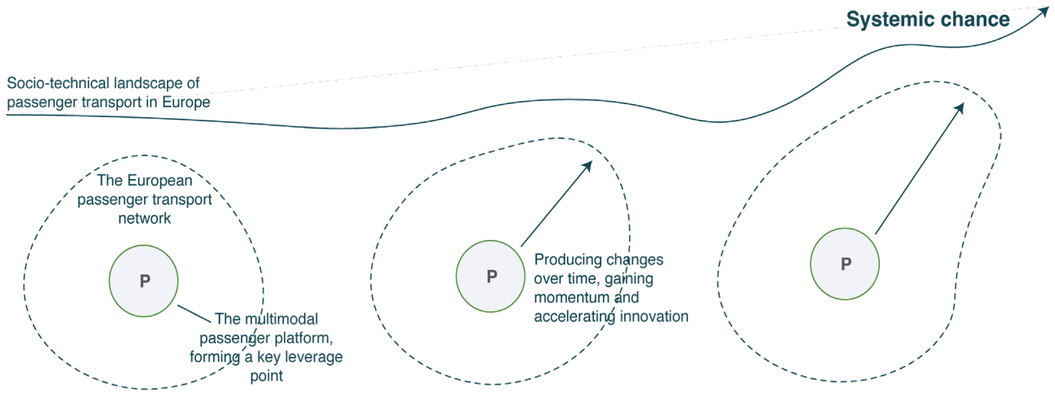


Figure 2.23: *Systems-shifting design combined with Multilevel Perspective Framework for the European passenger transport network*

2.6 Design Brief

Concluding all research into a design brief, defining a complemented problem statement and a design goal.

This section includes:

This section elaborates on the design brief. The design brief brings together all conclusions and findings from research. This design brief serves as the starting point for the next phase: DESIGN. It aims to construct a clear design scope, to support the development of the multimodal passenger platform and the platforms' goal of encouraging sustainable travel behaviour.

2.6.1
Vision and mission

To elaborate on a desired future, a vision and a mission have been established. The mission can be interpreted as the approach to reach the vision. This vision and mission will be integrated in the long-term strategy (roadmap).

Vision
A collaborative European passenger transport network, where seamless, sustainable, multimodal travel in Europe is accessible for everyone.

Mission*
Encouraging sustainable travel behaviour, while sparking systemic change in the European passenger transport network, via a multimodal passenger platform.

*The mission aligns with the design goal.

2.6.2
Problem definition

The final problem can be interpreted as an interplay of multiple problematic parameters interacting with each other in a system of causes and effects; the system of unsustainable travel behaviour, where unsustainable travel behaviour is the problematic effect. Unsustainable travel behaviour is undesirable due to its resulting transportation emissions and negative impact on the environment. There is an environmental need for a behavioural shift.

Figure 2.24 on the next page shows a graphical representation of the system.

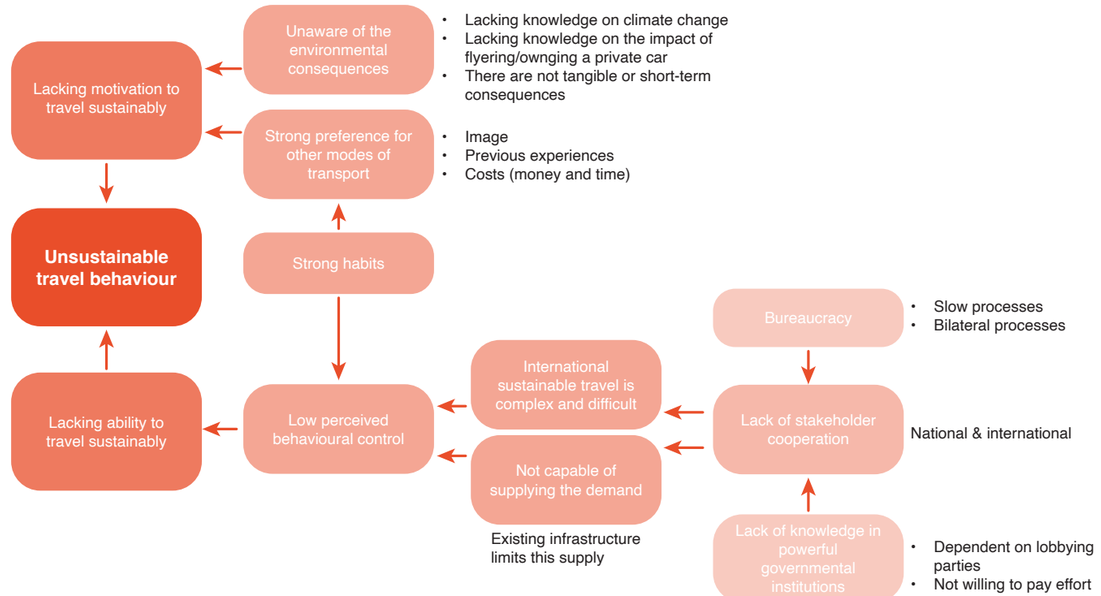


Figure 2.24: *System of unsustainable travel behavior*

To elaborate on this system, unsustainable travel behaviour is a result of travelers lacking both motivation and ability.
Where lacking motivation, results from (climate) unawareness and/or strong preference for other modes of transport (influenced by habits).
Lacking ability, lies with a low perceived behavioural control, often resulting from the complexity and difficulty of sustainable travel and/or supplying stakeholders who are incapable of meeting the high demand resulting in high prices, because infrastructure is almost completely occupied and unable (or unwilling?) to grant access to more modalities. These two influencing factors are results of a lacking stakeholder collaboration.

This system of unsustainable travel behaviour and its interacting parameters can be summarized in the following problem statement:

Lacking motivation and ability causing unsustainable travel behavioural resulting in transportation emissions is an ever-occurring environmental problem.

Sustainable travel innovations and -options are limited by lacking stakeholder collaboration, causing unnecessary complexity, difficulty and a disability to meet demand.

Opportunity

There is a silver lining that provides an opportunity to design upon. Namely, that there are already lots of travelers who are motivated and able to travel sustainably (the critical expert), including a lot of travel organizations that facilitate motivated travelers to travel sustainably. The system of unsustainable travel behaviour in figure 2.24, only points out the traveler segment of the unaware hesitator, who is unable and unmotivated.

Which is why the system of unsustainable travel behaviour, can be transformed into the system of travel behaviour (sustainable and unsustainable) and can be complemented as shown in figure 2.25. The four travel segments are implemented and outlined by the green boxes.

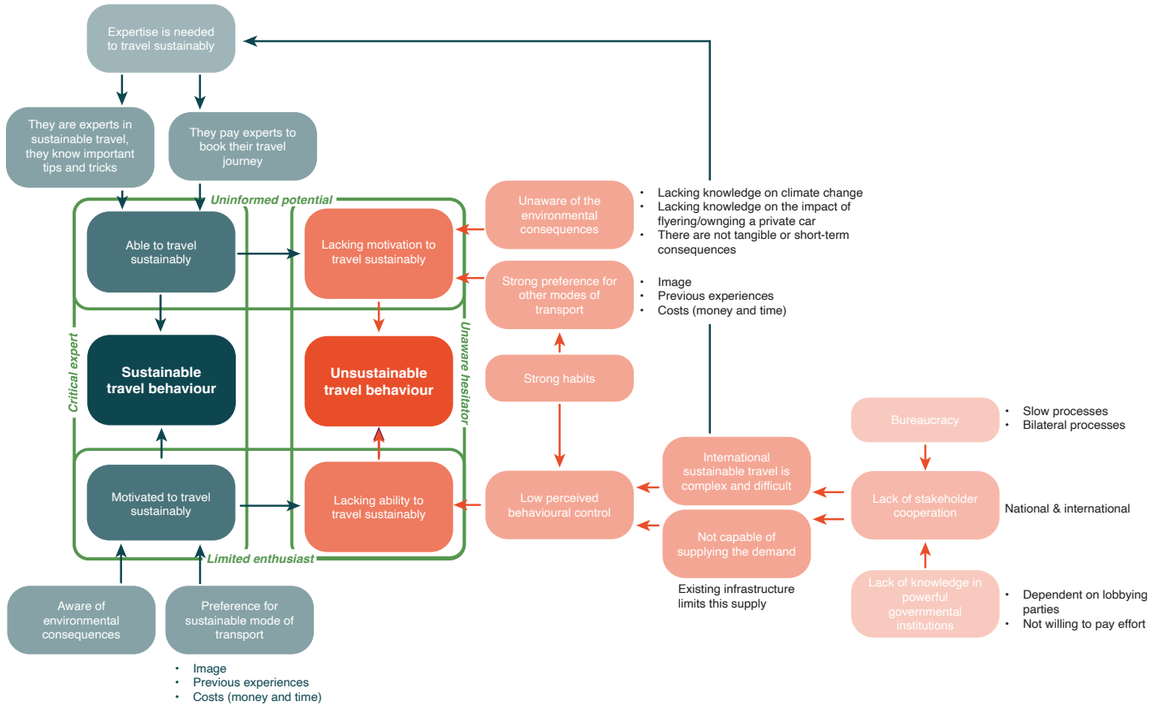


Figure 2.25: *System of travel behaviour*

2.6.3
Design goal

In order to address the double faceted problem, and design for each traveler segment to shift towards the quadrant of the critical expert (the left side of the system of travel behaviour), the design goal is as follows:

Design a strategy that encourages sustainable travel behaviour through a multimodal passenger platform, while sparking systemic change within the European passenger transport system.

The travel behaviour system requires a multifaceted strategy that addresses the entire system and its stakeholders. This will be done by targeting travel behaviour (demand); short-term development of the platform choice environment including a coherent behaviour change strategy, and by designing for systemic change (supply); long-term integral strategy communicated through a roadmap.

The design phase of this project can therefore be separated into three separate design challenges/ goals;

1. Designing for sustainable travel behavioural change (behavioural change strategy)
2. Designing the choice environment (a visual base for the behavioural change strategy)
3. Designing for systemic transformation (roadmap)

The upper two are closely related and therefore combined into one so-called platform strategy;

2.6.3.1 - Platform strategy

The platform strategy is a behavioural change strategy for the multimodal transport platform intertwined with the choice environment (the platform interface). The platform strategy will be defined by multiple nudging and informing design design interventions that are intertwined and work together towards the design goal...

...to motivate and facilitate sustainable travel via an accessible multimodal passenger TRIP platform.

The platform strategy should be initially be designed upon the following three main requirements:

1. The multimodal passenger platform should motivate its users to travel sustainably.
2. The multimodal passenger platform should facilitate its users in traveling sustainably.
3. The multimodal passenger platform should be accessible.

To elaborate on the relevance of the three subgoals of motivating, facilitating and accessibility, the three subgoals are connected to the three key pillars of innovation; desirability, feasibility and viability (see figure 2.26 on the next page).

These three subgoals can be complemented with 7 additional short-term requirements, and 3 long-term requirements, forming a list of requirements as shown in table 2.3 on the next page.

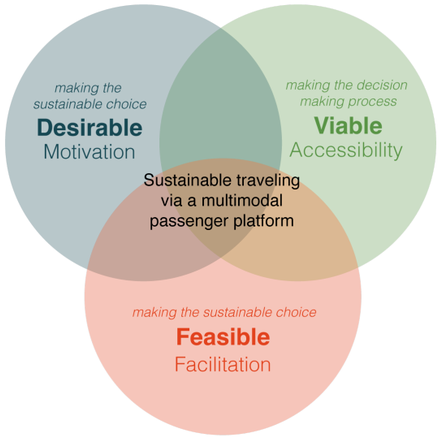


Figure 2.26: *Key pillars of innovation connected to platform*

To meet requirement 10, requirements 11, 12 and 13 have been identified for future integration into the platform. The development of these services is impossible in the short-term. They could however, be integrated in the integral strategy.

Table 2.3: *List of requirements for platform strategy*

	List of requirements
1	The platform is motivating its users to travel sustainably
2	The platform is facilitating its users in traveling sustainably
3	The platform is accessible
4	The platform applies nudging strategies
a	*The platform targets the individual self*
b	*The platform applies the social norm*
c	*The platform should set the sustainable travel option as a default*
5	The platform applies informing strategies
a	*The platform communicates tangible pieces of information on climate change*
6	The platform breaks habits
a	*The platform encourages the traveler to stop.. and rethink*
b	*The platform makes the sustainable option salient*
7	The platform increases the level of perceived behavioural control
8	The platform provides a feeling of power/ownership
9	The platform increases flight shame, difficult to ignore
10	The platform ensures a positive travel experience (habit formation)
11	The platform ideally provides an integrated ticketing service
12	The platform ideally provides real-time data
13	The platform ideally enables reserving co-shared vehicles/micromobility

2.6.3.2 - Integral strategy

Lacking stakeholder collaboration is currently limiting the development of innovative, multimodal (and/or sustainable) travel services. The integral strategy aims to look beyond the development of the platform itself, and focuses on what is needed on a systemic level to support the transport shift. The integral strategy will be presented as a design roadmap.

The aim for the integral strategy, the design roadmap, is to...

... spark systemic change within the European passenger transport network by stimulating stakeholder collaboration and charting the course towards seamless, sustainable, multimodal international travel in Europe.

Besides the long-term platform requirements 11, 12 and 13, identified on the previous page, research has already pointed out additional requirements and/or key moments/topics that should be integrated into the roadmap;

- The platform should, eventually, be accessible for all four traveler segments
- The roadmap focuses on shifting travel behaviour amongst all four traveler segments
- The platform should, besides being a frontrunning service, be a source of inspiration and -knowledge for other network stakeholders
- The roadmap should display how the platform supports systemic change towards the future vision of seamless, sustainable and multimodal travel through Europe
- The roadmap should incorporate key EU-wide environmental and/or mobility initiatives (like the European Green Deal and TEN-T)
- The roadmap elaborates on how to improve stakeholder collaboration over time between the key stakeholders (travelers, suppliers, governmental institutions & the platform itself)
- The main objective of the roadmap is to communicate the transport shift towards seamless, sustainable multimodal travel in the European passenger transport network.

Design.

3

3.0 Introduction

This chapter elaborates on the second phase of the project: the design phase. The design phase builds upon the outcomes of the first phase; the research phase. The design phase is divided into two subgoals, namely, designing and developing the platform strategy and the integral strategy. Together, these two subgoals form a multifaceted and intertwined design strategy that aims to encourage sustainable travel behaviour and spark systemic change in the European passenger transport system.

3.1 Design approach

3.1.1
Design process in general

The design phase has been split up into designing for three separate design goals (designing a baseline visual identity for the choice environment*, the behavioural change strategy* and the integral strategy; roadmap). The following three subsections elaborate on the design approaches for each of these design goals.
*Two separate design approaches will be elaborated on in the following subsections, but the design and development of the choice environment and the behavioural change strategy went hand in hand, forming the platform strategy.

3.1.2
Visual identity

To design the visual identity of the platform, existing platforms (potential competitors) have been investigated and experienced to understand how visual aspects affect user experience. Additionally, previous graduation projects on travel planners have been used as a source of inspiration. More specifically, the graduation projects from Sarah van Coevorden (2024) and Rosa Hendrixs (2021).

After designing a first draft of the baseline interface, a meeting with Leo Karabeg, employee at SINTEF and responsible for the final (visual) design and development of the multimodal passenger platform took place to receive feedback, tips and ideas, to iterate, optimize and finalize the interface accordingly. Additionally, fellow design students and potential platform users have been asked to provide feedback on the interfaces and visual features.

3.1.3
Behavioural change strategies

Four behavioural change strategies have been designed via three separate design sprints (see figure 3.1).

The co-creative sessions in design sprint 2 lent the opportunity to test the visual identity designs, and made it possible to improve the visualizations with fellow students and potential users.

Chapter 4, includes a quantitative study that has been conducted to test the effect of four final platform strategies that were concluded after the three initial design sprints. The quantitative study, an online questionnaire, serves as a final design sprint where the four platform strategies will be evaluated and optimized into one platform strategy.

3.1.4
Integral strategy; the roadmap

The integral strategy, a design roadmap, will be developed inspired by the design roadmapping methodology by Lianne Simonse (2018). A long-term vision and multiple goals have been identified in the research phase and will be placed within a time frame which will be divided into multiple horizons. Key milestones and objectives will be outlined, detailing the necessary steps and resources to achieve these goals and complete the phases (horizons).

Existing governmental reports, future mobility concepts and concluding research (Chapter 2. Research) have and will be re-examined to identify and understand the key components of the roadmap, such as the future vision, horizon timeframes, important objectives, steps, and resources.

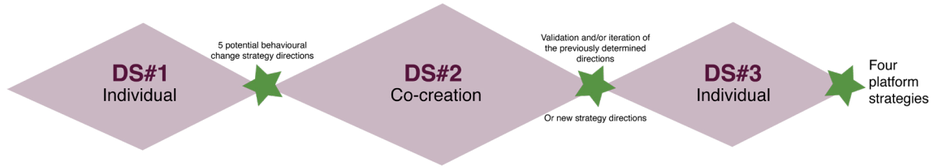


Figure 3.1: *Three design sprints for behavioural change strateiges*

3.2 Platform strategy

Designing for behavioural change

This section includes:

3.2.1 Visual identity

3.2.2 Baseline choice environment

3.2.3 Design sprint 1

3.2.4 Design sprint 2

3.2.5 Design sprint 3

In this section, firstly, a visual identity and the baseline choice environment will be developed. Following that, it will discuss the three design sprints which led towards the design of three behavioural change strategies in addition to the baseline interface, plus one additional strategy.

Ultimately, the effect of each platform strategy will be quantitatively tested in Chapter 4.

3.2.1
Visual identity

The colour palette of the TULIPS project has been used as a guideline in determining the visual identity of the platform, combined with a simple yet professional font: Helvetica (see figure 3.2).

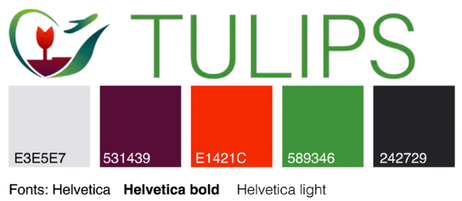


Figure 3.2: *Visual identity for the platform*

The TULIPS colour palette already provides a wide range of colors suitable for implementing colour nudging in platform strategies, so no colour adjustments were necessary. For example, the reddish color can indicate unsustainable modes of transport, while the green color can signify sustainable modes.

Some key tips from Leo Karabeg were;

1. Do not use a lot of different font sizes or a lot of different colours, but rather play around with the bold and light versions of the font, or change colour-density of the font.
2. Use white space, do not make the interface too full of information and keep it “simple” and convenient.
3. Some additional tips on how to use figma properly, on how to make e.g. a button look like a button rather than a form or on how to properly frame or group contents.

3.2.2

Baseline choice environment

After experiencing existing planners and generating a basic understanding of what a travel planner should look and feel like (appendix M), an iterative design approach has been followed to continuously improve on an initial interface design. Meanwhile, seeking external input, building upon the graphical design skills gained as an industrial designer.

The visual below (figure 3.3) shows the choice environment for two travel journeys and points out design decisions that have been made along the way.

The baseline interface provides an honest overview of the door-to-door travel journey, it informs the traveler on each part/leg of the journey. More details on the interface and user interactions are given in on page 86.

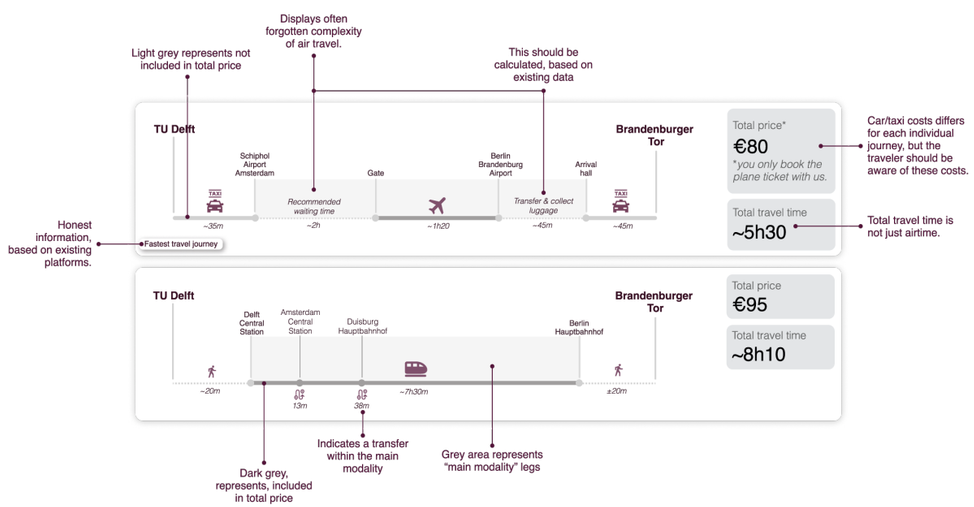


Figure 3.3: *Baseline interface and key design decisions*

Some key design decisions that have been made are

1

Differentiating the main modality (airplane or train) from the first- and last-mile transport using a light gray block helps clarify which travel segments are connected to the main modality. For instance, the recommended waiting time is now indicated as part of the main air modality. Additionally, this differentiation aligns with TULIPS' goal of implementing a drill-down approach for the final platform. This approach allows travelers to customize their journey by comparing and adjusting various first- and last-mile options in relation to the main modality in case of customization.

2

Using a dark gray beam to indicate which travel segments are included in the price, while a lighter gray beam shows that the segment is excluded from the price (e.g., the taxi is excluded), provides clear visual differentiation.

3

A dotted line represents walking or waiting, indicating no use of a vehicle or modality.

4

Displaying the total price instead of pricing specifications to prevent travelers from comparing main modality pricing and getting influenced in case of a significant difference (e.g., airplane vs. train).

5

Showing the total travel time, as well as separate times for each travel leg, to indicate how long travelers will be on the airplane or train. This is, both, considered key information to increase accessibility and a level of perceived behavioural control.

6

Provide a total travel time estimate (~), acknowledging that exact numbers are difficult to meet in practice.

7

Avoid specific colour nudging to ensure the baseline interface only informs about the multimodal door-to-door travel options.

8

Informing users about the fastest and cheapest travel options, similar to existing platforms.

9

Each icon has been chosen carefully to indicate different modalities. The different icons for each modality are displayed in figure 3.4. To differentiate the train from the metro and tram, the train icon is shown from the side rather than the front.

Figure 3.4: *Icons used per modality*

3.2.3
Design Sprint 1

The first design sprint (DS#1) aimed to ideate multiple behavioural change strategy directions and consisted of the following main steps:

1. Brainstorm
2. Concluding brainstorm
3. Ideate
4. Concluding DS#1

Each step will be briefly outlined in this subsection.

Brainstorm

Brainstorming in DS#1 existed out of multiple smaller brainstorm techniques; “how to..” activities, determining tensions/amplifiers between subgoals, examining existing products/services/product-service systems and finding analogies and metaphors to determine the ideal user interaction. Some of the brainstorm activities and outcomes are displayed in appendix G. The goal of these activities was to get the creative juices flowing while collecting a large pool of inspiration to build a foundation for ideation.

Concluding brainstorm

Brainstorming on how to motivate, how to facilitate and how to be accessible allowed expanding the meaning of the three subgoals. The answers to these open questions have been clustered into supporting themes, which have been put together into a thematic system (figure 3.5 on the next page)

A theme is considered 1) an explanatory element, elaborating on what the subgoals of motivating, facilitating or accessibility entail, or 2) an example on how to achieve that subgoal.

To elaborate on this thematic system, take a look at the left pillar of motivation (desirability), the thematic system explains that motivation exists out of individual-, social- and environmental drivers, these motivational drivers can be triggered through understandable effects or via rewards or set goals.

This thematic system, together with other brainstorm outcomes, like examining existing products and services, a list of existing behavioural change strategies (appendix B), analogies and metaphors, serve as a source of inspiration for ideation. Ideation is a form of brainstorming where an unlimited amount of ideas will be generated, till saturation;

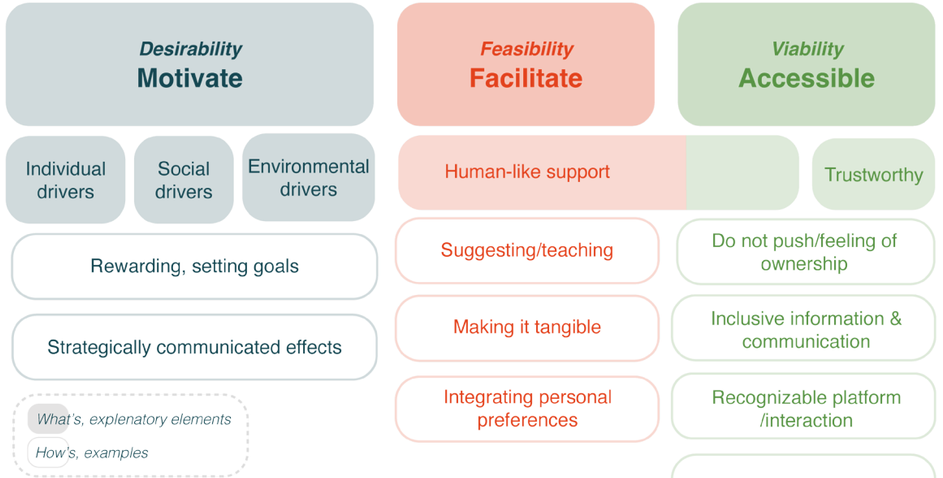


Figure 3.5: *Thematic system brainstorm DS#1*

Ideate

A lot of behavioural change strategy directions have been ideated. The five directions that appear most promising when comparing them to the list of requirements, determined in the design brief, are listed below (some additional ideas are displayed in appendix H).

Note that some of the ideated design directions in appendix H, specifically target the travel experience or the evaluation of the trip, influencing future long-term behavioural change (requirement 9). Although the primary focus of this graduation project is to design (for) the choice environment, some of these additional ideas will be incorporated into the project recommendations (section 5.3).

Concluding DS#1

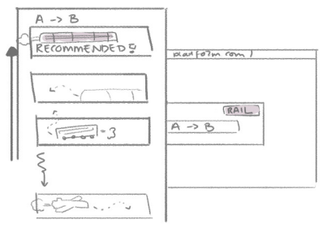
Five behavioural change strategy directions that are most promising when aligning them with the list of requirements are;

Sustainability score - easy climate impact comparison

A scale that shows the level of sustainability of each trip is primarily an environmental driver, increasing tangibility and making the impact more understandable compared to other travel options. This type of communication, similar to nutrition and energy labels, is a comprehensive and easy-to-understand way to communicate impact.

Default, suggesting

Make the rail option (most sustainable option) the default, list it on top when displaying possible travel journeys, or make it the default when choosing the main modality. Default nudging strongly suggests sustainable travel journeys.



Communicate through tangible metaphors

Make the impact of CO2 emissions more understandable and inclusive by linking it to a tangible metaphor. When chosen strategically, this metaphor can be motivating through social, internal and environmental drivers. For example, comparing CO2 emissions to the electricity consumption of an average household would have been particularly relevant during the winter of 2022-2023 due to high gas prices at the time. Tangible metaphors can also be effective when applied to total travel time or total price. For example, mentioning that a train ride to Berlin costs the same as a pair of new Levi's jeans, could make it appear relatively cheap. A downside could be that people might interpret this as quite manipulative.

Community (peer pressure > peer confirmation)

Apply the social norm and create a sense of community by showing the experiences of previous travelers. Explain that other travelers dared to take the sustainable option and confirm that they had a good experience. This is a recognizable way of presenting inclusive information. The opinions of others could also be visualized via stars or via a grade, or more extended reviews.

Rewarding, rail miles e.g.

Enable travelers to save "rail miles", via a point-based system integrated in the app. Choosing a green travel journey equals discounts or other rewards like e.g. a free coffee at the train station. Making it interesting for the individual self, integrating possible personal preferences (when allowing them to choose their own rewards). Linking the reward to a known benefit (rail miles or a starbucks coffee) could increase reliability through recognition.

3.2.4
Design Sprint 2

In the second design sprint the goal was to co-create with fellow students and potential platform users. DS#2 consisted of the following main steps:

1. Co-creative session with fellow designers
2. Co-creative session with non-designers

The goal for both co-creative sessions was to expand the pool of inspiration for ideation and design, generate additional ideas but also confirm existing design directions (outcomes DS#1) and expanding the thematic system with newly generated themes (both explanatory elements and examples).

Co-creative session with fellow designers (CC#1)

The session materials have been added in appendix I. The session has been split up in 1) brainstorming on the subgoals of motivating, facilitating and accessibility, 2) challenging the participants to ideate behavioural change strategies and 3) evaluating previous design sprint outcomes.

1) Brainstorming on three subgoals

Part 1 of the co-creative session elaborated on generating ideas on how to motivate and facilitate sustainable travel, and how to create an accessible multimodal passenger platform (for everyone and for the limited enthusiast specifically).

The answers and ideas provided by fellow designers have been digitized in miro, to enable clustering, theming and concluding. Although there were a lot of similarities between the brainstorm outcomes of DS#1, some complementing themes that arose during clustering the CC#1 outcomes are listed in table 3.1 per subgoal.

Table 3.1: *Interesting complementing themes from CC#1*

Motivation	Facilitate	Accessibility
Show a positive perspective	Seamless	Enable easy comparison
Create a community feeling	Assurance	

2) Ideating

Part 2 of the co-creation session focused on ideating “out of the box” holistic design solutions, to get inspired.

The designers have been challenged to redefine the initial platform goals of motivating, facilitating and being accessible into three substitute subgoals.

Two brainstorm sessions subsequently took place where the subgoals were replaced with the following new subgoals (in italics):

1. How can you *sustainably surprise* and *personally advise* a traveler via a *trustworthy* platform?
2. How can you *socially pressure* and *prioritize* a traveler via a *technological novice proof* platform?

Table 3.2 shows some inspirational ideas that ought to answer the revised research questions above. Additional ideas are displayed in appendix I. These answers serve as a source of inspiration and evaluation of existing ideas from DS#1.

3) Evaluate

Additionally, sketches and initial designs for the platforms’ visual identity and the baseline interface have been shown, discussed and comments have been integrated accordingly.

The participants of CC#1 were especially enthusiastic about the online community idea, comparing it to STRAVA, a platform that has an (extreme) motivating effect by applying social pressure.

Table 3.2: *Inspiring ideas from CC#1*

Research question 1	Research question 2
Turn the platform into something physical and spread it on train stations and airports, encouraging people to download and examine it while traveling	Social hubs for travelers on train stations, or speed dating on the train, inspired by the KLM lounge at Schiphol airport
Surprise QR codes during the train trip: with fun facts about the vehicle/environment, or a free coffee (reward)	“Best practices” via social media, mail, youtube > “Get ready with me to.. travel sustainably”. Enable people to share their trip like STRAVA.
AI, cookies, machine learning, what do we know about the traveler? How can we advertise on it? Supporting them personally via AI.	Physical help desks on train stations and in vehicles (like the trams in Rotterdam), or make sure the conductor is well-informed.

Co-creative session with non-designers (CC#2)

The session materials have been added in appendix I.

The goal of this co-creative session was to create a better understanding of 1) what motivation, facilitation and accessibility mean for potential users. To 2) understand how the platform can motivate, facilitate and be accessible to encourage them to travel sustainably.

1) Brainstorming on three subgoals

The answers and ideas provided by friends and family have been digitized in miro, to enable clustering, theming and concluding. Although there were a lot of similarities between the brainstorm outcomes of DS#1 and CC#1, some additional complementing themes that arose during clustering the CC#2 outcomes are listed in table 3.3 per subgoal.

2) Linking meaning to sustainable travel and the platform

After presenting the four traveler quadrants, and asking the participants to place themselves in one of the quadrants, the participants were asked which of the specific motivators, facilitators and accessibility factors they defined in part 1, would support them in moving toward the critical expert segment (right upper corner). Table 3.4 below shows their answers, forming a source of inspiration for designing in the next design sprint.

3) Evaluate

Additionally, sketches and initial designs for the platforms' visual identity and the baseline interface have been shown. Participants in CC#2 were e.g. critical of the way the train trip was presented, mentioning, for example, that the transfers were a bit unclear, which could increase an unconscious advantage to the train option due to misinformation. Their input has been integrated accordingly. They were enthusiastic about the design of the impact meter (A>E), which they found easy to read, as it is in line with the existing energy labeling in Europe.

Table 3.3: *Interesting complementing themes from CC#2*

Motivation	Facilitate	Accessibility
Make it fun	Deducting worries	Feeling at ease
Together with friends and/or family		A step wise process where simplicity is a good thing
Personal benefits		

Table 3.4: *Specific motivators, facilitators and accessibility factors that would encourage sustainable travel*

Part.	Motivator	Facilitator	Accessibility factor
1	Because others do it	Make use of someone else's' expertise	I feel at ease, I am with people that are just like me
2	Future focus	I feel seen and loved	Taken through it step-by-step
3	It makes me feel happy, good about myself	Supported by a friend	It works as I want it to, it is easy to do
4	Exploring new things and my expand my personal boundaries	Does not take too much time	Easy process, not too complex, little amount of actions

3.2.5 Design Sprint 3

The outcomes of DS#1 and DS#2 are combined and concluded and serve as an inspirational foundation for designing upon the previously determined strategy directions. Three behavioural change strategies have been designed in more detail and combined with the visual identity and baseline interface of the platform which leads to four platform strategies (A, B & C).

1. Combine DS#1 and DS#2
2. Design:
3. Baseline choice environment
4. Strategy A
5. Strategy B
6. Strategy C
7. Strategy ^2

Combine DS#1 and DS#2

All themes have been combined in one thematic system. This thematic system is now based on research outcomes (DS#1), opinions of fellow designers (CC#1) and potential users/non-designers (CC#2). The thematic system has been translated into a list of wishes (see table 3.5) and serves as a foundation to design upon.

Design

The goal is to eventually test a total of four platform strategies quantitatively, to determine their impact on travel behaviour. It is crucial that these strategies differ in their approach to behavioural change, to be able to conclude whether one particular approach is more effective. The following four pages elaborate on the four designed strategies that will be tested.

Table 3.5: *List of wishes (thematic analyis)*

	List of wishes
1	Individual drivers
a	Personal benefits
2	Social drivers
a	Community feeling
3	Environmental drivers
a	Impact on the environment
b	Show positive perspective
c	Rewarding, setting goals
d	Make it fun
3	Perceived behavioural control
4	Human-like support
a	Integrating personal preferences
b	Suggesting/teaching
c	Making it tangible
d	Assurance of smooth travel experience
5	Feeling at ease
a	Do not push
6	Trustworthy
a	Reliable data
b	Inclusive information
c	Recognizable platform/interaction
d	Easy comparison

Baseline choice environment

An honest overview

The baseline choice environment presents an **honest overview** of the possible travel journeys. Via an **accessible** and **facilitating** platform. It does not push, it provides inclusive information and communication and is based on existing platforms. The baseline interface allows comparison of different travel journeys. It enables the traveler to book a multimodal, door-to-door trip. It mainly informs and does not nudge, but the critical experts and the limited enthusiast, a traveler that mostly needs support and facilitation, might already be facilitated sufficiently in booking their sustainable multimodal journey.

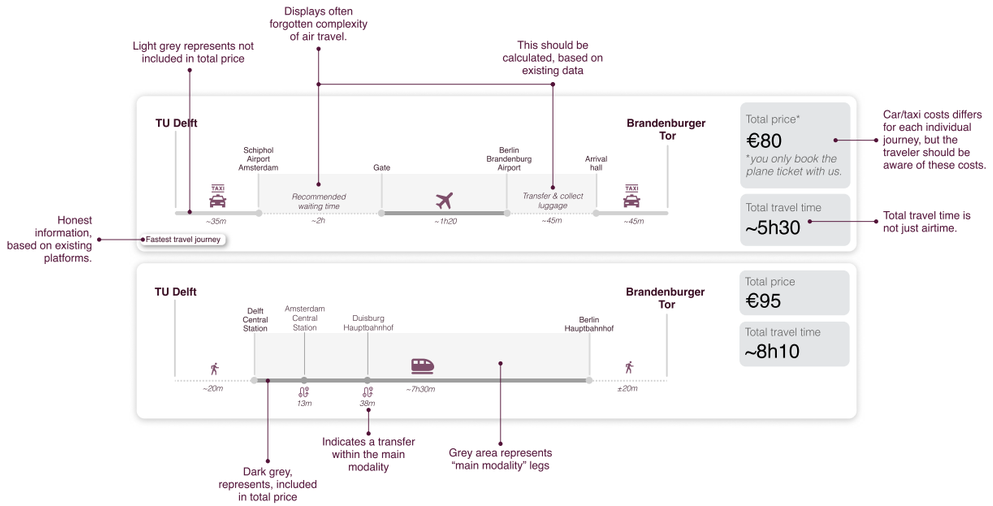


Figure 3.7: *Baseline interface: An honest overview*

When comparing this baseline interface with the list of requirements it overlaps as shown in table 3.6.

When looking at table 3.6, requirements 1, 4a, 4b, 6, 7, and 9 are not met.

On the following pages, three additional platform strategies will be presented. Given that these platform strategies are combined with the baseline choice environment, it is assumed that requirements 2, 3, 5a, and 8a are automatically met. Since the baseline choice environment lacks requirements 1, 4a, 4b, 6, 7, and 9, the additional platform strategies will be designed to address these requirements via different behavioural change approaches.

The key differences between the baseline choice environment and the other platform strategies therefore lie in motivational drivers and nudging strategies. Three behavioral change strategies will be developed based on three distinct motivators: 1) individual drivers, 2) social drivers, and 3) environmental drivers.
Thus, three design directions ideated in DS#1—1) a sustainability score (environmental driver), 2) a traveler community (social driver), and 3) rewarding rail miles (individual driver)—have been iterated and designed in detail.

Table 3.6: *Baseline interface - list of requirements*

	List of requirements	Baseline
1	The platform is motivating its users to travel sustainably	
2	The platform is facilitating its users in traveling sustainably	
3	The platform is accessible	
4	The platform applies nudging strategies	
a	*The platform targets the individual self*	
b	*The platform applies the social norm*	
c	*The platform should set the sustainable travel option as a default*	
5	The platform applies informing strategies	
a	*The platform communicates tangible pieces of information on climate change*	
6	The platform breaks habits	
a	*The platform encourages the traveler to stop.. and rethink*	
b	*The platform makes the sustainable option salient*	
7	The platform increases the level of perceived behavioural control	
8	The platform provides a feeling of power/ownership	
9	The platform increases flight shame, difficult to ignore	
10	The platform ensures a positive travel experience (habit formation)	

Strategy A
Sustainable travel navigator

Strategy A, aims to **navigate** the **traveler** towards the most **sustainable** option. The platform applies strong environmental drivers by nudging and informing on climate impact. It aims to increase tangibility by visually comparing climate impact per travel journey. This strategy aims to make the sustainable travel option desirable and feasible while remaining viable.

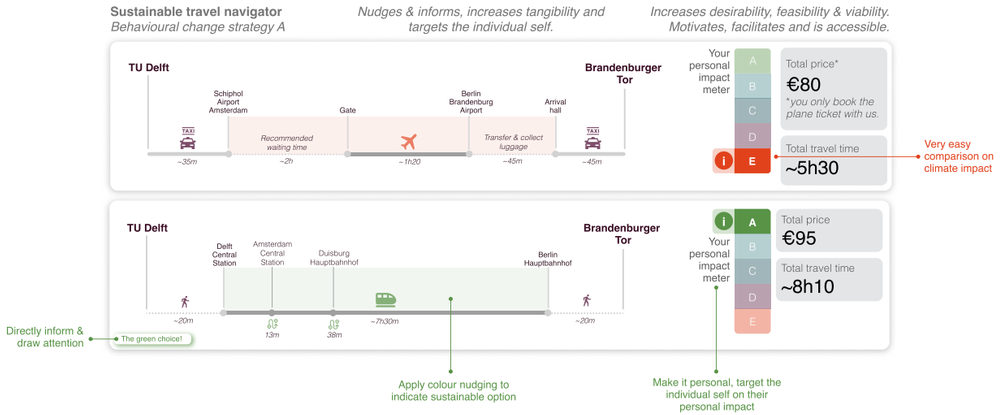


Figure 3.8: *Strategy A: Sustainable travel navigator*

Strategy B
Online traveler hub

Strategy B, aims to create a community feeling and create an **online traveler hub**, where the individual traveler is part of an online community. The platform uses traveler feedback to inform other travelers, and therefore increase the desirability and feasibility of specific travel journeys. Applying social drivers through confirmation, and sometimes maybe a bit of social pressure. Allowing travelers to read about someone else's experiences* makes the platform and the information on the travel journeys more accessible.

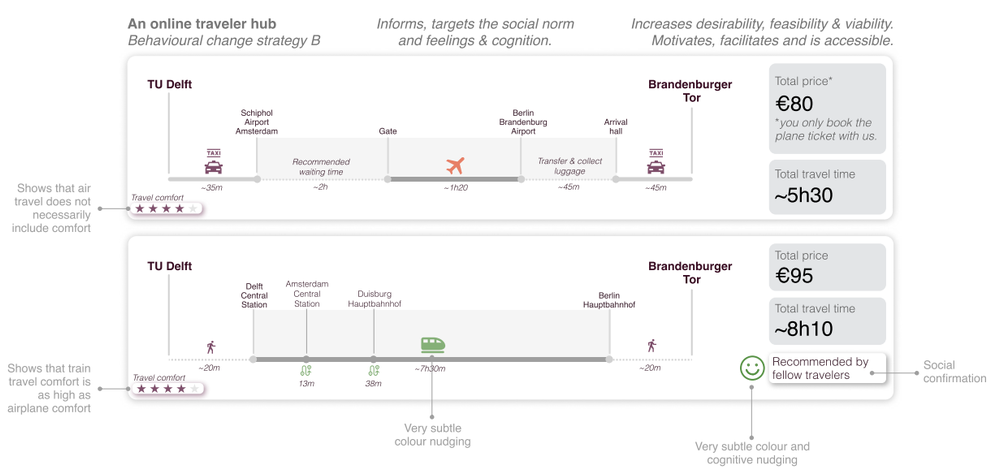


Figure 3.9: *Strategy B: Online traveler hub*

*DISCLAIMER: if the traveler strongly prefers the unsustainable travel option, this strategy might have a negative effect. For the quantitative study, it is assumed that fellow travelers would recommend the railway journeys.

Strategy C
Reframing through rewarding

Strategy C aims to target the individual self and the individuals' feelings and cognition. The strategy nudges travelers with **rewards** and informs them about the positive aspects of sustainable travel modes, **reframing** their attitude. Traveling longer is often perceived as something negative, but a train offers a steady and comfortable journey where travelers are able to use their time efficiently, for example, by reading a book, listening to a podcast, or watching a documentary. This is why, in this case, the reward for green travel is accessibility to some streaming services via the platform (application or website). This interesting thinking about this strategy is that it not only influences short-term decision making, but also ensures an improved travel experience.

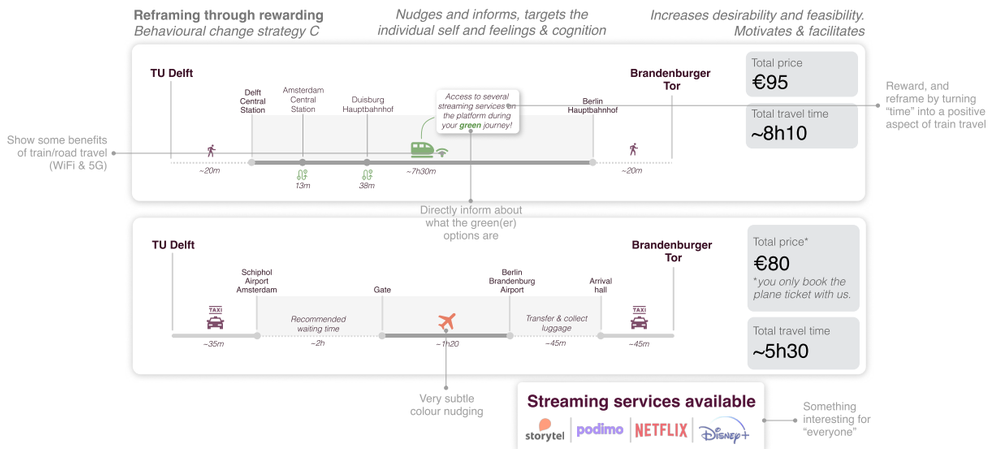


Figure 3.10: *Strategy C: Reframing through rewarding*

Table 3.7 and table 3.8 represent the overlap with the list of requirements and list of wishes for each interface/strategy. Dark blue means partly met.

Table 3.7: *List of requirements for each strategy*

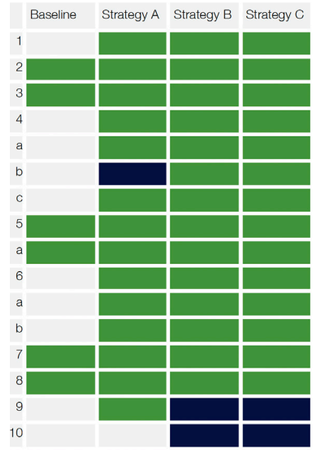
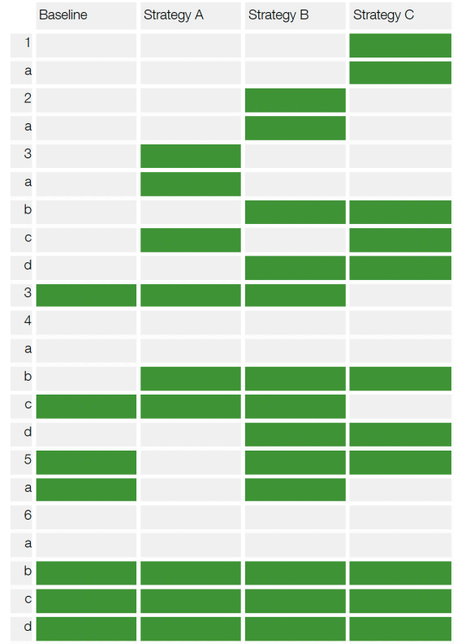


Table 3.8: *List of wishes for each strategy*



Strategy ^2
Trust

Although fellow traveler opinions might have an effect on perceived trustworthiness of the platform, travelers have no way to verify the reliability of the provided information (such as times and prices). To increase the level of trustworthiness and to make sure the platform is able to meet wish 6(a) on the list of wishes an additional trust strategy has been developed.

This strategy is based on the truth; an informational banner will be added to reflect the fact that relevant stakeholders are collaborating to realize this specific platform, including the European Commission, TULIPS, SINTEF, TU Delft, 9292, AVINOR, and Schiphol*. During the quantitative study, the impact of this informational banner on the platform's perceived reliability and trustworthiness will be tested.

Figure 3.11: *Strategy ^2: Trust, informational banner*

*Schiphol has been left out while testing quantitatively to prevent unnecessary social exposure.

3.3 Integral strategy

Designing for systemic change

This section includes:

This section elaborates on the integral strategy that has been designed for the future of multimodal travel behaviour and an improved EU-wide stakeholder collaboration. The integral strategy is communicated in a design roadmap, where systemic change is initiated and seamless, sustainable and multimodal travel forms the future vision.

3.3.1
Roadmap structure

This subsection aims to define a structure for the roadmap based on previous research, future visioning and time pacing. The structure will be built by defining vertical- and horizontal components. The content of the roadmap is based on research findings in the first phase, the guidelines set up in the design brief (page 69) were leading when putting the roadmap together.

Vertical components

Vertically, the roadmap will be divided along a timeline into multiple horizons. In addition to the timeline set for the TULIPS project, the previously introduced European Green Deal, TEN-T policy and the Sustainable Smart Mobility Strategy (SSMS) were leading when defining a total of four horizons and a future vision set for 2050.
Additionally, a study by Veeneman et al. (2020) elaborates on a so-called dreamy ideal for travelers' experience in 2040, aiming for an utopian situation of innovation (encouraging competition) and integration, where (governmental) authorities nurture and allow integration of newly developed innovations on their infrastructures.

Table 3.9: *Time pacing of the roadmap (vertical components)*

	Timeline	Main goals for that horizon
Horizon 0	2024 & 2025	The duration of the TULIPS projects
Transition*	2025 → 2026	What happens when the TULIPS project is finished?
Horizon 1	2026 - 2030	55% GHG reduction & Core Network completion
Horizon 2	2031 - 2040	90% GHG reduction, allowing competition and encourage innovation, while nurturing integration
Horizon 3	2041 - 2050	EU = climate neutral & Comprehensive Network completion (tripling high-speed rails)
Future vision	2050	?

*Transition

Between Horizon 0 and Horizon 1, a key transition phase occurs as the TULIPS project reaches completion. However, since this graduation project and the integral strategy aim for the platform to be further developed, and to encourage travelers to travel sustainably it is assumed that the platform will be launched in the beginning of Horizon 1.

Therefore, the results of the TULIPS project, or more specifically of Task Team 1.6, should be integrated through a merger or acquisition by an existing market player, seeking a key leverage point in the European passenger transport system, nesting to initiate systemic change (section 2.5). The knowledge gathered and multimodal passenger platform concept developed in Horizon 0 should be prepared for transfer to a new platform developer.

The roadmap itself does not provide detailed steps on how this transition period will be managed. Some suggestions and recommendations on possible transitions are elaborated on here;

Acquired by an airport of airline

A potential acquiring platform developer could be a European airport, such as Schiphol or AVINOR (both partners in the TULIPS consortium), or a European airline (e.g. KLM). This may seem contradictory, but there is an urgent need to decarbonize the transport sector, with aviation being the largest contributor to greenhouse gas emissions.
Decarbonization efforts are progressing slowly, and although not regulated at the EU level, some national governments are implementing stricter regulations on short-haul flights. For example, France has decided to suspend domestic flights that can be reached by train in less than 2.5 hours. Similarly, Austria has imposed a €30 tax on flights shorter than 350 kilometers and banned short-haul flights to destinations that can be reached by train in less than three hours (Willsher, 2021).
The Dutch government is also considering similar regulations (Willsher, 2021), making it advantageous for Schiphol to integrate a multimodal service into its existing set of services. Schiphol is already striving to become a multimodal hub (Schiphol, n.d.), and integrating such a service could future-proof them against potentially stricter regulations and allow them to replace short-haul flights with multimodal trips.

Acquired by international travel and tourism organization

Another potential acquiring partner could be international travel and tourism organizations (e.g. TUI), whose goal is already to guarantee a seamless travel experience. Adding the multimodal passenger platform to their current services would support this goal. Integrating a multimodal travel service would not only set them apart from competitors, future-proof their operations, and support their sustainability goals, but also offer a more cohesive and convenient travel experience. A multimodal service would drive customer satisfaction and loyalty while opening up new business opportunities and improving operational efficiencies.

Future vision

The future vision is the end goal of a design roadmap, but also key when designing for a systems-shift (van der Bijl-Brouwer, 2022).

The future vision should align with research findings and TULIPS' ambitions, values and the task team's specific mission of developing a multimodal passenger TRIP platform and ensure seamless travel. Therefore, the future vision aligns with the vision determined in the Design Brief (see 2.4.1 Vision and mission).

Because the roadmap addresses both a societal behavioural shift towards sustainable travel behaviour and systemic change within the European passenger transport network, the future vision in the Roadmap is divided into two parts:

A climate neutral EU, where people have access to seamless, sustainable and multimodal European travel.

A stabilized, innovative and collaborative European passenger transport network.

Horizontal dimensions

Horizontally the roadmap will exist out of five key dimensions. The dimensions represent different systemic layers that require change for reaching the future vision. The designation of these layers is based on previous research outcomes (literature- & market research and expert interviews).

1) Travel behavioural change will be tracked by the upper dimension; sustainable travel behavioural change, representing one key stakeholder: travelers.

2) The development of the platform will be tracked in the second dimension, representing the goal of developing a digital infrastructure; the multimodal passenger platform.

3) As previously introduced in section 2.5, systemic change is what is eventually aimed for. The third dimension provides a visual overview of this systemic change, resulting from travel behavioural change, the developing and improving the digital- and physical infrastructure and an improved stakeholder collaboration.

4) The fourth dimension elaborates on the planned and necessary improvements and developments related to the physical infrastructure of European transport. Input is based on the TEN-T policy and additional EU-wide regulated milestones within the European Green Deal and the SSMS.

5) Finally, the fifth dimension monitors stakeholder collaboration, involving the missing key stakeholders; governmental institutions, transport providers, infrastructure operators, and the platform operator (TULIPS and/or ?).

Horizon 0
2024 - 2025
Create a foundation, predevelopment

Transition phase

Horizon 1
2026 - 2030
Emerge in the system, becoming a key player

Horizon 2
2031 - 2040
Embrace competition and innovation till market saturation

Horizon 3
2041 - 2050
Stabilize the market, finalizing systemic change, together

TRAVELERS AND TRAVEL BEHAVIOUR

Co-creation with travelers, understanding and defining their wants and needs

The platform motivates but mainly facilitates sustainable travel journeys

Competition is rising, but the platform remains relevant and attracts- and shifts more travelers

Using a multimodal passenger platform is accessible and sustainable travel is normalized

Targeted traveler segments

DEVELOPING A DIGITAL ENVIRONMENT

Design and development of the multimodal passenger platform

Launch & strategically market

Maintain, iterate & expand
Finalize TRIP features

Maintain, iterate & expand
Develop integrated ticketing service

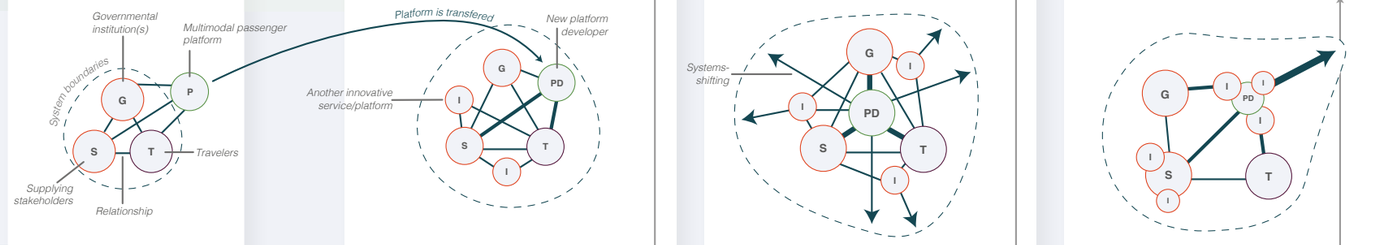
TULIPS

- Prepare a proposal for launching and marketing the platform (ideally in collaboration with new platform developer)
- High-end prototyping:
  - back- and front-end
  - develop KPIs
  - develop/integrate APIs
- Develop ticketing service

The following tasks should be performed by the new platform developer

- Launch and market the platform
- Track traveler-platform engagement, decisions/behaviour and customer base
- Continuously ask for and implement traveler feedback
- Gather data and translate into more available journeys
- Seperate ticketing per transport provider
- Continuously maintain and iterate
- Adjust platform interfaces and features accordingly
- Ensure realtime data and information for entire trip
- Prepare platform integrated ticketing service
- Wide range of EU multimodal travel options available on the platform
- Integrated ticketing for the entire travel journey

TRANSPORT SHIFT



IMPROVING PHYSICAL INFRASTRUCTURE

- Continuous development of TEN-T infrastructural plans
- Decarbonizing the aviation and road sector
- Completing the Core Network of the TEN-T policy
- High-speed rail traffic will double
- *Continuous innovation*
- 1 million electric charging points across the EU
- Higher use of rail and an efficient and interconnected multimodal transport system
- Shares of battery-electric and other zero-emission vehicles are projected to rise to over 60% for cars
- Readying zero-emission large aircraft
- Completing the Comprehensive Network of the TEN-T policy
- High-speed rail traffic will tripple
- A physical infrastructure for seamless multimodal door-to-door travel

STAKEHOLDER COLLABORATION

Set the tone for future development

Create a knowledge foundation, demonstrate change

Expand, improve and and collide

Optimal balance between competitive innovation and integration

European Commission

- Continuously support and fund innovative mobility projects
- Support and implement existing transport decarbonizing policy initiatives
  Focus on decarbonizing air and road transport
- Expand policy initiatives with innovative train, railway- and multimodal research and project proposals
- Introduce strict policy on short-distance flights between EU countries
- Stimulate open APIs and data sharing with MaaS/multimodal purposes
- Encourage innovation and nurture integration of new innovations on infrastructures, support stabalization

National governments

- Some national governments already introduce stricter regulations on short-distance flights
- More national aviation regulations
- Stricter EU-wide (PT) pricing regulation; simple tariff systems and price capping

Suppliers *(providers & operators)*

- Become familiar with TULIPS and the multimodal passenger platform
- Allow and enable data sharing and reselling of transport services via multimodal service platforms
- More transport providers join multimodal platforms and enable/allow data-sharing and ticket reselling
- *Or...*
- All providers share data and allow reselling of services via the (their own) TRIP/MaaS platforms
- Shared mobility services join collaboration
- Continuous innovation and sustainable development
- Additional TRIP, multimodal and MaaS services arise on the market
- Transport providers develop and/or acquire multimodal services

TULIPS *(Task team 1.6)*

- Develop a platform proposal and share research outcomes
- Find a new platform operator
- Transfer project and development in case of a new platform operator

Platform operator

- Actively promote the platform and maintain relationships with existing partners while attracting more transport providing partners
- Work together with other services to shift the market, together
- Lobby for stricter ticketing regulations, allowing integrated ticketing to be implemented in the platform
- High quality and fair price are ensured through competition on services and platforms

A climate neutral EU, where people have access to seamless, sustainable and multimodal European travel

A stabilized, innovative and collaborative European passenger transport network.

Legend

- Continue till 2050
- A.. leads to.. B
- Traveler / traveler behaviour specfic
- Platform specific
- Physical infrastructure
- Stakeholder collaboration
- Platform action
- Stakeholder action
- Action for multiple stakeholders

J.C. Gosens
A multifaceted design strategy to encourage sustainable travel behaviour
Master thesis I Strategic Product Design I 11-07-2024

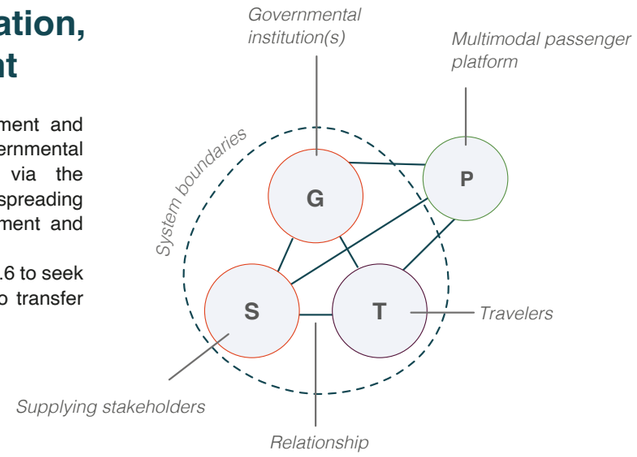
Supervisors
Dr. Ir. Suzanne Hiemstra-van Mastrigt
Prof. Dr. Ir. Ruth Mugge

2024 & 2025

Horizon 0

Create a foundation, predevelopment

The platform is in development and already linked with governmental institutions and suppliers via the TULIPS network, effectively spreading the word about its development and benefits.
it is important for task team 1.6 to seek an alliance with a supplier to transfer the platform to.



Co-creation with travelers, understanding and defining their wants and needs

Design and development of the multimodal passenger platform

Preparing for launch
High-end prototyping
Developing a ticketing service

Set the tone for future development

The transport sector is decarbonizing slowly, with a focus on decarbonizing air- and road transport. The European Commission is continuously supporting and funding innovative projects to achieve the European Green Deal and the infrastructural TEN-T core network completion. TULIPS task team 1.6 is developing a platform proposal and shares outcomes, allowing the market to become familiar with the multimodal passenger platform.

Physical infrastructural focus

Continuous development of TEN-T infrastructural plans

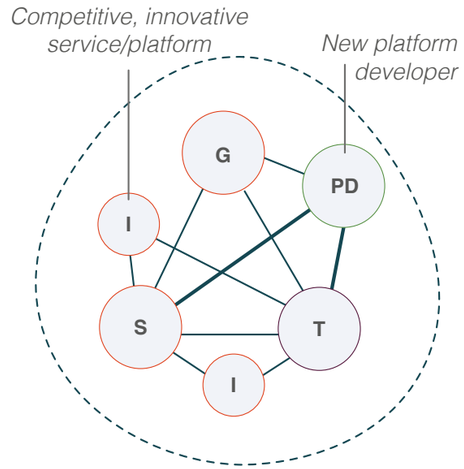
Decarbonizing transport sector

2026 - 2030

Horizon 1

Emerge in the system, becoming a key player

The platform emerges in the system, now connected to a new developer that acquired the multimodal passenger platform concept. The focus for this phase is to connect to/become a key leverage point in the system, become a key player, form alliances with as many providers as possible, and build a broad network of partners. Continuous improvement and maintenance are essential to stay relevant. It is expected that other service innovations will arise on the market as well.



The platform facilitates climate aware travelers in traveling sustainably

Launch and strategically market

Launch and market
Track traveler/user activities, and continuously implement feedback
Translate data into available journey
Offer seperate ticketing per provider

Create a knowledge foundation, while setting an example

The European Commission should expand the European Green Deal program with innovative research and project proposals in train, railway, and multimodal transport, creating a foundation for multimodal development. As more national governments regulate the aviation sector, supplying stakeholders will be encouraged to invest in- or partner with multimodal services.
Other multimodal TRIP and MaaS services will start emerging on the market, and competition will increase. A systemic shift is initiated, slowly normalizing and embracing multimodal and sustainable travel journeys.

Physical infrastructural focus

Completing TEN-T core network, doubling high-speed rail trafic

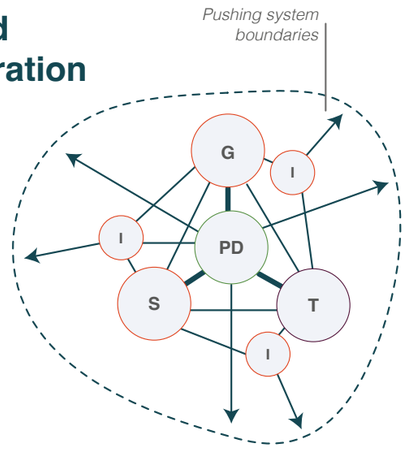
1 million electrical car charging points

2031 - 2040

Horizon 2

Embracing competition and innovation, till market saturation

More and more innovative travel services are emerging, expanding both knowledge and the market. Numerous new bilateral relationships are forming; this is where governmental institutions should closely monitor the market and foster the optimal integration of new innovations into government-regulated infrastructural systems. Customer interest and desirability of the platform, determine its success within such a competitive market. Continuously adapting and improving is therefore of high importance.



Competition is rising, but the platform remains relevant and attracts- and shifts more travelers

Maintain, iterate & expand
Finalize TRIP features

Continuously adapt to new features

Realtime data and information

Prepare for integrated ticketing

Expand, improve and collide

Due to stricter EU-wide policies on short-distance flights and the normalization of open APIs and data sharing for MaaS/multimodal purposes, more transport providers are joining or developing/acquiring multimodal services. This leads to a full and competitive market with high levels of innovation. Transport providers and the multimodal passenger platform should collaborate to manage this dynamic market while staying relevant and adapting to shifts in the industry. Together, these service providers could form a united front and lobby for stricter ticketing regulations while aiming for integrated ticketing solutions.

Physical infrastructural focus

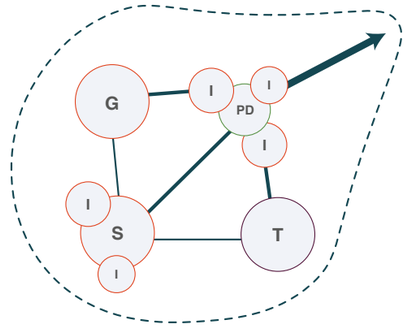
- Higher use of rail and an efficient and interconnected multimodal transport system
- Increase battery-electrice and zero-emission vehicle use
- Improvements in zero-emission aircraft technologies

2041 - 2050

Horizon 3

Stabilize the market, finalizing systemic change, together

The market should be stabilized by finding a balance between innovation, competition, and integration. Active stakeholders are working together towards the future vision of 2050. Governmental institutions monitor the market, but it primarily functions independently, with suppliers and commercial market players offering multimodal services. Improved infrastructure enables this market to provide seamless, sustainable, multimodal travel services.



Using a multimodal passenger platform is accessible and sustainable travel is normalized

Maintain, iterate & expand
Integrated ticketing

Expand available travel journeys

Integrated ticketing facilitated

Optimal balance between competitive innovation and integration

An optimal balance between competitive innovation and integration has been achieved, allowing a saturated market to access a comprehensive physical and digital infrastructure system. An integrated ticketing system across the EU is made possible through stricter EU-wide pricing regulations, simplified tariff systems, and price capping. High quality and fair prices are ensured through balanced competition in the transport service market.

Physical infrastructural focus

- Completing the Comprehensive Network of the TEN-T policy
- High-speed rail traffic will tripple
- A physical infrastructure for seamless, multimodal, door-to-door travel

Optimize.

4

4.0 Introduction

This chapter elaborates on the quantitative study that has been executed.

The effect on travel behaviour of the four designed platform strategies will be examined and analyzed to determine whether one/or more of these strategies has a significantly differing effect. Additionally, the data gathered from the questionnaire will uncover other results, which will be elaborated upon. The quantitative study aims to validate and/or optimize outcomes and conclusions from the research and design process, enabling iterating the platform strategy one final time.

4.1 Methodology

This section includes:

This section elaborates on the methodology for the quantitative study, a qualtrics questionnaire has been spread and the answers have been analyzed via SPSS Statistics.

4.1.1
Questionnaire design

From this point on, the platform strategies will be referred to as Baseline, Strategy A, Strategy B and Strategy C (see table 4.1).

In qualtrics a questionnaire has been developed where the four different platform strategies will be tested. An in-between block-design has been applied, to avoid respondent fatigue and a possible order effect. This “in-between block group” is preceded- and followed by multiple within question blocks (these blocks are the same for each participant).

Table 4.1: *Overview platform strategies*

An honest overview	Baseline
Sustainable navigator	Strategy A
Online traveler hub	Strategy B
Reframing through rewarding	Strategy C

Questionnaire architecture

The questionnaire was designed as graphically shown in figure 4.1 on the next page. A detailed export of the questionnaire can be found in appendix J.

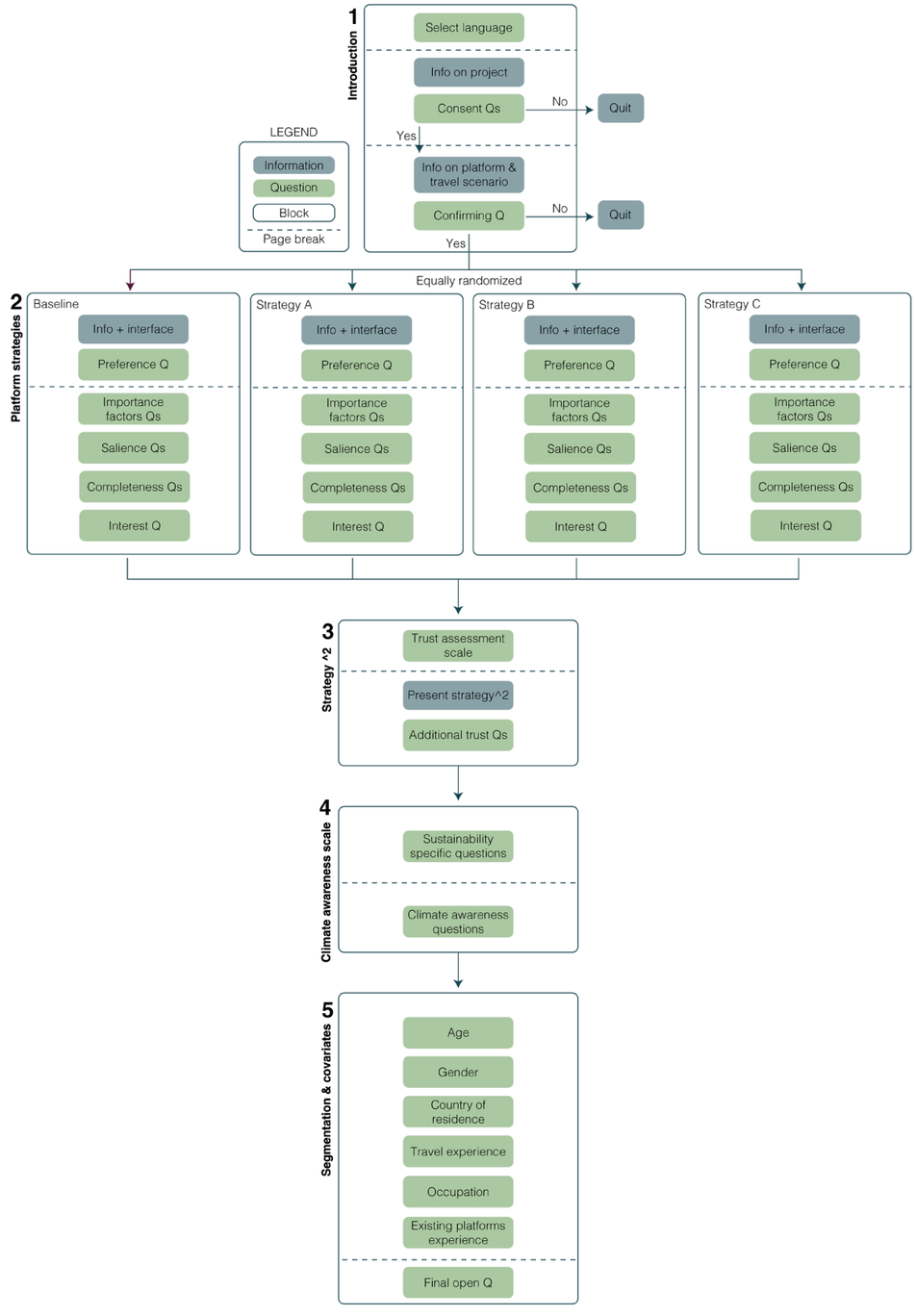


Figure 4.1: *Graphical representation of questionnaire architecture*

Block 1 - Introduction

The first block provides additional information and explanation about the project and the multimodal passenger platform, followed by several consent questions. The quantitative study and the questionnaire have been approved by the HREC committee of TU Delft (ID: 4165). This block also includes a detailed travel scenario and a confirmation question to ensure that participants answer according to their true personal preferences. If participants do not agree or confirm, they will not be able to proceed with the questionnaire.

Block group 2 - Platform strategies

This block group contains four in-between blocks, each participant is exposed to one of these blocks (equally randomized). Each block presents one platform strategy.

Only the question block of the baseline interface is added in appendix J; the blocks for Strategy A, Strategy B, and Strategy C are identical except for the interface screenshots (Appendix K).

Each block begins with the presentation of seven possible journeys, integrated into a screenshot of the platform strategy specific interface and strategy. After reviewing the interface and journeys, participants are asked to select a preferred journey. This is followed by some additional travel or platform related questions, such as the importance of certain factors, the salience of the sustainable travel journey, the completeness of the information, and whether they are interested in using such a platform.

Block 3 - Strategy^2

A trust assessment scale is included to test the general trustworthiness of the platform (Büttner & Götitz, 2008). Secondly, the informational banner called; Strategy ^2, is presented, and the participants are asked whether this strategy has an effect on their perceived level of trustworthiness/reliability of the platform.

Block 4 - Climate Awareness Scale

The fourth block includes a climate awareness scale (CAS) derived from a report by Zijlstra & Uitbeijerse (2023), previously referenced in this graduation report. Zijlstra & Uitbeijerse explain that awareness of climate change and the impact of flying will be measured using four statements, forming a latent variable called 'climate awareness'. Two of these statements link flying directly to climate change, while the other two emphasize the seriousness and consequences of climate change. Making an estimate of the level of climate awareness of participants can be adopted as a covariate that ought to be taken into consideration when examining the outcomes of the quantitative study.

Block 5 - Segmentation and covariates

The fifth block includes mostly fact-based questions (age, gender, experience e.g.). The goal of the data derived from these questions is to exclude or understand covariates and test the potential impact of specific factors (experience e.g.).

Scenario

In order to keep Control Variables (CV's) constant, and exclude room for interpretation, all participants are introduced to the same seven travel journeys within the same travel scenario: a trip from Delft University of Technology to the Brandenburger Tor, Berlin. The specific text and details are provided in the questionnaire export in appendix J.

Two air-journeys, two rail-journeys and three road-journeys are presented to each participant (see appendix K). Data used for the scenarios (price, time and transfer information) is based on true data from existing platforms (NS International, Trainline, Google Maps, DB, Cheaptickets, Skyscanner etc.). Table 4.2 elaborates on the different travel journeys, offering a wide variety of travel options differing in main modality and first- and last mile transport.

This specific scenario was chosen because the rail route between Delft and Berlin is considered semi-competitive and semi-attractive. Traveling to Berlin by train is feasible but longer compared to flying.Additionally, the accessibility of this rail route might surprise travelers.

Sharing the questionnaire

The questionnaire was spread via personal networks (whatsapp and social media) and professionally via LinkedIn. The TULIPS consortium posted the questionnaire on their LinkedIn, supporting the search for participants (outside of the Netherlands). The questionnaire was initially not promoted towards a specific traveler segment, this would only limit the number of respondents and it is difficult for people to determine whether they are e.g. a Limited Enthusiast.

Table 4.2: *Overview of seven travel journeys in questionnaire*

	First mile	**Main modality**	Last mile	Total time	Total price
Travel journey 1	Walking	**Train**	Walking	8h10	€95,-
Travel journey 2	PT	**Train**	PT	7h50	€110
Travel journey 3	Taxi	**Airplane**	Taxi	5h30	€80,- *only booking the airplane ticket*
Travel journey 4	Train/PT	**Airplane**	Train/PT	6h05	€93
Travel journey 5	Walking	**Tourbus (FLIX)**	Walking	13h40	€55
Travel journey 6	PT	**Tourbus (FLIX)**	PT	13h20	€60
Travel journey 7	-	**Private car**	-	7h30	*Not bookable on the platform*

4.1.2

Data analysis

Multiple tests and analyses have been conducted to examine the data obtained from the questionnaire responses. The answers were downloaded as an Excel file, which was initially searched for notable outliers and unfinished responses. Subsequently, the data was combined into a single spreadsheet, with answers still categorized according to their conditions. The subsections below elaborate on how various data sets were analyzed using SPSS Statistical.

Differences between conditions

The four platform strategies in block group 2 are an independent variable (IV), which aim to have an effect on decision making and travel behaviour; the dependent variable (DV).
An **Analysis of Variance (ANOVA)** is performed to capture whether there is a significant difference in effect between platform interfaces/strategies.
To test which specific strategies differ from each other in effect, a **Bonferroni post-hoc test** has been performed.

Examining covariates

To rule out the presence and/or understand the potential effects of covariates, **One-Way ANOVAs** and **ANCOVAs (Analysis of Covariance)** have been performed. A covariate is a variable that is not of primary interest but could influence de DV. It is assumed that most covariates are ruled out because of the detailed scenario.
The potential covariates that will be analyzed are:

- Experience with modalities (train, car, tour bus, and airplane)
- Climate Awareness Scale (CAS)
- Demographic features such as age, gender, and occupation

Evaluating through menas

In order to evaluate the platform, two questions in particular (trust scale and interest in the platform) will be analyzed. The answers to these questions will serve as an evaluation for TULIPS and the task team, testing the initial level of trust, the effect of Strategy^2 on trust, and the general interest in the platforms' services. This data will be analyzed using a **One-Sample T-test**, comparing the mean to a predetermined test value, the test value being the midpoint of the applied Likert scale (5) representing a hypothesized population mean.

Optimizing through open questions

The questionnaire included some open-ended questions to gather additional explanations for the closed answers. The responses to these questions will be read, reviewed, clustered and themed.

4.2 Hypotheses

The main goal of the quantitative study was to test the *hypothetical difference in effect between designed platform strategies and the baseline interface on travel behaviour*. Therefore, the three initial hypotheses are:

H1: Strategy A: The Sustainable Navigator, has a differing effect on travel behaviour compared to the baseline interface.

H2: Strategy B: The Online Traveler Hub, has a differing effect on travel behaviour compared to the baseline interface.

H3: Strategy C: Reframing Through Rewarding, has a differing effect on travel behaviour compared to the baseline interface.

The differing effect on sustainable travel behaviour will be measured in three ways: 1) average kg CO2 per traveler, 2) average sustainability level (A>E, quantitatively represented as 1>5) and 3) amount of preferred main modalities (1 = train, 2 = tour bus, 3 = car, 4 = airplane).

Additional effects and covariates will be tested upon the following hypotheses;

H4: There are no differences in climate awareness between the four conditional groups.
H4a: The level of climate awareness has an influence on preferred travel journey (is a covariate).

If both H4 and H4a are accepted, it indicates that the covariate "climate awareness" has had an effect on the sample as a whole and has influenced decision-making equally within all four conditions. It is expected that a higher level of climate awareness leads to an increased likelihood to travel with sustainable modalities and therefore influences decision making. If H4a is accepted, but H4 is rejected, it means that there is a statistically significant difference in climate awareness between the four condition samples. The same reasoning applies to the following potential covariates:

H5: There are no differences in age distribution between the four conditional groups.
***H5a*:** The participants' age has an influence on preferred travel journey (is a covariate).

H6: There is no difference in gender distribution between the four conditional groups.
***H6a*:** The participants' gender does not have an influence on preferred travel journey (is not a covariate)

H7: There is no difference in occupation distribution between the four conditional groups.
***H7a*:** The participants' occupation has an influence on preferred travel journey (is a covariate).

H8: There are no differences in previous experiences with modalities between the four conditional groups.

In addition to H8, the individual effect of experience levels (1 = yes, often, 2 = yes, sometimes, 3 = no) with each modality (IV) will be tested on chosen main modality (DV).

H9: The level of train experience has an effect on the chosen main modality (is a covariate).

H10: The level of airplane experience has an effect on the chosen main modality (is a covariate).

H11: The level of tour bus experience has an effect on the chosen main modality (is a covariate).

H12: The level of car experience has an effect on the chosen main modality (is a covariate).

Finally, the level of trust (trust scale), the effect of Strategy ^2, and the level of interest in the platform service will be analyzed, testing the following hypotheses:

H13: The level of trust is higher than the hypothesized population mean (3).

H14: Strategy^2 has an increasing effect on the level of trustworthiness/reliability of the multimodal passenger platform.

H15: The level of interest is higher than the hypothesized population mean (3).

If hypotheses need to be rejected due to statistically insignificant differences/effects or other unexpected analysis results, exploratory data analysis can be performed to understand the impact of possible covariates or other influencing factors to support previous research findings in a different way.

4.3 Results

This subsection elaborates on the results of the data analysis. The previously established hypotheses will be accepted or rejected based on statistical tests. An export of supporting SPSS output is added in appendix L. Additionally, qualitative answers to open questions have been clustered and examined accordingly. The questionnaire gathered a total of 96 fully finished answers (N = 96).

Testing the effect of the platform strategies on travel behaviour (H1, H2 & H3)

The effect of the platform strategies in comparison to the baseline interface has been tested via One-Way ANOVA. The effect has been measured in 1) kgCO2 per traveler and 2) sustainability level. Additionally, the effect on main modality preference has been analyzed. Table 4.3 shows the input data per preferred travel journey.

The kgCO2 per traveler is an estimate based on multiple sources, the kgCO2 travel calculators by Milieu Centraal (n.d.) and Eco Passenger (n.d.) have been leading.

Table 4.3: *Input data per chosen travel journey*

	kgCO2 per traveler	Sustainability level
Rail journey 1 (walking)	20	1
Rail journey 2 (PT)	20	1
Road journey 1 (PT)	30	2
Road journey 2 (walking)	30	2
Road journey 3 (car)	121	3
Air journey 1 (PT)	171	4
Air journey 2 (taxi)	181	5

Table 4.4 on the next page gives a descriptive overview on preferred travel journeys per condition.

Table 4.4: *Descriptives per condition per preffered travel journey*

	Baseline	A	B	C	Total
N	24	25	23	24	96
Rail journey 1 (walking)	12	15	7	9	43
Rail journey 2 (PT)	2	5	10	5	22
Road journey 1 (walking)	2	2	-	-	4
Road journey 2 (PT)	1	-	-	3	4
Road journey 3 (car)	-	2	-	1	3
Air journey 1 (PT)	3	-	4	-	7
Air journey 2 (taxi)	4	1	2	6	13

kgCO2 per traveler

Table 4.5 displays the mean in kgCO2 per traveler, per condition.

No statistically significant difference in kgCO2 emission per traveler was found between the conditions (F(3, 92) = 1.298, p = 0.280). Therefore, H1, H2 and H3 will be rejected.

Level of sustainable travel choices

In line with the previous outcomes, no statistically significant difference in sustainability level per condition was found (F(3,92) = 1.558, p = 0.205). Therefore, H1, H2 and H3 will once again, be rejected. Table 4.6 displays the average sustainability level of choice per condition.

Main modality preference

A distinction has been made between main modality preferences (value; 1 = train, 2 = tour bus, 3 = car, 4 = airplane).

The different platform strategies do not have a statistically significantly differing effect on preference for main modality preferences (F(3,92) = 1.420, p = 0.242).

Table 4.5: *Calculated means in kgCO2 per traveler*

Condition	*Mean [kgCO2 per traveler]*
Baseline	66.792
A	35.280
B	60.174
C	65.458
Total	56.667

Table 4.6: *Calculated means in sustainability level*

Platform strategy	*Mean [sust. level of choice], 1 = sustainable, 5 = unsustainable*
Baseline	2.17
A	1.40
B	1.87
C	2.21
Total	1.91

Analyzing covariates (H4(a), H5(a), H6(a), H7(a), H8)

Climate awareness

The participants' answers to the following four statements have been combined in one average of the Climate Awareness Scale (CAS);

- Climate change is a serious issue
- Climate change has an effect on our lives on planet earth
- CO2 emission as a result of human activity (like flying) contributes to climate change
- When I fly, I contribute to climate change

Table 4.7 displays the mean of "Climate Awareness" per participant per condition, where 1 = low climate awareness and 5 = high climate awareness.

No statistically significant difference was found in Climate Awareness between the four conditional groups (F(3,92) = 2.090, p = 0.107). H4 can be accepted.

An ANCOVA points out that there is a statistically significant relationship between the CAS and the preferred travel journey (F(1, 91) = 6.231, p = 0.014).

Table 4.7: *Calculated means in CAS*

Conditional group	*CAS, mean*
Baseline	4.3021
A	4.6900
B	4.4457
C	4.4167
Total	4.4661

A mean score of 4.5154 on the CAS appears to be relatively high. To determine whether this sample mean is high in comparison to a population mean, the results of this quantitative study could be compared to the KiM study by Zijlstra and Uitbeijerse (2023), as the applied CAS is inspired by their work. However, Zijlstra and Uitbeijerse (2023) do not provide exact numbers. Therefore, no true statistical analysis can be performed to assess whether the sample may have a high level of climate awareness compared to the average climate awareness of the population.

This high level of climate awareness is also recognized in the question where participants were asked to identify the most sustainable travel options. Almost all respondents selected one of the railway journeys as the most sustainable. Four respondents selected one of the road journeys (tour bus) as the most sustainable, assuming the tour bus was electric.

Age

No statistically significant difference was found in age between the four conditional groups (F(3,92) = 0.734, p = 0.535). H5 can be accepted.

ANCOVA points out that age does not have a statistically significant influence on the choice of preferred travel journey (F(1,88) = 1.496, p = 0.225). H5a can be rejected.

Gender

No statistically significant difference was found in gender between the four conditional groups (F(3,92) = 0.296, p = 0.847). H6 can be accepted.

ANCOVA points out that age does not have a statistically significant influence on the choice of preferred travel journey (F(1,91) = 1.084, p = 0.301). H6a can be accepted.

Occupation

No statistically significant difference was found in occupation between the four conditional groups ($F(3,92) = 1.165$, $p = 0.496$). H7 can be accepted.

ANCOVA points out that age does not have a statistically significant influence on the choice of preferred travel journey ($F(1,90) = 0.306$, $p = 0.581$). H7a can be rejected.

Experience

The participants were asked whether they traveled internationally with four different modalities: train, airplane, tour bus and the car, in the last 5 years. They could answer 1) yes, often, 2) yes, sometimes and 3) no.

No statistically significant difference was found in experience with international train travel between the four conditional groups ($F(3,92) = 0.069$, $p = 0.935$).

No statistically significant difference was found in experience with international air travel between the four conditional groups ($F(3,92) = 0.380$, $p = 0.991$).

No statistically significant difference was found in experience with international tour bus travel between the four conditional groups ($F(3,92) = 0.232$, $p = 0.635$).

No statistically significant difference was found in experience with international car travel between the four conditional groups ($F(3,92) = 0.715$, $p = 0.110$).

Therefore, H8 can be accepted.

The effect of modality experience (H9, H10, H11, H12)

During the research phase, the influence of previous modality experiences was identified as one of the long-term factors affecting travel behaviour (see section 2.2.2). To analyze the effect of previous experiences on main modality preference, multiple One-Way ANOVAs and ANCOVAs were conducted.

Effect of experience with train travel

A statistically significant difference between the effect of three levels of train travel experience on main modality preference was found ($F(3,92) = 6.586$, $p = 0.011$). A Bonferroni Post Hoc Test revealed that “Yes, often” and “No” differ statistically significant in their effect on preferred main modality ($p = 0.014$).
An ANCOVA confirmed train experience to be a covariate on main modality preference ($F(1,91) = 8.982$, $p = 0.004$)

Effect of experience with air travel

No statistically significant difference between levels of air travel experience was found ($F(2,93) = 0.216$, $p = 0.807$).
An ANCOVA points out that plane experience is not an influencing covariate on main modality preference ($F(1,91) = 0.001$, $p = 0.979$).

Effect of experience with tour bus travel

No statistically significant difference between levels of tour bus travel experience was found ($F(3,93) = 0.304$, $p = 0.739$).
An ANCOVA points out that tour bus experience is not an influencing covariate on main modality preference ($F(1,91) = 0.229$, $p = 0.633$).

Effect of experience with car travel

No statistically significant difference between levels of car travel experience was found ($F(2,93) = 0.574$, $p = 0.565$).
An ANCOVA points out that car experience is not an influencing covariate on main modality preference ($F(1,91) = 0.000$, $p = 0.996$).

Validating through means (H13, H14, H15)

Trust

A One-Way ANOVA points out that there is no significant difference between level of trust between conditions ($F(3,92) = 0.144$, $p = 0.934$).

The table below shows the different means per condition and the total level of trustworthiness for all conditions together.

To test whether the total mean of 3.744 can be concluded as statistically significant higher than the midpoint of the likert scale: hypothesized population mean (3).

A significant difference was found in trustworthiness of the platform in comparison to a test value of 3 ($t(95) = 11.407$, $p < 0.001$). Therefore H9 can be accepted.

Table 4.8: *Calculated means from trust scale*

Condition	*Level of trust*
Baseline	3.729
A	3.789
B	3.663
C	3.750
Total	3.732

Effect Strategy ^2

After presenting the informational banner, the participants were asked whether they find the platform 1) less trustworthy, 2) equally trustworthy or 3) more trustworthy. The average among all 96 participants was 2.61.

A One-sample T-test has been applied, where test value = 2 has been used, representing equally trustworthy.

The informational banner has a statistically significant increasing effect on trustworthiness ($t(95) = 10.258$, $p < 0.001$). Therefore H10 can be accepted.

To elaborate on this, one of the participants wrote:

“Good experiences with 9292 and TU Delft. And by adding something from Europe it increases validation.”

Someone else wrote that she/he found the platform more trustworthy, because:

“Well-known and official platforms and organizations”

Interest

The general interest in such a multimodal passenger platform is tested via a One-Sample T-test, where the within mean (4.32) is compared to the midpoint of the likert scale: hypothesized population mean (3).

A significant difference was found in interest in the platform in comparison to a hypothesized population mean of 3 ($t(95) = 14.038$, $p < 0.001$). Therefore H11 can be accepted.

Additionally, no statistically significant difference in interest per condition was measured via a one-way ANOVA ($t(3,92) = 0.136$, $p = 0.938$).

Exploratory data analysis

In total six different factors have been rated on a likert scale of 1 (not important) to 5 (very important). These factors were:

- Total price
- Total travel time
- Previous travel experiences
- Travel comfort
- Impact on the environment
- Opinions of others

A repeated measures ANOVA has been conducted to examine whether one or more of these factors differs in importance from the other factors. Table 4.9 displays the SPSS output means.

Table 4.9: *Factors and their mean in importance*

Factor	*Mean in importance*
Total price	3.78
Total travel time	4.01
Previous travel experiences	3.52
Travel comfort	3.82
Impact on the environment	3.57
Opinions of others	1.62

A repeated measures ANOVA indicates a statistically significant difference between the importance of the six factors ($F(5, 475) = 78.609$, $p < 0.001$).

To indicate which importance factors statistically significantly differ in pairwise comparison, a Bonferroni Post-hoc test has been conducted.

The Post-hoc test revealed that factor 6: importance of others (mean = 1.679), differs statistically significant in importance with factor 1: total price (mean = 3.728, $p < 0.001$), factor 2: total travel time (mean = 3.914, $p < 0.001$), factor 3: my previous travel experiences (mean = 3.642, $p < 0.001$), factor 4: travel comfort (mean = 3.827, $p < 0.001$) & factor 5: impact on the environment (mean = 3.630, $p < 0.001$).

Quantitative, qualitative data analysis

Each participant was asked what information they missed in order to make an informed decision. The responses were clustered into the following themes, listed from most to least frequently mentioned features:

1. Sustainable impact: CO2 emissions or another method to communicate sustainability ratings
2. Support/security: Additional information on transfers and a possible plan B in case of delays or disruptions
3. Missing prices: Estimates of car and/or taxi prices
4. Times: More detailed information on travel times
5. Comfort: Information on seat reservations and information on travel comfort
6. Personalisation: More options and the ability to customize the journey
7. Explaining prices: More information on the pricing structure
8. Other details: More detailed information for each travel leg (e.g., which provider)

There were little to no comments on the visual identity of the platform, most comments referred to missing information.

4.4 Conslusion and discussion

Comparing platform strategies

Desired platform strategy

This quantitative study found no statistically significant differences between the four platform strategies in encouraging sustainable travel behaviour. Consequently, it is challenging to recommend one of the specific platform strategies for implementation in the final multimodal passenger platform.

Several potential reasons might explain the lack of significant findings:

- Low Number of Respondents: Each condition had only around 25 responses, which might be insufficient to accurately represent the population.
- High Climate Awareness: Participants might have had a relatively high level of climate awareness, predisposing them to choose railway options over flying to Berlin from the start. This factor couldn't be statistically tested due to the lack of a comparative mean.
- Competitive Route: The railway journeys to Berlin may have been too attractive compared to air options, with nearly 67% of participants (65 out of n = 96) choosing a railway travel journey.
- Baseline Interface: The baseline interface already applied informing strategies, making it difficult to compare the results of the platform strategies to the baseline interface.

If the questionnaire attracted respondents with a strong awareness of climate change and an existing motivation to travel sustainably (Critical Expert and Limited Enthusiast), it could be concluded that the goal of facilitating both the Critical Expert and especially the Limited Enthusiast to travel sustainably has been achieved. This is because the high rate of preferred rail travel indicates how effectively the platform facilitates sustainable travel for this group. However, this is purely hypothetical and does not count as a statistically significant result or -conclusion.

During exploratory data analysis, it was concluded that the factor: "opinion of others" is statistically significantly less important compared to other factors. This could explain why Strategy B (Online Traveler Hub) did not encourage sustainable travel behaviour. It is recommended to focus on motivating via environmental- and individual drivers rather than social drivers. The other five factors (time, price, experience, comfort, and impact) are concluded to be equally important. Time and price needs to be improved over time with an improved physical infrastructure and improved stakeholder collaboration, while a positive experience, assured level of comfort, and climate impact information can and should be incorporated into the final platform strategy.

Equally distributed conditional groups
Because H4, H5, H6, H7, and H8 were accepted, the conditional groups are considered equally characterized in terms of climate awareness, age, gender, occupation, and previous travel experiences. Therefore, differences between sample characteristics can be ruled out as covariates or potential reasons as to why no differences between platform strategies have been found. The level of previous international travel experience by train and the level of climate awareness, have however been indicated as covariates;

Designing for climate awareness
Since the level of climate awareness is indicated as a covariate, informing on climate impact and thereby increasing the level of climate awareness is expected to have a positive influence on decision making. Tangible information on ones' climate impact, e.g. via the personal impact meter, is, as expected, desirable to be integrated in the final platform strategy. Transforming the Unaware Hesitator into the Limited Enthusiast, and the Uninformed Potential into a Critical Expert.

Confirming previous research finding on influence of experience with modality
Travelers with "yes, often" - international train experience tend to choose the train as their main modality, while those with no such experience tend to avoid railway travel. In contrast, experiences with international air and road travel do not affect future travel behaviour. This statistical conclusion supports previous research findings on the importance of travel experience in long-term behavioural change and future decision-making. If the platform is able to facilitate a positive international train experience, they are likely to travel internationally by train again, aiming for habit formation. Small rewards to increase the level of comfort and a positive experience might have an impact on that, however, this is not statistically proven.

The platform is perceived as trustworthy
Examining the trustworthiness of the platform, it can be concluded that the multimodal passenger platform is perceived as statistically significantly trustworthy. Including an informational banner statistically significantly increases the platform's trustworthiness and reliability. Therefore, this quantitative study indicates that TULIPS, the task team, should implement such an informational banner, or find some other way to communicate participation of these (and additional) key stakeholders.

There is a high demand for multimodal passenger services
A final, confirming conclusion for TULIPS is the statistically significant high interest in the multimodal passenger platform. This finding indicates a high demand for multimodal door-to-door services, which supplying providers are not yet able to meet in the current European passenger transport network.

Open questions

While more clusters were formed during the analysis of open-ended responses, this conclusion elaborates on the two clusters most frequently mentioned which align with and strengthen other questionnaire findings.

Adding CO2 emission information
Participants who reviewed the baseline interface, Strategy B, or Strategy C expressed a need for information on climate impact or CO2 emissions. Even for Strategy A, two participants mentioned they would like to see more detailed CO2 emission information for each travel leg. It is recommended to include feedback on climate impact in the final platform strategy, and iterate further on the "personal impact meter" used in Strategy A.

Support
Many participants sought additional information on transfers and train options mentioning e.g. low trust in the (German) railway system. One participant mentioned the following:

"Whether I make my transfers and perhaps with what organization I am traveling. For example, I know that in Germany the ICE is almost always delayed. So then I wonder what effects that has on my trip?"

This indicates that travelers seek support both before and during their travel to ensure smooth transfers and reassurance in case of delays or disruptions; a seamless experience.

Recommendations for further quantitative research

Complementary testing
Since no statistically significant differences were found between the platform strategies in encouraging sustainable travel behaviour, it is recommended to test with a bigger and a more diverse group of participants (representing all four traveler segments). The CAS and level of international (train) travel experience makes it somewhat possible to distinguish the distribution of the four traveler segments.

Testing additional strategies
Additionally, it could be possible to test different behavioural change strategy specifications. In the case of testing different strategies, it would still be recommended to maintain a distinction between the targeting individual self, applying the social norm, and communicating environmental effects.

Use a different baseline interface
For future tests, it is recommended to use a different baseline condition that does not include such strong visual/informing elements. It could e.g. be possible to simply list the travel journeys in text, without any form of visualization. For example: "You walk for 20 minutes from TU Delft to Delft Central Train Station, where you take the train to Schiphol Airport, and then board a plane to Berlin," and so on.

Use a different route destination
For the Critical Expert and the Limited Enthusiast, taking the train from Delft to Berlin is a bit too obvious, which is why it is difficult to measure a shift in their preferences/behaviour. However, if an equal distribution of all four traveler segments along conditions can be confirmed, the route between Delft and Berlin can still be interesting.

Carefully consider different multimodal travel journeys based on kgCO2
Ensure that the presented travel journeys show distinct differences in kgCO2 emissions per traveler. Currently, the tour bus and train options do not exhibit significant variation, which challenges the reliability of data supporting the sustainable navigator strategy. For future testing, it is advised to carefully review and verify kgCO2 calculations.

Carefully consider scenario specifications
Introducing a detailed travel scenario is crucial for eliminating covariates and preventing travelers from interpreting the trip in their own way. However, it's important to balance detail and clarity to avoid information overload. In this quantitative study, some respondents complained about the scenario's length, while others found the information still too general (e.g., specifying whether the car or taxi is gasoline or electric). It is recommended to pre-test the scenario to see how long it takes to read and understand, while examining which details are still open to interpretation.

Preparing for the final iterative step

Based on the quantitative study, the list of wishes has been slightly adjusted.

Content-wise, the list of wishes has been revised to reflect the importance of factors by 1) removing social drivers and 2) adding a comfortable journey to the facilitating subgoal (see table 4.10).

In the following chapter, the final platform strategy will be iterated once more and finalized. This list of requirements, supported by the revised list of wishes, will serve as a final checklist to determine when the platform strategy is complete and used to draw up final recommendations for improvement.

Table 4.10: *Revised list of wishes*

	List of wishes
1	Individual drivers
a	Personal benefits
2	Environmental drivers
a	Impact on the environment
b	Show positive perspective
c	Rewarding, setting goals
d	Make it fun
3	Perceived behavioural control
4	Human-like support
a	Integrating personal preferences
b	Suggesting/teaching
c	Making it tangible
d	Assurance of smooth travel experience
e	Assurance of a comfortable journey
5	Feeling at ease
a	Do not push
6	Trustworthy
a	Reliable data
b	Inclusive information
c	Recognizable platform/interaction
d	Easy comparison

Finalize.

5

5.0 Introduction

In this chapter, the quantitative study outcomes will be integrated into one final platform strategy.

The Sustainable Navigator (Strategy A) and Reframing through Rewarding (Strategy C) will be combined. While focusing on meeting all platform requirements and checking off as many wishes as possible. The informational banner will be integrated, to increase trustworthiness and therefore accessibility of the platform.

Finally, some additional design recommendations will be discussed.

5.1 Final design iterations

Combining the Strategy A: Sustainable Navigator with Strategy B: Reframing Through Rewarding results in the following visual representation of the choice environment.

Small iterations are;

- The departure and arrival times have been added to the interface design.
- A specific indication on what option is the most “green” is left out, since the salience of the sustainable option is already high enough without an additional button.
- The reward for traveling sustainably (now access to several streaming services) can be anything. It is however important that the reward is still able to reframe and shed a positive light on the railway journey.

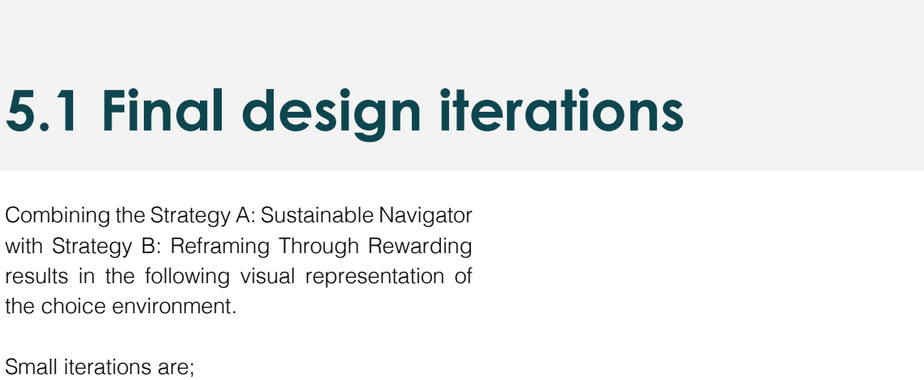


Figure 5.1: *Combining strategy A and strategy C*

The text box could also include information on travel comfort of reservation options (figure 5.2), targeting both individual drivers and perceived behavioural control.

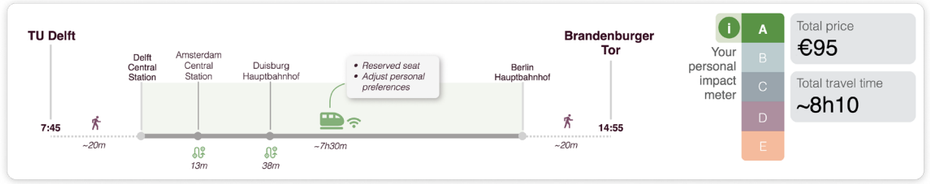


Figure 5.2: *Additional usage of text box*

Such information could also be provided when clicking on the travel journey by showing a more elaborate overview (figure 5.4).

To take away concern of international train transfers and increase the robustness of the railway journey. The platform should already take desired calculated transfer times into account. Communicating this level of robustness for a train transfer could be as shown in figure 5.3 but it could also be part of the unfolded informational overview (figure 5.4).

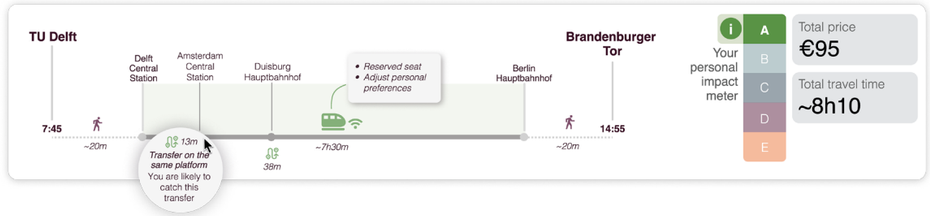


Figure 5.3: *Communicating robustness of a transfer*

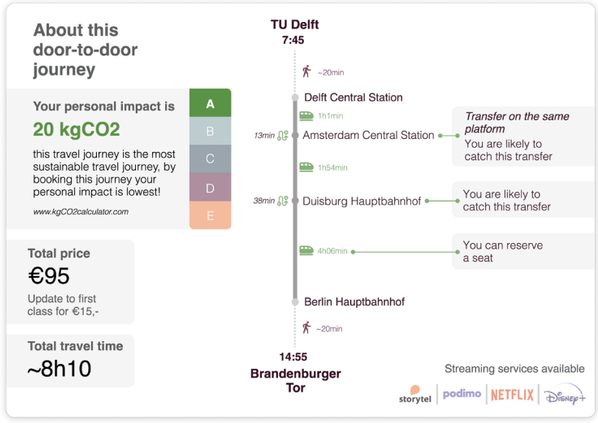


Figure 5.4: *Unfolded travel overview*

To increase the level of climate awareness and make it more difficult to ignore climate impact, the personal impact meter could be elaborated on as shown in the figure 5.6;

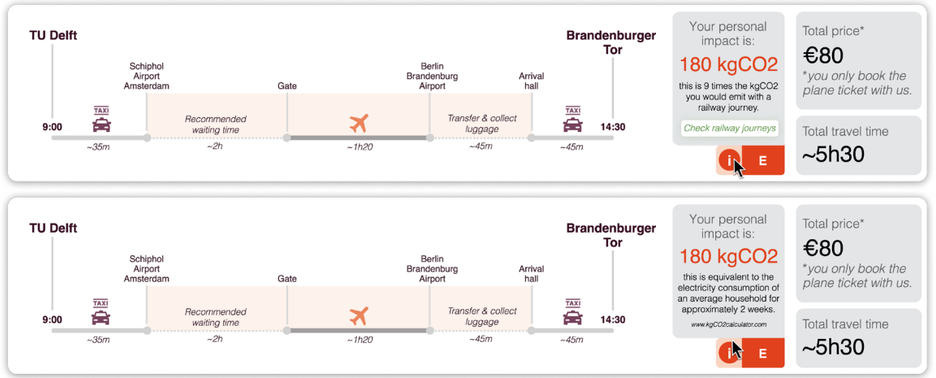


Figure 5.6: *Information on personal impact meter*

When clicking on the information button, the platform could provide a more tangible metaphor to compare the kgCO2 to partly teach about the kgCO2 impact of flying, or the platform could more radically communicate the difference between air and rail travel and suggest looking at rail travel instead.

In addition, while hovering over an unsustainable travel option, a green suggestion could pop up saying that you can make a difference by simply switching first- and last mile transportation (figure 5.7).

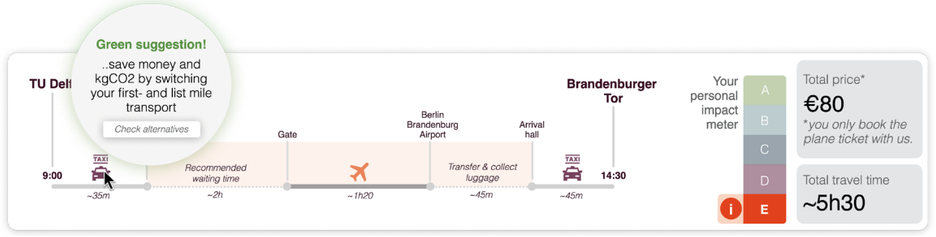


Figure 5.7: *Green pop-up suggestion*

Finally, the informational banner is integrated on the home page, where a traveler can share their travel preferences. The aim is to attract travelers through increased reliability and initial trust, thus encouraging them to try out the platform.

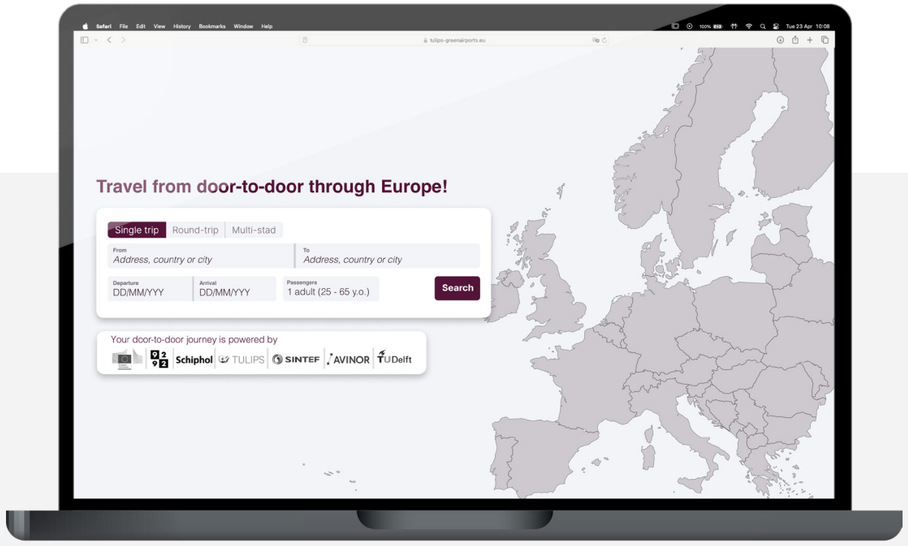
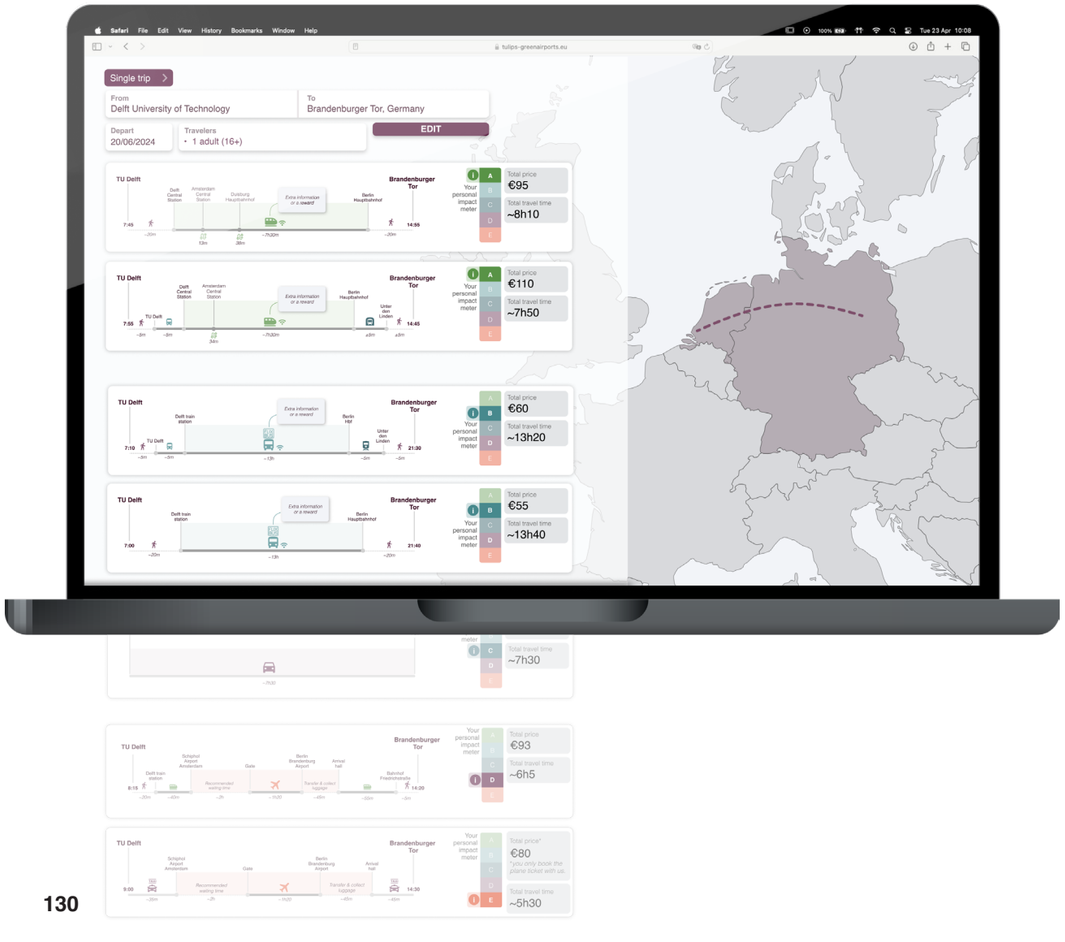


Figure 5.8: *Home page platform*

5.2 Platform strategy

These final iterations result in a comprehensive platform strategy where climate impact is communicated through a personal impact meter and supported by tangible explanatory information on kgCO2 per travel journey. The strategy includes visual nudging through default settings and colour-coding. The strategy aims to reframe the negative image of train journeys by offering rewards that enhance perceived levels of comfort and make the journey more fun. Optimal transfer times are calculated and integrated in the travel journey to improve robustness. Several interactive features allow communication of additional details on transfers, greener suggestions, personalizations, and environmental impact.

Resulting in the following visualization of the platform;



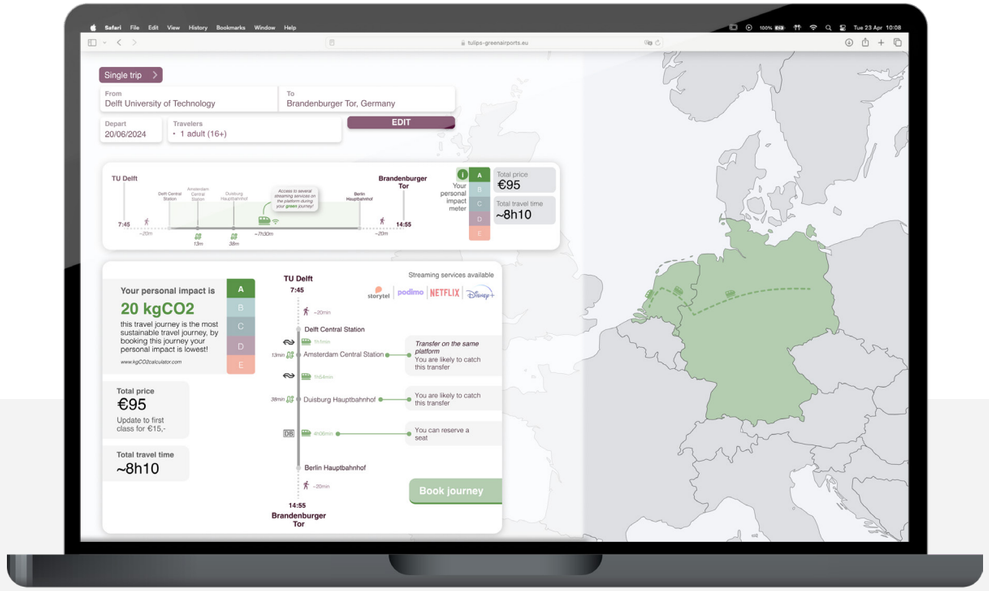


Table 5.1: *Final platform strategy - list of requirements*

	List of requirements	Baseline
1	The platform is motivating its users to travel sustainably	
2	The platform is facilitating its users in traveling sustainably	
3	The platform is accessible	
4	The platform applies nudging strategies	
a	*The platform targets the individual self*	
b	*The platform applies the social norm*	
c	*The platform should set the sustainable travel option as a default*	
5	The platform applies informing strategies	
a	*The platform communicates tangible pieces of information on climate change*	
6	The platform breaks habits	
a	*The platform encourages the traveler to stop.. and rethink*	
b	*The platform makes the sustainable option salient*	
7	The platform increases the level of perceived behavioural control	
8	The platform provides a feeling of power/ownership	
9	The platform increases flight shame, difficult to ignore	
10	The platform ensures a positive travel experience (habit formation)	

The platform meets almost all requirements and wishes, further recommendations in the next section elaborate on the unmet ones.

Table 5.2: *Final platform strategy - list of wishes*

	List of wishes	
1	Individual drivers	
a	Personal benefits	
2	Environmental drivers	
a	Impact on the environment	
b	Show positive perspective	
c	Rewarding, setting goals	
d	Make it fun	
3	Perceived behavioural control	
4	Human-like support	
a	Integrating personal preferences	
b	Suggesting/teaching	
c	Making it tangible	
d	Assurance of smooth travel experience	
e	Assurance of a comfortable journey	
5	Feeling at ease	
a	Do not push	
6	Trustworthy	
a	Reliable data	
b	Inclusive information	
c	Recognizable platform/interaction	
d	Easy comparison	

5.3 Platform recommendations

As shown, the platform only partially meets requirement 10 and could still increase its level of human-like support to ensure a smooth travel experience and make the traveler feel comfortable. To enable the platform to meet this last requirement and wishes, some recommendations are given in this subsection.

Ultimately, the platform should be able to support travel behaviour in all five travel phases (investigate, book, prepare, travel, and evaluate). The platform strategy developed and finalized in the previous sections focuses mainly on the booking phase. The following recommendations are organized by the five phases of travel, supporting the previously mentioned interfaces in table 2.2 on page 37 and the touchpoints in the customer travel journey in appendix D.

Investigate

Ideally, the platform attracts all four traveler segments; from people who are willing and able to travel sustainably to people who are unwilling and unable. The platform should be introduced and marketed carefully in order to do so. This is where accessibility wishes come in handy.
Enabling people to look around at the platform and try out door-to-door trips, without pushing them to create an account or share any personal information (a bit like the interaction with Rome2Rio/Google Maps).

The facilitating features should be obvious, the environmental drivers should be less prominent in the home page, which is why the initial interface remains rather recognizable and neutral, comparable to the baseline visual identity (see figure 5.7).
Create a level of accessibility by marketing and promoting the platform as a multimodal door-to-door service, not as thé sustainable travel planner. On Google, the platform should be positioned as a door-to-door journey facilitator, and when looking for airlines, train or tour buses, the platform should pop up, to make sure everyone who investigates trips ends up on the platforms' website.

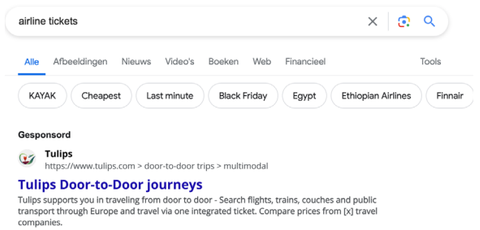


Figure 5.8: *Google search for airline tickets*

Booking | Drill-down approach

During this graduation project, task team 1.6 decided to implement a drill-down, step-by-step, (tunneling) approach to guide travelers through the booking phase. This approach enables users to first select their primary mode of transport and then add first- and last-mile travel legs. It simplifies the booking of sustainable travel journeys, reduces complexity, and allows travelers to customize their trip. Sunio & Schmöcker (2017) confirm that tunneling provides opportunities to persuade consumer behaviour via applications. A step-by-step approach has also been mentioned during CC#2, and was asked for multiple times in the questionnaire. However, because an interactive platform environment was not feasible within the time and scope of this project, the choice environment designed and tested did not include this desired drill-down approach. It is recommended that this interaction is to be designed, and that the desirability and potential impact of such a drill-down approach on decision making will be researched and tested.

It is recommended to implement a "progress bar" like visualization on top of the platform when a traveler constructs his personalized journey over multiple steps. This visualization could also help explain the difference between the main modality and the first and last mile legs of the journey. An example of what this could look like is shown in figure 5.9.

Prepare

After booking the trip, the platform ideally, provides information and tips on how to prepare for the trip. Sharing general tips and tricks on e.g. the type of luggage you should carry or a list of things that should not be forgotten (e.g. passport, ticket, or a powerbank when the train does not contain any sockets).

After the trip is booked, the platform sends an overview of the journey via e-mail, providing insights on journey specifications (times, providers but also kgCO2). Allow an evaluation of one's decisions and explain to them that they should download the app and link their booked journey to the app to be fully prepared. In the case of a sustainable travel journey, the travel overview aim is to increase this feeling of pride over one's' sustainable decisions, rewarding them for choosing sustainably. Additionally, it is important to not "shame" in case of an unsustainable decision, to stay accessible for future travel journeys. An example of how this can be done is shown in figure 5.10.

When something changes in the travelers' itinerary, the platform provides an update via mail and via the travelers' account in the app, updating them on changes and explaining how their itinerary has changed.

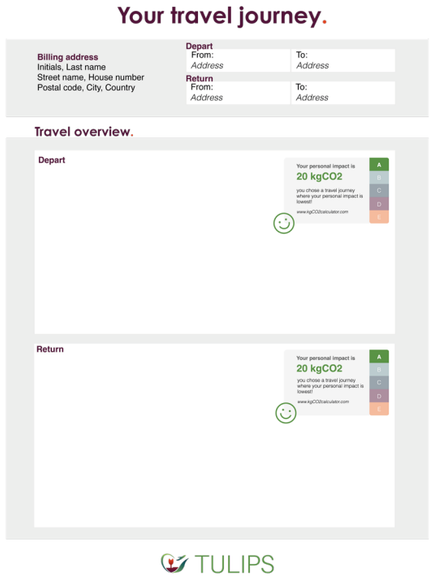


Figure 5.10: *Travel overview in mailbox*

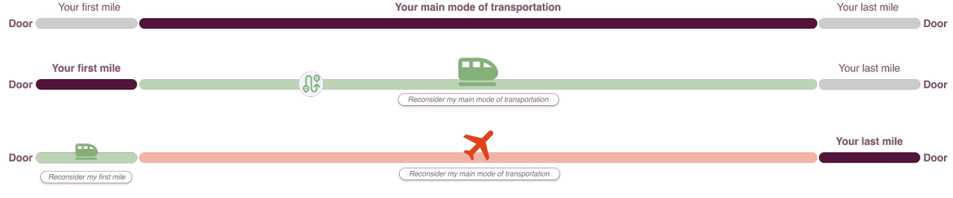


Figure 5.9: *Progress-bar on top of drill-down interface*

Traveling

During the trip, the traveler can use the app to stay continuously updated on their itinerary. The app provides real time data and explains how to get from a to b in case of a modality switch or when transferring within the main modality. An integrated ticketing service ensures a seamless experience where the traveler can easily check-in with each modality with one ticket, combined with their identity card or passport.

Additionally, the platform should be 24/7 approachable in case of delay or disruption, and to optimally support the traveler during their trip in case the app is unable to ensure a stress free experience.

In the case of the reframing through reward strategy, when the traveler logs in to the website or app, they can use the promised streaming services on their own devices while using the WiFi in the modality they are traveling with. Other services can also be integrated into the app to make the trip more fun, during CC#1 one of the participants mentioned that it would be nice to receive some fun facts about the cities/places a train passes through.

Evaluating

The platform should not just provide feedback, the platform should also ask for feedback. This is in line with the long-term goal to continuously improve and iterate the platform while remaining relevant.

An additional feature could be to share a very brief overview of “your trip” that is easy to share via social media or via whatsapp (figure 5.11). Allowing travelers to share their (hopefully) positive experience and spread the word.

Additionally, to motivate the traveler to travel sustainably again, the traveler could be rewarded with rail miles or with a discount if he/she books another sustainable multimodal trip.

The goal is to ensure a bilateral customer-platform relation and make sure the traveler will start over and investigate their door-to-door trip again via the multimodal passenger platform.

Figure 5.10: *Sharing platform experience via social media*

Conclusion.

6

The goal of this project was to create a multifaceted design strategy for encouraging sustainable travel behaviour via a multimodal passenger platform, while sparking systemic change in the European passenger transport network.

To understand what to design and how to design, research was conducted and insights were gathered. This research was concluded in a design brief. Wherefrom a roadmap and several platform strategies were designed, these platform strategies have been tested quantitatively to enable the finalization of one final platform strategy. The project and design goal focused on realizing the future vision (2050): a climate neutral EU, where people have access to seamless, sustainable and multimodal European travel.

Research revealed that unsustainable travel behaviour stems from a lack of motivation and low ability, demanding a platform that both motivates and facilitates sustainable travel. Multimodal innovations were identified as key to improving the environmental performance of passenger transport, addressing a market gap, and meeting an existing demand for seamless multimodal services. Additionally, research pointed out that successful development of such a platform is still hindered by the current passenger transport system and lacking stakeholder collaboration.

The following to strategies together, form the multifaceted design strategy;

1. A platform strategy that motivates and facilitates sustainable travel via an accessible multimodal TRIP platform.
2. A design roadmap that sparks systemic change within the European passenger transport network by stimulating stakeholder collaboration and charting the course towards seamless, sustainable, multimodal international travel in Europe.

These two strategies are interdependent and essential for achieving the design goal and reaching the future vision.

Platform strategy

The platform strategy encourages travelers to travel sustainably by nudging travelers towards sustainable options through purposeful adjustments in choice architecture. It informs travelers about their impact on climate change and applies environmental and individual motivators to make sustainable travel choices desirable.

The platform aims to make sustainable travel feasible, by increasing perceived behavioural control and offering human-like support. It suggests sustainable options and educates travelers about the best choices for the environment, while facilitating a seamless and comfortable travel experience tailored to personal preferences. An initial level of accessibility and trustworthiness is fostered through an informational banner on the interface, making travelers feel supported.

By encouraging travelers to rethink their decision-making and making sustainable options highly

salient, the platform aims to disrupt habitual behavior. Providing a positive, seamless and fun experience encourages travelers to repeat their sustainable travel decisions and therefore form new sustainable habits.

Design roadmap

The design roadmap presents an inspirational future mobility scenario, where enhanced stakeholder collaboration and advancements in both physical and digital infrastructure support the realization of the transport shift. This shift includes both societal behavioural change towards sustainable travel and a systemic transformation towards a stable, innovative, and collaborative European passenger transport network (figure 6.1, displays the two key shifts).

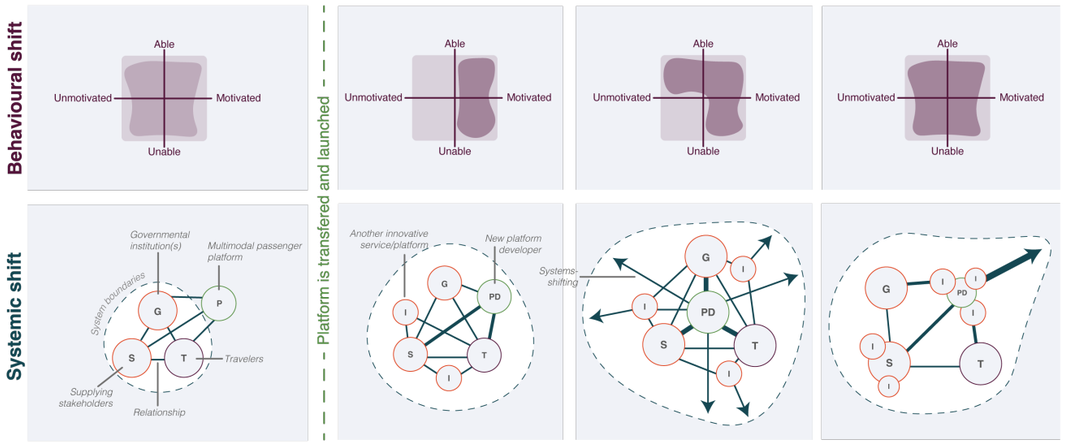


Figure 6.1: *Behavioual- and systemic shift*

Discussion.

7

This discussion elaborates on both limitations to this research and recommendations for further development of the platform and future research. After introducing a limitation, a recommendation is provided on how to address this specific limitation in future research, complemented by additional recommendations or interesting future research and design directions. The recommendations provided for future quantitative research (section 4.4, page 121) and the platform design (section 5.3, page 132) are not included in this chapter, but should be equally acknowledged.

This graduation report establishes a foundational knowledge base and a source of inspiration for multimodal travel in Europe. Future research and platform development can expand upon both the research findings and the design outcomes presented in this report. Moreover, the quantitative testing methodology and outcomes serve as a pilot study for future quantitative tests within task team 1.6. The final platform strategy designed in chapter 5, serves as a strategic and visual foundation for future platform design.

Prototype usability testing

The goal of the TULIPS task team is to develop a prototype of the platform and conduct qualitative usability testing. This involves presenting customers with scenarios where they use the prototype to “book” a ticket from point A to point B. Ideally, both the booking (choice environment) and travel interfaces will be tested to ensure not only a smooth booking process but to additionally assess whether the platform (app) can optimally support travelers throughout their journey ensuring a positive travel experience.

Gather more traveler insights

The four traveler segments are based on existing research, which is considered trustworthy. However, it is recommended to further investigate the specific wants and needs of these segments and to determine how to e.g. market the platform to attract them as users. This can be achieved through additional qualitative research, such as co-creation with traveler segments and qualitative interviews, as well as further quantitative testing, as mentioned in the roadmap. Understanding and iterating upon customer wants and needs is integrated in the integral strategy as well.

Focus on the complete journey

Focusing on the choice environment was necessary to keep the project feasible within a six-month timeframe, but designing for extended support is crucial to motivate and facilitate travelers along the way, encouraging them to form new sustainable travel habits.

The platform (strategy) should eventually encourage travelers in traveling sustainably from the moment they investigate travel options until they evaluate their trip after arrival.

Section 5.3 provides a list of specific design recommendations for the additional travel phases and a brief introduction and design direction for the desired drill-down approach.

Seek expert evaluation

The roadmap lacks expert validation, as it is primarily based on desk research and existing reports on future environmental and infrastructural plans. Consulting with experts or stakeholder representatives would have validated the roadmap and future platform plans. For instance, a meeting with Schiphol, KLM, or another potential platform developer could have confirmed the assumption that such suppliers are interested in acquiring these services. Three possible representatives were contacted in the

final weeks of this graduation project, but no response was received.

Investigate transition more thoroughly

In addition to the previous point, it is crucial to further investigate the transfer period between horizon 0 and 1. This can be done in coordination with possible platform developers that are already incorporated in the TULIPS consortium (e.g. Schiphol, KLM, AVINOR).

Explore economic viability

The project lacks insights into potential economic value. While possible ticketing approaches have been integrated in the design roadmap, it would be valuable to investigate a more precise business model for the multimodal passenger platform. Key questions include how the platform would generate revenue, and what the financial benefits would be beyond its environmental and social advantages. Additionally, it is important to determine the optimal fee to charge on top of resold tickets, finding the right balance between revenue generation without disabling users due to high costs (influencing perceived behavioural control).

Ambitious

The roadmap is quite ambitious, as it assumes that the research conducted by the TULIPS task team will ultimately lead to the development of a multimodal passenger platform. While the actual likelihood of this happening may be lower than suggested. The complexity of the European passenger transport network has been difficult to manage, and some obstacles are probably still to be overcome.

The project outcomes serve as inspiration, showcasing what is possible. They aim to stimulate the European Commission to invest more time, effort, and funding into researching innovations in the rail, train, and multimodal mobility sectors in the near years (horizon 1). Alternatively, they could increase support and funding for initiatives like TULIPS to develop innovative multimodal/MaaS technologies and services.

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Appendix.

Content

Appendix A: **Project brief**

DESIGN FOR our future

TU Delft

Personal Project Brief – IDE Master Graduation Project

Name student Jenske Gosens **Student number** 4657527

PROJECT TITLE, INTRODUCTION, PROBLEM DEFINITION and ASSIGNMENT
Complete all fields, keep information clear, specific and concise

Project title A strategy for an online multimodal passenger transportation service platform, encouraging sustainable consumer traveling behaviour.

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

Introduction

Describe the context of your project here; What is the domain in which your project takes place? Who are the main stakeholders and what interests are at stake? Describe the opportunities (and limitations) in this domain to better serve the stakeholder interests. (max 250 words)

TULIPS is a European consortium that accelerates the implementation of innovative and sustainable technologies to reduce emissions at airports (TULIPS, 2022). Delft University of Technology is one of the many TULIPS partners, including the faculty of Industrial Design Engineering.

One of these projects focuses on developing and testing intermodal (using different modes of transport) services. Two of the subgoals are 1) increase use of public transport and 2) shift traveling behaviour to green commuting modes of transport. Aiming to create digital solutions for the stimulation of international green travel (TULIPS, 2022a).

One of these digital solutions is developing an online TRIP platform that displays all different intermodal commuting options (TRIP = Transaction, Reservation, Information & Planning).
Via this platform TULIPS aims to properly inform and update travelers about their travel options and real-time data of their journey.
The aim of this platform is to inform and educate on multimodal transportation options, and (un)consciously nudge sustainable travel behaviour, resulting in a reduced carbon footprint of travel journeys.
This graduation project focuses on designing a strategy for this platform, aiming to support them in encouraging sustainable consumer traveling behaviour and -decision making.

The development of this platform is executed in collaboration with the Norwegian research organization SINTEF. SINTEF is also one of the partners of the TULIPS consortium and will contribute expertise and technological solutions. They act upon the opportunity to participate in testing and developing green solutions both at Amsterdam Airport and at Norwegian airports, which is in this case the development of an intermodal transport service platform (SINTEF, 2021).

➔ *space available for images / figures on next page*

DESIGN FOR our future

TU Delft

Personal Project Brief – IDE Master Graduation Project

Problem Definition

What problem do you want to solve in the context described in the introduction, and within the available time frame of 100 working days? (= Master Graduation Project of 30 EC). What opportunities do you see to create added value for the described stakeholders? Substantiate your choice.
(max 200 words)

The previously introduced platform is currently being developed, it is still unclear what strategies are desired to encourage sustainable travel behaviour. Sustainable travel behaviour refers to a persons' effort to travel via eco-friendly modes of transport supporting the limitation of negative impacts of passenger transport, in terms of pollution, congestion and climate change (Andersson et al., 2018).

Environmental problems caused by humans is still an increasing problem (Gust, 2004). In industrialized countries (e.g., Europe), there is relatively high climate change awareness and therefore opportunity (Lee et al., 2015). However, lack of information, education, (financial) means etc. often results in undesired unsustainable behaviour (Capaldi & Zelenski, 2016).

Europe offers a wide set of intermodal transport service options, but what latent wants, needs and values control often rather unsustainable travel behaviour? Consumer behaviour is often a result from a set of interacting factors (Gust, 2004; Fogg, 2009). Researching which factors influence behaviour offers an interesting design research opportunity. Consequently, these factors should be exposed, understood, and most importantly integrated within the final strategy for the service platform.

Assignment

This is the most important part of the project brief because it will give a clear direction of what you are heading for. Formulate an assignment to yourself regarding what you expect to deliver as result at the end of your project. (1 sentence)
As you graduate as an industrial design engineer, your assignment will start with a verb (Design/Investigate/Validate/Create), and you may use the green text format:

Design a strategy to (un)consciously encourage sustainable consumer travel behaviour, for the TULIPS online intermodal passenger transport service TRIP platform.

Then explain your project approach to carrying out your graduation project and what research and design methods you plan to use to generate your design solution (max 150 words)

1. Literature review & market research > 5 weeks
Deep dive in project topics (sustainable travel behaviour, sustainable consumer behaviour, multimodal mobility, transport service platforms etc). Look at the current market of service platforms. Integrate a future focus, to make sure the platform stays relevant. Prepare qualitative research study.
2. Qualitative user research > 3 weeks
Confirm latent needs, wants and values that steer consumer behaviour, found in literature. Conclude what steers a travelers' behaviour.
3. Designing a strategy & prototype > 6 weeks
Brainstorming and designing a few possible strategies. Create a testable prototype. Create online quantitative testing environment, in collaboration with SINTEF.
4. Validate & finetune strategy > 6 weeks
Quantitatively test strategies, and decide on most beneficial strategy. Integrate outcomes in final design. Discuss strategy with experts/travellers and finalise design.

Project planning and key moments

To make visible how you plan to spend your time, you must make a planning for the full project. You are advised to use a Gantt chart format to show the different phases of your project, deliverables you have in mind, meetings and in-between deadlines. Keep in mind that all activities should fit within the given run time of 100 working days. Your planning should include a ***kick-off meeting, mid-term evaluation meeting, green light meeting*** *and* ***graduation ceremony****. 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 course activities).*

Make sure to attach the full plan to this project brief.
The four key moment dates must be filled in below

Kick off meeting	12/02/2024
Mid-term evaluation	11/04/2024
Green light meeting	11/06/2024
Graduation ceremony	08/07/2024

In exceptional cases (part of) the Graduation Project may need to be scheduled part-time. Indicate here if such applies to your project

Part of project scheduled part-time	
For how many project weeks	
Number of project days per week	

Comments:

Motivation and personal ambitions

Explain why you wish to start this project, what competencies you want to prove or develop (e.g. competencies acquired in your MSc programme, electives, extra-curricular activities or other).

Optionally, describe whether you have some personal learning ambitions which you explicitly want to address in this project, on top of the learning objectives of the Graduation Project itself. You might think of e.g. acquiring in depth knowledge on a specific subject, broadening your competencies or experimenting with a specific tool or methodology. Personal learning ambitions are limited to a maximum number of five.
(200 words max)

Climate change is one of my biggest worries. Over the years, I realized, that as a designer, I can contribute to this endeavor. I believe in making the good ones big, and the big ones good, where my personal interest is within the latter part. The mobility sector appears to be the perfect fit for this ambition.

As a strategic design student, I believe in a holistic design approach where stakeholder engagement and -collaboration are at its core. The TULIPS initiative is the perfect example of stakeholders collaborating to set systemic change.
Consumers are an important stakeholder; they influence markets and steer "supply" by behaving in a certain way to create "demand". However, strategically designed services/products can influence their demand as well.

Personal learning objectives
1. Learning how to properly validate and test a strategy
2. Improve and expand existing qualitative (user) research skills
3. Gaining experience with designing for sustainable consumer behavioural change, and therefore, design for a better future.
4. Maintaining a professional attitude, as a base for my professional career. Making use of the elaborate network within TULIPS, to position myself on the (mobility) job market as a strategic change enabler.

Appendix B: **List of behavioural change strategies and interventions found in literature**

This list is on the SHIFT framework from White et al. (2019), based on nudging and informing researches (Ölander & Thøgerson, 2014)(Lehner et al., 2016). Based on studies on case studies in existing apps (Andersson et al., 2018)(Sunio & Schmöcker, 2017)

Social influence
- Social norms
- General belief of what is socially appropriate
- Make a behaviour part of someone's social identity
- Status symbols, community feeling
- Make behaviour socially desirable
- Influence by targeting the effect of someones' behaviour on other individuals

Habit formation
- Discontinuity to change a bad habit
- Disruption (in choice architecture), surprising effect
- Penalties
- Implementation of intentions
- Making it easy
- Show that it is not difficult to travel sustainably
- Prompts
- Incentives
- Feedback
- Give information/feedback on CO_2 emissions
- Real-time data, feedback to make the travel stress free

Individual self
- The self-concept
- Facilitate a positive self view
- Traveling sustainable gives a good feeling because you do good for the world
- Self-consistency
- People want consistency, try to disrupt habits and create sustainable consistency
- Self-assessment
- Self-interest
- Add and highlight self-benefits (railmiles)
- Sustainable travel is cheaper, affordability
- Aesthetics
- Self-efficacy
- Give someone confidence/believe in themselves
- Make someone feel good about themselves
- Individual differences
- Acknowledge different groups

Feelings & cognition
- Make a distinction between the feeling route and the cognitive route.
- Negative emotions
- Fear, guilt, sadness
- Positive emotions
- Joy & pride, optimism, increased feeling of tenderness
- Information, learning & knowledge
- Information about desired behaviour and their consequences
- Eco-labeling
- Attention grabbing, easily understandable, consistent across categories
- Framing (focus on future costs instead of future savings)

Tangibility
- Matching temporal focus
- Present-focused
- Communicate local and proximal impacts
- Use current issues
- Concrete communications
- Images, analogies, narratives
- Encourage desire for intangibles
- Promote dematerialization
- Make the travel an intangible good > make it into an experience

Nudging

A lot of the strategies and interventions above match nudging and/or informing, but some additional strategies that have been given for each of these is listed here

- Default (good in combination with informing)
- Anchor (also informing)
- Confirmatory bias (follow the herd)

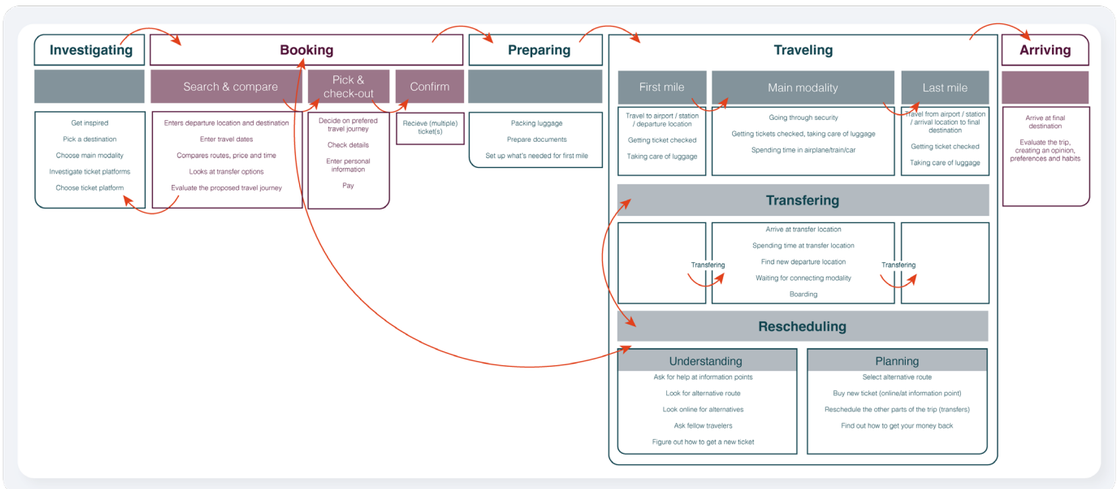
Informing (tips)

- Display information strategically to increase the tangibility and present perceived benefits of traveling sustainably via mass media, but in general environmental behavioural change via mass media is not very effective.
- No small prints/small texts
- Decision tree guidance
- Not too much information
- Prevent competition for consumers' attention
- Only add images if they add something
- Don't use complex texts or "legalistic" wording
- Focus on heuristics people use when processing information

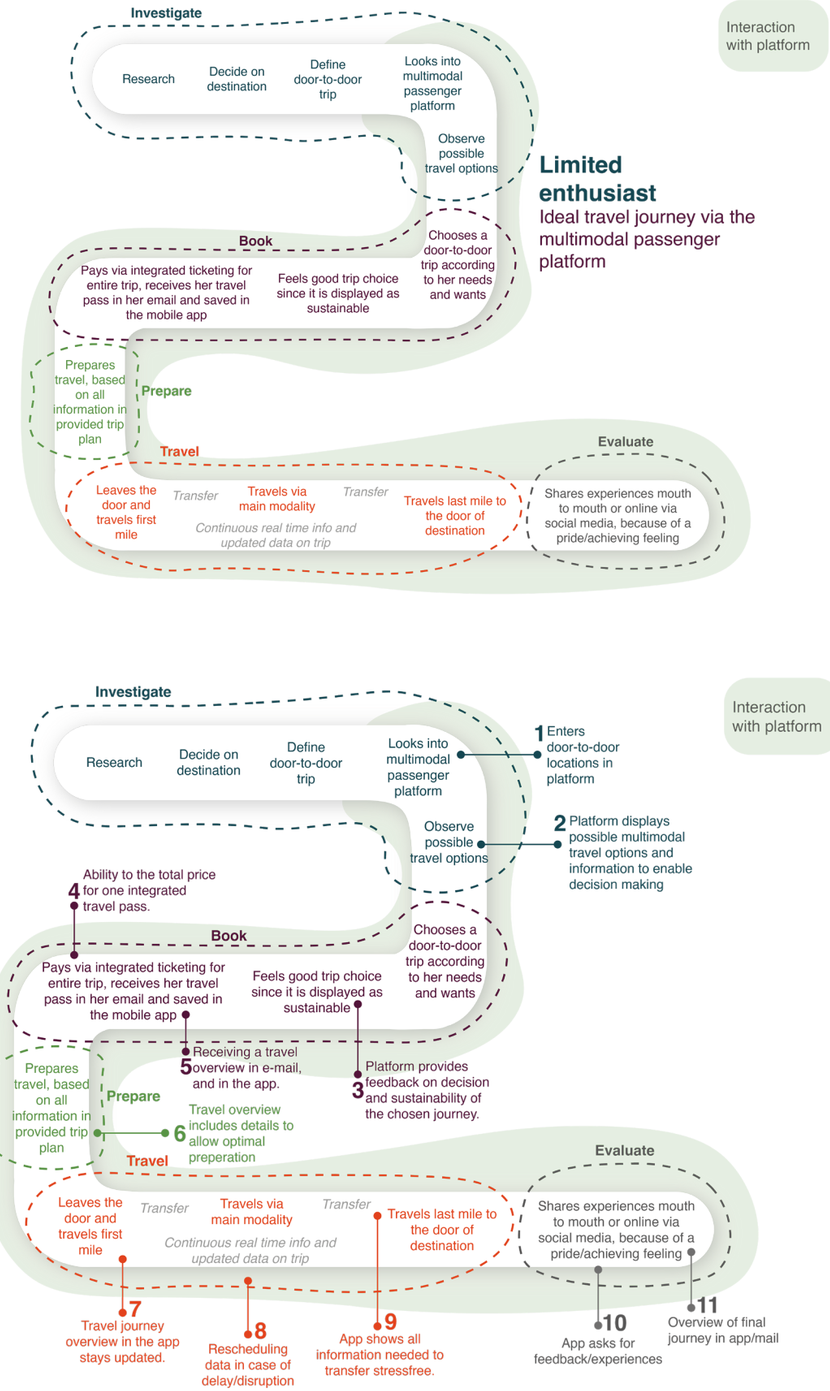
Specific strategies/interventions that have been applied in applications before

- Simplification & framing of information
- Defaults
- Social norms
- A social dilemma, private interests conflict with public/common interest
- Create a feeling of ownership and increase perceived behavioural control
- Reduction
- Small simple tasks
- Tunneling
- Step-by-step format
- Tailoring/personalisation
- Filters, information different for each participant
- Self-monitoring
- Enable track and view user's behaviour
- Simulation
- Observe cause-effect relationship, and display it, simulate positive and negative effects of decisions
- Rehearsal
- Praise
- A pop-up notification
- E-mail afterwards with positive effect
- Rewards
- Railmiles e.g.
- Reminders
- Remind about sustainable option
- Suggestion
- Highlight sustainable travel options
- Similarity
- Designed to look familiar, can help in creating trusts (e.g.: use 9292 logo)
- Liking
- Visually attractive
- Social role
- Coach, instructor, buddy kind of attitude from the app
- Social comparison
- Ability to compare to others > social media?
- Normative influence
- Normative information about target behaviour or usage
- Social facilitation
- Connection with other participants
- Cooperation
- Cooperation between different participants to achieve x amount of co2 reduction
- Competition
- Recognition
- Show successful users (social media?)

Appendix C: **Detailed travel journey**



Appendix D: **Additional information limited enthusiast**



Appendix E: **Competitive routes, specifications**

Four different measures are applied to compare rail with air and road:

Time
The air travel time is an estimate, including waiting time at the airport and collecting luggage

Price
The pricing differentiation is an estimate. Because the moment of booking influences the price of rail and air travel. Besides, the price of car travel depends on the amount of travelers that travel by one car

Frequency
Refers to how often trains depart in comparison to how many aircrafts depart
Not relevant for road travel, since someone can depart with their private car at any time they want

Transfers
Refers to the amount of significant actions that could increase the stress-level of the traveler, within the entire travel journey (transfers, ticket check, parking your car)

Paris	Average travel time (hours)	Average price (€)			
Car	5	160		Frequency	
Airplane*	5,15	75 - 141	Transfers**	12	Conclusion
Train	4,15	35 - 135	0	14	Highly competitive on all possible levels
	* Airplane time is including check-in time douane etc on the airport				
	** Transfers is based on lowest possible transfer rate				
Berlin	Average travel time (hours)	Average price (€)			
Car	7,2	100 - 200		Frequency	
Airplane	5,15	94 - 168	Transfers	9	Conclusion
Train	6,00	38 - 131	0	7	Highly competitive, slightly longer, but no significant difference
London	Average travel time (hours)	Average price (€)			
Car	7,00	190		Frequency	
Airplane	5	69 - 168	Transfers	51	Conclusion
Train	6,10	83 - 206	0	7	Somewhat competitive, here timing in booking is especially important for price range.
Copenhagen	Average travel time (hours)	Average price (€)			
Car	9,20	100		Frequency	
Airplane	5,25	97 - 181	Transfers	11	Conclusion
Train	12	60 - 348	2	8	Only competitive on pricing, time-wise only slightly competitive with car.
					It could be interesting to find out the level of comfort of this trip in comparison to the car
Vienna	Average travel time (hours)	Average price (€)			
Car	12	122		Frequency	
Airplane	5,45	125 - 180	Transfers	8	Conclusion
Train	14	40 - 200	0***	7	Competitive with the carride, nightjet is somewhat competitive with air
			*** when you go with nightjet, else you will have at least 2 transfers		
Prague	Average travel time (hours)	Average price (€)			
Car	8,45	97		Frequency	
Airplane	5,5	58 - 160	Transfers	8	Conclusion
Train	11,45	55 - 130	3	6	Could be competitive with the car, but not competitive yet with air.

Appendix F: **Consent form & interview guide (NL)**

Consent form.

U wordt uitgenodigd om deel te nemen, als expert, aan een afstudeerproject genaamd:

A strategy for a multimodal passenger transport TRIP platform, to encourage sustainable travel behaviour.

Dit onderzoek wordt uitgevoerd door Jenske Gosens van de TU Delft, in samenwerking met het Europese consortium: TULIPS, en het Noorse onderzoeksbedrijf: SINTEF.

Het doel van dit interview is het opdoen van kennis over internationale treinreizen en zal ongeveer 30-45 minuten in beslag nemen. Uw antwoorden zullen binnen dit project dienen ter verduidelijking van het Europese treinen netwerk, en als inspiratie in het vormen van een gepaste reizigers ondersteuning. U wordt gevraagd om een aantal vragen te beantwoorden in een telefoongesprek.

Zoals bij elke onlineactiviteit is het risico van een databreuk aanwezig. Wij doen ons best om uw antwoorden vertrouwelijk te houden. We minimaliseren de risico's door opnames en notities op te slaan in een vergrendelde map op een externe schijf en data na afloop van het interview te anonimiseren.

Gedurende het interview zal er een opname worden gemaakt. Na afloop van het interview zullen de opnames worden verwerkt in de vorm van een transcript. Quotes en opmerkingen kunnen worden gebruikt in het eindverslag van dit afstudeerproject. Dit eindverslag wordt gepubliceerd in de "education repository" van de TU Delft (https://repository.tudelft.nl). Quotes en opmerkingen zullen worden geanonimiseerd.

Uw deelname aan dit onderzoek is volledig vrijwillig, en u kunt zich elk moment terugtrekken zonder reden op te geven. U bent vrij om vragen niet te beantwoorden. Na het afronden van dit afstudeerproject zullen opnames en notities worden verwijderd.

Jenske Gosens

J.C.Gosens@student.tudelft.nl

+31 6 37542712

Handtekening

Naam deelnemer	Handtekening	Datum

Ik, **de onderzoeker**, verklaar dat ik de informatie en het instemmingsformulier correct met de potentiële deelnemer heb doorgenomen en, naar het beste van mijn vermogen, heb verzekerd dat de deelnemer begrijpt waar hij/zij vrijwillig mee instemt.

Jenske Gosens		
Naam onderzoeker	Handtekening	Datum

Interview guide

1. Introductie over mijzelf

Hoi!
Ik ben Jenske en ik rond hopelijk komende zomer mijn masteropleiding “Strategic Product Design” af. Deze master is een vervolgopleiding van de Bachelor “Industrieel Product Ontwerpen”, maar binnen mijn master zijn we eigenlijk met alles behalve fysieke producten bezig. We ontwerpen namelijk innovatie strategien, voor organisaties en bedrijven, om te helpen en te ondersteunen in een wereld van toenemende technologische mogelijkheden en groeiende zorgen over de planeet en de maatschappij.

2. Consent form

Voordat ik begin met een korte introductie over mijn project, wilde ik nog een keer dubbel checken of het oke is als ik dit gesprek opneem en notities maak. Ik heb u gister een PDF documentje opgestuurd met de consent form. Ik snap dat dit misschien een beetje heftig en officieel overkomt, maar het is met name belangrijk zodat we zogenaamde “Human Research Ethics Committee” van mijn studie kan controleren of ik alles via de juiste, etisch geinformeerde weg heb gedaan. Zoals toegelicht in de consent form, zal ik dus een opname maken van dit gesprek, het gesprek uittypen en mocht het relevant zijn een aantal quotes of opmerkingen in mijn eindverslag verwerken, om bijvoorbeeld een getrokken conclusie te onderbouwen. Ik zal in mijn verslag niet uw naam gebruiken en bijvoorbeeld bij de quote “expert 2” schrijven. De opname, het transcript en notities staan in een vergrendelde map op mijn computer, en de opname en het transcript worden direct verwijderd na mijn project.
Als het oke met u is, start ik bij deze de opname en start ik het interview. En dan zou ik u ook willen vragen om in de komende dagen het consent form online te ondertekenen en naar mij op te sturen.

3. Introductie project

Vanwege een goede match met mijn studie, maar ook vanwege mijn persoonlijke interesse in complexe systemen en het klimaat, ben ik terecht gekomen in de mobiliteitssector voor mijn afstudeerproject.
Zelf heb ik al vaker met de trein door Europa gereist, en ken ik de veelvoorkomende problemen, maar kies ik er dus wel bewust voor, binnen Europa de trein op te zoeken ipv het vliegtuig. Ik vond het interessant dat veel mensen in mijn omgeving, en daarbuiten, heel hard schreeuwen dat ze klimaatbewust zijn, en dat ze minder gaan vliegen, maar uit persoonlijke voorbeelden en uit onderzoek blijkt dat toch nog weinig mensen echt de overstap maken op treinen. Hier startte officieel mijn interesse in duurzaam reizigersgedrag, en hoe hier voor te ontwerpen.
Toen ben ik via een van mijn inmiddels begeleiders vanuit de TU Delft, bij TULIPS terecht gekomen. Zij is zelf gespecialiseerd in zogenaamd “seamless travel” en in MaaS (Mobility as a Service), en onderdeel van het TULIPS project. TULIPS is een Europees consortium, en ze streven naar het verduurzamen van de luchtvaart sector. De meeste projecten binnen TULIPS gaan over bvb: duurzamere brandstoffen of het duurzamer maken van het vliegtuig en vliegveld zelf.
Maar, zoals uitgelegd in de mail, ben ik binnen TULIPS onderdeel van een specifiek project team, welke een multimodaal reizigersplatform ontwerpt en maakt. Het einddoel van het platform is het toegankelijker maken van de trein, tram, metro etc. Het is mijn taak, hen te ondersteunen in het begrijpen van de reiziger, en het begrijpen van de mogelijke communicatie strategien die zij zouden kunnen toepassen de reiziger aan te moedigen de trein een kans te geven.
In mijn onderzoek tot dusver ben ik erachter gekomen dat reizigersgedrag ontstaat vanuit twee grote drijfveren: motivatie en vaardigheid/kunnen (ability), hier ontstaat dan ook de interessante “intentie-gedrags” kloof (attitude-behaviour gap), die ik al eerder aankaartte. Mensen hebben de juiste motivatie, ze zijn klimaat bewust en willen minder vliegen, maar hebben het idee dat ze niet anders kunnen, door belemmerende factoren zoals bvb: gewoontes van vroeger uit, kosten, tijd, de ontoegankelijkheid van internationaal treinen, of ze praten het goed in hun hoofd door de verantwoordelijkheid bij de overheid neer te leggen, en met vingers te wijzen naar medereizigers “als zij het niet doen, doe ik het ook niet”. Het platform zal toegankelijk moeten zijn voor elke reiziger, je kunt er ook vluchten op boeken, en op deze manier hopen we ook de mensen die in eerste instantie voor een vlucht op het platform kijken, te stimuleren de trein te overwegen.

4. Introductie [naam] [bedrijf]

Zou u, uzelf en uw connectie, met [bedrijf] kunnen introduceren?

Hoe is het oprichten van [bedrijf] gegaan, en hoe is het bedrijf geëvolueerd tot waar het nu staat?

Kunt u iets vertellen over de service die jullie bieden? Op jullie website zie ik namelijk dat die verder reikt dan slechts de rit zelf.

5. Klanten(service), wat doen ze

Mocht er tijdens de reis een onverwachte tegenslag zijn, een vertraging of een annulering bijvoorbeeld, hoe lossen jullie dat dan op?

Wat zijn trajecten, waar dit vaak gebeurt? Proberen jullie hier bij voorbaat al op in te spelen? (bvb via extra overstap tijd).

Hoe zou u de gemiddelde klant schetsen?

Wat zijn eigenschappen, zijn ze bijvoorbeeld jong, of wat ouder? Waar ligt volgens jullie de vraag naar een duurzamere reis?

Heeft u enig idee wat de hoogste drempels zijn voor mensen om zelf de treinreis te boeken?

Als u een inschatting moet maken, wat denkt u dan?

6. Normen en waarden, missie

Op jullie website schrijven jullie: duurzaam en comfortabel, zijn dat de twee uitgangspunten van reizen via choo choo met de trein?

Is duurzaamheid eigenlijk de enige beweegreden voor uw klanten om met de trein te gaan?

Wat zijn volgens u andere voordelen van treinreizen dan duurzaamheid?

7. Moeilijkheden

We hebben het hiervoor kort al even gehad over annuleringen of vertragingen, maar..
Zijn er andere moeilijkheden/drempels waar jullie mee te maken hebben in het boekingsproces?

Werken jullie samen met nationale ticketproviders? Hebben jullie een eigen netwerk?

Zijn er ticket providers, of organisaties, waar het volgens u significant beter of slechter is geregeld?

Jullie schrijven zelf al op jullie website dat het knap lastig is om duurzaam te reizen,

Wat is volgens u de grootste reden dat dit duurzaam reizen knap lastig is?

Zijn er specifieke tips & tricks, die jullie toepassen bij het boeken van een reis?

Wat belemmert de “niet expert” in het boeken van een treinreis, volgens u?

8. Toekomst perspectief

Als laatste, afsluitende vraag, ben ik erg benieuwd naar uw visie op de toekomst van het treinreizen.
Wat zou er volgens u als eerste moeten veranderen, om treinreizen aantrekkelijker te maken? Op de kaart te zetten?

9. Afsluiting

Heel erg bedankt voor uw antwoorden! Heeft u verder nog vragen over mijn onderzoek, de consent form, of heeft u misschien nog andere opmerkingen/inzichten die u te binnen schiet die u graag nader toelicht?
Schroom niet contact met me op te nemen, mocht u nog een vraag hebben, of simpelweg benieuwd zijn naar de uitkomsten van het project!

Appendix G: **Additional brainstorm outcomes**

HCY - motivate/facilitate/accessibility

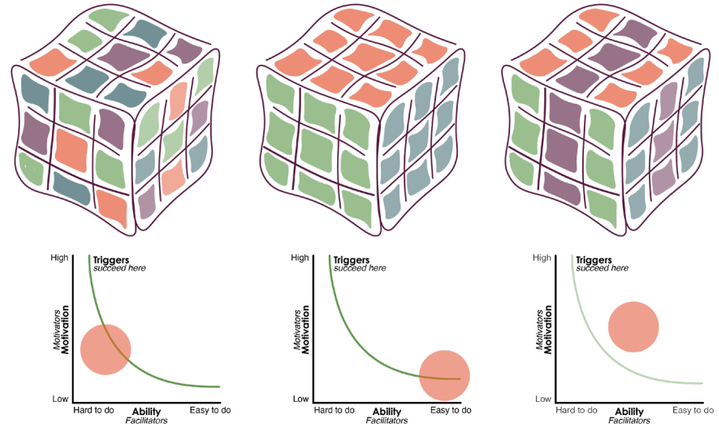
Motivate	*Sales/money, people that you love, it is a challenge, showing consequences/effect, targeting personal ambitions, lead by example, social norm, generate a “team” feeling*
Facilitate	*24/7 support, providing a lot of options, step by step support, providing a safe space, visuals & images, providing clear instructions/a workshop, tunneling/drill-down*
Accessibility	*No difficult wording/all languages available, it is free, no threshold to participate, the way of framing, inclusive, a clean/simple design, community/via peers*

HCY - motivate/facilitate/accessibility - limited enthusiast

Motivate	*Self-efficacy (make them feel proud), make it fun to travel by train, inform them/educate them, peer influence of the people they love, cognitive dissonance > mental tension (flight shame)*
Facilitate	*The platform itself facilitates the limited enthusiast, offer tailored support, inform/educate on effect (tangibility)*
Accessibility	*Create a community, ask for feedback, free to try out without preconditions, provide with tips and tricks and recommendations, do not overwhelm, keep it simple*

Analogies

In order to encourage the limited enthusiast to travel sustainable, the platform should support them in making their own decisions. An analogy would be the rubiks cube (see figure below), handing the puzzle solved is not motivating the limited enthusiast at all, but handing it totally hustled is disencouraging due to the complexity and difficulty (see figure below).



Tensions & amplifiers

Motivation < > Accessibility
Foster a feeling of ownership over the travelers' decisions, suggest but do not make the decision for them. Accessibility can motivate but it can also bore.
Foster a feeling of pride, as a result of someone's sustainable decision/journey. Use the social norm, and encourage people to share their journey (online or mouth to mouth).

Inform < > Facilitate/Accessibility
Inform but do not overwhelm, although supporting and informing is an easy way to facilitate, the platform should remain accessible and easy to interact with. The platform should remain accessible for everyone.

Personalization < > Community
Target the individual self, but apply the social norm. Create a feeling of community to influence the self-concept and target feelings and cognition via individual and social expectations.

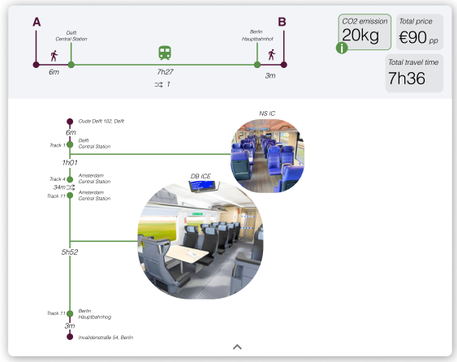
Inspiring products/services/systems

Conclusion	Inspired by..
Motivating via (online) sharing, built in a social aspect but do not make it controlling (community feeling)	STRAVA, Spotify wrapped
Real time data feedback makes it possible for the user to evaluate previous behaviour. Enable reflection on previous travel journeys, provide tips on how to improve ones' behaviour.	Smart thermostat
Show someone else's experiences, as a source of inspiration and confirmation.	AirBnB
Make comparison easy, creating an informing and nudging visual	The nutriscore/energy label

Appendix H: **Additional ideation outcomes**

Additional ideas worth mentioning

Visually show the comfort of train travel



Show an example itinerary and inspire what is possible

Possibility to track previous travels > get feedback on previous journeys

Get an overview of your previous trip

Create community feeling, confirmatory bias, enable liking each other trip

Following	Followers	Activities
42	41	202

Make it possible to book for others and add them to your trip, possibility to let someone else book your trip (just like Airbnb)

"Your trip" in your e-mail, filled with feedback and information
Via the app? Make is possible to screenshot and share

TRIP diary/report
Like polarsteps > only sustainably
"Check out my sustainable trip"

Add a self-monitoring option to enable them to track their sustainable habits
Overview of all trips (also previous trips)
Make it possible to make progress in comparison to previous trip

Brand as something hip/trendy, make it into an online trend (just like interrail)

Make it very easy to share the trip you booked (via social media) or via mail/whats app

Drill-down, tunneling
Reduction, small simple tasks > take traveler by the hand

Strategically design the platform, make it look like other platforms, make it recognizable to increase trust

Eco-friendly, route suggestions

Educational content, learn the traveler something

Collaborate with existing initiatives, green-initiatives to offer discount or a free trial somewhere.

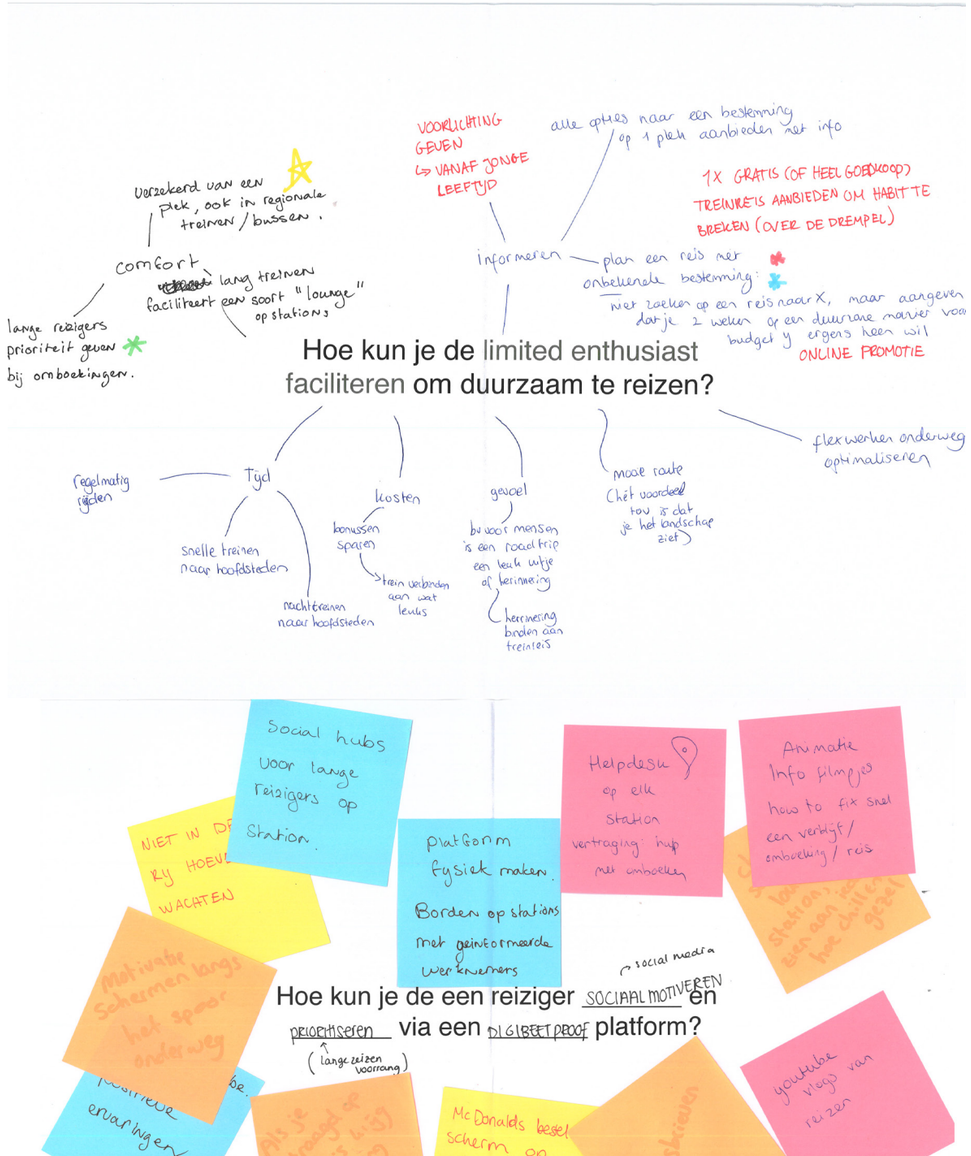
Real-time emission data while traveling (shame)

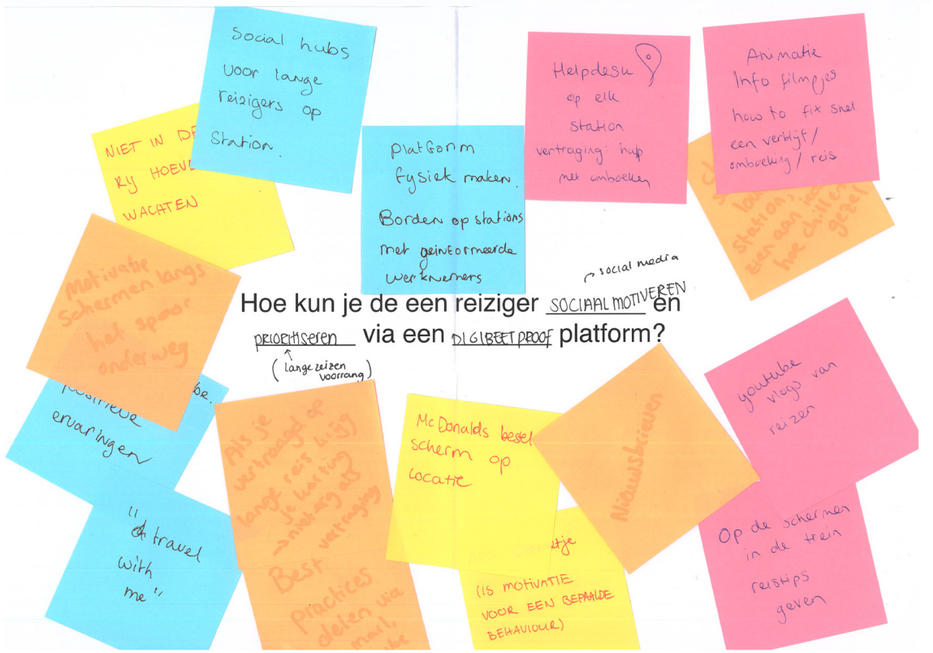
Appendix I: **Co-creative sessions**

With fellow design students

With fellow-students			
What	**Time (min)**	**What do I say?**	**What do I need?**
Introduction	5	Welcome	Something to drink & something to eat, lunch
Graduation project	10	Explain graduation project, give some background information	Powerpoint presentation
How to	4x2	Subgoals: motivate, facilitate, accessible someone in general	3 canvasses for each HCY
Introducing the limited enthusiast	5	Explain the quadrants and the limited enthusiast	Powerpoint presentation
How to	4x2	Subgoals: motivate, facilitate, accessible the limited enthusiast	3 canvasses for each HCY
Pick favourites	5	For each subgoal, everyone should pick 2 favourites	Dots stickers
Break	10	*I need to fill out the favourites per subgoal in the ppt table*	Powerpoint presentation
Choose combinations	5	Discuss possible combinations and pick 2 variating combinations	The filled out table in the ppt
Generate ideas	2x5	Generate product/service ideas for each seperate for the combinations	Empty canvasses & post it notes

The filled out canvasses below have been made for all three subgoals, and give an insight into how the co-creative session went.





With family/friends, non designers

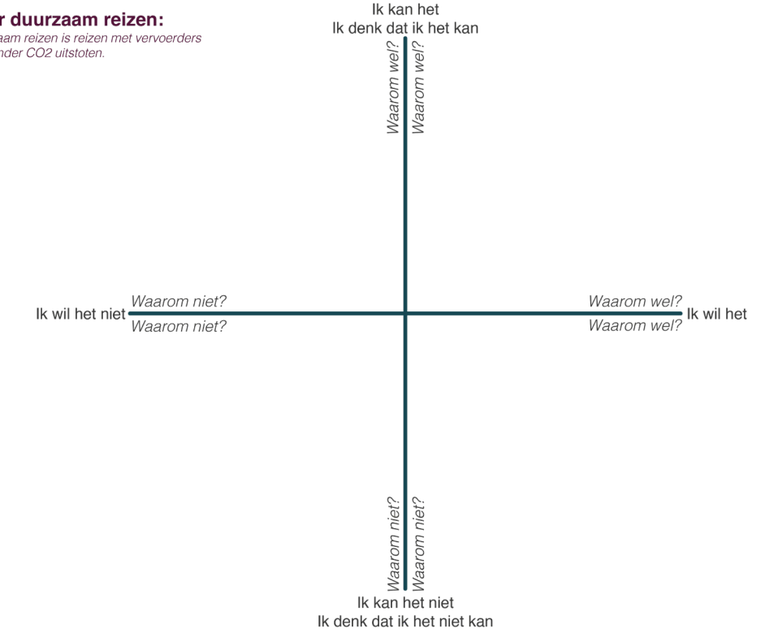
Family/friends			
What	**Time**	**What do I say?**	**What do I need?**
Introduction	10	Provide lunch and welcome everyone	Lunch
Graduation project	10	Explain graduation project, give some background information	Powerpoint presentation
Look for similar experiences	3 x 2	When did you feel… motivated/facilitate/accessible	Canvas 1 x 4
Try to explain each experience	3 x 5	Why did you feel… motivated/facilitated/accessible in that situation	Canvas 1 x 4
Pick one	5	Pick the motivator, facilitator, accessibility factor that feels most relevant/important	Filled out canvasses 1
Explain the quadrants	5	Explain the different traveler segments and there specific wants/needs	PPTX
Place yourself on the quadrant	5	Ask them to put themselves somewhere on the quadrant	Canvas 2 x 4
Why that quadrant	10	Ask them to explain why they picked that quadrant	Canvas 2 x 4
Combine canvas 1 & 2	5	Ask them to point out 1 motivator, 1 facilitator, 1 accessibility factor, that would have supported them in being the "critical expert"	Filled out canvas 1 & 2

The canvasses below have been filled out by each participants.

Naam:

Motiveren	Faciliteren	Toegankelijk
Een situatie waarin ik mijn gemotiveerd voelde:	Een situatie waarin ik mijn gefaciliteerd voelde:	Een product/dienst wat ik als toegankelijk heb ervaren:
Motiveren = stimuleren en inspireren	*Faciliteren = ondersteunen, helpen, makkelijk maken*	*Toegankelijk = benaderbaar, begrijpbaar, bruikbaar*
Ik voelde mij gemotiveerd omdat:	Ik voelde mij gefacliteerd omdat:	Ik vond dit toegankelijke omdat:

Over duurzaam reizen:
Duurzaam reizen is reizen met vervoerders die minder CO2 uitstoten.



Appendix J: **Questionnaire export**

The following pages show an export of the questionnaire in Qualtrics. It only shows one group within block group 2 (namely, the baseline condition). The blocks for the other three conditions are identical, exept for the platform interface screenshorts (appendix K).

QUANTITATIVE USER STUDY - MULTIMODAL PASSENGER PLATFORM - JENSKE GOSENS

Start of Block: Intro

Language EN: Select the language you prefer, in the right upper corner (English & Dutch are the only options).

It is strongly recommended to fill out this questionnaire on a computer/laptop.

NL: Selecteer de taal waar uw voorkeur naar uit gaat, rechts boven in (Engels en Nederlands zijn de enige opties).

Het is sterk aanbevolen deze vragenlijst op uw computer/laptop in te vullen.

Page Break

Intro_general Hi!

My name is Jenske, and I'm currently in the process of completing my master's degree in Strategic Product Design at Delft University of Technology.

You are invited to participate in a quantitative user study. This study is part of my graduation project and involves a questionnaire that takes a maximum of 10 minutes to complete.

My graduation project is in collaboration with the Norwegian research agency SINTEF, and together we are developing a multimodal travel planner as a part of the TULIPS consortium (a European research project).
A multimodal travel planner is an online platform (website & mobile app) that assists you in booking your international travel journey from door to door. Multimodal in this scenario, refers to traveling via various modes of transportation, for example: traveling to your work by bike, train and tram.

The purpose of this questionnaire is to test and evaluate the multimodal travel planner with you. Your answers will be used to validate and optimize the platform.

As with any online activity, there is a risk of data breach. We do everything within our reach to manage your answers confidentially and securely. To minimize risks, we will not ask for direct personal data, and your answers will be stored on a secured OneDrive. This research study has been approved by the Human Ethics Research Committee of the TU Delft (ID: 4165).

Your participation in this study is entirely voluntary, and you can withdraw at any time. If you have any questions, please feel free to ask via J.C.Gosens@student.tudelft.nl.

Thank you very much in advance for your effort and, of course, your answers!

Kind regards, Jenske Gosens

Consent Please answer the following questions:

	NO (1)	YES (2)
I have read the information above, and I understand the information. (1)	○	○
I understand that there is a risk of a data breach and that measures have been taken to prevent this. (2)	○	○
I voluntarily consent to the storage, processing and analysing of my answers for this- and future research. (3)	○	○

Page Break

Intro_platform The following questions refer to the previously introduced multimodal travel platform. As explained, the aim of this platform is to support you in traveling from door to door by using various modes of transportation (multimodal).

Take the following scenario into consideration:

Imagine traveling alone to Berlin, specifically, to the Brandenburger Tor. You want to book a (multimodal) ticket to this specific location. The starting point of your journey is the University of Technology in Delft. You have a backpack with you, which you can easily carry on your back. You're traveling to Berlin for leisure purposes, to explore the city.

You will stay in Berlin for 5 nights, in a hotel near the Brandenburger Tor. On your way back to Delft, you will travel together with a friend in her/his private car.

You can book a (multimodal) travel ticket via the multimodal travel platform. After selecting and booking your preferred travel journey, the platform compiles an integrated ticket that you can use for each mode of transportation and leg of your journey. A travel overview will be shared with you via e-mail and via the platform application on your phone, this app will keep you updated on possible real-time travel changes and provide you with recommendations when needed.

*

confirmation I hereby confirm, that I will truthfully answer the questions that follow according to my personal preferences.

- ○ I confirm (1)
- ○ I do not confirm (2)

End of Block: Intro

Start of Block: CO Control

CO_info After filling out the needed travel information and details, the platform provides you with the following 7 travel options; two air journeys, two railway journeys and three road journeys (indicated A to G). Please examine the options in detail. It is a screenshot, you are not able to look at any more options or other details.

The screenshot does not include departure and/or arrival times, you can assume that the

departure times are similar for each displayed travel journey.

CO_choice Please choose the travel journey that you want to book for your trip to Berlin

- A (1)
- B (2)
- C (3)
- D (4)
- E (5) tour bus 1
- F (6) tour bus 2
- G (7) auto

Page Break

CO_DV_intro Next, we will ask you some questions regarding the travel alternatives that you just evaluated. If you want to see the options again, you can scroll down to the bottom of the screen.

CO_important How important where the following factors when choosing for this travel journey?

	1 - Not important (1)	2 (2)	3 (3)	4 (4)	5 - Very important (5)
The total price (4)	○	○	○	○	○
The total travel time (5)	○	○	○	○	○
My previous travel experiences (6)	○	○	○	○	○
Travel comfort (8)	○	○	○	○	○
Impact on the environment (9)	○	○	○	○	○
Opinion of others (13)	○	○	○	○	○

CO_saliance Which option do you identify as the most sustainable option?

- A (1)
- B (2)
- C (3)
- D (4)
- E (5)
- F (6)
- G (7)
- I don't know (8)

CO_reason Why do you believe this travel option is most sustainable?

_____

_____

_____

_____

_____

CO_completeness Do you feel that the information provided for each option was sufficient to make an informed decision?

	1 - Insufficient (1)	2 (2)	3 (3)	4 (4)	5 - Sufficient (5)
The information was... (4)	○	○	○	○	○

CO_missing What (type of) information could have supported you in making a more informed decision?

_____

_____

_____

_____

_____

CO_interest To what extent would you be interested in using this multimodal passenger platform to book a travel journey?

	1 - Not interested (1)	2 (2)	3 (3)	4 (4)	5 - Very interested (5)
I would be.. (4)	○	○	○	○	○

CO_image

End of Block: CO Control

Start of Block: A SUSTAINABLE NAVIGATOR

A_info After filling out the needed travel information and details, the platform provides you with the following 7 travel options; two railway journeys, three road journeys and two air journeys (indicated A to G). Please examine the options in detail. It is a screenshot, you are not able to look at any more options or other details.

The screenshot does not include departure and/or arrival times, you can assume that the departure times are similar for each displayed travel journey.

Scale_trust To what extent do you agree with these statements?

	1 - Not at all (1)	2 (2)	3 (3)	4 (4)	5 - Yes, definitely (5)
One can expect good advice from this platform (1)	○	○	○	○	○
This platform is genuinely interested in its travelers' welfare (8)	○	○	○	○	○
You can believe the information on this platform (10)	○	○	○	○	○
I would rely on advice from this platform (11)	○	○	○	○	○

Page Break

Visual Imagine we include the following informational banner on the platform:

Reliable 2.0 Given this information, do you find the platform less, equally or more reliable/trustworthy?

	Less reliable/trustworthy (1)	Equally reliable/trustworthy (2)	More reliable/trustworthy (3)
I find the platform.. (1)	○	○	○

Why reliable Could you elaborate on your answer, why do you find the platform less, equally or more reliable/trustworthy?

End of Block: Provider

Start of Block: Values

Explanation The following questions are not related to the multimodal passenger platform, answer them according to your personal opinion.

Sustainability_AS To what extent do you agree with the following statements?

	Strongly disagree (2)	Disagree (3)	Neutral (4)	Agree (5)	Strongly agree (6)
I am worried about global warming (1)	○	○	○	○	○
I do not see the need for sustainability measures (2)	○	○	○	○	○
Climate change is a serious issue (3)	○	○	○	○	○
Environmental problems are greatly exaggerated (4)	○	○	○	○	○

Page Break

Awareness_AS To what extent do you agree with the following statements?

	Strongly disagree (2)	Disagree (3)	Neutral (4)	Agree (5)	Strongly agree (6)
Climate change has an effect on our lives and on planet earth (1)	○	○	○	○	○
CO2 emission as a result of human activity (like flying) contributes to climate change (2)	○	○	○	○	○
When I fly, I contribute to climate change (3)	○	○	○	○	○

End of Block: Values

Start of Block: Segmentation demo Qs

*

Age What is your current age? Write as: 34.

Gender What is your gender?

- Female (1)
- Male (2)
- Other (3)
- I would rather not say (4)

Residence What is your country of residence?

▼ Albania (27) ... Other (53)

Experience Have you traveled internationally with one of the modalities below, in the past 5 years?

	Yes, often (1)	Yes, sometimes (2)	No (3)
Train (1)	○	○	○
Airplane (2)	○	○	○
Tour bus (3)	○	○	○
Car (4)	○	○	○

Occupation What is your current occupation?

- Student (1)
- Working (2)
- Looking for a job (3)
- Retired (4)
- None of the above (5)

Other platforms Are you familiar with the following travel (international) planners/platforms? Feel free to complement! (multiple choice)

- [ ] Google maps (1)
- [ ] Trainline (2)
- [ ] NS international (3)
- [ ] OMIO (4)
- [ ] KAYAK (5)
- [ ] GreenCityTrip (6)
- [ ] Locomocheap (7)
- [ ] Choo-choo (8)
- [ ] Eurail (9)
- [ ] Cheaptickets (10)
- [ ] Kiwi (11)
- [ ] Skyscanner (12)
- [ ] 9292 (13)

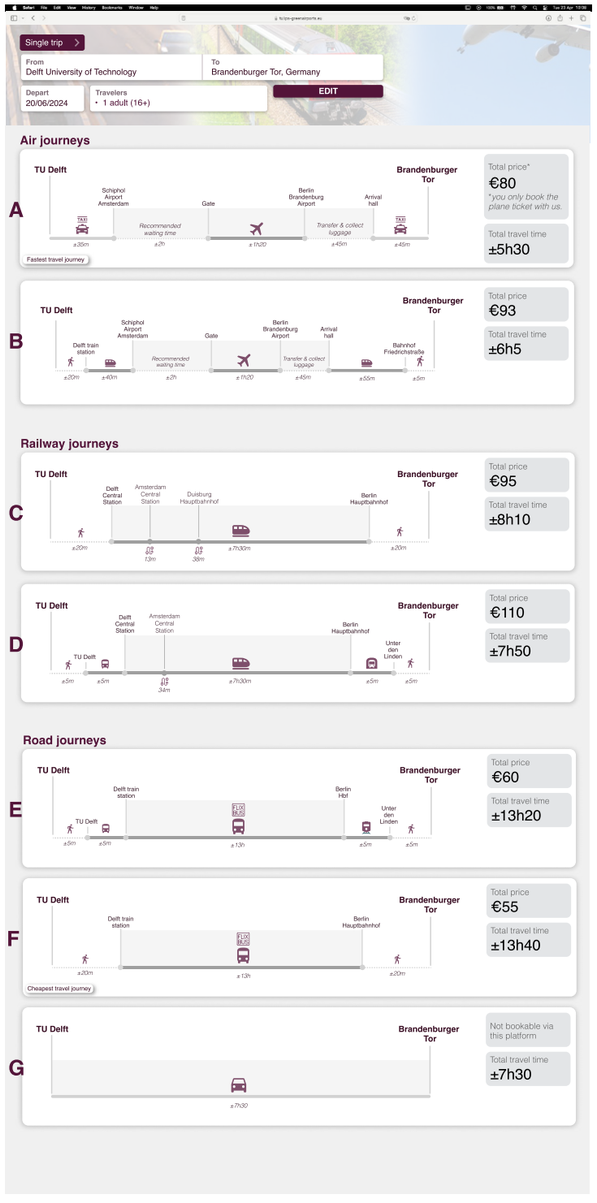
Final Q This is the end of this questionnaire, if you have any additional comments or suggestions, you can leave them here. Thank you for your time and effort!

_____

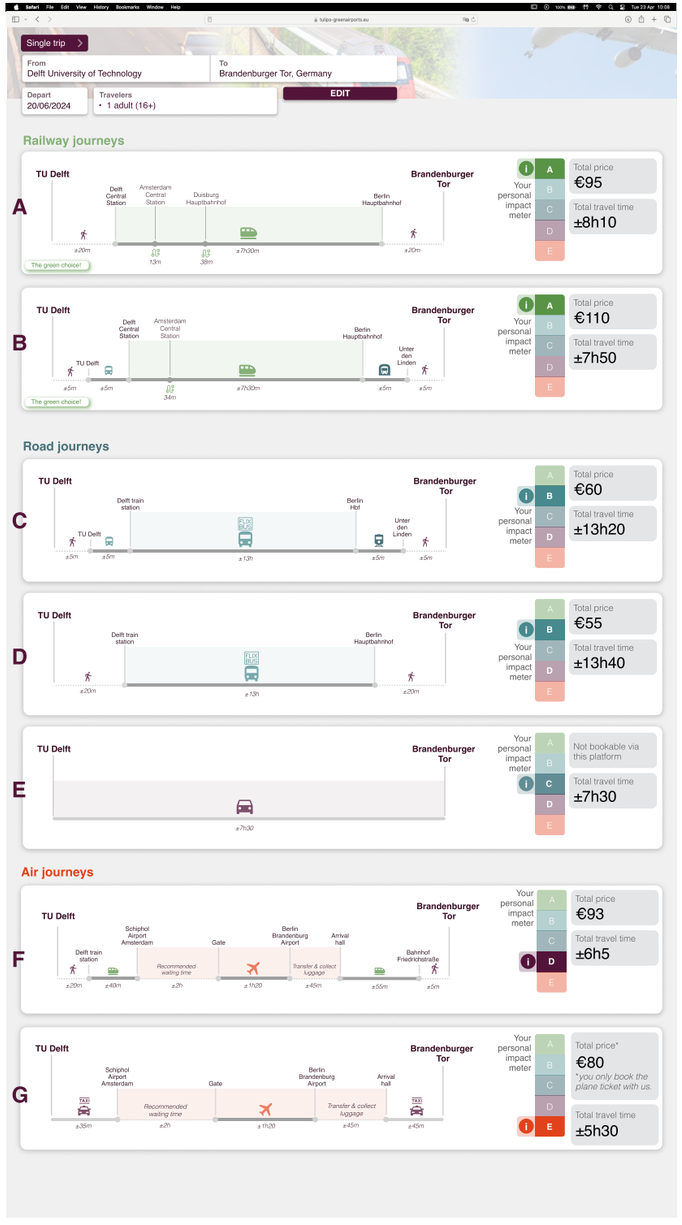
End of Block: Segmentation demo Qs

Appendix K: **Four presented interfaces**

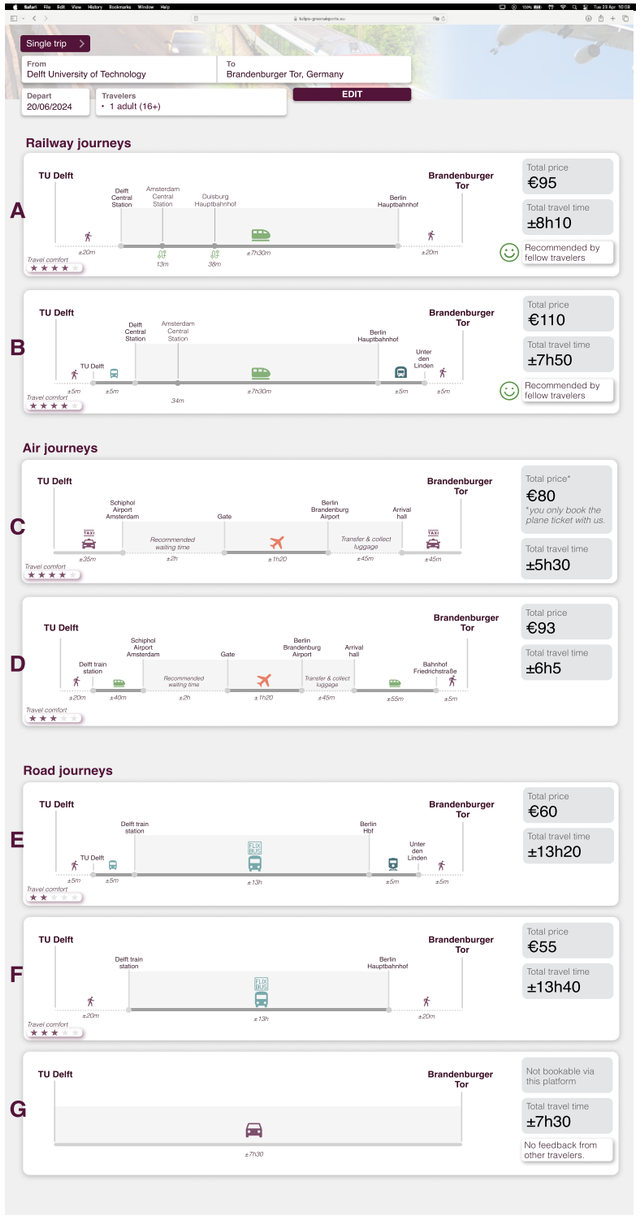
BASELINE



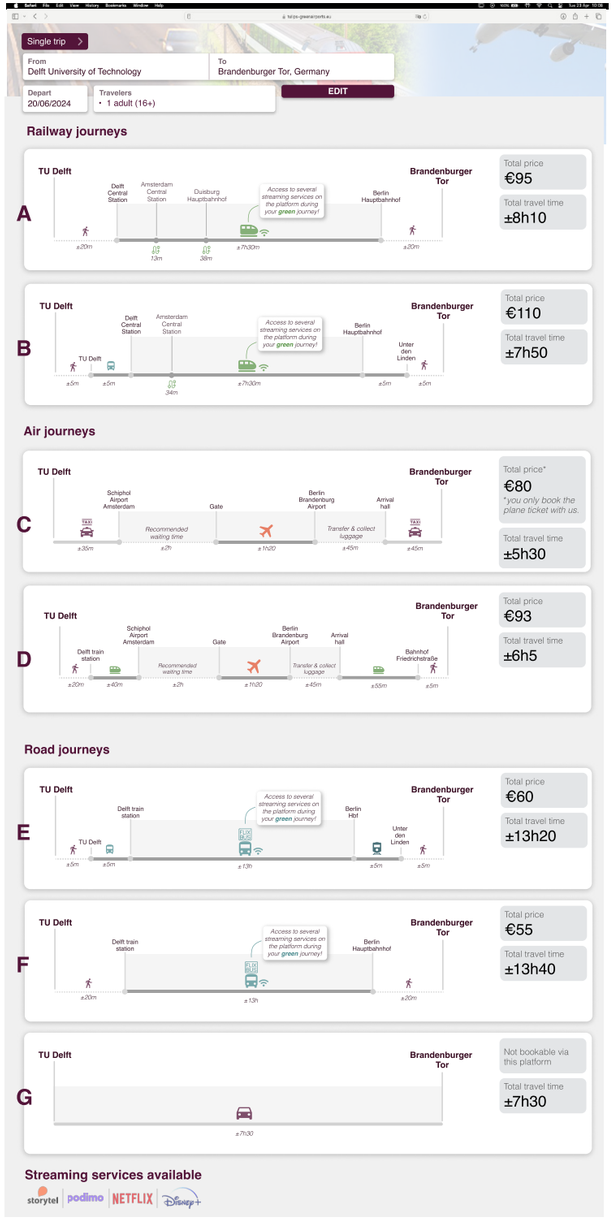
STRATEGY A



STRATEGY B



STRATEGY C



Appendix L: **Supporting SPSS output**

SPSS output tables have been added in the same order as their results are mentioned in section 3.4: Chapter 4.

One-way ANOVA, effect of IV on average kgCO2 per traveler

ANOVA

Choice_CO2

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	16033.072	3	5344.357	1.298	.280
Within Groups	378710.261	92	4116.416		
Total	394743.333	95			

One-way ANOVA, effect of IV on average sustainability level

ANOVA

Scale_sustb

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	10.256	3	3.419	1.558	.205
Within Groups	201.900	92	2.195		
Total	212.156	95			

One-way ANOVA, effect of IV on prefered main modality

ANOVA

Main_modality_preference

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6.327	3	2.109	1.420	.242
Within Groups	136.631	92	1.485		
Total	142.958	95			

One-way ANOVA, CAS average per condition

ANOVA

Average_CAS

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.967	3	.656	2.090	.107
Within Groups	28.860	92	.314		
Total	30.827	95			

ANCOVA. CAS as a covariate

Tests of Between-Subjects Effects

Dependent Variable: Choice_ordered

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	53.660[a]	4	13.415	2.901	.026	.113
Intercept	74.162	1	74.162	16.037	<.001	.150
Average_CAS	28.815	1	28.815	6.231	.014	.064
Condition	13.703	3	4.568	.988	.402	.032
Error	420.830	91	4.625			
Total	1195.000	96				
Corrected Total	474.490	95				

a. R Squared = .113 (Adjusted R Squared = .074)

One-way ANOVA, age distribution along conditional samples

ANOVA

Age

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	408.503	3	136.168	.734	.535
Within Groups	16513.196	89	185.542		
Total	16921.699	92			

ANCOVA, age as a covariate

Tests of Between-Subjects Effects

Dependent Variable: Choice_ordered

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	33.072[a]	4	8.268	1.701	.157	.072
Intercept	44.658	1	44.658	9.189	.003	.095
Age	7.272	1	7.272	1.496	.225	.017
Condition	27.378	3	9.126	1.878	.139	.060
Error	427.659	88	4.860			
Total	1149.000	93				
Corrected Total	460.731	92				

a. R Squared = .072 (Adjusted R Squared = .030)

One-way ANOVA, gender distribution along conditional samples

ANOVA

Gender

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.261	3	.087	.269	.847
Within Groups	29.697	92	.323		
Total	29.958	95			

ANCOVA, gender as a covariate

Tests of Between-Subjects Effects

Dependent Variable: Choice_ordered

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	30.138[a]	4	7.534	1.543	.196	.064
Intercept	135.215	1	135.215	27.691	<.001	.233
Gender	5.293	1	5.293	1.084	.301	.012
Condition	26.786	3	8.929	1.829	.148	.057
Error	444.352	91	4.883			
Total	1195.000	96				
Corrected Total	474.490	95				

a. R Squared = .064 (Adjusted R Squared = .022)

One-way ANOVA, occupation distribution along conditional samples

ANOVA

Occupation

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.165	3	.388	.802	.496
Within Groups	44.056	91	.484		
Total	45.221	94			

ANCOVA, occupation as a covariate

Tests of Between-Subjects Effects

Dependent Variable: Choice_ordered

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	22.651[a]	4	5.663	1.176	.327	.050
Intercept	104.155	1	104.155	21.624	<.001	.194
Occupation	1.474	1	1.474	.306	.581	.003
Condition	21.247	3	7.082	1.470	.228	.047
Error	433.496	90	4.817			
Total	1146.000	95				
Corrected Total	456.147	94				

a. R Squared = .050 (Adjusted R Squared = .007)

One-way ANOVA, testing experience for modality per contional sample

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Experience_train	Between Groups	.181	3	.060	.142	.935
	Within Groups	39.308	92	.427		
	Total	39.490	95			
Experience_plane	Between Groups	.041	3	.014	.036	.991
	Within Groups	34.949	92	.380		
	Total	34.990	95			
Experience_tourbus	Between Groups	.695	3	.232	.571	.635
	Within Groups	37.305	92	.405		
	Total	38.000	95			
Experience_car	Between Groups	2.145	3	.715	2.065	.110
	Within Groups	31.845	92	.346		
	Total	33.990	95			

One-way ANOVA, testing differences between effects of levels of train experience on main modality preference

ANOVA

Main_modality_preference

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	13.172	2	6.586	4.719	.011
Within Groups	129.786	93	1.396		
Total	142.958	95			

POSTHOC - BONFERRONI, testing which level of train experience differs

Post Hoc Tests

Multiple Comparisons

Dependent Variable: Main_modality_preference

Bonferroni

(I) Experience_train	(J) Experience_train	Mean Difference (I–J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Yes, often	Yes, sometimes	-.529	.262	.137	-1.17	.11
	No	-1.193*	.410	.014	-2.19	-.19
Yes, sometimes	Yes, often	.529	.262	.137	-.11	1.17
	No	-.663	.393	.284	-1.62	.29
No	Yes, often	1.193*	.410	.014	.19	2.19
	Yes, sometimes	.663	.393	.284	-.29	1.62

*. The mean difference is significant at the 0.05 level.

ANCOVA, testing whether train experience is a covariate

Tests of Between-Subjects Effects

Dependent Variable: Main_modality_preference

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	18.602[a]	4	4.650	3.403	.012	.130
Intercept	7.015	1	7.015	5.133	.026	.053
Experience_train	12.275	1	12.275	8.982	.004	.090
Condition	5.519	3	1.840	1.346	.264	.042
Error	124.357	91	1.367			
Total	444.000	96				
Corrected Total	142.958	95				

a. R Squared = .130 (Adjusted R Squared = .092)

One-way ANOVA, testing differences between effects of levels of airplane experience on main modality preference

ANOVA

Main_modality_preference

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.660	2	.330	.216	.807
Within Groups	142.299	93	1.530		
Total	142.958	95			

ANCOVA, testing whether airplane experience is a covariate

Tests of Between-Subjects Effects

Dependent Variable: Main_modality_preference

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	6.328[a]	4	1.582	1.054	.384	.044
Intercept	35.041	1	35.041	23.338	<.001	.204
Experience_plane	.001	1	.001	.001	.979	.000
Condition	6.328	3	2.109	1.405	.247	.044
Error	136.630	91	1.501			
Total	444.000	96				
Corrected Total	142.958	95				

a. R Squared = .044 (Adjusted R Squared = .002)

One-way ANOVA, testing differences between effects of levels of tour bus experience on main modality preference

ANOVA

Main_modality_preference

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.929	2	.464	.304	.739
Within Groups	142.030	93	1.527		
Total	142.958	95			

ANCOVA, testing whether tour bus experience is a covariate

Tests of Between-Subjects Effects

Dependent Variable: Main_modality_preference

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	6.670[a]	4	1.668	1.113	.355	.047
Intercept	13.252	1	13.252	8.848	.004	.089
Experience_tourbus	.344	1	.344	.229	.633	.003
Condition	6.013	3	2.004	1.338	.267	.042
Error	136.288	91	1.498			
Total	444.000	96				
Corrected Total	142.958	95				

a. R Squared = .047 (Adjusted R Squared = .005)

One-way ANOVA, testing differences between effects of levels of car experience on main modality preference

ANOVA

Main_modality_preference

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.742	2	.871	.574	.565
Within Groups	141.216	93	1.518		
Total	142.958	95			

ANCOVA, testing whether car experience is a covariate

Tests of Between-Subjects Effects

Dependent Variable: Main_modality_preference

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	6.327[a]	4	1.582	1.053	.384	.044
Intercept	39.492	1	39.492	26.303	<.001	.224
Experience_car	2.950E-5	1	2.950E-5	.000	.996	.000
Condition	6.235	3	2.078	1.384	.253	.044
Error	136.631	91	1.501			
Total	444.000	96				
Corrected Total	142.958	95				

a. R Squared = .044 (Adjusted R Squared = .002)

One-way ANOVA, differences in trust level per conditional sample

ANOVA

Average_trust

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.175	3	.058	.144	.934
Within Groups	37.356	92	.406		
Total	37.531	95			

T-Test Trust scale

One-Sample Test

Test Value = 3

	t	df	Significance One-Sided p	Significance Two-Sided p	Mean Difference	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper
Average_trust	11.407	95	<.001	<.001	.7318	.604	.859

T-Test Trust strategy ^2

One-Sample Test

Test Value = 2

	t	df	Significance One-Sided p	Significance Two-Sided p	Mean Difference	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper
Trust_strategy	10.258	95	<.001	<.001	.615	.50	.73

T-Test Interest in platform

One-Sample Test

Test Value = 3

	t	df	Significance One-Sided p	Significance Two-Sided p	Mean Difference	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper
Interest	14.038	95	<.001	<.001	1.323	1.14	1.51

One-way ANOVA interest per condition

ANOVA

Interest

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.358	3	.119	.136	.938
Within Groups	80.631	92	.876		
Total	80.990	95			

Repeated measures anova on factors importance

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Factor_importance	Sphericity Assumed	373.556	5	74.711	78.609	<.001
	Greenhouse-Geisser	373.556	3.747	99.705	78.609	<.001
	Huynh-Feldt	373.556	3.920	95.306	78.609	<.001
	Lower-bound	373.556	1.000	373.556	78.609	<.001
Error(Factor_importance)	Sphericity Assumed	451.444	475	.950		
	Greenhouse-Geisser	451.444	355.926	1.268		
	Huynh-Feldt	451.444	372.358	1.212		
	Lower-bound	451.444	95.000	4.752		

Post-hoc, bonferroni, testing factors importance

Pairwise Comparisons

Measure: MEASURE_1

(I) Factor_importance	(J) Factor_importance	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	95% Confidence Interval for Difference[b] Upper Bound
1	2	-.229	.095	.273	-.516	.058
	3	.260	.162	1.000	-.229	.749
	4	-.042	.149	1.000	-.492	.409
	5	.208	.167	1.000	-.294	.711
	6	2.156*	.126	<.001	1.777	2.535
2	1	.229	.095	.273	-.058	.516
	3	.490*	.151	.025	.035	.944
	4	.187	.127	1.000	-.194	.569
	5	.437	.168	.161	-.069	.944
	6	2.385*	.122	<.001	2.017	2.754
3	1	-.260	.162	1.000	-.749	.229
	2	-.490*	.151	.025	-.944	-.035
	4	-.302	.110	.108	-.633	.029
	5	-.052	.141	1.000	-.476	.372
	6	1.896*	.134	<.001	1.493	2.298
4	1	.042	.149	1.000	-.409	.492
	2	-.187	.127	1.000	-.569	.194
	3	.302	.110	.108	-.029	.633
	5	.250	.151	1.000	-.205	.705
	6	2.198*	.138	<.001	1.783	2.613
5	1	-.208	.167	1.000	-.711	.294
	2	-.437	.168	.161	-.944	.069
	3	.052	.141	1.000	-.372	.476
	4	-.250	.151	1.000	-.705	.205
	6	1.948*	.148	<.001	1.503	2.392
6	1	-2.156*	.126	<.001	-2.535	-1.777
	2	-2.385*	.122	<.001	-2.754	-2.017
	3	-1.896*	.134	<.001	-2.298	-1.493
	4	-2.198*	.138	<.001	-2.613	-1.783
	5	-1.948*	.148	<.001	-2.392	-1.503

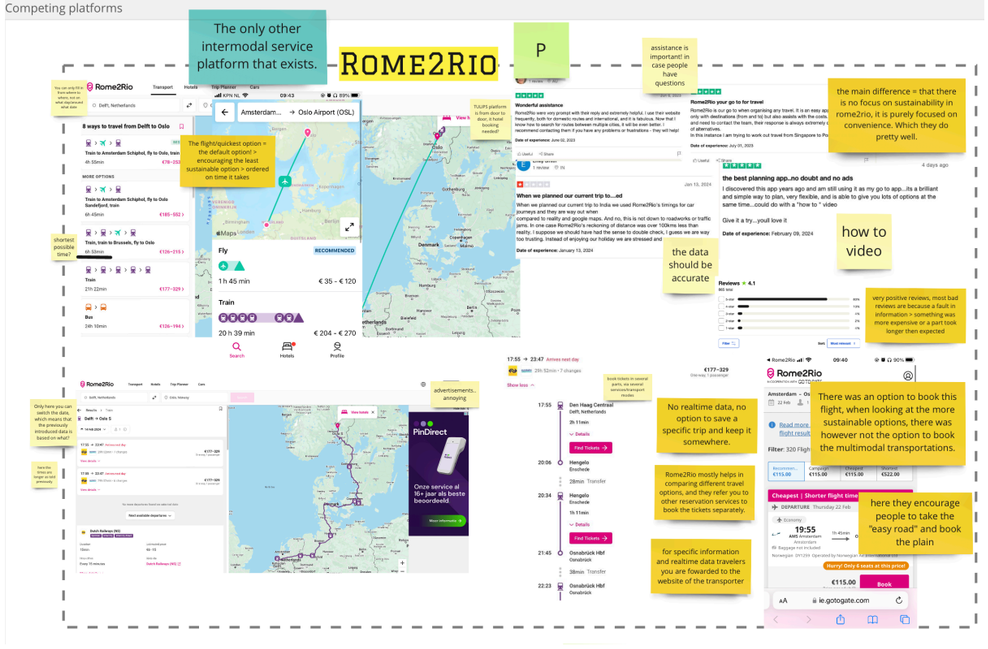
Based on estimated marginal means

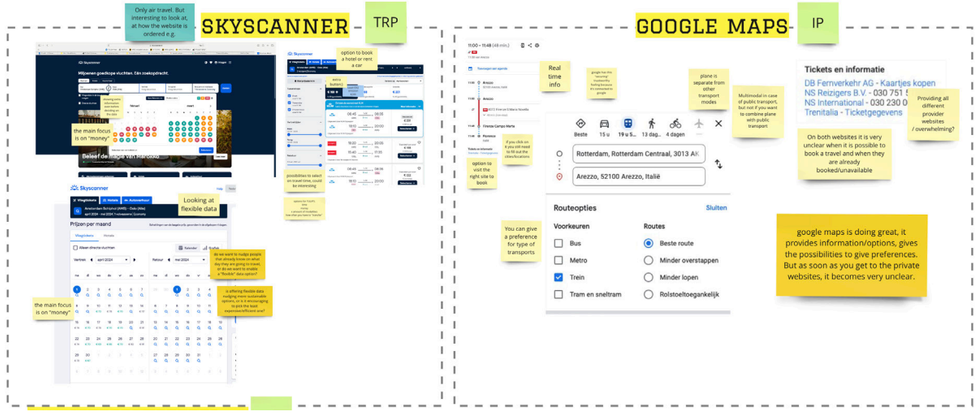
*. The mean difference is significant at the .05 level.

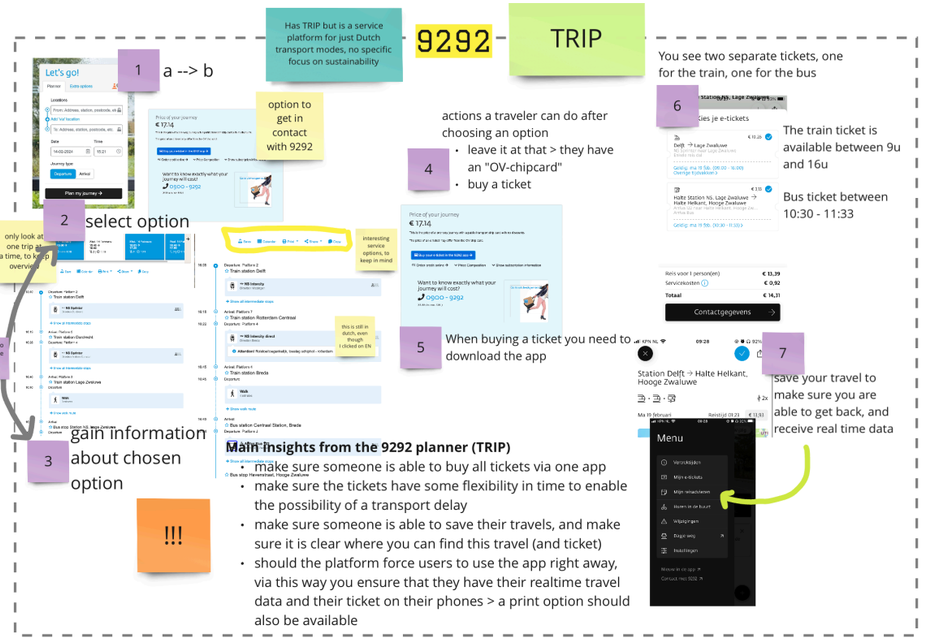
b. Adjustment for multiple comparisons: Bonferroni.

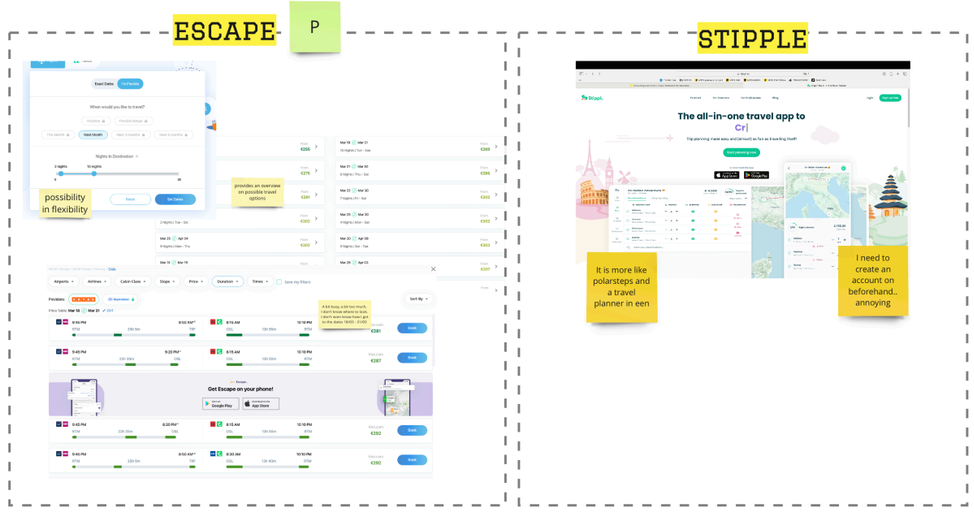
Appendix M:
Investigating existing platforms

Competing platforms







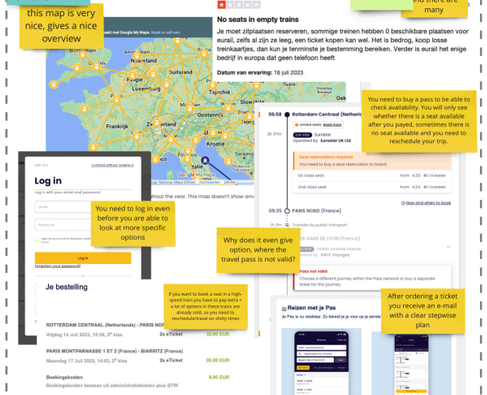


INTERRAIL - EURAIL

TP

Shitty service but well-known platform, especially among younger generation

this map is very nice, gives a nice overview

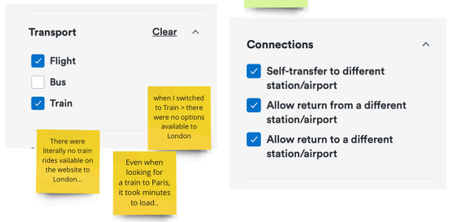


Main insights from Eurail (how not to design a platform)

- Be transparent about added costs/availaiblity
- Provide the option to look at seat availability options before buying a pass
- Create a clear map on train network > maybe layered with all transport options? > or is that maybe too much information?

KIWI.COM

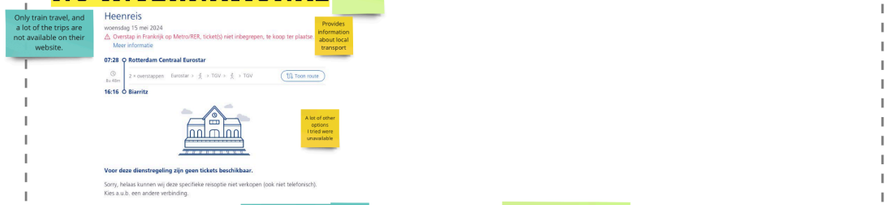
TP



NS INTERNATIONAL

TRIP

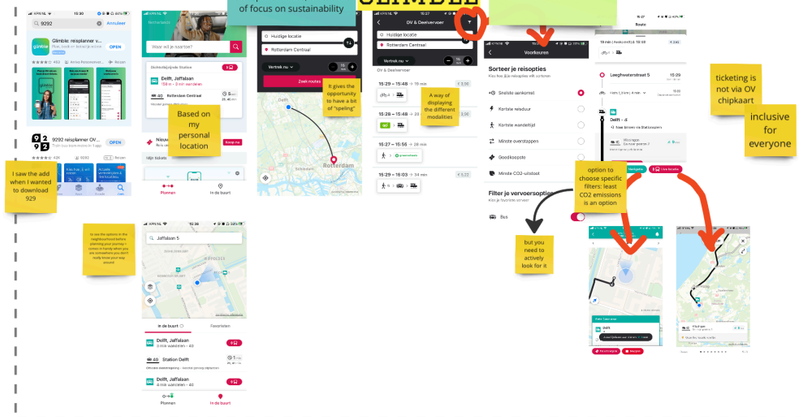
Only train travel, and a lot of the trips are not available on their website.



GLIMBLE

TRIP

Has TRIP but is a service platform for just Dutch transport modes, a little bit of focus on sustainability



Faculty of Industrial Design Engineering
Landbergstraat 15
2628 CE Delft

www.io.tudelft.nl

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