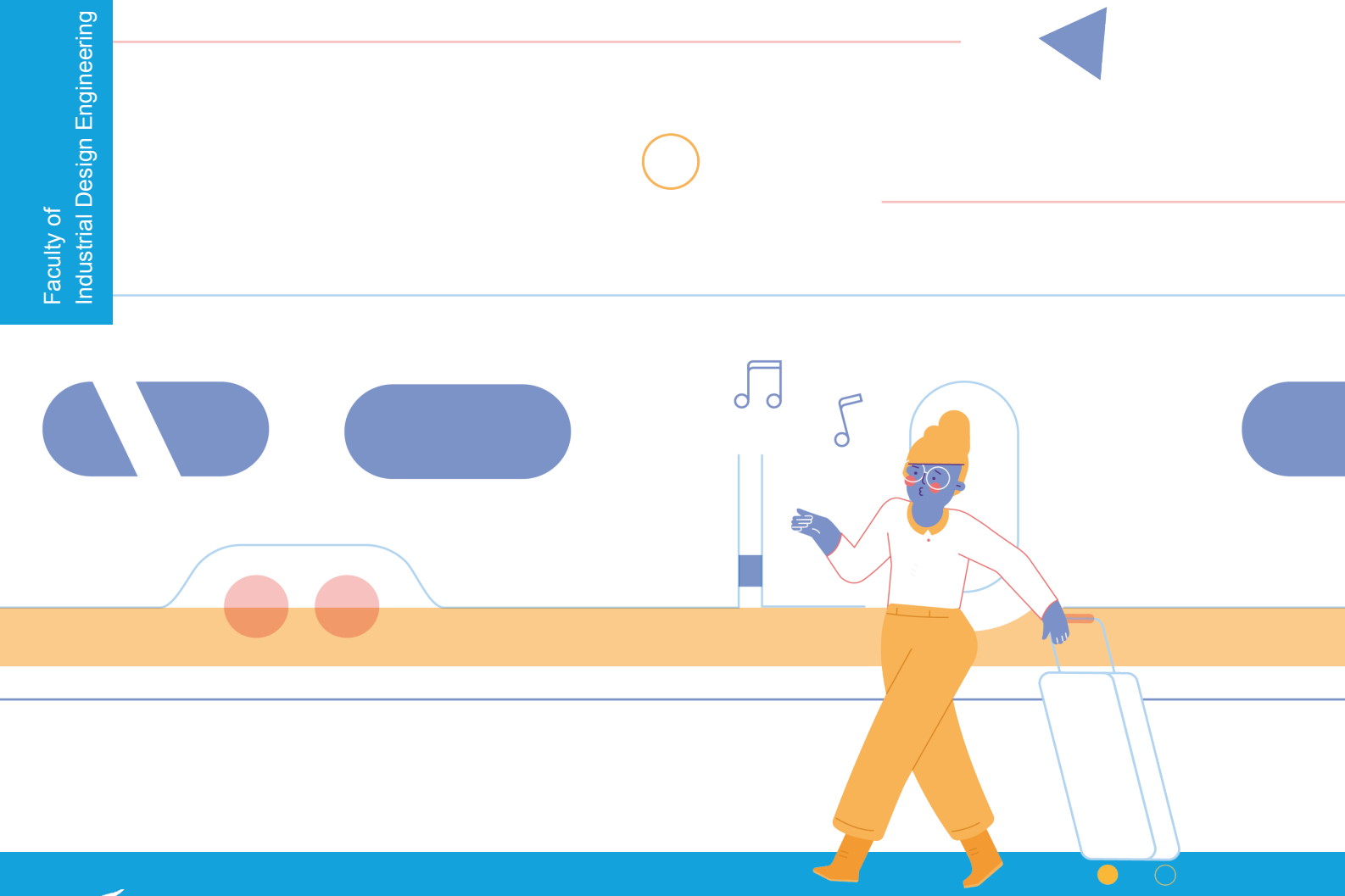
A design vision towards seamless European train journeys

Master thesis, January 2021

Seamless Personal Mobility Lab

Laura van Overhagen

Faculty of Industrial Design Engineering



TU Delft

A design vision towards seamless European train journeys

Making the train the default option to travel within Europe

Master thesis, January 2021

Seamless Personal Mobility Lab

Laura van Overhagen

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

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Author
Laura van Overhagen

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

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

Ir. R.G.H.Bluemink

Project execution
Laura van Overhagen
I

Project partners
NS International
Ministry of Infrastructure and Water Management

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Preface


BOOKING
PREPARING
DEPARTING
ARRIVING
No tickets needed
Compare live crowdedness
Just hop on the next train
MaaS App
MaaS App

Dear reader,

For the past few months I have been working on my graduation project for the Seamless Personal Mobility Lab. The complex context of European train travel with its many stakeholders and my ambitious goals to solve every piece of the puzzle were challenging at times, but also provided me with an enriching learning experience. I mostly worked from home with days full of Zoom meetings. The rare moments when I could meet or interview someone in person were especially refreshing. Although I could not travel by international train during the project, the project itself has felt like a journey. The ultimate result is the thesis in front of you and I would like to thank a few people for helping me make this possible.

First, I would like to thank the chair and mentor of my supervisory team for all their constructive feedback, suggestions and ongoing support during the project.

Suzanne, thank you for providing me with the opportunity to engage in such a challenging project in the lab, and supporting me in many different ways.

Bart, thank you for your outsider perspective on the project. Your advice and critical questions always helped me think more outside of the box.

I would like to thank my involved stakeholders (NS International and the Ministry of Infrastructure and Water Management) for their input and feedback during every phase of my project.

I would like to thank my family and friends for their belief in me and support during the project. They were always open to give me an honest opinion and managed to make me see the fun in it too.

Tycho, thank you for all your great thinking along, sending me “daily boosts” during deadline weeks and providing Visuals as a Service.

Eva, thank you for proofreading my entire thesis and functioning as my language guru.

Freek, thank you for putting in so much extra effort to make an animation that perfectly suits the project and implementing all my last minute changes along the way.

Thanks for the time and energy of all student colleagues participating in one of my creative sessions: Floris, Eva, Marsha, Fieke, Fay and Tess.

And a final thanks to my roommates, that kept repeating “you got this” during every step of this journey.

Enjoy reading!

LAURA

Abstract

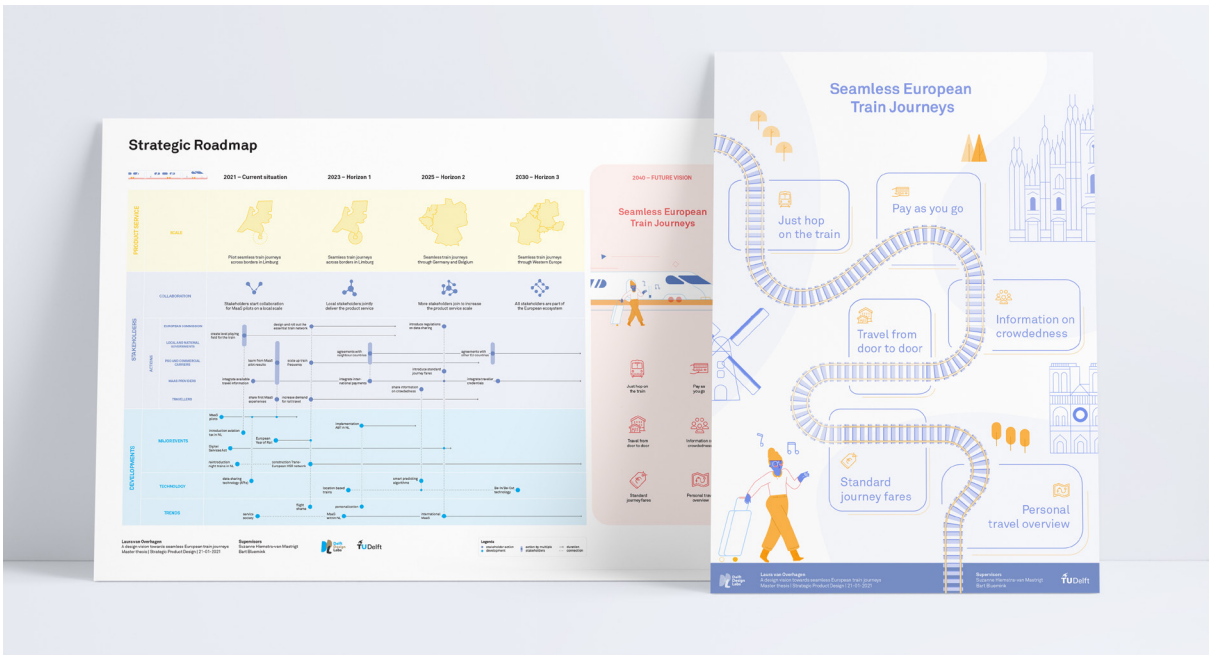
Our current travel behaviour is having a detrimental impact on the environment. Especially air travel is a huge contributor to climate change, with its large amounts of polluting carbon emissions. Due to increasing concerns regarding the environmental impact of air travel, international train travel may become an increasingly popular mode of transport for European journeys in the near future.

However, current European train journeys are not an integrated and supported experience from start to finish. Finding suitable tickets can be complicated due to the variety of booking platforms and irregularity of ticket prices. Moreover, train journeys themselves can be stressful because of delays in transfers and the inflexibility of departure times. As a result, many people are withheld from actually taking the train and prefer to travel by plane or car.

In order to stimulate more people to choose the train as their mode of travel, this project created a design vision towards **seamless European train journeys**. In this future vision travellers are able to travel anywhere they want, whenever they want to. It allows you to just hop on any international train, without having to book a ticket in advance. With your personal travel account and location being updated behind the scenes, it is possible to travel across borders and pay as you go. Standard journey fares are introduced, so travellers will not face any unpleasant surprises afterwards.

This project puts forward a strategic roadmap presenting the main steps, actions and developments that are needed to realise the future vision. Seamless European train journeys should take shape by incremental scale increases over time, starting with current pilots that make it possible to seamlessly travel across borders in the Netherlands. Governments, railway companies and mobility providers should collaborate to break down borders and create an integrated cross-border travel experience. The European Commission should take up a guiding role to foster this implementation and collaboration, by setting regulations on data transparency and rolling out the essential network.

After implementing the future vision, it is expected that more European travellers prefer to travel by train instead of plane or car. In the longer term, the train becomes the default option for European travel and the future vision and roadmap developed in this project can positively contribute to the transition towards more sustainable transportation.



List of abbreviations

ABT	Account Based Ticketing
API	Application Programming Interface
BIBO	Be-In/Be-Out
CO2	Carbon dioxide
DB	Deutsche Bahn (Germany Railways)
EC	European Commission
HSR	High Speed Rail
IenW	Ministry of Infrastructure and Water management
MaaS	Mobility as a Service
NMBS	Nationale Maatschappij der Belgische Spoorwegen (Belgian Railways)
NS	Nederlandse Spoorwegen (National Dutch Railways)
NSI	NS International
ÖBB	Österreichische Bundesbahnen (Austrian Railways)
PSO	Public service obligation
SNCF	Société nationale des chemins de fer français (French Railways)

List of definitions

Account Based Ticketing
A ticketing and payment system in which any travel token, that is linked to your personal account, can be used for transactions (cooperatieovbedrijven.nl).

Be-In/Be-Out
A technology that enables travellers to obtain their (virtual) travel tickets just by “being” inside a vehicle (Narzt et.al, 2015).

Carrier
Railway company operating on the rail network and providing railway services for travellers (NS international).

Concession
The right to perform public transport to the exclusion of others in a certain area during a certain period of time (Overheid.nl, 2019).

Concessionaire
Licensed public transport operator to whom a concession has been granted (Overheid.nl, 2019).

Fare
The money paid for a journey on public transport (Lexico, 2019a).

Interoperability
The ability of computer systems or software to exchange and make use of information. (Lexico, 2019b).

Mobility as a Service (MaaS)
A new transport concept that integrates existing and new mobility services into one single digital platform, providing customized door to door transport and offering personalized trip planning and payment options. Instead of owning individual modes of transportation, or to complement them, customers would purchase mobility service packages tailored to their individual needs, or simply pay per trip (Durand et al., 2018).

Modality
A mode of transportation.

Open access
The possibility for every company to perform public transport.

OV-chipcard
The OV-chipcard is the payment method for public transport in the Netherlands. You charge the card with a balance in euros or you put a travel product on it, such as a one-way ticket, a monthly home-work travel subscription or a travel card (Translink, 2019).

Public service obligation
An obligation for carriers to provide railway services of general interest imposed by governments by contract (European Commission).

Public Transport
Passenger transport open to every one according to a timetable with a car, bus, train, metro, tram or a vehicle propelled through a guidance system (Overheid.nl, 2019).

Shared transport
Demand-driven vehicle-sharing arrangements in which travellers share a vehicle either simultaneously as a group or over time (Wikipedia).

Traveller
A person who is travelling or who often travels (Lexico, 2019c).

Travel Product
A travel product is essentially an (electronic) “right” that enables the traveller to travel on public transport at a certain time and place at a certain price (Autoriteit Consument Markt, 2018).

Travel Token
A travel token is a means of identification used for checking-in and out on public transport. Examples of travel tokens are the OV-chipcard, smartphone, barcode, and debit card.

Table of contents

Introduction

1

Project context

Our current travel behaviour is having a big negative impact on the environment. Especially air travel is a huge contributor to climate change due to the large amount of polluting greenhouse gases. “Someone flying from Lisbon to New York and back generates roughly the same level of [CO2] emissions as the average person in the EU does by heating their home for a whole year” (ec.europe.eu). Short flights produce an even larger amount of greenhouse gas emissions per traveller compared to longer routes. To achieve climate neutrality, the aviation industry will have to contribute to the reduction of transport emissions set out the European Green Deal (ec.europe.eu).

Due to increasing concerns regarding the environmental impact of air travel, international train travel may become an increasingly popular mode of transport for European journeys in the near future. There already seems to be an increasing (returning) interest, both for high speed rail connections as well as for international sleeper trains. For example, Eurostar recently introduced a new high-speed rail service from Rotterdam to London.

However, current international rail services are not an integrated and supported experience from start to finish. That is one of the reasons why air travel is quite often still more preferred. Booking and comparing flights is experienced as easy and understandable, while ticketing for the same destination by train can be so complicated that special companies have to do this for you. The journey itself also comes with more difficulties when accomplished by train. Moreover, rail travel is often much more expensive, since budget airlines compete with extremely low priced flights. Figure 1 shows the comparison of air and rail travel journeys from Amsterdam to Copenhagen.

Figure 1: Comparison of air and rail travel journeys from Amsterdam to Copenhagen

In order to reach the desired modal shift from air to rail, a European approach is needed to “lead to more adequate services for the international rail travellers, seamless travelling and more specific ticketing being one of the most important issues to act upon” (Four Country Platform for Cross Border Passenger Railway services, Final report and recommendations, October 2019).

Cross border rail services should be the first choice for international travellers, attracting customers by quality, ease of use and reliable availability at a reasonable price.

Societal goal

This project aims to contribute to a more sustainable world, where less green house gases are emitted by human activities. If more people travel by sustainable modes of transportation, like trains, we can decrease the carbon footprint of travelling and contribute to climate neutrality.

Scope

This project explores the future of international railway services and delivers a solution that enhances a more seamless travel experience. The project is scoped on international rail services within Europe, with a more specific focus on the Dutch railway sector and the other countries of the Four Country Collaboration Platform.

Assignment

The assignment is formulated as follows: Develop a design vision for a seamless international rail travel experience within Europe and create a roadmap illustrated through a product-service concept to amplify this future vision.

The purpose of this project is to inspire and encourage the railway sector, governments and other parties to improve European train journeys.

Seamless Personal Mobility Lab

This graduation project is executed within the Expertise centre for User-Centred Mobility Service, one of the projects of the Seamless Personal Mobility Lab, which is one of the Delft Design Labs of the faculty of Industrial Design Engineering (IDE). In this research and design lab, students and researchers of IDE at TU Delft work together with transport operators, mobility companies, government and technology developers to gain better understanding of the wants, needs and behaviour of travellers. Within the lab, multiple graduation and research projects are executed.

The following parties are connected to the Expertisecentre for User-Centred Mobility Services:

- 9292
- GVB
- Ministry of Infrastructure and Water Management
- CROW
- DOVA
- RET
- Rover
- Translink

Project specifc partners

For this project, one existing partner from the SPM lab and one additional partner relevant for the context of this project, are actively connected and are referred to as the main stakeholders throughout this report:

- Ministry of Infrastructure and Water Management (IenW)
- NS International (NSI)

IenW is the part of the national government that is occupied with policy around international rail travel. NSI is the division for international rail travel of the Nederlandse Spoorwegen (NS), the national Dutch railways.

Project approach

2

Process

This project consists of five phases: deconstruction, future context, ideation, conceptualisation and implementation. Figure 2 shows the five phases plotted on the well-known double diamond process of design thinking. Table 1 shows an overview of the main activities and outcomes during the project. Throughout the project, several elements of the Vision in Product (ViP) design approach are used (Hekkert & van Dijk, 2016).

Deconstruction

The first phase deconstructs the current situation of international rail travel. This is done from a systems perspective and from a customer perspective. In addition, car and air travel are used as a benchmark.

Future context

The second phase explores the future context of international travel in Europe in 2040 following the steps of the ViP process. This results in a future context vision and design mission.

Ideation

I the third phase, three creative sessions generate ideas for a concept in this future context. The result consists of three concept directions, one of which is chosen for detailing.

Conceptualisation

The fourth phase documents the final concept design (the future vision) in six vision elements and an animation video. A customer journey and service blueprint give further explanation.

Implementation

The fifth and final phase combines the stakeholder actions to reach the future vision in a roadmap. Additionally, the design vision is validated with users, stakeholders and experts.

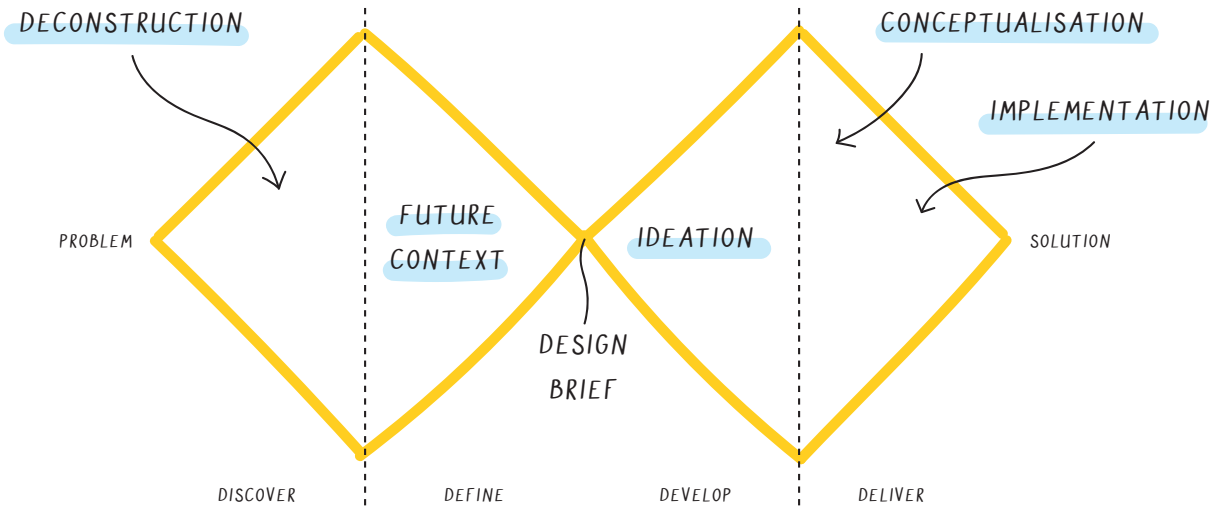


Figure 2: Overview of process phases

Table 1: The activities and outcomes of this project

Description	Methods	Participants	Outcomes
Deconstruction analysis	Literature research, stakeholder interviews, expert interviews, traveller interviews	**7 stakeholders** (NSI, IenW, Arriva, Flixtrain) **8 experts** (Royal HaskoningDHV, Rover, Eurail, Treinreiziger.nl, TU Delft) **6 travellers**	Deconstruction of the international railway system, the international train traveller and inter-national rail market potential (chapter 3)
Future context analysis	Literature research, expert interviews	**4 Experts** (Royal HaskoningDHV, Eurail, TU Delft)	Driving forces, context structure, travel attitudes (chapter 4)
Creative session 1: First exploration	Digital brainstorm using Zoom and Miro: Purge, metaphor associations, how to's, worst idea ever, fixing it and concept designs	**6 participants** IDE master students	Wide exploration of solution space (chapter 6)
Creative session 2: A future train journey	Digital brainstorm using Zoom and Miro: How to's and placing ideas on the customer journey	**15 participants** Visitors of the Human Factors NL conference	Input for concept directions (chapter 6)
Creative session 3: Three concepts	Digital brainstorm using Zoom and Miro: Metaphor associations, how to's and concept design	**5 participants** Members of the Seamless Personal Mobility Lab	Input for concept directions (chapter 6)
Additional user research	User survey via Instagram stories	**130 participants**	Input for final design (chapter 7)
User validation	Traveller interviews using the future vision animation movie	**9 participants**	Initial reactions and pros/ cons (chapter 8)
Stakeholder validation	Discussion using the future vision and strategic roadmap Presentation and Miro during knowledge sharing session with the SPM lab	**6 stakeholders** (NSI, IenW) **Lab partners** (Translink, DOVA, RET, 9292, CROW, Rover, IenW, MRDH)	Initial reactions and possible bottlenecks (chapter 8)
Expert validation	Discussion using the future vision and strategic roadmap	**2 experts** (Royal HaskoningDHV, TU Delft)	Initial reactions and possible bottlenecks (chapter 8)

Report structure

The report structure follows the five phases mentioned before. Each phase forms a separate chapter. One additional chapter explains the design brief formulated in between the second and third phases. There is an introduction at the start of each chapter.

In this public report, some confidential information has been censored like the example below.

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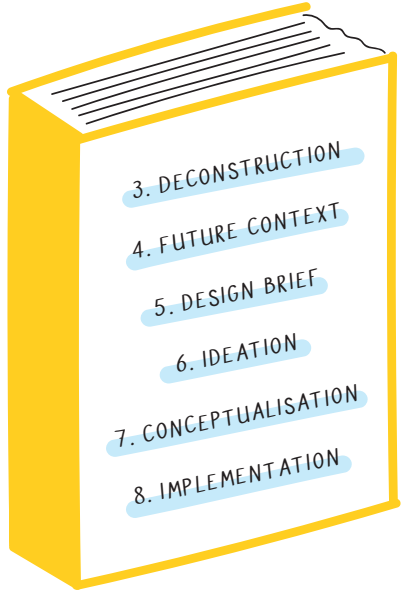


Deconstruction

3

In this chapter I will deconstruct the current situation of international rail travel by combining literature research and interview insights. The full list of interviewed stakeholders and experts can be found in appendix B.

In the stakeholder analysis (3.1, page 36) I explain the main stakeholders in the international railway sector. First I elaborate on the specific stakeholders in the Dutch context, before I show how all different stakeholders relate to one antother in a wider perspective.

In the system analysis (3.2, page 32) I will deconstruct the international railway system based on a model that splits up the system in four layers. For each layer, I explain the current situation and developments that are going on. An overview of all developments is added in the chapter conclusion (3.5, page 63).

To gain deeper understanding of the user, I will look at the travel experience of international train travellers (3.3, page 45), which I explain in a customer journey map. Comparing air and car travel will help to find out how travellers are making their modality choices. With these insights I will create a customer adoption funnel that shows how travellers are (not) adopting to travel by international train.

To show the relevancy of this project, I will elaborate on the international rail market potential (3.4, page 57), looking at the potential of trains to substitute flights and a level playing field for air and rail travel prices.

From the complete deconstruction, I concluded strengths, weaknesses, opportunities and threats for rail travel in a SWOT analysis (3.5, page 63).

3.1

Stakeholders

This subchapter introduces the main stakeholders in the international railway sector. I will first elaborate on the specific stakeholders in the Dutch context and then I will show an overview of how all stakeholders relate to each other in a wider perspective.

Stakeholders in the international railway sector

The international railway sector is very complex. It does not only involve many countries, but within each country close collaboration between public and private parties is required to enable international train travel. The main parties involved in international rail travel are the government, infrastructure management, transport companies and supervisory bodies. An overview of how all these parties relate to each other can be found in the stakeholder map (see figure 4). In line with the scope of this project, the Dutch stakeholders will be explained more elaborately.

Dutch stakeholders

In the Netherlands, three main parties work closely together to enable international train travel (see figure 3). These are NS International (NSI), ProRail and the Ministry of Infrastructure and Water Management (IenW). The roles, responsibilities and authorisations of the parties involved in rail transport are determined by The Railway Act (2003).

Figure 3: Overview of Dutch stakeholders

Responsibilities NS/NSI

- Operating trains
- Providing rail services for national and international travellers
- Commercially operating train stations

Responsibilities ProRail

- Construction, maintenance and management of the Dutch rail network on behalf of the national government
- Capacity allocation on the rail network
- Rail traffic control

Responsibilities IenW

- Operator contracts
- European collaboration
- Monitor the safety (Human Environment and Transport Inspectorate)

From these three main parties, NS International is the only stakeholder that operates in direct contact with the traveller and can therefore have a direct impact to improve the traveller experience.

NS International

NS International (NSI) is the division for international rail travel of the Nederlandse Spoorwegen (NS), the national Dutch railways. Since international rail travel is quite different from domestic travel and collaborations with foreign parties are required for crossing borders, NSI operates as an independent department that can make its own business decisions. However, because domestic rail travel is the core business of NS and NSI is only providing a small percentage of the total revenue, domestic trains are having priority on the Dutch tracks. It can be hard to combine international trains in the domestic train timetable, because track and platform capacity have to be managed.

NSI is working hard towards the potential of getting more people to travel by international trains. The ambition of NSI for international rail travel is two-folded:

- Shorten travel times on distances up to 700 km
- Together with other parties offer and facilitate longer distance train journeys

Operational model
On cross border services, NSI always has to collaborate with other carriers, like NMBS (Belgium), SNCF (France) and DB (Germany). In most of these collaborations, NSI functions as carrier in the Netherlands and provides educated train personnel for (parts of) the journey. NSI fulfils part of the job and receives a certain amount of revenue in return.

Ticket distributor
NSI sells tickets for all rail services in which they operate and receives a percentage of the ticket price. In general, NSI only sells tickets in the Netherlands. Although it is possible to book tickets from NSI from abroad, hardly any marketing is focused on sales in foreign countries. It is very traditional that every national carrier sells tickets in its own country. Eurostar and Thalys sell tickets to all countries independently as well, because then they don't have to pay NSI a distribution fee. The additional value of NSI for the traveller is that you can also book your connecting trains in the Netherlands.

ProRail
ProRail is the infrastructure management company of the Dutch railway network on behalf of the national government. They are responsible for constructing new infrastructure and maintaining existing infrastructure. Also, they allocate capacity on the Dutch rail network and therefore control the rail traffic. Rail tracks are used by carriers, which have to pay a certain fee for this usage to ProRail.

Ministry of Infrastructure and Water Management
The Ministry of Infrastructure and Water Management (IenW) could be described as the employer of NS(I) and ProRail. IenW determines who may fulfill the *concession* on the main railway network and who may manage the railway (rijksoverheid.nl). These transport concessions are needed in order to transport passengers via the main railway network and can be optained via tendering procedures. NS was granted the main Dutch concession, and can be seen as a Public Service Obligation (PSO) carrier, which means the organisation is obliged to provide a service of general interest. Within this concession, NS has the sole right to transport passengers on the main Dutch railway network.

However, NSI does not have this sole right for international railway services. There is a so-called *open access* system, where multiple carriers are allowed to start operating international trains. The ministry is not paying for this, so the operators have to earn money from the travellers themselves. Although it is theoretically possible, there have been no new parties stepping into the Dutch international market yet.

It is up to the ministry to revise the national priority and decide who comes first, the PSO or the open access trains. More information about new entrants in an open access model can be found on page 36.

The ministry also collaborates on a European level. The European Commission (EC) can impose legislation or future plans to the member states. For example, the ministry has recently started a pledge towards the EC to boost international rail services and make it an attractive alternative over distances where it is currently not competitive. However, the EC consists of representatives of the member states themselves, so if a plan can't be rolled out before the deadline, the deadline is usually extended by a few years.

Other international operators
Besides NSI, there are also other train operators providing rail services crossing the Dutch borders. These companies are operating on a more local or regional scale compared to NSI. One of these operators is Arriva.

Stakeholders in other countries

Many European countries have a similar combination of collaborating stakeholders in the international railway sector. Table 2 shows an overview of these main parties for Belgium, Germany and France.

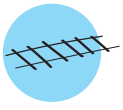
Table 2: Overview stakeholders in other countries

	National government	Infrastructure management	National transport companies	Local/regional transport companies
The Netherlands	Ministry of Infrastructure and Water Management	ProRail	NS/NSI	Arriva
Belgium	Federal Public Service Mobility and Transport	Infrabel	NMBS	unknown
Germany	Federal Ministry of Transport and Digital Infrastructure	DB Netze	DB	DB regio
France	unknown	SNCF Reseau	SNCF	unknown

Overview of all stakeholders

European Commission
The EC is the executive party of the European Union. In this context she is responsible for setting regulations and granting subsidy to governments and carriers.

Governments
This includes both national and local governments who create policy for international rail travel and put out tenders for transport concessions with carriers.



Infrastructure
These parties construct and manage the rail network that is used by the carriers for a rail use fee in return.

Stations
This stakeholder is not an active decision-maker, but does play a key role to enable trains to stop at a platform and offer facilities for (transfer) travellers.

Carriers
The train companies that are responsible for operating trains are called carriers. They form the centre of the stakeholder map as they directly relate to all other stakeholders.

Distributors
These parties sell train tickets to travellers. This includes independent distributors as well as the train companies selling their own tickets.

Travellers
These people travel by international train, buy tickets for their train journeys via carriers or ticket distributors and spend time at train stations.

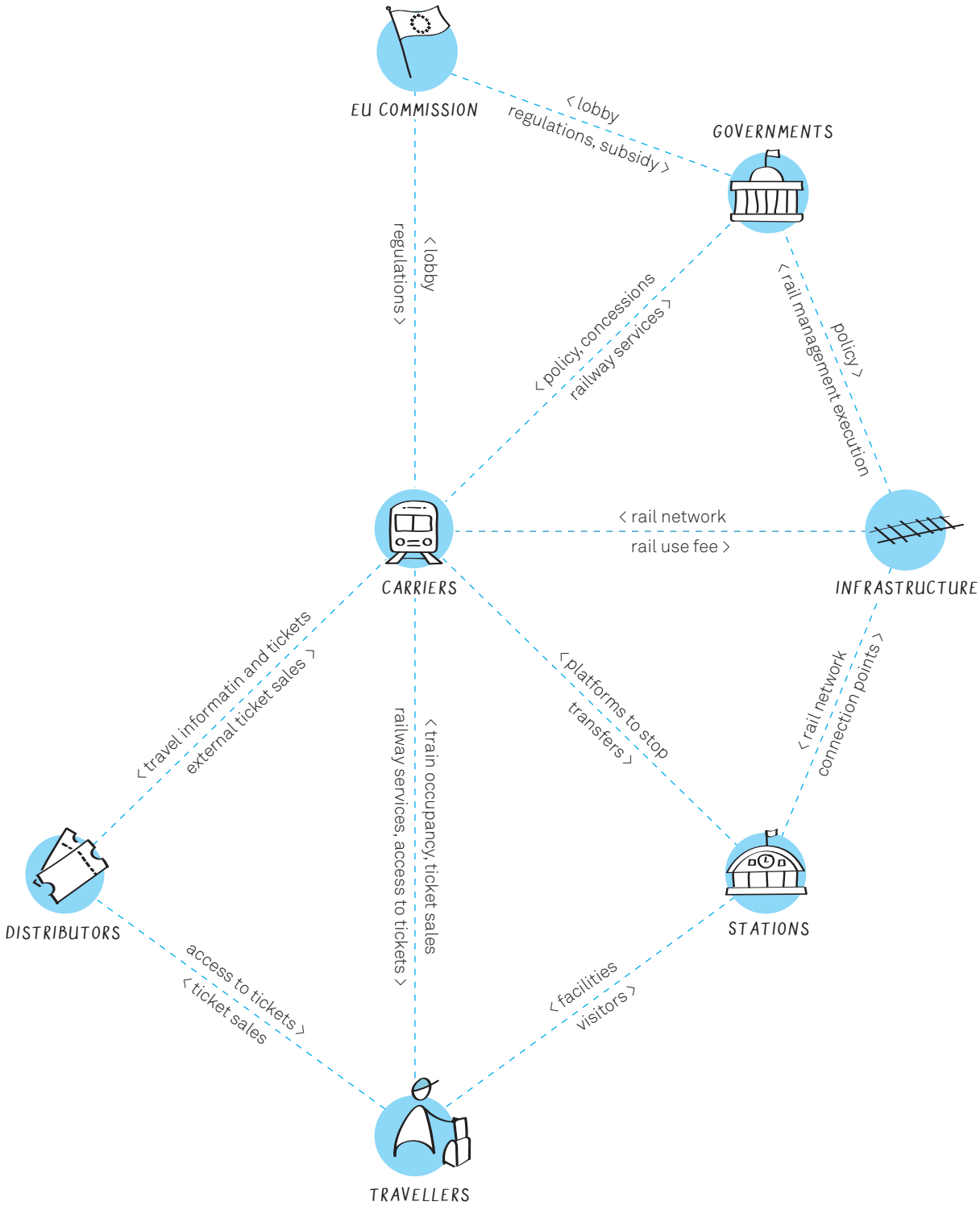


Figure 4: International railway sector stakeholder map

3.2

System

In this subchapter I will deconstruct the international railway system based on a model that splits up the system in four layers (Rli, 2020). For each layer, the current situation and developments are explained. An overview of all developments is shown as an conclusion in 3.5 (page 62).

The international railway system in four layers

From a traveller's point of view, the organisation of the complex international railway system can be deconstructed in four layers (Rli, 2020). Each layer has its own characteristics and different parties that play a role.

1. Infrastructure
The bottom layer includes the physical and ICT infrastructure. The base of the railway system consists of rails, stations and ICT hardware.

2. Traffic services
The second layer consists of traffic services. This includes all measures and instruments that enable an optimal and safe use of the railway infrastructure, such as the European Rail Traffic Management System (ERTMS) that stimulates flow and safety.

3. Transportation services
In the third layer there are the transport services. These are related to the users of the railway system, like the rail operators, and the transportation means and services that move the traveller through the system.

4. Mobility services
The mobility services form the fourth and top layer. These include more traditional mobility services, like travel information and travel planners, and also newer, often ICT related mobility services, like real time travel information and Mobility as a Service (MaaS) concepts, which focus on the journey from A to B rather than on the modality.

In the next sections I will explain these four layers in more detail. For each layer, I will elaborate on the current situation and developments that are going on. The first section elaborates on the bottom two layers, infrastructure and traffic services (page 34). Subsequently, I will elaborate on top two layers, transportation services (page 37) and mobility services (page 42).

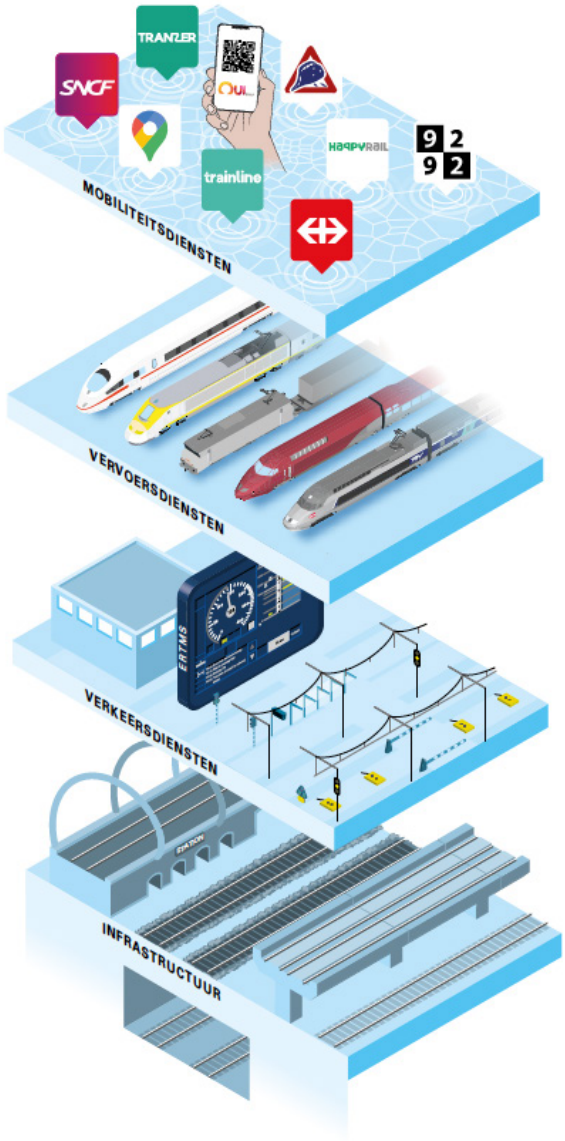


Figure 5: The 4 layers of the international railway system (Rli, 2020)

Infrastructure and traffic services

The bottom two layers of the international railway system are formed by infrastructure and traffic services. Each country developed its own rail network and systems, which resulted in technical inconsistency across countries in Europe.

Structural barriers

I have discovered three main structural barriers that limit the interoperability of the rail network.

Differences in rail width

Not all rail tracks in Europe are similar. The accepted normal rail width is 1435 mm, but in some countries a wider rail of 1668 mm is used (see figure 6). Because trains need to be adjusted to continue riding on a different rail width, travellers always need to transfer trains in these situations.

Differences in overhead wire current

Similar to rail width differences, countries use different currents in the overhead wire. This challenge can be overcome by equipping trains with a system that can handle multiple currents. The only side effect is that these trains are more expensive.

Different European safety systems

European countries also developed different safety systems. This brings more difficulties for border crossings as well. Not only rolling stock needs to be equipped with all the different systems again, engine drivers need to be trained to work with different safety systems as well.

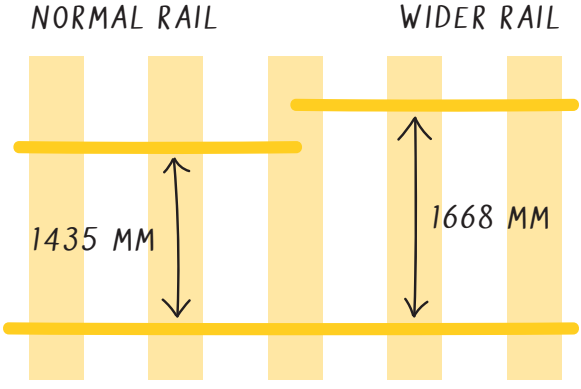


Figure 6: Differences in European rail width

Developments

Towards a single European Railway Area

To improve interoperability of international rail tracks, the European Commission has put a series of measures in the Fourth Railway Package (European Commission). One of the main developments under the technical pillar of this package is the implementation of the European Rail Traffic Management System (ERMTS). If ERMTS is to be implemented in all European countries, international rail capacity and safety would be increased, making it possible to let more international trains travel on the current infrastructure.

But a total European shift to a similar system takes very long. And while implementing ERMTS, newer versions of the system get developed, so you need to update the software of the first implemented systems in order to be exactly the same.

> "ERMTS might be hip and trendy, but before we have a solution that works for the entire area [(Europe as a whole)], it will take another 30 or 40 years." – Regional development manager, Arriva

Trans-European high-speed rail network

The current network of high-speed rail (HSR) shows gaps in coherency. Figure 7 shows that there are many loose ends just before the country borders. Fast (but also slower) cross border connections are limited due to prioritisation of national concerns. For the traveller this mainly means that cross-border train journeys are longer than needed. To realise more and faster cross border connections, European countries need to put the international priority higher on the agenda.

In a report to compare air and rail travel for short distances, Royal HaskoningDHV proposes a more coherent European HSR network (see figure 8). Orange lines are new connections and yellow lines are already existing connections. The proposed network improvements can realise spectacular travel time reductions for connections to Amsterdam, making most train journeys twice as fast as flights (see appendix C).

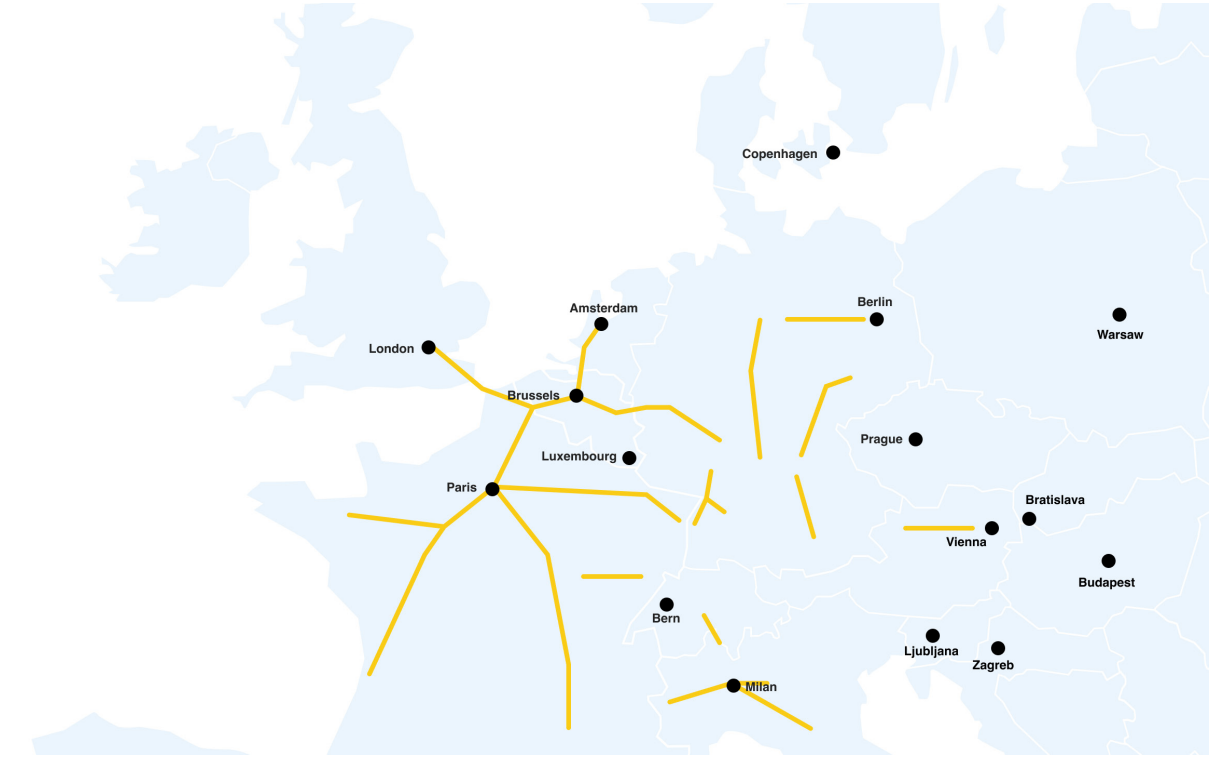


Figure 7: Current high-speed rail network (based on Royal HaskoningDHV, 2018)

Figure 8: Proposed European high-speed rail network (based on Royal HaskoningDHV, 2018)

However, the realisation of such a European HSR network is a very complicated task. First of all, investments in infrastructure are very expensive projects, which are often subsidized by the European Commission. Secondly, these investments are also very time-costly. “On average it takes about 16 years between the start of building activities and the introduction of new high-speed lines.” (Europese Rekenkamer, 2018) As a result, the benefits and improvements won’t pay off any time soon.

Conclusion

The main bottleneck for the traveller lies in speed limitations as a result of limited capacity and quality of existing infrastructure. Developments to improve the network take long, that’s why it is important to act now.

Transportation services

The third layer of the international railway system is formed by transportation services. These are related to the users of the railway system, like the rail operators, and the transportation means and services that move the traveller through the system.

Current situation

International transportation services can be divided in three different categories of increasing scale: regional cross-border, capital-to-capital and long distances.

Regional cross-border

People that live close to the German-Dutch or Belgian-Dutch borders are crossing these borders on a regular basis as social and economic activities are greatly connected. Limburg is the only province in the Netherlands borders two other countries, and shows a good example with the train from Maastricht to Aken. Regional operator Arriva is responsible for the Dutch side of the Maastricht-Aken service and closely collaborates with the German operator.

> "For the operation we have a partnership with DB Regio on that line from the border, because it is much easier for us to carry out the operation." – Regional development manager, Arriva

However, international operational collaborations are not always easy to create, if companies are approaching it from their national point of view. National orientations can clash and make it harder to collaborate.

> "The cultural differences between countries often mean that some things are not possible. The fact that people do not speak each other's language, that they are not familiar with the business rules and hierarchies, can destroy a lot. Make yourself known as a company to be successful." – Regional development manager, Arriva

For Arriva it really helps to have several people from across the border working at the company as well. The company is merging the cultural differences and becoming an international company, focussed on multiple countries.

It is also key that these cross-border services are well aligned with national rail services for a seamless travel experience. For the purpose of the traveller, Arriva and NS are able to set aside their competitive nature and supplement each other in these situations. In the end they have the shared goal of creating the best experience for the traveller.

> "In some places you are competitors, but in many places you have additional roles because you want to be there together for the customer." – Regional development manager, Arriva

Capital-to-capital

Five transportation services exist that form a direct connection from and to the Netherlands; Thalys, Eurostar, Intercity Brussels, IC Berlin and ICE international (see figure 9). These services are growing in popularity and have great potential to substitute air travel (see 3.4, page 56).

The incumbents

The international railway market is dominated by large national railway companies, the so-called incumbents. For these national railways, national services have always been a priority. National services are their biggest revenue source and the national traveller is their most important customer. A majority of rail experts even considers these national interests as the main factor curtailing international rail (Rli Online Event International Rail). The case study IC Berlin shows the consequences for transportation services of national concern.

Figure 9: Overview of direct capital-to-capital services from Amsterdam (Amsterdamtrips.com)

On the other hand, incumbents are also willing to collaborate. Railteam is an alliance of eight high-speed rail operators in Western Europe to optimize cross-border rail transport in speed, price and comfort. The Railteam members are shown in figure 10. However this alliance actually seems to be more like a network club. The once promising cooperative effort to make international rail travel easier for travellers resulted in very little projects. Hop on the next available train (HOTNAT) is the only European agreement realised by Railteam. It allows travellers to take the next high-speed service leaving from the same station as originally planned when a delay on or cancellation of a preceding Railteam member's high-speed service prevents them from making their originally-planned connection (Railteam.eu).

Open access market

Since 2007 the European Commission has started to head for an open market, as she beliefs that competition in the rail travel market will improve the service quality for the traveller (Fourth Railway package, European Commission). But not everyone is welcoming this shift with kind cooperation. For example, incumbents are not always willing to share information with new operators.

In theory, any company is now able to start operating trains on any international connection. However, it is very expensive and difficult to enter the market as a new operator. You have to make big investments in rolling stock and there is no reassurance that you would have when operating in a concession. If a connection is less profitable than expected it is difficult to pack up your trains and start operating somewhere else.

Although it is hard to start as a business, there are examples in Italy and Germany where it did happen. For example, NTV-Italo as a new entrant is competing with Frecciarossa services of the established Trenitalia. And Flixtrain is operating as a new entrant in Germany.

Flixtrain is currently experiencing problems to expand their transportation services. The international rail market might be liberated, the national markets are in most cases not. For example, if Flixtrain would cross the border and extend their

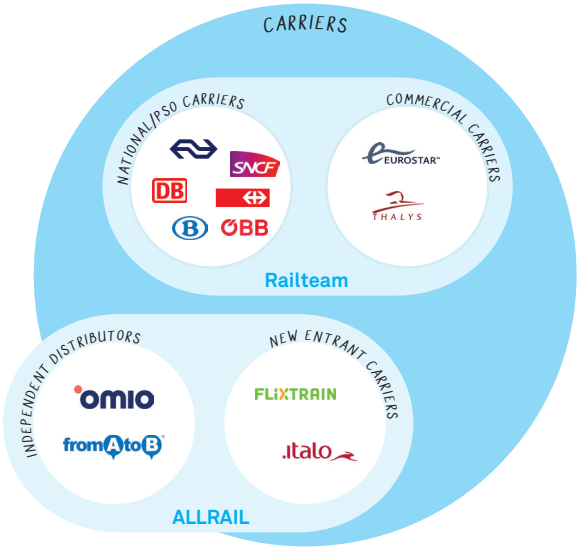


Figure 10: Overview of Railteam and ALLRAIL alliances

lines into the Netherlands, they are currently not allowed to board national travellers, because this is part of the main rail concession (3.1, page 26).

> "Currently we are only operating on the German market. The Netherlands is keeping its market closed." – Flixtrain

ALLRAIL

The new entrants also established an Alliance of Rail New Entrants (ALLRAIL) in 2017 to seek fair competition, non-discriminatory conditions and market opening in passenger rail (allrail.eu). ALLRAIL represents independent passenger rail companies, both railway carriers and ticket distributors. The members share the believe in faster opening up the market for more players to accelerate a shift to rail.

Although market opening shows great potential of improving passenger rail, there can also be downsides for the traveller in a system where the independent operator can do what he wants.

> "You don't have the reliability or certainty that the service will be available in a month or 2 or a year. And you do have that if you have a concessionary transport, where the carrier is obliged to do something." – Regional development manager, Arriva

Long distances

The third scale category in transportation services are train journeys for longer distances. Departing from Amsterdam these journeys currently always require a transfer and are executed by multiple operators. NS International is offering train journeys to many locations in Europe.

Another rail service to travel long distances are night trains. Once the Netherlands was counting several night train connections but over the years they have all come to an end.

International train stations

Many national train stations in the Netherlands are currently included in the network of international trains (see figure 9). This is convenient for travellers as they have many departure locations to choose from. However, the resulting downside is that international trains make more stops and journeys take longer, like is shown in the case study IC Berlin.

From the perspective of international rail travel, it would make sense to have less international train stations in the Netherlands, or even one international travel hub. It is essential to find out how many international train stations would be logical and where they should then be located. In case more stations and stops are skipped, local networks should be more seamlessly connected for efficient transferring of trains.

Case study IC Berlin

This "direct" train from Amsterdam to Berlin takes 6 hours and 20 minutes. The train is unnecessarily stopping 15 times and when crossing the German border there is a change of loc in Bad Bentheim (see figure 11). Currently, NS does not want to skip any Dutch stations, like Hilversum and Almelo, if Germany does not do so either (Roger van Boxtel, NS).

The travel time could be reduced with 1,5 hours if the loc was not changed, small changes to the infrastructure were done and stations were skipped. This would make the connection a stronger competing alternative for car and air travel.

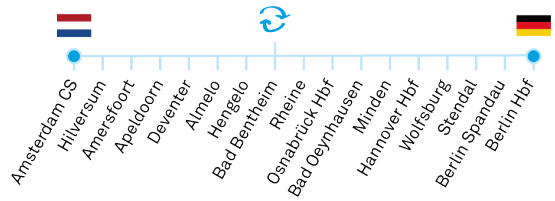


Figure 11: Overview of stops IC Berlin

Developments

Thalys and Eurostar join forces
Thalys and Eurostar are going to merge in 2021. This development will give them the possibility to offer a bigger network, better connections and more trains (Eurostar.com). They will probably strengthen their position in the market and make them an even more powerful force as a monopoly, making it harder for new entrants.

Comeback of the night train
The night train will return to the Netherlands. As of 2021, Austrian night rain specialist ÖBB and NS will run a daily night train from Amsterdam to Munich, Innsbruck and Vienna (nsinternational.com). This development shows potential in serving a very specific target group: travellers who need to arrive early in the morning or travellers who efficiently want to spend their sleeping time to travel as well.

Trans-Europe-Express 2.0
September 2020, Germany proposed its plans for a Trans-Europe-Express (TEE) renaissance (Treinreiziger.nl, 2020). The legendary TEE once flourished as a luxurious international high-speed train connecting 70 cities in Europe. The TEE 2.0 would consist of a network of international long-distance high-speed passenger services spanning much of Western Europe.

However, in December 2020, DB, OBB, SNCF and SBB signed a letter of intent to revive TEE 2.0 by only introducing new cross-border night train connections in Europe (spoorpro.nl, 2020).

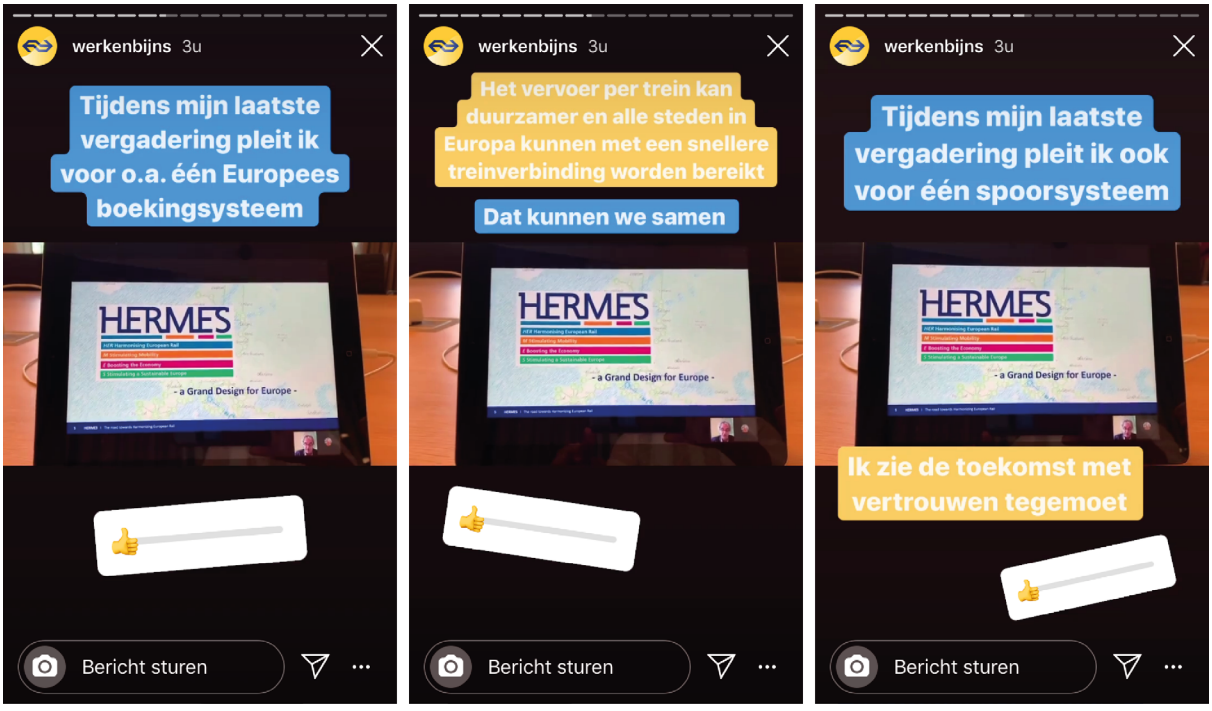


Figure 12: Roger van Boxtel's Instagram stories @werkenbijns (30/09/2020)

Growing momentum to improve European passenger rail

Both from governments and transport companies, there is a growing momentum to improve European passenger rail. On June 3rd 2020, 24 countries signed a pledge to boost international rail routes. Transport ministers want to make international rail services an attractive alternative for flights over distances where it is currently not competitive (Rli Online Event International Rail, 2020).

In a recent meeting with European railway companies on September 21st 2020, Roger van Boxtel (former director NS) is proposing a plan to harmonize European rail (HERMES). In his plan he pleads for one European booking system and one European rail system. Besides the quote below, it is hard to find out what the plans entail exactly, but it does show the momentum from an operator perspective.

> "We as European railway companies are the ones that can really take steps to enhance ticketing and make it easier to book a ticket throughout Europe. Rail in particular is expected to be a gamechanger, thanks to its truly sustainable way of moving people and freight. After Covid, we have a chance to rebuild European green ... Together with you, our partners and stakeholders across Europe, we want to take the lead in raising European passenger rail to a higher level." - Former director, NS

Conclusion

From this analysis I understood three main conflicting elements that form a barrier for successful international rail travel collaborations.

- National carriers versus new entrants
- PSO versus open access
- National concern versus EU priority

Incumbents versus new entrants

Incumbents want to keep their strong position as market leader and are afraid of the new entrants. New entrants are passionate to conquer the market and become market leaders themselves.

PSO versus open access

Contrasting business models of operators nationally and internationally make it complex to harmonise the international railway market.

National concern versus EU priority

National concerns can hinder the development of European Passenger Railway services. This barrier is seen on all four levels of the international rail system.

Main insights to overcome barriers

- Operating partners are essential for carriers to realise cross-border services.
- Carriers should be international if they want to ride trains internationally.

What does this mean for the traveller?

Unsuccessful international rail travel collaborations can hinder the traveller in many ways. But most importantly, if the international traveller is not a priority, cross-border train journeys won't be an integrated service or seamless experience.

Mobility services

The fourth and top layer of the system consists of mobility services, which make it possible for travellers to plan and book international train journeys.

Benchmarking travel planners and ticket distributors
Travellers have many ways to get access to international train journeys. Different travel planners and ticket distributors exist to plan and book an international train journey (see figure 13).

In general it is very traditional, every national railway company sells train tickets in their own country. But travellers can also decide to book tickets at the national railway company of the country of destination or directly at commercial carriers, like Thalys or Eurostar. Another option is to book tickets through an independent distributor, like Omio or Trainline. These online booking platforms are emerging rapidly but there is not yet on platform that serves all our need, which we are used to in aviation.

> "Good first steps are being taken, but how things are now arranged, it is too difficult to realize the Skyscanner for train tickets." – Columnist, Treinreiziger.nl

Barriers within ticketing

There are several reasons why it is difficult to realize the Skyscanner for train tickets. The main barriers within ticketing are explained below.

No European standard
Tickets and conditions are different everywhere. Travellers need to buy separate tickets if a journey with a transfer is carried out by different operators. This means that the traveller has a contract with two separate parties, so his travel rights are split up as well.

Limited time in advance
Tickets are only available 3 months before departure. Compared to flight tickets, which can be booked 9 months in advance, this booking availability is very limited. This can be annoying for a traveller who would like to book more in advance.

Not sharing data
Although rail operators have to open up their data since 2014, they do not always let other platforms sell all their train

Figure 13: An overview of international travel planners

tickets. For example, NSI cannot sell the cheaper Ouigo tickets from SNCF. For the traveller, this results in higher ticket prices, which is of course unwanted.

Price differences per country
Ticket prices are not consistent along all booking platforms in different countries. Prices differ for the same ticket on different websites (Mak & van Lieshout, 2016). For the traveller, this is rather strange, because he or she would expect tickets for the exact same train to be similarly priced.

Culture differences
In southern Europe journeys are booked for one date, one time and with seat reservation. In Germany and the Netherlands it is less predetermined. This makes it more difficult to reach one European ticket system.

Interrail pass
In Europe, a special mobility service exists that gives travellers the possibility to travel by train through Europe with one single ticket, the interrail pass. The interrail pass can be bought for different time lengths, starting from 3 days. This mobility service is focussed on making a longer or round trip through Europe, not on point to point travel. For international train travellers, it would be really interesting if the ease of travelling with an Interrail pass could be incorporated in regular train travel as well.

Eurail, the company behind the interrail pass, is actually a collaboration of all participating European carriers. With

an Interrail pass the traveller can just easily hop on any international train in Europe (although it is sometimes required to make a seat reservation). It is interesting to see how all the travel companies came to this cooperation, because they let anyone with an Interrail pass hop on their trains. The sales profit is fairly divided through a percentual agreement of all parties.

Developments

Mobility as a Service (MaaS)
MaaS apps will form an important part of mobility (de Jong, R. in INFO, 2020). Multiple modalities are integrated in a platform where travellers can plan, book and pay for their journey from A to B. MaaS apps are emerging mainly on a national level, but some platforms, like Tranzer, have the ambition to expand across borders as well (Bol, 2019).

International MaaS
MaaS will evolve into international forms. Dutch and international public transport and other mobility services will be offered through one platform (Taylor Parkins, 2020). It is expected that these MaaS services will be used for work, study or leisure activities by travellers living in border areas. One example of an international MaaS initiative in such a border area is LinkingAlps. LinkingAlps aims to improve cross-border travel information in the Alpine region by linking mobility information services and encouraging open exchange (www.alpine-space.eu).

MaaS pilot in Limburg
The MaaS pilot in Limburg is a great example of international MaaS. IenW and local operators like Arriva are working together, to simplify cross-border, multimodal travel (Ministerie van Infrastructuur en Waterstaat, 2019). The starting point is a technology standard to connect ticketing systems on both sides of the border. For the traveller, this should result in a more seamless ticketing experience when crossing the borders of Limburg. However, the pilot tests have not yet started, so there are no insights in the MaaS experience and perception of consumers.

> "Due to technological developments now, the national systems can also come closer together. This makes it easier for the customer that ticket barcodes are matched, but also for the clearing at the back end. That makes it cheaper, and that is another drop that will get more cross-border transport off the ground." – Regional development manager, Arriva

Account based ticketing (ABT)
This technical development is planned to be implemented in the Netherlands from 2023 onwards. We are currently having a card based ticketing system, where it is only possible to check in and out with a specific card, the OV-chipkaart. Account based ticketing (ABT) is a ticketing and payment system where all data is linked to your personal account and processed in the background system (cooperatieovbedrijven.nl). With ABT, other devices like bank cards and smartphones can be used as travel token for transactions.

Digital travel buddy
All mobility services and travel information will (in the end) be provided digitally. With personalisation options and frequent use, mobility apps like 9292 will intuitively adapt to you as a traveller and feel really like a travel buddy (Rademaker, T. & van der Made, J. in INFO, 2020). In line with this, the NS-app also longs for more personalised travel support.

Conclusion
From this analysis I understood five main barriers to realise a unified platform to plan and book European train journeys.
- No European standard
- Limited time in advance
- Not sharing data
- Price differences per country
- Culture differences

International MaaS shows big potential to break down borders and make it easier for travellers to travel across borders. International MaaS pilots and providers are emerging and Limburg is a good example case of testing seamless cross-border, multimodal travel.

However, realisation of international MaaS faces three main barriers:
- Commercial relationships between rail operators and between operators and suppliers of other modes of transport
- Complexity in business models of PSO and open access carriers
- Lack of standards around ticket distribution and inventory

3.3

International train travellers

In this chapter I will look at the customer experience of the international train traveller. First, I have combined insights from traveller interviews and existing field research to understand the current international rail travel journey. Then, I will compare rail travel to air and car travel and find out how travellers are making their modality choices. Finally, with insights from both analyses I create a customer adoption funnel that shows how travellers are not adopting to travel by international train.

Current international train journey

There is not one customer journey that predicts the travel experience of international railway travellers. Journeys will vary greatly based on the reason of travel and needs and wants of the traveller. This results in a variation of journey steps, actions and occurring issues. However, the following four phases will be the starting point of every border-crossing train journey: Pre public transport, Pre travel, Travel and Post travel (Mak & van Lieshout, 2016). The existing journey maps by Boon (2017) and Mak & van Lieshout (2016) have been combined and completed with own user research.

User research approach
Six travellers were interviewed about their previous international train journey experiences. The participants were selected based on how recently they had travelled by international train in Europe. The focus during the interview was put around the barriers that they had faced before and during the train journey. More information can be found in appendix D.

Customer journey phases

The international train journey is split up in eight phases. These journey phases are also illustrated by thoughts, actions and emotions in a customer journey map (see figure 14). The phases and especially the concerns within each phase will be described below.

Orienting

When travellers are getting inspired to go on an international train journey, they have to make several decisions: the decision to travel at all, the decision of the destination, the decision to travel by public transport and the decision of travelling by train. These decisions don't have to be made in a linear order; they are often made in parallel, as choice of destination and modality are greatly intertwined. Travellers would like to make a good comparison in the information jungle of all these options. Currently, they are not able to compare journeys and prices of different modalities at the same time (see Benchmarking air and car travel, page 50). But even finding the right information about rail journeys can be a difficult task, due to the variety of travel planners and incompleteness of information.

Booking

Booking train tickets can be experienced as a complicated task if people have limited understanding of ticket options (Mak & van Lieshout, 2016). When booking a ticket for a train journey with a transfer, you are buying separate tickets for each stretch of the journey. This does not have to be so obvious for travellers, but they are actually getting multiple contracts with operators, which results in travel rights not being considered as one journey. If something goes wrong along the journey they cannot blame the carrier, because they had a single contract with each of them.

Train tickets can only be booked 3 months prior to departure. Some travellers would like to book earlier in advance which is not possible. Other times certain tickets are not available for online sales at all which disappoints the traveller.

Furthermore, many travellers mentioned that train tickets are considered (too) expensive. Only when tickets are released 3 months prior to departure, a lower ticket price can be found. Also, ticket prices for the exact same train can differ per booking site.

> "I prefer to book via NS International, because that is exactly €1 cheaper than on the site of NMBS. However, NS International offers less online payment options, so I cannot pay with my regular Belgian bank account." – Participant 2

The irregularity of ticket prices can be very frustrating for travellers, as they like to feel as if they have made a good deal.

Preparing

When going on an international journey, travellers want to be well prepared, like having all the necessary travel documents before departure. Also, most travellers will arrange their first mile transport during this journey phase.

Departing

When departing on an international journey, travellers might get across some problems around the station. Research showed that service personnel is not always able to help, because they may not have knowledge about international railway services (Mak & van Lieshout, 2016). This can be frustrating for a traveller that is in need of help.
When boarding the train, it can be unclearly indicated where to board the train as seat reservations numbers are generally not indicated from outside the train. In case travellers board the wrong cabin, they have to carry all their luggage through the train to find their seat, which can be a big hassle.

Travelling

Once on the train, travellers want to have access to all relevant journey information. Not every travel app seems to have a complete overview of all necessary information. Sometimes travellers need to use multiple apps to have access to all necessary and up-to-date information.

> "I use the NSI app for the route, but it doesn't show the platforms. So, I also use the NMBS app to look up the platforms." – Participant 2

Transferring

In general, travellers prefer direct railway services, as transfer journeys require more waiting. A transfer is also an uncertain element that brings stress over the risk of missing your connecting train. Cross-border trains currently do not wait for a delayed train with transfer travellers with seat reservations. Although this is logical from an organisational perspective, it does result in some frustrated travellers.

> "We booked the whole cabin for 45 people and because our train was delayed, we missed our connecting train in Hannover just with a minute. It seemed as if there was no contact between the two German trains." – Participant 4

Some travellers would rather reduce the risk of missing their connection by deliberately choosing for a longer transfer time.

> "I would rather have a longer transfer to be on the safe side, and have a few hours of fun in a city, than have a short transfer with the risk of delays and missing connections." – Participant 6

Rescheduling

In the unwanted situation of delays and missing your connecting train, travellers often don't know what to do. Especially because pre-booked tickets for a specific train with seat reservations are rather inflexible. There is little clarity about where you have to go and how to get on the next departing train. This is especially a very high knowledge barrier for new rail travellers who are not experienced with the situation. The traveller would like to see carriers proactively solve issues.

Arriving

When arriving at a foreign station, things are often arranged a little differently than in the home country. Here in the Netherlands the stations have gates where travellers need to scan their tickets to exit the paid area. These closed payment borders can be a problem for international travellers that are not used to such a system (Mak & van Lieshout, 2016). After exiting the station, the traveller wants to quickly find out how to best travel the last mile.

Conclusion

When looking at international train journeys, every step in the journey counts, as they all add up to the total experience of travellers. A negative train journey experience will greatly influence the choice of modality for next time. A positive experience can make the train more preferential.

Overall, international train journeys require a large amount of knowledge for travellers to be fully capable of understanding the system. It should be made easier for all travellers to access information, book tickets and travel by international train.

Phase	ORIENTING	BOOKING	PREPARING	DEPARTING
Thoughts	I'm getting inspired to take a trip. I want to easily find all the information I need about international rail travel in order to make a good comparison with other modalities and to make the right decision.	I want to easily book a ticket and get a clear overview of all the possibilities so I can make a good decision.	I want to be well prepared for my trip and have access to current travel information to keep myself updated.	I plan to arrive a little early at the departure station, since I do not want to miss my international train, but I also want to avoid waiting for too long.
Actions	• Getting inspired • Choosing destination and modality • Planning journey	• Searching tickets • Selecting tickets • Purchasing tickets	• Packing luggage • Preparing documents • Preparing transport to the station	• Going to and waiting at the station • Entering paid area • Finding platform • Going through security • Boarding train

Emotions

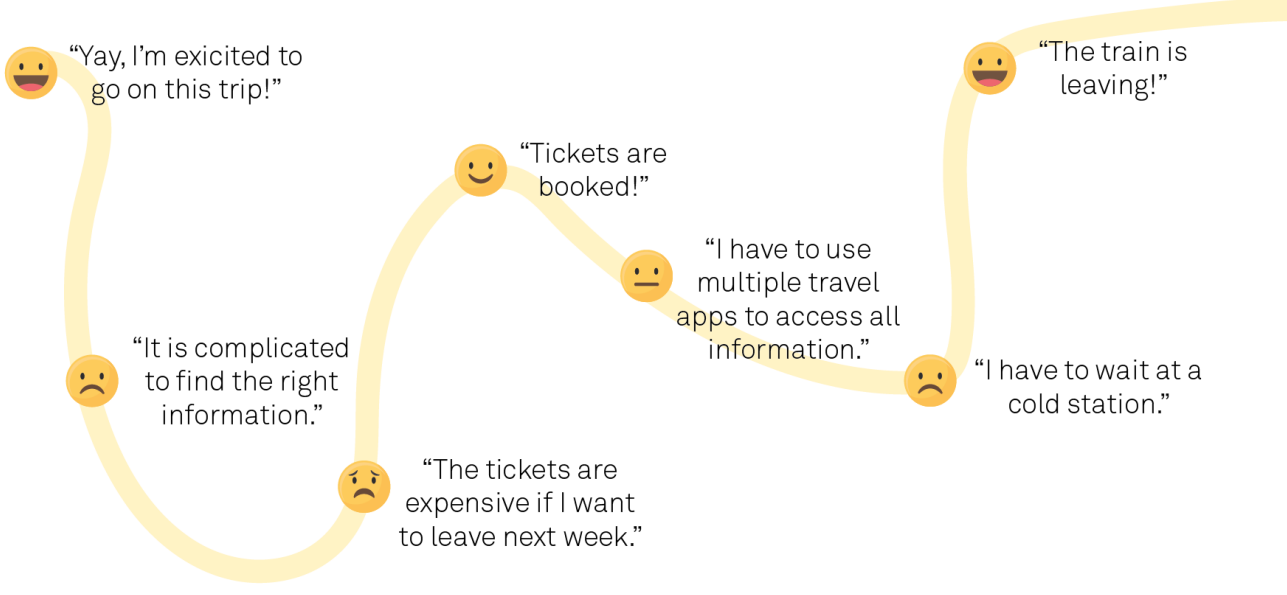
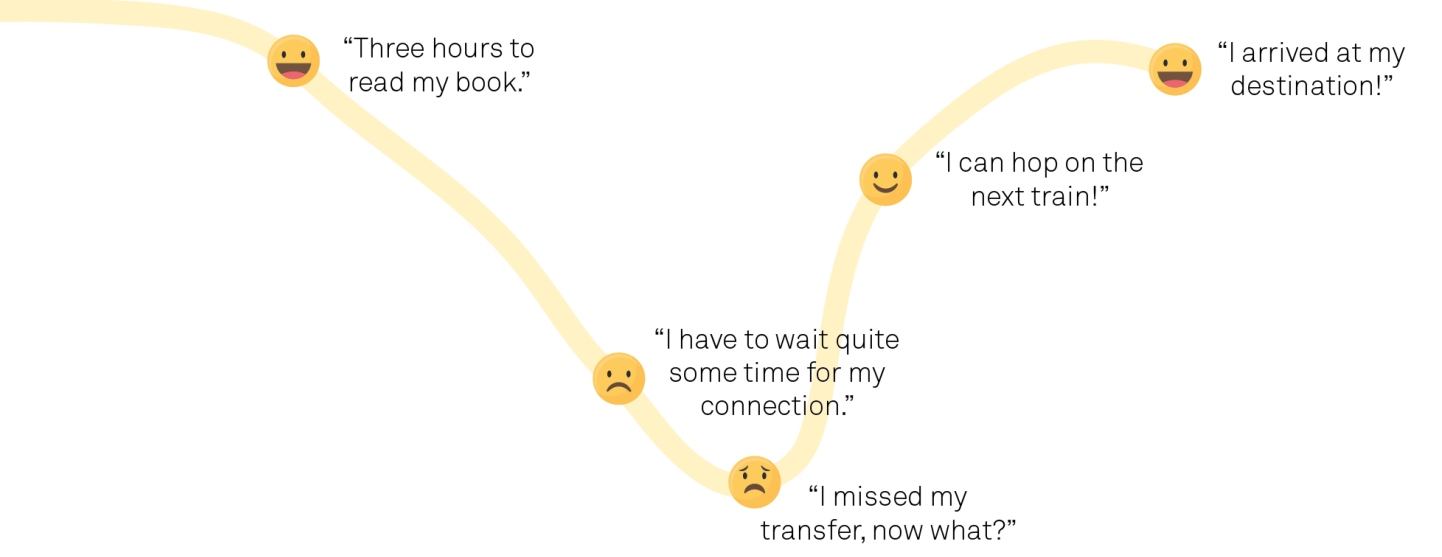


Figure 14: Current international train journey based on Boon (2017), and Mak & Van Lieshout (2016)

TRAVELLING	TRANSFERRING	RESCHEDULING	ARRIVING
I expect to have a comfortable trip towards my destination in which I can enjoy the view, relax or maybe do some work.	I want to avoid waiting too long for my connecting train, but I also want to make sure I have enough time to not miss my transfer. With a short transfer time I want to know how to get to my connecting train.	In the undesired situation of missing a transfer, I want to know what I have to do to be able to get on the next train. I am at a station I do not know and where I have no idea where I should go.	I want to arrive at my destination as planned. I want to know how I can best travel the last mile to my destination.
• Finding seat • Finding place for luggage • Ticket control • Spending time on the train	• Arriving at transfer station • Internal local transport • Waiting for connecting train • Boarding connecting train	• Checking current travel information • Going to service desk • Getting tickets for next train • Waiting for train	• Arriving at the station • Exiting paid area • Travelling last mile



Benchmarking air and car travel

In this section rail travel is compared to two competing modalities, air and car travel. The goal of this benchmark is to find out when and why travellers prefer certain modalities. These insights will later be used as inspiration to improve international train journeys.

Current modal split

To first get an understanding of the market position of rail travel we could look at the modal split, the market share of each modality. However, it is even more interesting to look at the preferred modality per distance area (see figure 15). A research report calculated the market share in 2015 for different travel distances (Donners, 2016). More information about these calculations can be found in appendix C.
The calculations show that car travel has the biggest market share for travel distances up to 350 km and air travel the biggest over 450 km. Based on these results it can be concluded that the car is the preferred modality for distances under 350 km and the airplane is the preferred modality for distances over 450 km. Only for distances from 350 to 450 km, the high-speed train has the biggest market share and is therefore considered as the preferred modality in this distance area.

Figure 15: Preferred modality by travellers per distance area for airplane, high-speed train and car (visual based on results from report Donners (2016))

However, in the calculations high-speed rail travel and conventional rail travel are taken as two different modalities. If the market shares were combined as one modality ‘rail travel’, rail would already be the preferred modality for a bigger distance range.

These conclusions show that modal split is currently varying per distance, but travel distance is definitely not the only factor influencing the choice of modality. The next section will elaborate on other modality choice factors.

Choice of modality

Travellers choose their mode of transportation based on several factors. A research report about the substitution possibilities from air to rail identified four factors that influence the choice behaviour of travellers; travel time, number of travel possibilities per day, ticket pricing and ease and comfort (KiM, 2018). These choice factors are described below.

Travel time

Travel time is considered to be one of the most important factors influencing the choice of modality, because travellers have a preference for shorter travel times. However, there is a mismatch in the perceived travel time and the actual travel time. When travellers are comparing different modalities on travel time, only the actual time spent within the modality, like the flight duration or time on the train is taken into account. The comparison of objective travel times results in the plane being perceived as the faster option for most destinations, which is not always true if door to door travel time is calculated.

Access and egress times

The time travellers spend on travelling the first and last mile of their journey is referred to as access and egress times. The modality differences in access and egress times can be explained by a visual overview of door to door travel. Figure 16 shows that car travel is the most direct mode of transportation, giving travellers the freedom to depart from home. Rail travel comes in second, as train stations have a central location and bring travellers close to their destination. Air travel has the longest access and egress times, because airports are located further away from cities.

Figure 16: Visual overview of door to door travel with different modalities

Waiting times
Sauter-Servaes et al. (2019) found that travellers spent an average of 157 minutes at airports and 32 minutes at train stations. Some multimodal travel platforms already include some extra travel time. However, compared to the research results, they seem to underestimate the waiting times, which distorts traveller perception in favour of air travel" (Sauter-Servaes et al., 2019).

Objective travel time comparison
A comparison of current travel times by train and plane for 31 destinations from Amsterdam can be found in appendix C. In the current situation, travel time by train is only shorter for Brussels and Paris compared to travel time by plane (Royal HaskoningDHV, 2018). Another report shows a more optimistic result, with travel time by train being shorter for travelling to four European cities. If we include pre and post travel transport time and waiting time at the airport, the door to door travel time is already shorter for trains to Paris, Frankfurt, Brussels and Düsseldorf (KiM, 2018).

Number of travel possibilities per day

High travel frequencies are important to give flexibility to travellers for planning their trip. For example, an hourly connection gives greater flexibility for activities than a connection once per day. However, the perception of when frequency is adequate depends. An interview with a frequent Dutch/Belgian border-crossing traveller revealed that the hourly direct connection should be increased in frequency. Besides, the connection to Belgium stops operating too early in the evening, which should be changed to midnight. Business travellers are especially interested in frequent connections during rush hour. They want to travel early in the morning and at the end of the day to optimize working hours.

Ticket pricing

Traveller interviews confirmed that ticket prices have an important influence on their modality choices. It is in our human nature that we are tempted by cheap options.

And the cheap options are experienced to be hard to find. Ticket prices show big variations, depending on when travellers book and when they want to travel. This is a result of a system called yield ticketing, where operators can fluctuate prices.

Depending on the carrier or airline, additional costs can be charged for seat reservation and baggage transport as well. Similar to comparing objective travel times, these costs should be added in comparison of ticket prices.

Ease and comfort

The fourth choice factor is about the level of ease and comfort of the modality. In general travellers always prefer direct connections over transfer journeys. Direct services score better in travel comfort and travellers experience a lower level of stress compared to transfer journeys. Looking at car travel, ease scores high as you do not have to make any arrangements if you want to leave. Comfort is lower than the train, because the space is small, you cannot stand up and the driver can't relax behind the wheel.

The ease of information and ticketing

As mentioned in the current customer journey (page 45), finding and booking an international train ticket is not perceived as being easy. On the other hand, booking a plane ticket is considered to be less complicated. The big difference between the two sectors is that aviation has an umbrella ticketing system, which has made it much less complex for the traveller. Also, booking platforms like Skyscanner show a complete overview of information and the traveller is in control of finding suitable tickets.

Dealing with luggage

Currently, air travel is offering more services around handling your luggage. Traditionally in train journeys travellers take care of their luggage themselves. This has advantages and disadvantages. It can be experienced as a hassle to carry luggage around, especially when transferring at a big station, but it is beneficial that there is no waiting time for luggage when arriving at the station.

Comfort at airport/stations and in planes/trains

Comfort in trains is considered to be higher than comfort in planes. Because travellers have much more personal space and travellers are able to stand up and go for a walk. On the other hand, comfort at stations is considered to be lower than comfort at airports. The airport is created for longer waiting times and therefore has more facilities to offer.

Environmental impact

Next to the four choice factors explained above, a fifth factor rooted in environmental concerns seems to increase the popularity of rail travel. According to Milieucentraal, a flight has 7 to 11 times more impact on the environment as the same journey by train. The difference between the two modalities is biggest on distances shorter than 700 km.

> "All the determinants for traveller behaviour had hardly changed, and yet there were about 13% more international train travellers in 2019 than in 2018. And we think this has to do with flight shame, but not much research has been done on that." – mobility expert, TU Delft

The so-called flight shame movement is influencing the modality choice. For environmental reasons, more people are choosing sustainable alternative modes of transportation and feel ashamed to take a plane.

Conclusion

Air travel can be a preferential modality for many reasons, but usually it is because air travel is preferred because it is the fastest or cheapest way to travel. Especially for longer distances, air travel is the preferred travel option.

Car travel can be a preferential modality for its flexibility and independence. Travellers are not bound to tickets and departure times and have the full freedom of when they want to leave. Because travellers have to drive the vehicle by themselves, however, this modality is mainly preferred on shorter distances.

Rail travel can be a preferential modality for its comfort and sustainability. Rail is currently the preferred travel option for short and mediu m distances, but has the potential to compete on longer distances as well. This is further explained in the section on international rail market potential (3.4, page 56).

Customer adoption funnel

A customer adoption funnel combines the insights from the current customer journey, related traveller concerns and the benchmark of air and car travel (see figure 17). This customer adoption funnel shows the reasons why travellers do not adopt the international train as their travel modality. The funnel is based on the four purchase steps of the classic AIDA-model, Awareness, Interest, Desire and Action (Strong, 1925).

At the start of the funnel on the top, we begin with all travellers that want to travel to location X, the total market. While moving downwards through the funnel, more and more travellers decide not to travel by train. We end up with the adopted market; all travellers that are actually travelling by train to location X.

Awareness

The first reason why the potential market is reduced, is that travellers are unaware of the opportunity. They simply do not know that the train is an option for travelling to their destination.

Interest

The second step is that travellers need to have interest in travelling by train. So, if they are aware that the train could be an option to travel to their destination, they need to perceive the train as a suitable option as well. If the train is not perceived as a suitable alternative, it is likely that other modalities are preferred. This lack of interest in the train can be related to habitual behaviour. If people are used to always travel with a certain modality, which they are satisfied with, they are less likely to consider alternatives. The interest can also be absent due to existing beliefs or certain expectations of the different modalities.

Desire

Closely related to “interest” is the next level, where travellers also need to have the desire to travel by train. The train can be an undesirable modality for several reasons. First of all, the travel time can be considered too long or the train journey too complicated. The fact that the journey requires a train transfer, or that connecting trains form a bad connection resulting in a long transfer, makes the train unpreferred.

Action

Finally, potential train travellers needs to take action to actually plan and book the train journey. If the traveller does not want to predetermine his or her departure time yet, the action can be postponed to a later moment. Travellers can also be excluded from acting if train tickets are not available for online booking. Some train tickets can also be considered to be too expensive, especially when booking prior to departure and other modalities are available for lower prices.

Conclusion

So, in order to increase the adopted market, we need to increase the awareness, interest, desire and action to travel by train. More specifically, we should better promote train travel, optimize train journey travel times and transfers, and ease the process of finding train tickets.

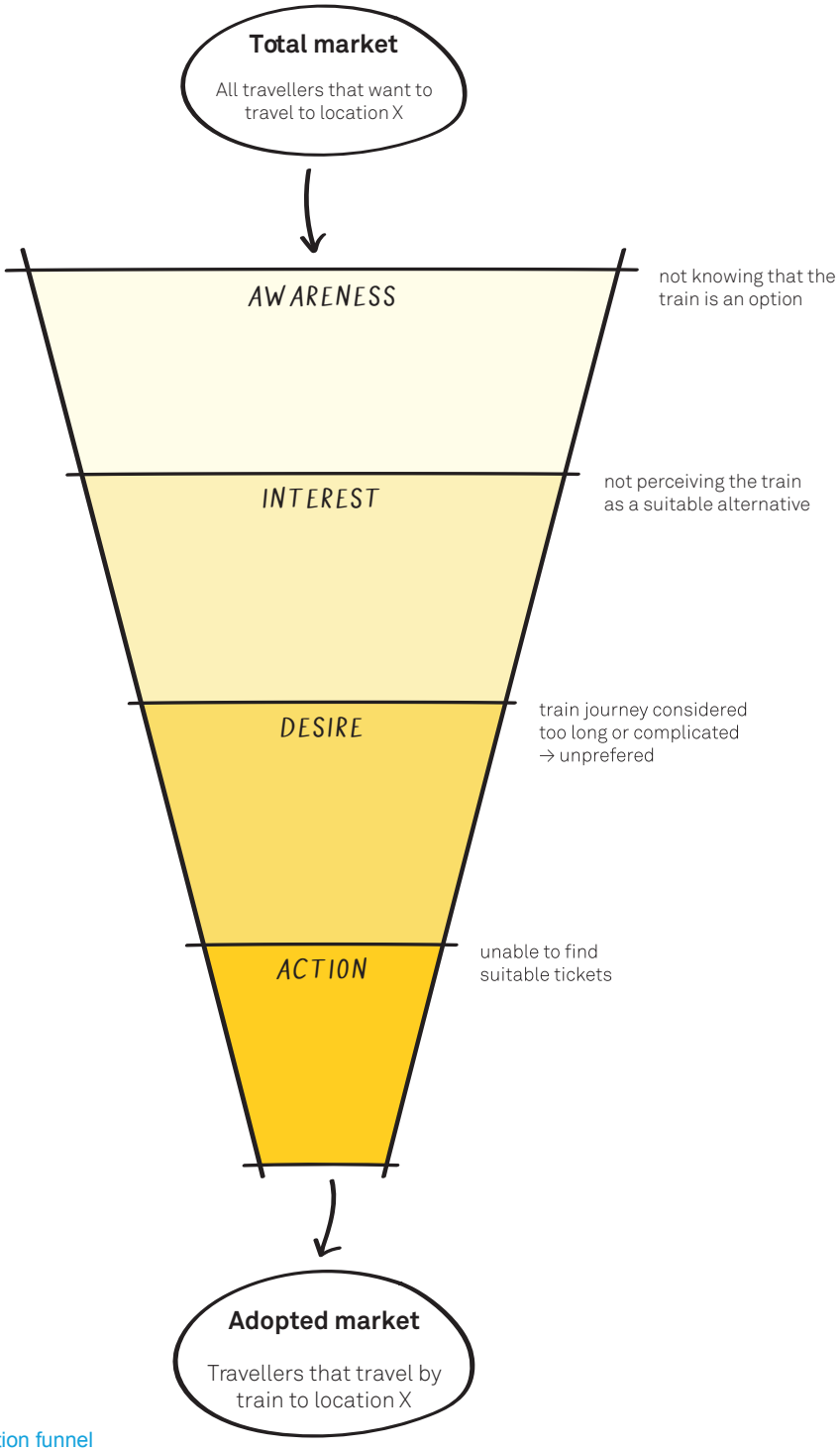


Figure 17: Customer adoption funnel

3.4

International rail market potential

In the previous subchapter, we have already slightly touched upon the current market of international rail travel by benchmarking air and car travel. This section will elaborate on the possible future market of international rail; the market potential. This potential is looked at from the perspective of rail travel substituting air travel.

The potential of rail to substitute flights

For environmental reasons, more and more attention is given to the negative environmental impact of air travel, especially for short-distance flights, and the potential of international trains to replace those flights. A study by Royal HaskoningDHV (2018) to compare air and rail travel is used as the main input for this section and is referred to as 'the study'.

Impact area

When looking at the impact area where rail travel could be competing with air travel, there is a distance boundary at which point rail travel times are generally not competitive anymore. For distances up to 750 km, the train can be a compatible alternative for flights.

To further calculate substitution potential, the study selected all European metropoles within this distance range that have direct flights to Amsterdam. This resulted in 31 selected destinations that have potential for air rail substitution (see figure 18).

Figure 18: Selected destinations wihin impact area (Royal HaskoningDHV, 2018)

Current air traffic

Looking at statistics from current air traffic, short haul flights form a major part of the air travel business. 70% of all flights from and towards Schiphol travel within Europe, and 38% travel to destinations closer than 750 km (Schiphol, 2018). This already shows an indication of the huge potential for rail travel.

Between Schiphol and the 31 selected destinations we see 241 flights per day, which adds up to a total of 176.000 flights per year (Royal HaskoningDHV, 2018). This makes up for approximately 35% of all flights from and towards Schiphol and 22 million passengers per year (Schiphol, 2018).

The study plotted the yearly number of travellers from and to Schiphol for the 31 selected destinations (see figure 19), with the left axis for the green bars and the right axis for the blue bars. It is remarkable that by far, most of these air travel passengers are travelling to London, Brussels and Paris. These cities already have fast existing train connections with Amsterdam, that could be attractive and competing in travel times. However, it should be mentioned that this includes a big percentage of transfer flights, with travellers from overseas who transfer flights at Schiphol. To substitute these short haul flights, travellers could go on a combined air-rail journey. Services around air-rail journeys sould therefore be more unified (Hendrikx, 2021).

Substitution potential

To calculate the number of travellers that will actually make the shift from air to rail, the study uses travel time as the most important modality choice factor to predict future travel behaviour. In the current situation rail travel times are only shorter for Brussels and Paris (see appendix C).

However, rail travel times can be optimised and become more competing with air travel times. In scenario 1, when lifting operational barriers, rail travel times to Brussels, Dusseldorf, Hannover, London, Frankfurt, Paris, Luxembourg and Rennes will be similar or shorter to air travel times (Royal HaskoningDHV, 2018). With the construction of a European HSR network in scenario 2 (as proposed in section 3.2, page 34), rail travel times for 25 of the 31 destinations will be shorter than air travel (see appendix C).

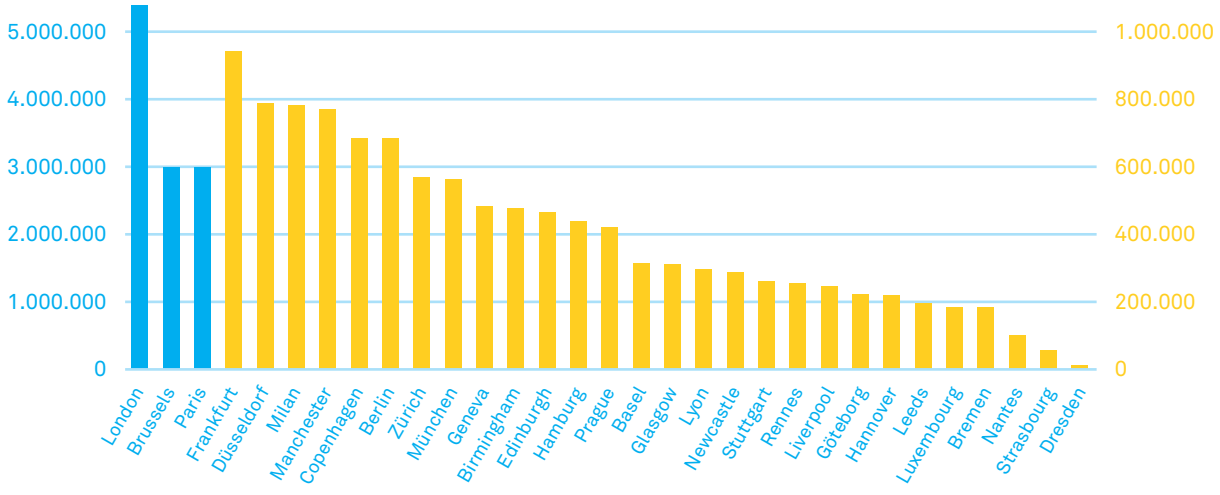


Figure 19: Yearly number of travellers from and to Schiphol (Royal HaskoningDHV, 2018)

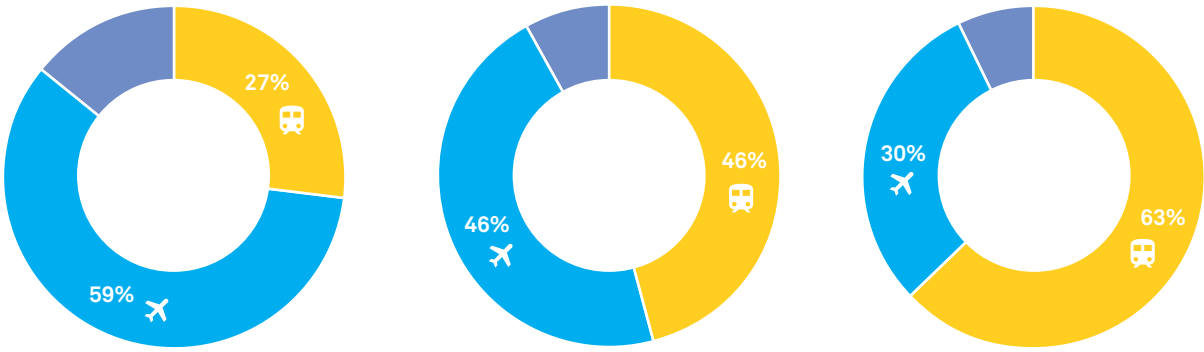


Figure 20: Modality choice evolution, average for all 31 destinations (Royal HaskoningDHV, 2018)

The average modal split for these 31 destinations is calculated for the current situation and two travel time optimalisations (see figure 20). Table 3 gives an overview of the main statistics in this section. For all destinations together the rail travel market share increases from 27% in the current situation to 46% when optimising travel times and to 63% with the European HSR network. This would respectively mean a potential increase from approximately 10 million train travellers per year to 17 million in scenario 1 and 23,5 million in scenario 2.*

CO2 reduction

An increased market share of rail travel will cause a decrease in flights, which could result in large CO2 reductions. Table 3 shows the decrease in flights that the study predicts and the corresponding CO2 reduction. In the first scenario with optimalisation of travel times, the study calculated that 327 million kg CO2 emissions can be saved. In the second scenario with the construction of a European HSR network and more travel time optimalisations, the study calculated that 998 million kg CO2 emissions can be saved.

**This is based on own calculations assuming that the current market share of air travel includes 22 million pax per year (see appendix C).*

Table 3: Overview of substitution potential based on Royal HaskoningHDV (2018) and own calculations

	Current	Scenario 1	Scenario 2
Total market share of rail	27%	46%	63%
Number of train travellers	10 M	17 M	23,5 M
Numer of flights per year	176 K	87 K	43 K
CO2 reduction	-	327 M kg	998 M kg

Conclusion

The train has great potential to substitute planes and reduce CO2 emissions of travel for distances up to 750 km as currently 22 million travellers are travelling in this area by plane. Especially when travel times would be optimised, the market share of rail could increase a lot. However, the behaviour of travellers could also be influenced without improving current rail travel times, because travel time is definitely not the only factor for modality choices.

A level playing field for air and rail travel prices

Another way to change the travel behaviour and let people choose rail over air travel is based on the choice factor *price*. From a traveller perspective, rail travel is often considered to be expensive. This perception is formed when comparing rail travel prices to air travel. But one could also turn the problem around and say that air travel prices are too low. This section shows the current unfair situation and plans to create a level playing field for air and rail prices.

An unfair competition

Currently, the aviation sector is very good at offering cheap flight tickets, especially for short distances within Europe. These short haul flights can be offered for attractive low prices, because the real profits are being made with long distance flights. Flight tickets are cheap because many airlines receive subsidy, there is no excise tax on kerosine and no tax on tickets. Aviation has been free of taxes for a long time, since this been decided in the Chicago Convention in 1944 to stimulate commercial aviation (Business insider, 2018).

Compared to other modalities, air travel is currently not being charged for its environmental impact, although aviation is causing 2% of the global CO2 emissions and 12% of all transport emissions (Atag, 2020).

Creating a level playing field

What is currently being done to address the unfairness of air and rail travel prices?

Introducing flight taxes

In line with the European Green Deal climate agreements, more and more people question why aviation is still taxfree. Aviation is causing 2,5% of the global CO2 emission and is not being charged for this environmental impact. Together with 8 European countries, the Netherlands is pledging the EC to propose a form of flight tax (Rijksoverheid, 2019). The Netherlands will introduce a national flight tax if there are no European agreements before 2021.The introduction of such a policy is of course a disadvantage for the air traveller and will also invite resistance. The way to introduce such a political decision is by using transparent politics (mobility expert, TU Delft). When the government announces a tax raise on flights, people will more easily accept this if a clear counteract is presented as well. For example, if the money earned by the flight tax will be invested in improving high speed rail.

Introducing minimum flight prices

Another way to let rail travel prices appear more attractive is by introducing minimum flight prices. Austria is the first European country to take this measure in order to make short distance flights less attractive. To receive subsidy, Austrian Airlines tickets will soon cost at least €40 and flights shorter than 350 km will get a supplement of €30 (NOS, 2020).

Conclusion

To create a level playing field for air and rail travel prices, air travel should be charged for its environmental impact. The European Commission should introduce measures like flight taxes and minimum flight prices, which are currently undertaken by national governments themselves.

3.5

Conclusion

In this chapter, I have deconstructed the current context of international rail from many different perspectives. This conclusion summarizes the deconstruction in two ways. First, I looked at the main strengths and weaknesses of rail travel in the form of a SWOT analysis. Second, I plot the main developments in the different levels of the system on a timeline.

SWOT analysis

By looking at the deconstruction of international rail travel, I found several internal strengths and weaknesses of rail travel compared to air and car travel. I also identified external factors that either form opportunities or threats for rail. The SWOT analysis summarizes these strengths, weaknesses, opportunities and threats for rail travel (see figure 21).

Figure 21: SWOT analysis rail travel

Developments timeline

Within the deconstruction of the international railway system, several developments came to the foreground. Figure 22 gives an overview of the main developments on a timeline to get a better understanding of when and how long the developments will take place. The developments are categorized by the 4 levels of the international railway system (see chapter 3.2) and a fifth political layer is added.

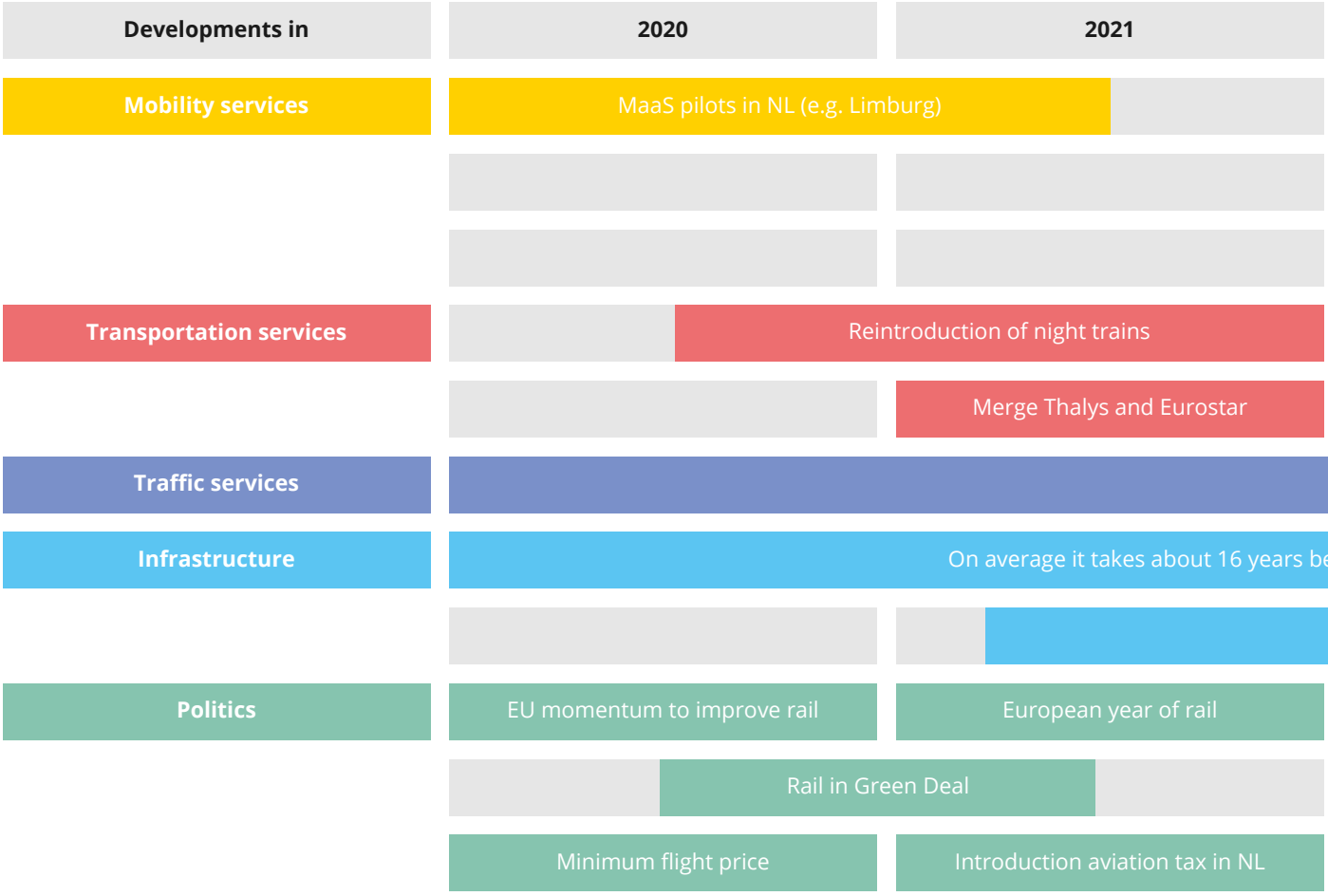
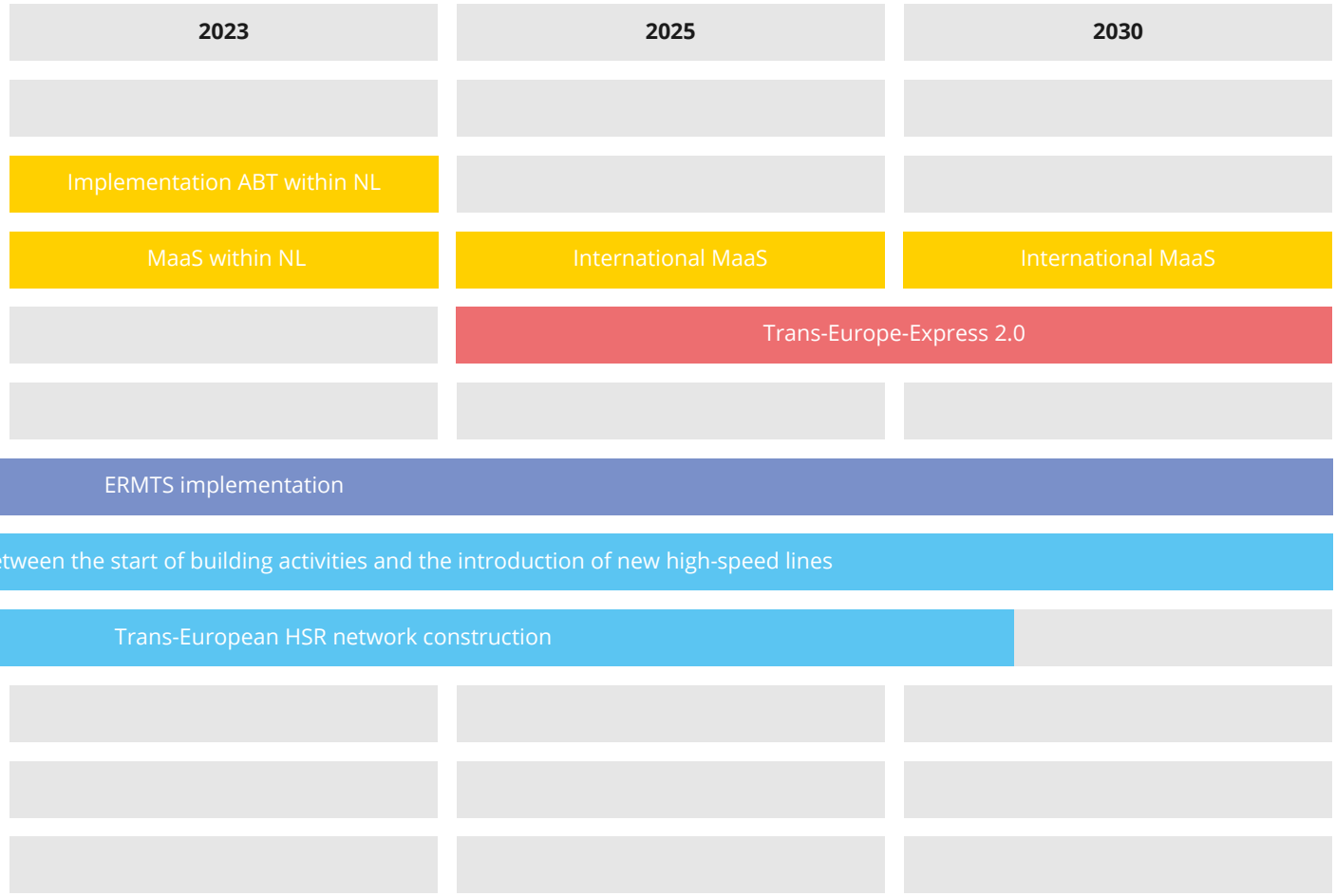


Figure 22: Main developments on timeline


2023
2025
2030
Implementation ABT within NL
MaaS within NL
International MaaS
International MaaS
Trans-Europe-Express 2.0
ERMTS implementation
tween the start of building activities and the introduction of new high-speed lines
Trans-European HSR network construction

Future context

4

In this chapter I will develop an understanding of the future context. During this process I follow the main steps of building a future context from the Vision in Product design approach (Hekkert & van Dijk, 2016). The first step is setting the domain and a time of the future context.

Domain
International travel in Europe in 2040

Within this domain, I collected around 50 context factors through expert interviews and literature research. These context factors showed patterns and I clustered them into eight bigger driving forces (4.1, page 70), that “drive” the possible future.

I further reduced the variety of the initial context factors, by finding a structure within the driving forces. The context structure (4.2, page 88) consists of a storyline and a framework that shows four future traveller attitudes.

To conclude, I described the relevance of trains in the future context of international travel in Europe in 2040 (4.3, page 96)

Context factors

Context factors can be seen as the building blocks of a future context. Four types of context factors can be distinguished, each varying in the level of stability. A development is a change or change at hand. Trends are special developments that describe changes in the behaviour, values or preferences of people. States describe conditions and situations that seem relatively stable at the moment of observation. Principles are laws or patterns in human behaviour, nature or a complex system and won't change over time.
Besides these four types, context factors are also labelled with the specific field that they are describing.

A total of 50 context factors has been collected through desk research and expert interviews. The table below shows an overview of how the factors are divided across types and fields. The complete list of context factors can be found in Appendix E.

Table 4: Overview of conext factors composition

	Development	Trend	State	Principle
Economic	3		1	2
Political	4			1
Cultural		4	2	1
Psychological		3	2	6
Demographic	2			
Technological	7			
Sociological	1		1	
Ecological		2		
Transport	3	3	1	1

4.1

Driving forces

From context factors to driving forces

To start seeing the context as a whole, the variety (or complexity) of all separate factors needs to be reduced. This is done through the process of clustering. Factors can correlate positively and negatively and can be combined in different ways. For this project, the first cycle of clustering was done in an online session with two other designers (see figure 23). Several iterations with some new perspectives of other designers followed to reach the final set of clusters, which are then referred to as driving forces.

The future context of international travel in Europe can be explained based on the following eight driving forces, which will each be described in the next sections of this chapter.

1. International travel keeps growing
2. Further away is getting closer
3. Policy stimulating sustainable travel
4. Pressure of social image
5. Search for efficiency
6. Enriching journeys
7. Growing wish for individuality
8. More seamless travel

Figure 23: An impression of the online clustering session

1 International travel keeps growing

Despite the current transport dip due to covid-19, international travel is still expected to be double in 20 years time (mobility expert, Royal HaskoningDHV). With the predicted economic growth, we will have more money to spend, so we are also able to travel more (and further). We are also living and working abroad more often (mobility expert, TU Delft).

Now forced to work from home, people are much more positive about virtual collaboration tools (andersreizen.nu). People make more conscious decisions about when to travel, but miss spontaneous meetings and getting to know new people at conferences. Although we may not travel anymore for a meeting that can be followed digitally (resulting in less travel), the situation of working remotely also showed that if we can work anywhere, we can also live anywhere (resulting in more travel).

Repetition of the same action automizes our decision-making which creates habits in our behaviour (Klöckner, 2012). If we are used to a certain mode of transportation, we will not consider other options. Also, the thought that going on holiday equals traveling abroad is ingrained in our minds (travel expert, Treinreiziger.nl). The external force of covid-19 has now been able to let us appreciate our local environment more. Only time will tell if this wake-up call will have a long-term effect on our behaviour as well. A long-term effect is most likely to happen for business travel rather than leisure travel (mobility expert, TU Delft).


transavia
-HTVD

2 Further away is getting closer

There is a theory of constant travel time budgets (=Marchetti's constant). If you take a big group of people, like the Dutch population, they will travel an average of 60 to 75 minutes per day (mobility expert, TU Delft). This has been constant over time and different countries.

However, the distance that we travel in that constant travel time has increased a lot. With faster modes of transportation, we are able to travel further in the same time (INFO, 2020), which means the distances that we travel have increased. For example, the introduction of the high-speed train Lyon-Paris enables people to live in one city and work in the other. It is interesting to mention that highly educated people travel further to work than lower educated and this difference is growing (PBL Netherlands Environmental Assessment Agency, 2020).

Innovative technological developments will keep bringing faraway closer to home. Amsterdam-Paris in 30 minutes is unimaginable but might be realised in the far future with Hyperloop: a super-fast train in a low-pressure tube (delfthyperloop.nl). The vehicles can travel with speeds of over 1000 km/h while being better for the environment than airplanes. However, this won't become a marketable modality before 2040 (future modality expert, TU Delft).

Compared to the average increase in travel growth, long distance journeys are increasing the most (mobility expert, TU Delft). We are never going to travel for a shorter amount of time, only further.


LOOK
THE DRAMATIC CONCLUSION OF
THE DEATH OF A PRESIDENT

3 Policy stimulating sustainable travel

There is an increasing governmental ambition to make sustainable modes of transportation more attractive in order to minimize the total CO2 emissions of transport. On June 3rd 2020, 24 European countries signed a pledge to boost international rail routes (Rli Online Event International Rail, 2020). Transport ministers want to make international rail services an attractive alternative for distances where it is currently not competitive. The European Commission said that train travel should be given special attention in 2021 as part of the EU Green Deal environmental agenda, suggesting that next year should be the 'European Year of Rail' (Euractiv.com, 2020).

One of the most important incentives that can stimulate a behaviour change of travellers is costs. When planning a journey, we tend to search for the cheapest option and the feeling of making a good deal (traveller interview 2). A development that stimulates a fairer financial competition, is the introduction of a minimum flight price. Austrian Airlines tickets will soon cost at least €40 and flights shorter than 350 km will get a supplement of €30 (NOS.nl, 2020). Austria is the first European country to take these measures to make short distance flights less attractive.

There is an ongoing discussion if taxes on kerosine should be introduced. In line with climate agreements, there is an increasing critique on why aviation is still tax-free. Frans Timmermans (European Commission) wants to introduce taxes on aviation fuel (rijksoverheid.nl, 2019). Such a change arouses resistance as well, but transparent politics can foster acceptation (mobility expert, TU Delft). Governments should clearly explain what the earned money from taxes will be used for.


ECONOMY CLASS
GATE
C7
BOARDING TIME
09:30
SEAT
46H
ZONE
5
TPE-MFM
EVAAIR
US AIRWAYS
E-TICKET
ZONE 2
SSSS
SSSS
100 EURO

4 Pressure of social image

In daily life we care a lot about what other people think about our actions and decisions. We have reached a state in which, especially among youth, cool travel experiences have become a status symbol (Zijlstra in INFO, 2020). The wanderlust trend on social media has created a race to post the most likeable travel pictures. It has become more of a social obligation than a source of inner fulfilment and getting to know the world.

Social media dominates travellers: by searching for inspiration we are mainly just copying others. Interestingly, increased media attention for the train Amsterdam-Berlin resulted in a 20-40% increase in yearly sales (mobility expert, Royal HaskoningDHV).

On the other hand, we see the increasing flight shame movement. A social trend where people are deliberately choosing to no longer travel by plane for environmental reasons. More companies encourage stimulating sustainable business travel among their employees as well. Vliegwijzer helps companies to change travel policies to decrease CO2 emissions (andersreizen.nu). It's key to better inform and give insight to employees' travel behaviour and reward sustainable choices. A more sustainable travel policy will positively boost the company's corporate responsibility image.

However, the social pressure on sustainable choices that is very present in our daily life, is easily dropped during holidays. On holiday we tend to escape from all these concerns and become more careless about our environmental impact (Welten, 2013). We even try to justify the trip with our green behaviour throughout the rest of the year.

5 Search for efficiency

People don't want to waste their time. We are living in an era where our agendas are fully booked and we feel constant pressure of using our time more effectively. Our travels are also goal-oriented: we want to reach our destination as efficiently as possible. Especially business travellers seek to minimize travel time, since time equals money (mobility expert, Royal HaskoningDHV). Fast and direct services are preferred over longer and transfer journeys (traveller interviews). Eurostar is currently working on direct connections from Amsterdam and Rotterdam to London. This reduces the total travel time by one hour.

On the other hand, we do realise that travel time is not necessarily a waste of time but can also be seen as useful time. The design and layout of vehicles can support this change in perception (INFO, 2020). The wish for privacy is growing, not only due to covid-19 related health concerns, but to enhance personal efficiency (mobility expert, Royal HaskoningDHV).

The search for the most efficient movement can also be translated in the reintroduction of the night train. While you're sleeping you're being transported to your destination. As of December 13th 2020, ÖBB and NS will run a daily night train from Amsterdam to Munich, Innsbruck and Vienna (NS International).

If we could press a button and teleport ourselves, we would do it.


03:30
COBY

6 Enriching journeys

Traveling is connected to a progressive, cosmopolitan state of mind (Welten, 2013). By traveling we get in touch with other landscapes, cultures and habits. This enrichment is enhanced if the journey forms an integrated part of the full travel experience.

The trend of slow travel peaches to enjoy the journey as much as the destination (The Economic Times, 2020). Eurail has tripled yearly sales of Interrail tickets compared to 2006 illustrating the popularity of rail travel (OV-magazine, 2020). If you travel by train or car, you can see the environment changing. The natural transitions create a logical feeling of time and place (participant 1). If you travel by plane, it is harder to understand the sudden shift in landscape and culture. A slow journey helps you to mindfully prepare for the arrival of your journey.

Slow travel also includes spending an immersive amount of time in one destination. A longer stay helps to make deeper connections via local experiences, which enhance your personal enrichment as well.

The value of well-being might become of greater importance during the travel journey (value expert, TU Delft). This could influence the preferences of our ideal journey experience in the future.

7 Growing wish for individuality

Travellers want to be treated as individuals and have services more tailored to their needs and wishes. The phenomenon of door to door travel is enhancing the wish for individuality (value expert, TU Delft). You can plan your travel from your own door to your destination.

With personalisation options and frequent use, mobility apps (like 9292) will intuitively adapt to you as a traveller and feel really like a travel buddy (Rademaker and van der Made in INFO, 2020). The NS-app also longs for more personalised travel support.

When preparing for a longer journey, people however tend to not plan everything beforehand. Only the biggest stretch of the main journey, like the flight or the train ticket, is booked in advance. The pre and post transport is preferred to be less determined and rather flexible to decide the best option on the spot (mobility expert, Royal HaskoningDHV). For example, the use of on demand mobility services like Uber is increasing.

Cars have been serving as the perfect modality for the need of flexibility and individuality. Because of electrification, car use will become cheaper and more sustainable and therefore cars will still dominate in the future (INFO, 2020).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8 More seamless travel

A smooth journey, without any unpredicted interruptions, is what many travellers desire. Since holidays are associated with being free from daily life obligations (Welten, 2013), a seamless journey can further enhance the low level of stress.

The rise of Mobility as a Service apps will form an important part of our mobility (de Jong in INFO, 2020). Multiple modalities are integrated in a platform where travellers can plan, book and pay for their journey from A to B. The idea of treating a journey from door to door forms the basis of seamless travel. Technical developments like account based ticketing will also smoothen our journeys (cooperatieovbedrijven.nl, 2018). This ticketing and payment system links all data to your personal account which is processed in the background. Travel transactions can be done with any device, like bank cards and smartphones. The Internet of Things will enable all vehicles to communicate with each other, which will strengthen the integration of multiple modalities (Fawzi in INFO, 2020).

Customers also become more demanding in their expectations (van der Made in INFO, 2020). Because of technology, we might travel less in some situations. But if we do travel, we want higher quality and a better travel experience.

4.2

Context structure

From driving forces to context structure

To further reduce the variety and complexity of the initial set of factors into a coherent structure that describes the main patterns in the context, two ways to combine clusters are used. The first way is looking for a pattern or storyline. “When you look at all your clusters ‘from a distance’, a pattern or thread may appear that unites the clusters into a sort of narrative.” (Hekkert & van Dijk, 2011) The second way is looking for dimensions. “When clusters seem to conflict or refer to opposing forces, it may be meaningful to place them in one or more polar and conceptually clearly distinct dimensions.” (Hekkert & van Dijk, 2011)

Finding a coherent structure is a very thoughtful process that requires several iterations. During this process I sometimes asked another designer to think along to get a fresh perspective on the context structure. This helped to develop a clear and consistent picture of the future world.

The resulting context structure is a combination of two separate structures. Half of the driving forces are united into a pattern, a sort of narrative that tells the story of a sustainable travel transition. How the related driving forces build up towards this story is visualised in figure 25.The other four driving forces seem to form two pairs of opposing forces, which are placed as the poles of distinct dimensions. These dimensions consequently form a 2x2 framework (see figure 26). Within this framework, every unique combination of two opposing forces describes a certain travel behaviour. These combinations result in four different behaviours in the future context of international travel, which are referred to as traveller types.

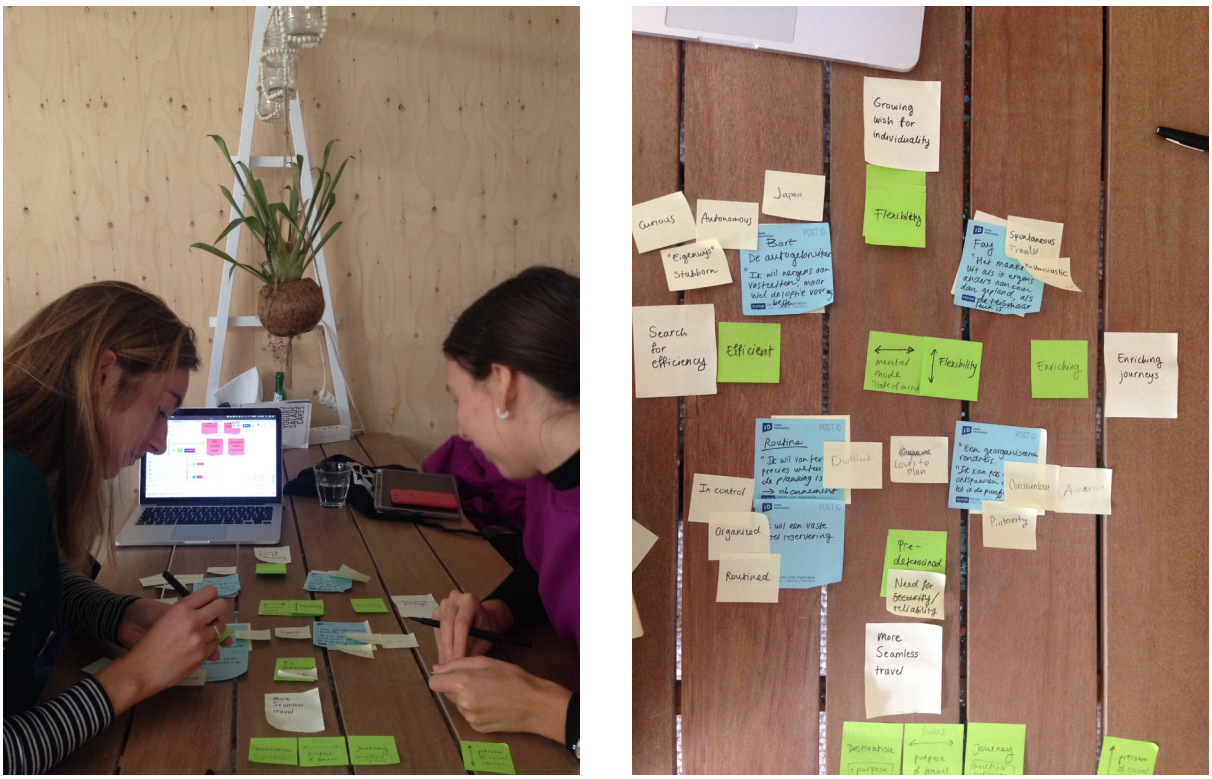


Figure 24: An impression of the iterative context structuring process

The sustainable travel transition

International travel has always been growing. The inventions of faster modes of transportation make it possible to travel further in the same amount of time. Economic growth enables more people to have the financial means to travel internationally. Globalisation makes our world more connected and means that more people are living abroad, resulting in more travel as well. Travelling has become a trendy hobby, in which the total distance travelled is one of the important indicators.

However, we are on the edge of a changing point. Not only individual travellers, but also companies and governments are showing signals that we cannot just continue like this. Covid-19 was able to give a wake-up call that the environmental impact of our current travel behaviour is simply too big. Some first steps and actions to decrease this negative impact are already being taken. But a transition towards sustainable international travel requires many adjustments on different levels to the travel system and our current behaviour.

1 International travel keeps growing

2 Further away is getting closer

3 Policy stimulating sustainable travel

4 Pressure of social image

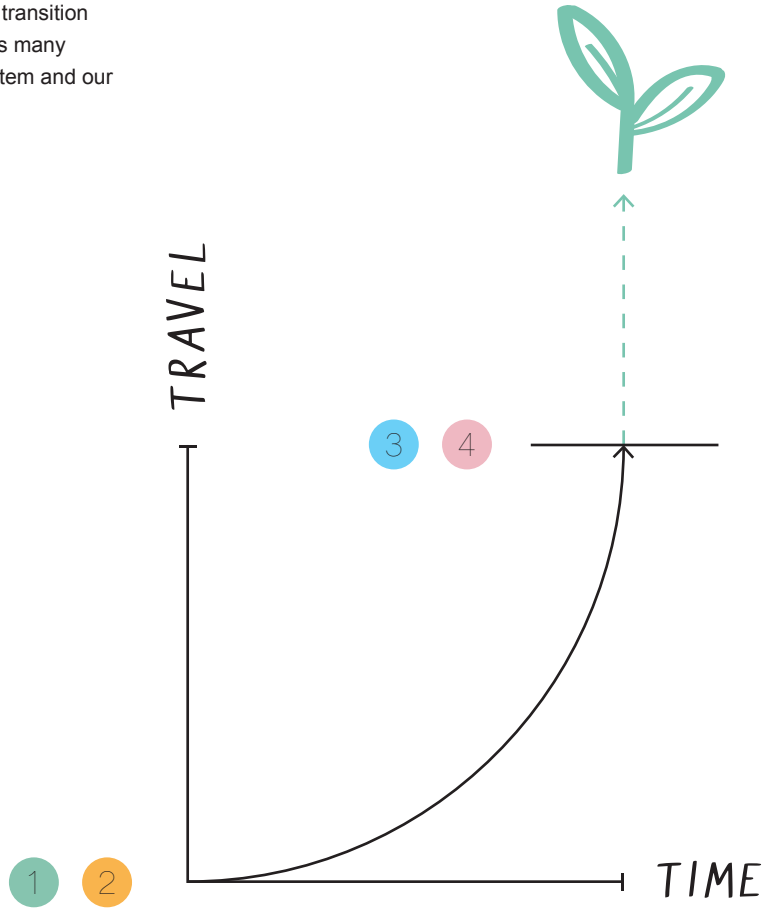


Figure 25: Overview of context structure 1

Future context vision

In 2040, the transition towards more sustainable international travel will be flourishing. Thanks to policy regulations and travellers' environmental awareness, rail travel is gaining ground on the European travel market. Air travel will only be the preferred modality for long distances overseas.

Framework

Two pairs of opposing driving forces form the two dimensions of the framework. These dimensions are explained below. The two dimensions are combined as a 2x2 framework (see figure 26)

5 Search for efficiency

6 Enriching journeys

7 Growing wish for individuality

8 More seamless travel

Dimension 1 | Core travel value

Every trip consists of a journey towards a destination. But the extent to which either the journey or the destination is considered more important, fundamentally changes the state of mind of the traveller. If the destination is the main point of attention, the core value in travel can be called efficiency. On the other hand, if it's more about the journey than the destination, the value of enrichment is guiding.

Driving forces 5 and 6 support the two opposites in this dimension.

5 Efficiency — CORE TRAVEL VALUE — Enrichment 6

Dimension 2 | Planning attitude

The attitudes towards planning behaviour can differ from being oriented on flexibility and on reliability. On the flexibility side, travellers prefer to decide in the moment and for themselves what the best option is. Travellers expect the system to be adaptive to their individual needs. On the other hand, the orientation on reliability is more about planning in advance and adapting to the general system. Travellers are having high expectations of the seamlessness of the system.

Driving forces 7 and 8 support the two opposites in this dimension.

7 Flexibility — PLANNING MINDSET — Reliability 8

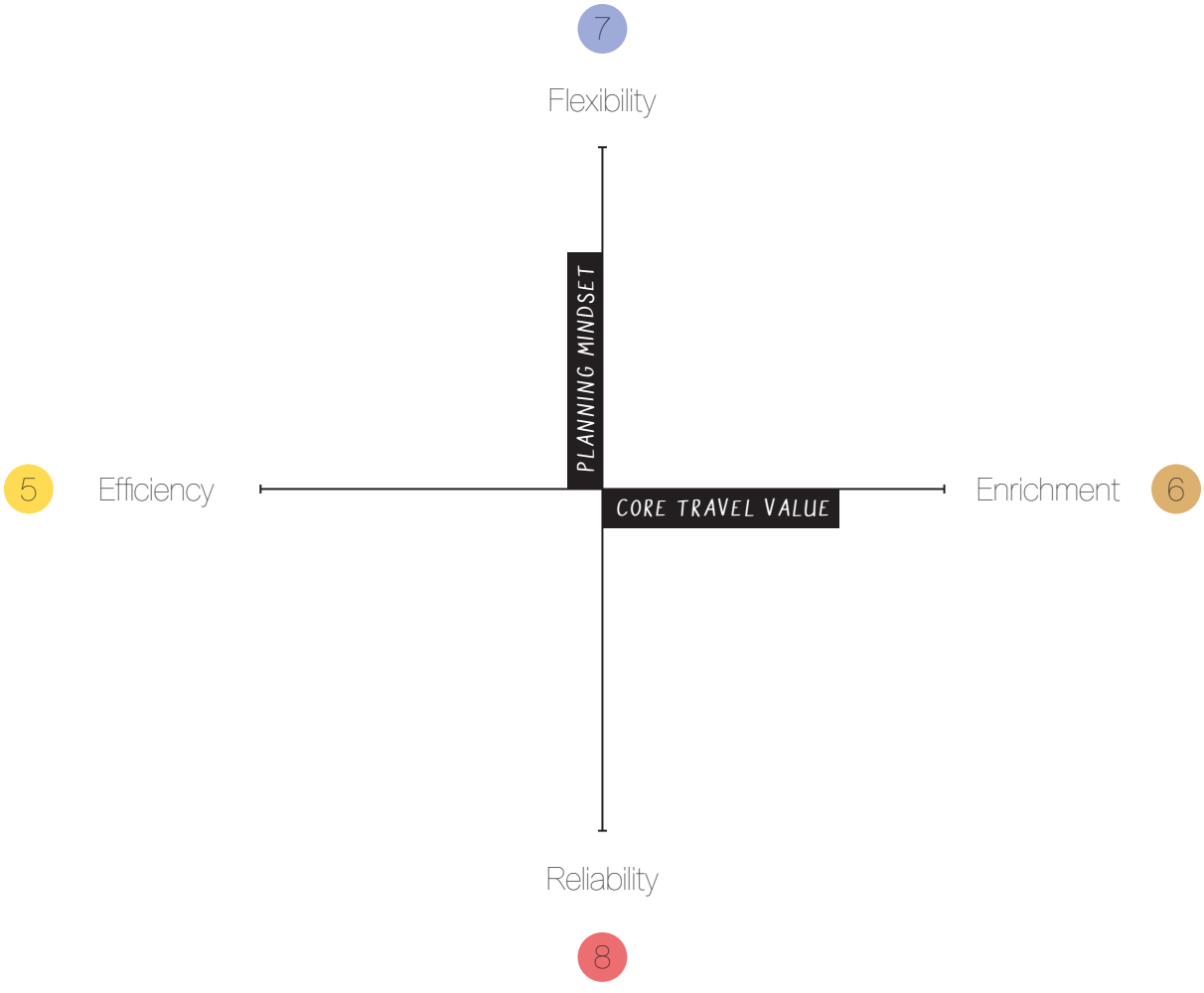


Figure 26: Overview of context structure 2 | the framework

Future travel attitudes

If the two dimensions are combined in a 2x2 framework, four future traveller types emerge with a distinctive attitude towards international travel (see figure 27). I will explain each traveller type with an imaginable quote, characteristics and description.

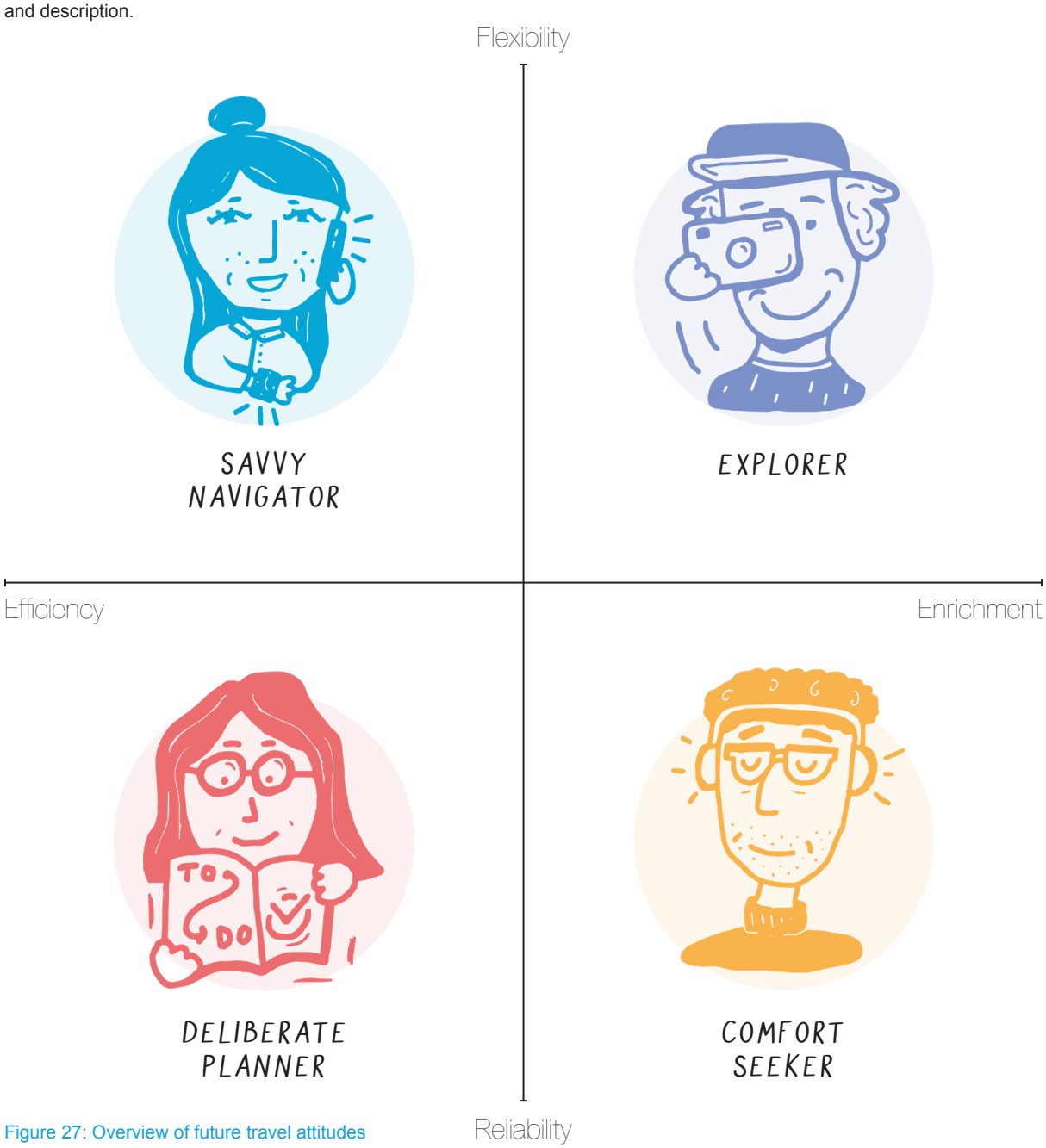


Figure 27: Overview of future travel attitudes

"I don't want to be bound to something. I compare all alternatives to find the best fitting option for me."

Characteristics: autonomous, curious, stubborn

Savvy navigator

The savvy navigator behaves according to a combination of efficiency and flexibility. He is very self-sufficient as he can take care of everything on his own. He knows his ways and get arounds to compare all possible alternatives to find the best option tailored to his needs. His main travel priorities are embedded in efficiency. He doesn't want to travel longer unnecessary and he doesn't want to pay too much for the journey as well. The savvy navigator wants to keep the flexibility open, because he doesn't want to reduce his flexibility by planning too ahead in advance.

"It doesn't matter if I arrive somewhere different, as long as the journey is fun."

Characteristics: spontaneous, enthusiastic, adventurous

Explorer

The explorer mainly behaves according to a combination of flexibility and enrichment. This travel enthusiast is not so picky when it comes to perfect arrangements. The most important thing is that he is having an enjoyable time when travelling. When and how to arrive at the destination exactly is of lesser importance for this traveller. The flexible planning mindset support this traveller to be spontaneous and experience the travel journey as a beautiful adventure.

"I want to exactly know the planning of my trip in advance, because I don't like surprises."

Characteristics: goal-driven, organized, determined

Deliberate planner

The deliberate planner behaves according to a combination of reliability and efficiency. This traveller has his reasons why he really needs to reach his destination on time, for example attending an important business meeting. He therefore deliberately plans and well prepares for his travel journey, so he doesn't get across any surprises along the way. In case something does go wrong, he has done his research about how to continue his journey.

"I can only sit back and relax when I know that everything will be arranged perfectly."

Characteristics: conscientious, dependent, careful

Comfort seeker

The comfort seeker behaves according to a combination of reliability and enrichment. This traveller wants to relax and enjoy the journey towards the destination, but needs to be reassured that everything will be arranged according to the plan. For example, when travelling with other people you are responsible for, like children, you want to reduce everything that can cause unnecessary stress. This traveller will therefore accept all support to increase comfort along the journey.

4.3

Conclusion

The future context analysis showed my understanding of the future context of international travel in Europe in 2040, which includes a transition towards more sustainable travel. In this conclusion I will discuss the relevance of rail for sustainable travel in 2040.

Relevance of rail for sustainable travel in 2040

The future context analysis of international travel in Europe 2040 shows that we are transitioning towards a future with more sustainable travel. Currently, we have learned that rail travel is one of the most sustainable modalities. But as we move towards the future, the international train might have to deal with competition of new sustainable modes of transportation in speed (Hyperloop) and flexibility (autonomous electric vehicles). An associate professor from TU Delft, who is an expert on new modalities, was interviewed to assess the relevance of international rail for sustainable travel in 2040.

New technologies won't take over

It is an illusion to think that Hyperloop will be an actual threat to rail travel any soon. It will take a very long time from the current technical testing phase until it is actually being introduced, as it also took almost 60 years to introduce trains with the Maglev principle. On the functional side it is imaginable that Hyperloop will mainly be used for high capacity connections, for example from airport to airport, and therefore not directly compete with international rail travel.

> "Hyperloop is a great new transport technology that will be developed, and it will find its place to operate, but within 20 years time it won't influence the international travel market." – transport expert, TU Delft

The same goes for electric autonomous cars which will inevitably develop and get better and better. There is definitely a market for this technology, but it won't make a huge leap in scale. In the end it will always depend per journey and destination which modality best suits the needs and wishes of the traveller.

Rail keeps being relevant

The growing economy China has deliberately chosen to invest in rail, while it could also choose a different modality. This year, China has opened 1178km of new rail infrastructure, including 605km of high-speed rail (International Railway Journal, 2020).

According to the interviewed expert, there are several arguments why rail is staying a relevant modality.
First of all, rail is a very mature technology. It has so fully developed that it is a safe form of transport and rail will keep being further developed. The maturity also means that rail is understood by everyone. This understanding and recognizability are both very important for the experience of travellers.

Secondly, rail has the ability to develop systemically on regional networks. International high-speed trains can be connected to existing national trains, making it possible to offer attractive railway services.

Third, rail has the ability to insert a station, which makes it possible to transfer. This includes transfers between trains, but also transfers to other modalities. The joining infrastructure already exists in cities.

Design brief

5

The previous chapters gave insight into the current and future context of international rail travel in Europe. In this chapter I will establish a design position within this context. The design brief consists of a future context vision, design mission, design goal and design criteria.

Future context vision

In 2040, the transition towards more sustainable international travel will be flourishing. Thanks to policy regulations and travellers' environmental awareness, rail travel is gaining ground on the European travel market. Air travel will only be the preferred modality for long distances overseas.

Design mission

I want to stimulate people who travel more internationally to do so by train in order to reduce the carbon footprint of travelling.

Design goal

Design a travel experience that makes European train journeys as easy as air and car travel and puts the train as default option for European travel.

Why travel experience?

To allow more people take actually travel by international train, the travel experience should be improved. A future travel experience, from the perspective of the traveller, could function as a shared goal among stakeholders to take action and improve European passenger services.

Why as easy as air and car travel?

Currently, air and car travel are in many cases considered to be easier than rail travel. The international train journey should be just as easy as the other modalities, so rail can be a competitive alternative for more people.

Why rail as default option?

To really foster the sustainable travel transition, rail should be the first choice for European travel. It should be needless to say why rail is preferred, because it is rather an exception to not travel by train.

Design criteria

Flexibility

I want to enable travellers to be flexible in their journey from A to B. The traveller should have the freedom of choice where, when and how he or she wants to travel.

Control

Travellers should feel in control about their journey and travel time. At any moment in the journey, travellers should have enough knowledge to be confident in making decisions. Transparency in information is important.

Seamlessness

The journey from A to B is integrated as one single journey experience. International railway services are an integrated part of the total travel system. The traveller has a smooth travel experience from door to door.

Enjoyment

Travellers are having an enjoyable experience when travelling by international train. The train journey facilitates valuable time that travellers can use meaningful according to their own preferences.

Ideation

6

In this chapter I will explain the creative process of solution making that is used to tackle the design goal. For inspiration I will first formulate an interaction vision by using a metaphor.

I organized three creative sessions with designers, conference participants and SPM Lab members to generate a large quantity of ideas. I used the most promising or inspiring ideas from the creative sessions as input for three concept directions. These directions I then presented to the stakeholders, whose input I used to select one direction to develop further as the ideal future travel journey.

Interaction vision

As the first step of the ideation phase of the ideal rail travel journey, I have searched for an analogous situation in which the human-product interaction could be a source of inspiration. “Working with an analogy can help you to see the appropriate interaction from a fresh perspective.” (Hekkert & van Dijk, 2011)

This interaction vision is formulated as follows:
Travelling by international train should feel like a magic carpet ride.

A magic carpet enables you to travel anywhere whenever you want. Your friend is always ready at your service to bring you where you want to go. But you do not have to decide that in advance. You can also just let yourself being taken to new places on a comfortable ride. A magic carpet ride is a fun experience and flying above the scenic surroundings, you can enjoy the view and wonder about a whole new world.

Interaction qualities
Freedom
Comfort
Wonder

Travelling by international train should feel like a magic carpet ride.

6.1

Creative sessions

This section describes the purpose and main take-aways of the three creative sessions. The first session widely explored the solution area, the second session create future train journeys and the third session explored one solution direction in depth.

Creative session 1 | Wide exploration

Participants: 6 design student colleagues
Time span: 2 hours

The goal of this first creative session was to explore the solution space that came from the design brief. I really saw this session as a kickstart of the ideation phase to stimulate my own creative flow. The magic carpet metaphor and design criteria were used as a starting point for generating a large quantity of ideas. This brainwriting was followed by the worst idea ever, fix-it and three concepts for the ideal future travel journey. The session planning and results can be found in appendix F. The session was held online using collaborative platforms Miro and Zoom. Figure 28 shows an impression of the digital session environment.

Main take-aways
This session was not specified for a target group or traveller attitude. Therefore, some ideas stay on a more generic level because they didn't have to fit to more specific needs and wishes.

Looking at all the generated ideas and concepts, I could make a distinction into two main topics. The first being physical or in train solutions to create a more enjoyable travel journey. The second being digital services around improving information, booking and ticketing. However, there could be an interesting combination of these two: an enjoyable booking experience. This direction will be further explored in the third creative session.

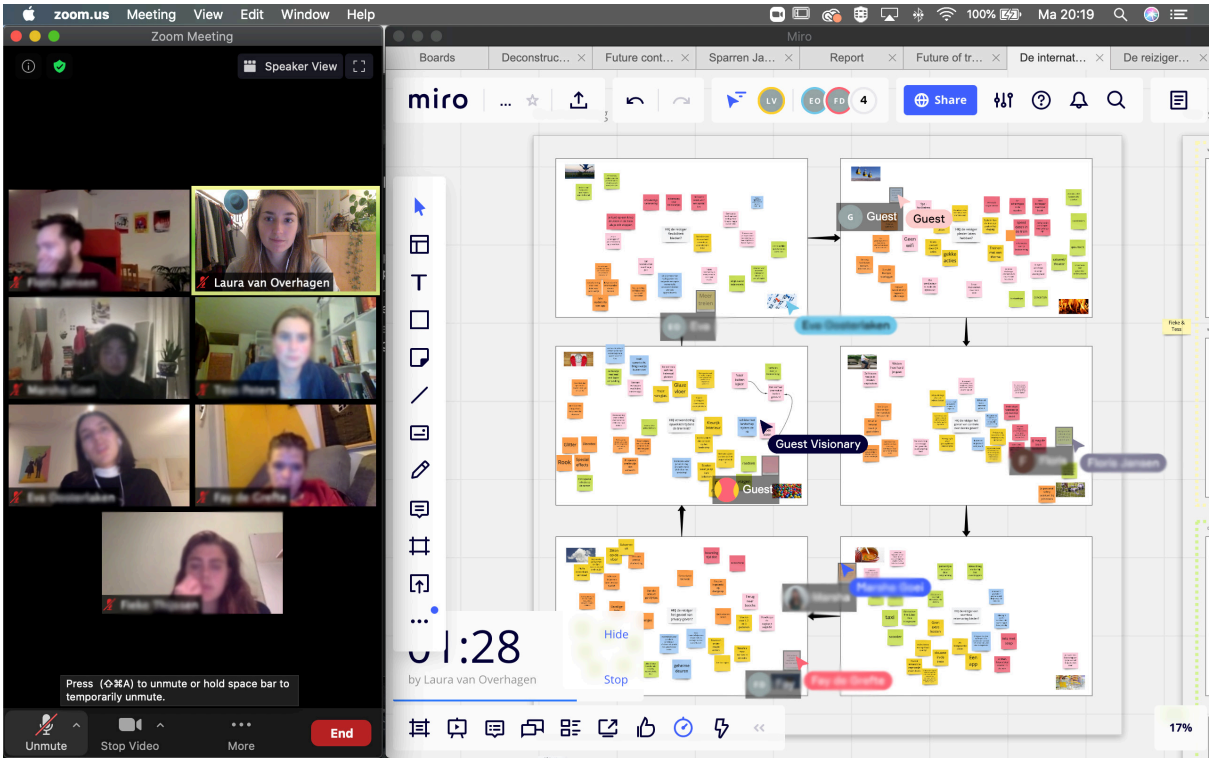


Figure 28: An impression of the digital session environment of session 1

Creative session 2 | A future train journey

> Participants: 15 visitors of the Human Factors NL conference
> Time span: 20 minutes

As part of a yearly Human Factors NL conference, the SPM lab had the opportunity to deliver a contribution to the online programme. The goal of these creative sessions was to zoom in on specific traveller needs and to fill in the customer journey. The session planning and results can be found in appendix F.

The two groups were each given 2 contrasting traveller attitudes, for which several ideas were generated on the journey. Consequently, the ideas for one traveller type were compared to the other traveller type to find out if it would be desirable for both of them (clapping hands emoji) or a conflict of interests (lightning stroke emoji). Figure 29 shows an impression of the set-up of this session environment. Due to limited time and difference in group size, the output quality and quantity varied among the two groups.

Main take-aways

In contrast with session 1, this session was more limited and resulted in ideas that were less out of the box. The ideas are mainly oriented in the present rather than the future.

Figure 29: An impression of the digital session environment of session 2

Creative session 3 | In depth exploration

Participants: 5 SPM Lab members
Time span: 1 hour

Based on the result of session 1, the goal of this creative session was to further explore the solution direction of an enjoyable booking experience. The orienting and booking phase of the international rail travel journey were selected as a focus on.

The session started with generating association to the metaphor of the magic carpet (see figure 30), followed by brainwriting, idea selection and concept generation. The session planning and results can be found in appendix F.

Main take-aways

- In a world where everything is becoming digital, travellers could (re)value physical elements as well.
- You can also make the booking process more enjoyable, by not having to need to book at all.

Figure 30: Associations to the metaphor translated into future rail travel experiences

6.2

Concept directions

This section converges the large quantity of ideas that resulted from the three creative sessions into more presentable ideas. I used the selected ideas from the creative sessions as input to create three concept directions to improve the booking experience of international rail travel: personal booking experience, joyful booking experience and no booking experience.


strippen kaart voor een aantal km
Ticket/ reservering is niet per trein maar per traject
je kunt op een knop drukken in de trein als je wilt stoppen
alle mogelijke opties/routes laten zien
Je mixt alle 'ingrediënten' van reizen in één soep: je koopt een kaartje (=Felyx, trein, bus & boot)
Overal iemand die zegt wat je moet doen
De treintickets boven aan het lijstje aanbieden, boven de vliegtickets
Sneak peak van de treinreis zelf
verrassingspakket opgestuurd krijgen thuis om alvast een locaal product te proeven
Het een AI laten doen die jou persoonlijk heel goed kent
Naam kaartje op je plek
krijg korting als je met de trein reist of vaak met de trein reist
net zoals bij oude trams dat je overal kan in- en uitstappen terwijl die rijdt
ticket swap voor treinkaartjes
Pas op de dag zelf kijken hoe laat je wil vertrekken
interrail voor iedereen: onbeperkt binnen x aantal dagen
Een reiziger als een bagagestuk behandelen
steward/beg eleider bij het overstappen
Niet hoeven betalen, dit gaat automatisch van je ov af
De ervaringen van gelijke "types"
alle zintuigen aanspreken - geuren/visueel /audio van je bestemming
jezelf als "hologram" in de trein al neerzetten, ipv alleen een stoel kiezen.
boeken is ook vaak een gezamenlijk proces, bijv waar gaan we heen (keuze als familie)
Ervaringen van andere reizigers delen over de bestemming
Je kan aanvragen of andere treinen op je wachten
Er staan fietsen /deel scouter in de trein
Treinreis niet verkopen maar bestemming: je kan altijd kiezen hoe en wanneer
Alles op 1 kaart / telefoon / ID kaart, maar 1 bewijs nodig
één trein + first & last mile inbegrepen
Reiziger neemt een slaappil en wordt wakker op bestemming
Niet hoeven boeken, je kunt gewoon gaan en de trein automatisch herkent dat jij het bent
combinatiereizen: bij boeken hotel krijg je treinticket inclusief
Niet een eindbestemming boeken maar een reis
Kennismaken met de crew via zoom
Elke trein kunnen pakken met je kaartje
je krijgt iets fysieks opgestuurd
Een rechtstreeks aanspreekpunt (klantenservice zonder wachttijd)
Vertraging is altijd gekoppelt met nieuwe optie
Een voice assistant in elke stoel die je informatie geeft wanneer jij het wilt ipv conducteur
cafe trein coupe waar je echt kan zitten
Treinen met een thema
zoekplaatjes van dingen waar je langs rijd
pro-actief advies geven obv jouw persoonlijke situatie
tijdens het boeken komen je familieleden naar voren die advies geven
Preferences van vorige reizen meenemen
Trein schema automatisch aanpassen naar hoeveelheid mensen
boeken via VR om zo al een goed beeld te krijgen van de reis
suggesties voor hoe je je tijd aan boord kunt besteden
Infopunt die je altijd can bellen/chatten
Zeg hoelaat je aan moet komen en de reis zorgt dat het goed komt (ook al heb je vertraging)
Japanse stiptheid van de treinen
lokaal eten & drinken proeven (met uitleg)
informatie over je bestemming
trein radio met verschillende kanalen
tips voor nieuwe bestemmingen die vergelijkbare mensen ook kiezen
Betaal wat je het waard vind ipv prijzen qua vraag/aanbod systeem
Persoonlijk contact met medewerker tijdens boeken bijvoorbeeld chat of belletje tijdens boeken
Tijdelijke exposities laten zien in een overzicht
Kennismaken met de crew via zoom
Preferences van vorige reizen meenemen
En of er iemand naast je gaat zitten
soort uber, overzicht van alle treinen die bewegen bij jou in de buurt
trein stopt wanneer je op de knop drukt
een bordspel/ kaartspel hoek
Genoeg faciliteiten (stroom, internet, etc.)
De conducteur is zoals de EJW-toren
Meer stilstaan bij waarom je gaat reizen
het leuk maken om te boeken samen met je reisgenoten
Verassing bij het boeken, gratis koffietje die je kan ophalen in de trein
Verschillende routes naar een bestemming
een reistegoed (bijv aantal treinkm)
Trein schema automatisch aanpassen naar hoeveelheid mensen
Trein van glas.
Traject aanleggen over water, coole plekken
verhalen over je bestemming
Weten wat de reiziger wil zonder dat de reiziger het hoeft aan te geven
Als er opeens een vriend ook in de trein zit die mee gaat op reis
schilder het landschap tijdens de rit
Tijdens reis updates over andere routes en aansluitende treinen
Mensen verrassen met kleine 'easter eggs'
Naar buiten kijken
mooie gekleurde lichtjes


Hey Google, Take me to Berlin
€89
€119
€15


WOW
VR

1 | Personal booking experience

What if your computer knows your travel preferences so well, that it can give you personal advice about your travel journey? In this first concept direction a smart AI assistant creates a personal booking experience for travellers.

As a traveller you do not have to spend time searching for travel routes and tickets, you can simply say “Hey Google, I want to go to Berlin.” Your digital travel buddy will ask you some more questions, like when and where you want to leave from and how long you want to stay, and starts planning the perfect travel journey and finding the best prices for you. The only thing you have to do is saying “yes” to confirm your travel plans and turn it into an actual booking. In your travel account, you will get an overview of your personal trip in which you can also find your train tickets and seat reservations. However, you do not need to exactly know all this information, because your digital travel buddy will remind you when it is almost time to leave. In the station your buddy will guide you to the right platform and to your reserved seat in the train. This will lead to the traveller having to worry less in preparation to and during his train journey.

Although your AI assistant takes care of everything, you can always interrupt and be in control of your own travel time. For example, if you wish to plan a longer stop for lunch, you can easily adjust the transfer time of your personalized travel journey.


Hey Google,
Take me to Berlin
€89
HOTEL
€119
€15

2 | Joyful booking experience

What if you could already wonder about your train journey without leaving your home? In this second concept direction, the booking experience is a fun and joyful experience to let travellers look forward to their journeys.

Imagine you wish to go on a train journey through the Alpes. You are very excited for the beautiful views of the mountains that you will experience during this train journey and you cannot wait to go on your trip. In an immersive virtual reality, you can now already get a preview experience of the train travel route and your destination.

If you are planning to make this journey with other people, you can connect your travel buddies and it is possible to experience the virtual reality preview together. Maybe you have some fellow travellers who prefer to travel to the destination by plane or car. Sharing this preview experience of the train journey might help you to persuade them to choose for the train.

When you have booked your trip, you will receive a surprise package related to your country of destination. This package could for example contain local food, or a card game that makes you learn about the foreign culture. This surprise will make you (and your travel buddies) even more excited to go on the journey.


WOW
VR

3 | No booking experience

What if you did not have to book tickets for train journeys at all and you can just hop on the train? In this third concept direction, travellers are liberated from all booking activities, making it more accessible to take the train.

Imagine you want to visit friends or family that live in another European country or that you have to travel abroad for work. You have a general idea of when you want to go, but you do not want to define your precise departure times yet. You can now decide on the day itself which specific train you will take, because no tickets or reservations are required. You also do not have to spend time searching for the right tickets anymore.

Train journeys are easily planned, because you can find all European train routes and schedules in one overview. While travelling, you do not experience any issues around borders, as all European countries are connected to travel with this ticketless system. You pay for your train journeys as you go, because your location is used to track the journeys and calculate the payments afterwards. Your payments are then automatically distributed among the rightful carriers.


MIL

6.3

Conclusion

This chapter forms the conclusion of the ideation phase, in which I will select one concept direction for further detailling. I have combined Harris profiles with the four design criteria and stakeholder discussions, to make the final selection.

Selection of concept direction

To quickly generate a visual overview that compares the three concept directions I created Harris profiles. This graphic representation shows strengths and weakenesses of each concept direction (van Boeijen et. al., 2013). I scored each of the concept directions on the four design criteria: flexibility, seamlessness, control and enjoyment. The Harris profiles in figure 31 show that concept direction 3 has slightly more strengths compare to concept direction 1 and 2.

In order to select one of the three concept directions, I have discussed them with the stakeholders NSI and IenW. Based on their input in the discussion and the Harris profiles, I selected concept direction 3 for three reasons.

First of all, the other directions, advanced personalisation and immersive experience are considered to be more of luxurious elements, concealing the current ticketing issues. This selected direction is tackling the core of the ticketing problem. Looking at the level of need fulfilment, this direction is addressing a lower layer in the pyramid and therefore more essential for the user.

Secondly, this direction has a greater potential to be a radical change that can disrupt the current ticketing system. It is therefore more inspiring as a future vision as well. Such a disrupter perspective can in a way also force the railway sector to change.

Thirdly, this concept direction could be a catalyst of new travel scenarios. Because this concept direction is in essence proposing a whole new system, there are several additions to new forms of behaviour in this system imaginable.

> "It could be an enabler of other scenarios." – UX designer, NSI

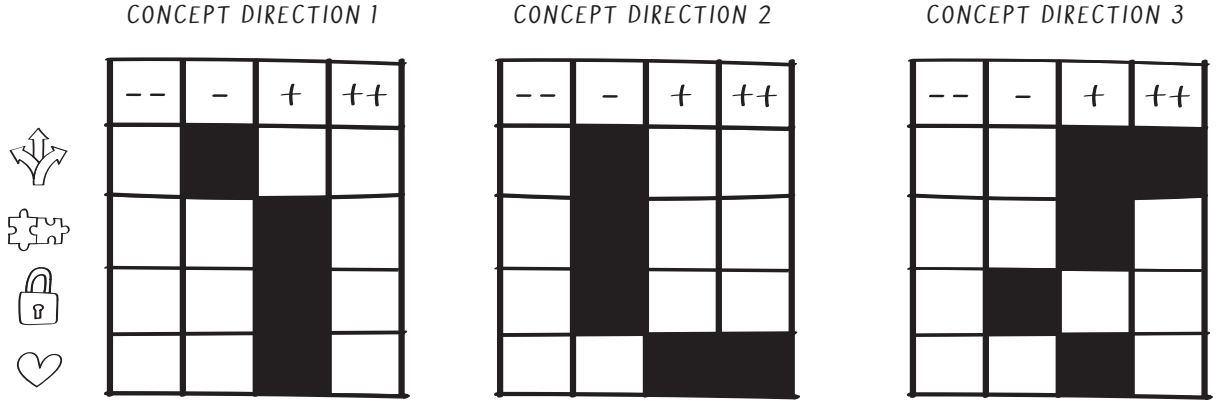


Figure 31: Harris profiles of three concept directions

Conceptualization

7

During the conceptualization phase of this project, I further developed the selected concept direction “no booking experience”. I did additional user research to evidence design decisions about the final concept. The future concept is explained through a customer journey map and service blueprint. At the end of this chapter, I will reflect on the desirability, viability and feasibility of this concept.

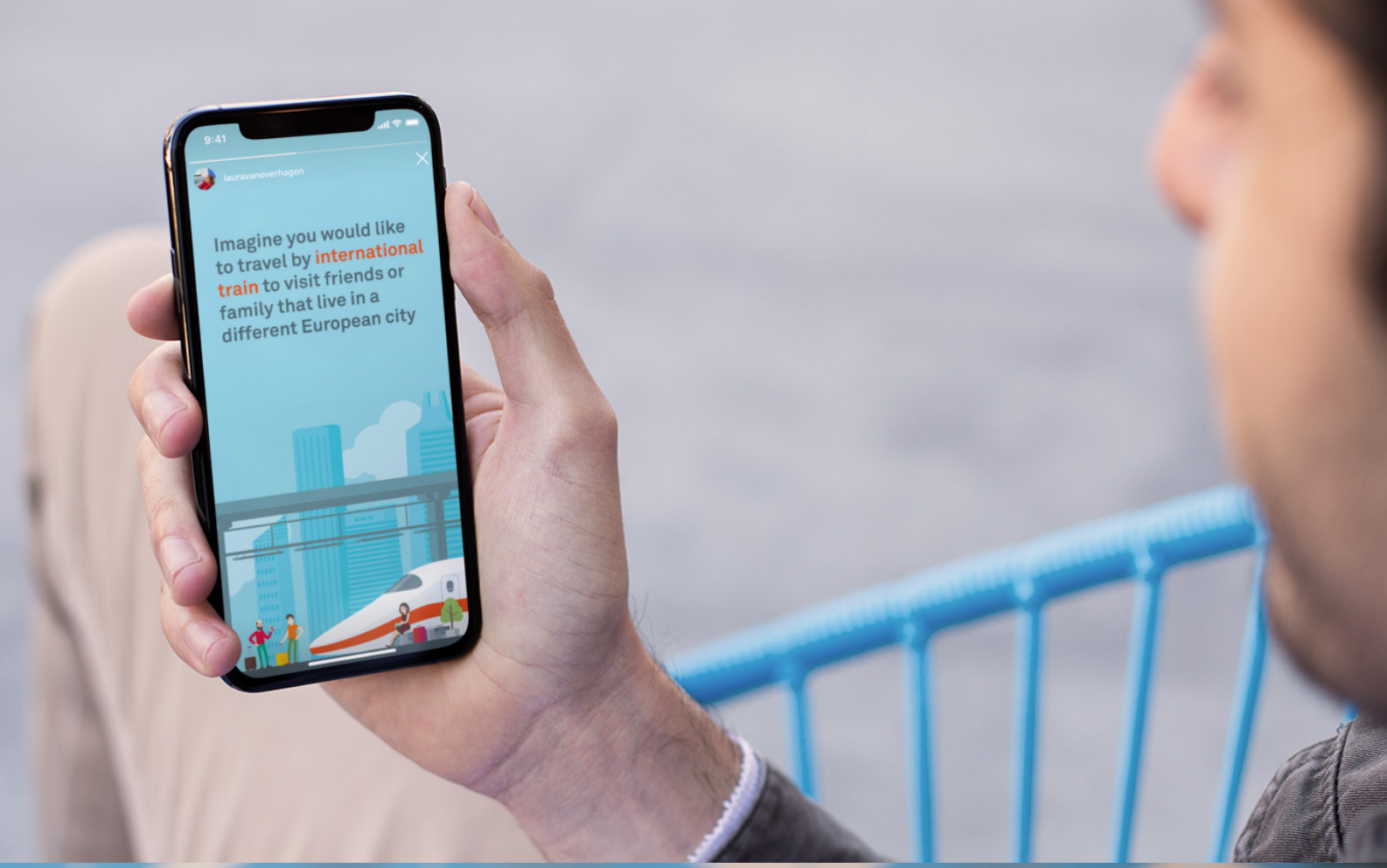
Additional user research

In the scenario where travellers can just hop on any train they would like to take without a ticket, some questions arise. When and what would travellers pay for their travel journey? Do they still want to make a seat reservation, perhaps very close to departure? Or would they rather check expected and real time crowdedness?

To address these questions and better understand the specific preferences of travellers within this concept direction, I sent out a user survey with eight travel dilemmas. The participants are not informed about the future concept direction. To introduce the topic I asked them to, “imagine you would like to travel by international train to visit friends or family that live in a different European city” and then the travel dilemmas are given to them. The survey was spread through Instagram stories resulting in a total of 132 participants.*

In addition, two of these participants are interviewed to further elaborate on their preferences to gather more qualitative information. The research set-up and results can be found in appendix G.

**The group of participants is not a well-distributed representation of society. The results are therefore only used for inspiration rather than statistic conclusions.*


9:41
lauravanoverhagen
Imagine you would like to travel by international train to visit friends or family that live in a different European city


9:41
lauravanoverhagen
Would you rather...
Buy a train ticket for a specific departure time in advance
Just hop on any train you would like to take without a ticket
Stuur bericht

Results

The majority (64%) of people would rather just hop on any train you would like to take without a ticket, than buy a train ticket for a specific departure time in advance. This emphasizes the desirability of the concept direction. Many people don't want to be bound to specific departure times and especially not decide on their departure time three months in advance. This is currently the timing when tickets become available for booking and also when travellers can best book their tickets to find low prices. However, the majority (75%) of people would rather pay a standard price when travelling without tickets, than put effort into booking in advance to guarantee low ticket prices.

> "Ticket prices are allowed to get lower than the standard price, but not higher. It is fair that people who book three months in advance pay a lower price, but it is unfair that the same tickets two days in advance become sky high." – Participant 1

When asking a similar question but without mentioning the resemblance with national public transport, a smaller majority (60%) prefers to pay as they go rather than pay for their travels in advance. This is an important insight when introducing transaction-based travel on international journeys. Within the Netherlands, travellers approximately know what their journey will cost, given that it will never cost more than the longest journey from Groningen to Maastricht. For international travel, the range of how much a journey will cost is much bigger. Therefore, transparent information about the international tariff system is needed so travellers have a good expectation of the travel costs.

> "If journeys can have fluctuating prices as they have now it would feel as a big risk to pay as you go. Then there really needs to be a standard fare that I know of in advance." – Participant 1

When it comes to payments, people don't want to be surprised with high travel expenses afterwards, they would rather just pay immediately. The majority of people (72%) prefers to pay for their travels automatically rather than pay all their travel costs at once through a (monthly) invoice.

The same goes for seat reservations; people prefer to be more flexible. The majority (70%) of people would rather not reserve a seat and be flexible in which train to take, than make a seat reservation for a specific train in advance. However, this preference can also differ depending on the destination. Although travellers may not reserve a seat, they still want the guarantee that there will always be a free spot for them. Some travellers mentioned that they would trust seat availability in a train to Berlin. This train departs frequently and is considered to not always be full, so seat reservation would be unnecessary. However, when going to Paris, travellers feel the need to reserve for the Thalys. This is due to the current strict and airliny image that the Thalys projects. Today it is barely imaginable that you could just hop on the Thalys or Eurostar without a ticket.

> "For the train to Berlin I would believe that there is an empty seat, but travelling to Paris that would be a bigger risk." – Participant 2

An even bigger majority (82%) would rather be able to reserve a seat until the final moment they hop on the train. This is actually a kind of trade-off of actual flexibility. They won't feel the freedom of being able to hop on any international train as much as if there was no possibility to reserve seats. Travellers would check the availability of reservations more frequently and therefore actually spend more time around planning their journey.

> "If you are able to always reserve a seat, and you know that all other people can reserve seats until the final moment too, you would feel an increased urge to make a seat reservation. This contradicts with the fact that you actually wanted to be flexible." – Participant 1

> "If nobody can book and reserve a ticket, it would be more relaxed. Trains will be built to accommodate everyone." – Participant 2

Combining travellers with and without seat reservations would require skilled crowd management.

A smaller majority (63%) prefers to decide which train to take based on expected and real time information about crowdedness. It would be interesting to base ticket prices on

this crowdedness as well. Very crowded trains could be more expensive to travel with and therefore even less attractive for travellers than they already are.

> "If I now want to take my bike in the train, I always check the availability of bike places. If there are enough spots left, I know I can just go. For me, this would be the same for information about crowdedness in international trains." – Participant 2

On the other hand, if all travellers can see the same information on crowdedness, wouldn't they all take the least crowded train and therefore turn the empty train into a crowded train in the end? The information on crowdedness should be accurate enough, so travellers can really depend on it.

Finally, the majority of people (75%) would rather be able to use their national travel app for international journeys as well, than use a separate European travel app to plan their journey. Downloading another app would be another task and people prefer to use an app that they already know, and which provides their native language.

In conclusion

More flexibility in international rail travel is preferred among the majority of the sample. This preferred flexibility is translated to the traveller not being bound to departure times and not having to book a ticket in advance. Transaction-based travel is preferred over prepaid travel, but the traveller does not want to lose control of his or her travel expenses.

Travellers prefer flexibility of departure time over seat reservation in advance. This is a controversial topic, because travellers only dare to be fully flexible if they can trust on the system that there will be a place for them. Because this project aims to create an inspiring concept of a future travel experience, I choose to amplify the flexibility and neglect seat reservations for now.

Futhermore, national travel apps should be made operable for international journeys as well, so travellers can seamlessly travel across borders without noticing any borders.

7.1

Future vision

In this chapter I have detailed the selected concept direction into the final design of the future vision: seamless European train journeys. Six vision elements describe the future travel experience. Besides, I have created a customer journey map of the future international train journey and a service blueprint of how that journey is realised at the backend.

Seamless European train journeys

I have taken the main insights from the additional user research as inspiration to fill in the ideal international rail travel journey of the future. In this section I will explain this future travel experience in three ways; by sketching a future scenario, by highlighting the main experience drivers and by elaborating on the customer journey phases.

A future scenario

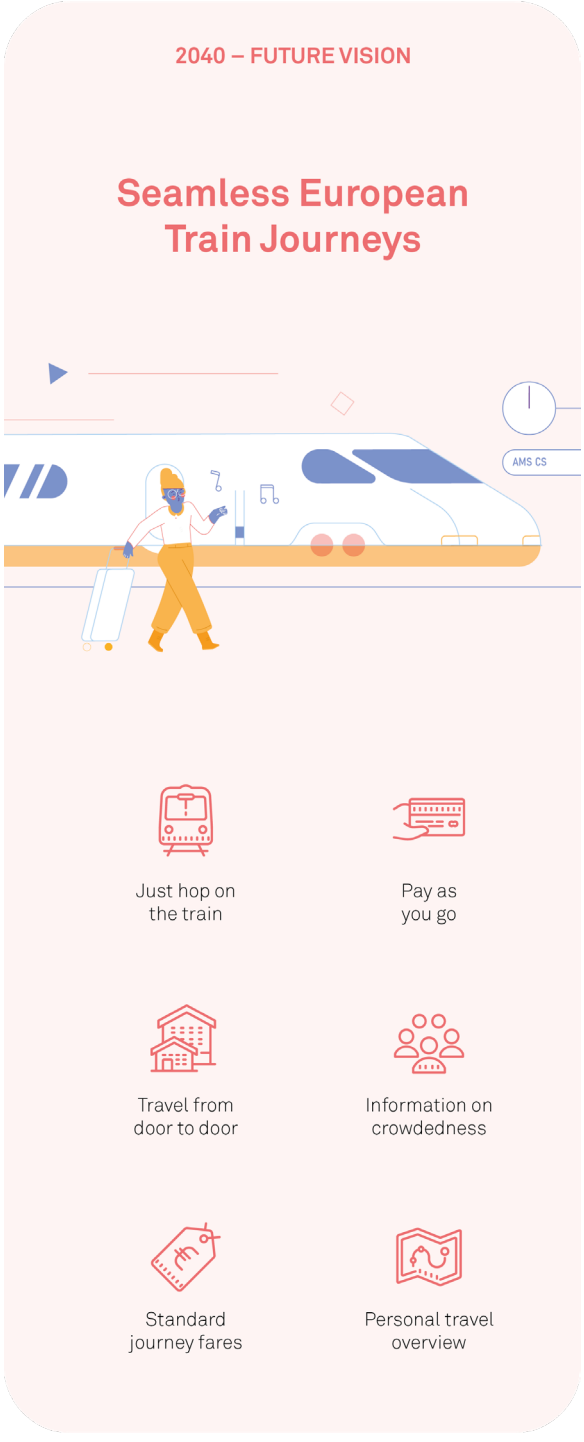
Let's take your friend's birthday as an example. You want to pay a visit, but he doesn't exactly live around the corner. You start to plan your journey from door to door. Whenever you intend to leave, the journey prices remain the same. Also, there is no need to book a ticket, you can simply take the train without any arrangements. As you hop on, your location is linked to your travel account, from which everything is arranged automatically. While moving towards your destination, your location is continuously updated behind the scenes. After completing your journey, you can easily check you travel activity based on passed locations, as payments are automatically distributed among the rightful operators. During your entire means of travel, you do not have to arrange a thing, allowing you to fully enjoy the journey towards your destination.

Vision elements

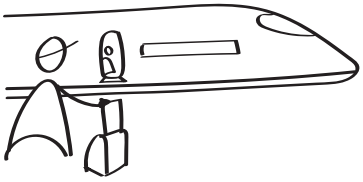
The future vision of seamless European train journeys consists of six main elements that influence the experience of the traveller. The six vision elements are explained on the right.

To bring the vision of this future travel experience to life, an animated movie is made in collaboration with Freek Trimbach Animations. The script and storyboard can be found in appendix H.

SCAN THIS CODE TO WATCH THE ANIMATION

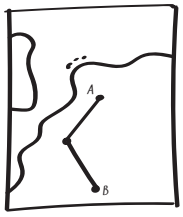


Vision elements

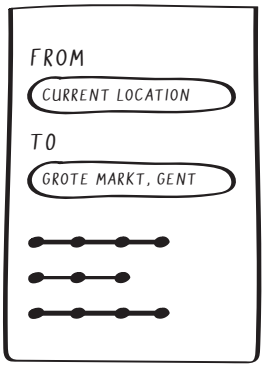


1 | Just hop on the train
The core of this ideal future travel journey is that the traveller can always just hop on an international train, without a pre-booked ticket and without any arrangements.

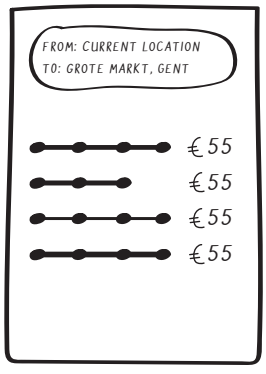
2 | Pay as you go
Travelling without a pre-booked ticket includes that you pay as you go. When travelling towards your destination, your location is used as input for your travel activity and payments.



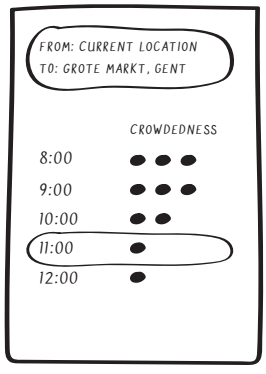
3 | Personal travel overview
When you have arrived at your destination, your travel activity and payments can be viewed in your travel history.



4 | Travel from door to door
To plan journeys from door to door, international train information is integrated with other forms of transport in multimodal platforms, like MaaS apps. Any national or international MaaS app, up to the preference of the traveller, can be used for planning the journey.



5 | Standard journey fares
When orienting about destinations and routes, the traveller is presented with the standard journey fares. When travelling, the traveller knows what the journey will cost.



6 | Information on crowdedness
When comparing trains, expected and real time information on crowdedness is shared, so the traveller can decide to travel with a less crowded train.

Future international train journey

In this future train travel experience, it has become really easy to go on an international train journey as travellers do not have the hassle of endless searching for a ticket anymore. They can now simply hop on an international train without any complicated arrangements in advance. The main journey phases and customer thoughts, actions and emotions are illustrated in a customer journey map (see figure 32). Each phase is further clarified in the following section.

Orienting and planning

In this future travel journey, orienting and planning can be done close to departure. Travellers have the flexibility to decide until the final moment which train to take. Comparing the future customer journey map with the current customer journey (page), the booking phase is removed and replaced by an additional planning phase. This is because travellers in this scenario are not booking a ticket anymore. They are not attached to anything, but only flexibly planning their journey.

Preparing

Getting closer to departure travellers will make up his mind about his preferred departure time. Expected and real time information on crowdedness can be used to base this decision on.

Departing

Travellers can leave when they want to. They can easily plan their first mile transport to the station in the MaaS app where all forms of shared and public transport are integrated. According to their personal needs and wishes they can decide how and when to travel to the station.

Travelling

When travelling, travellers can decide for themselves how to spend their time meaningful. The train is a comfortable journey where they can enjoy the view or do some work. During the trip travellers can totally relax, because there is no need to worry about anything. Everything will be arranged automatically to enhance a seamless travel experience.

Transferring

The journey does not have to be a linear and predetermined planned route from A to B. Travellers are flexible to change the planning along the way. Going back to the planning phase can be done at any point in the travel journey, but is only indicated as a feedback loop from the transferring phase. For example, when transferring travellers are able to replan the transfer time.

Arriving

When arriving at the station, it is very easy to arrange last mile transport in the MaaS app. All options are presented in a clear overview so travellers can quickly make a decision.

Post travel

After completing the journey, travellers can look back on the travel journey and check their travel expenses. These are presented in a clear overview so travellers can easily have a look without spending too much time.

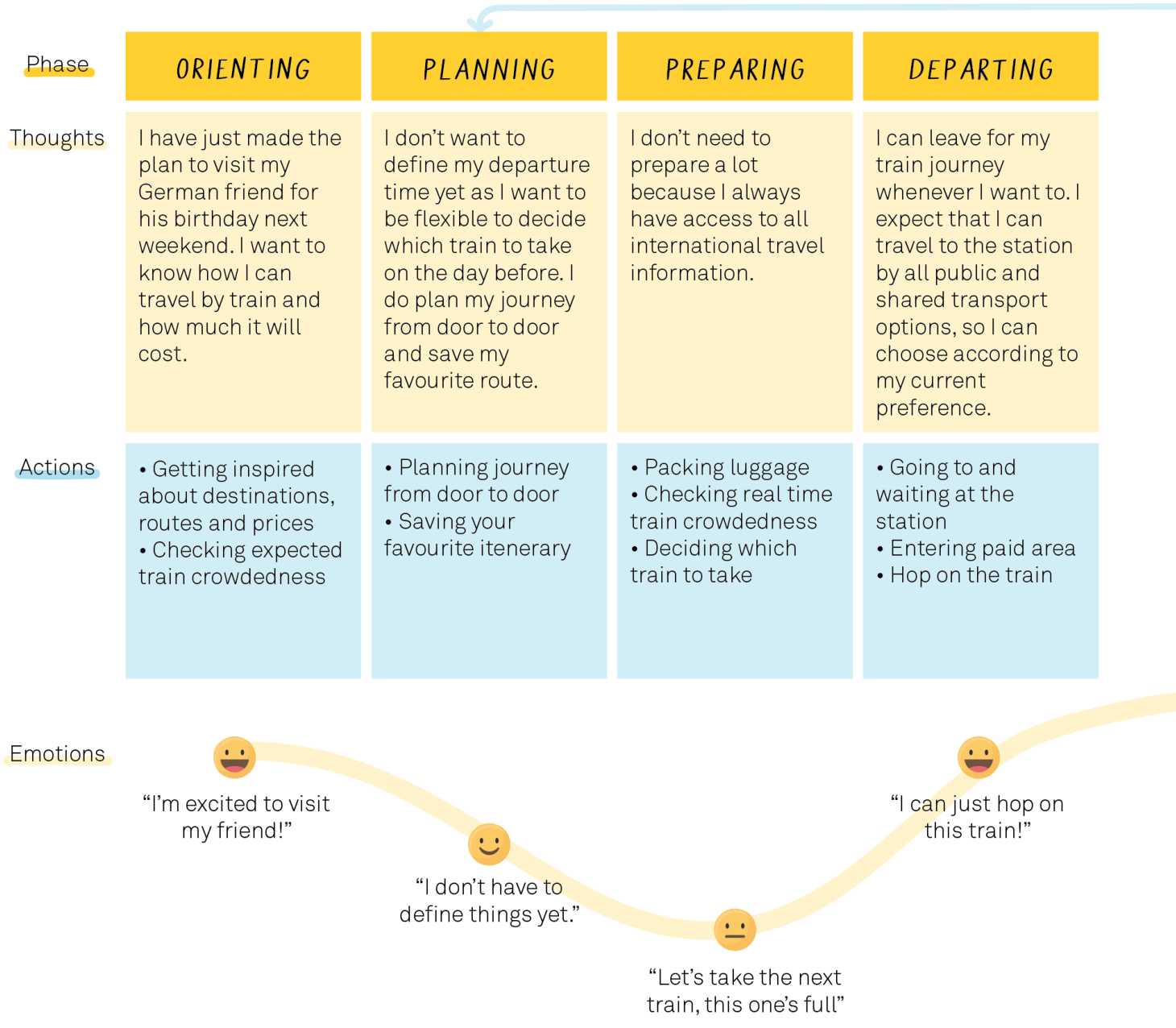


Figure 32: Customer journey map of the future international train journey

TRAVELLING	TRANSFERRING	ARRIVING	POST TRAVEL
I expect to have a comfortable trip towards my destination in which I don't have to worry about anything. I can just enjoy the view, relax or maybe do some work.	I want to define my transfer time on the go. If I happen to arrive somewhere nice I want to be flexible to take the next connecting train.	I expect that I can travel to my final destination by all public and shared transport options in the foreign country, and access those options in my preferred MaaS app.	I don't want to be surprised by any unexpected travel expenses, so I check my travel activity when I have arrived at my destination.
• Finding a place to sit and store your luggage • Spending time on the train	• Arriving at transfer station • Exploring the city • Hop on the first connecting train	• Arriving at the station • Exiting paid area • Travelling last mile	• Looking back on travel journey • Checking travel activity

"Yay! 3 hours to do what I want to."

"Change of plans, let's get lunch!"

"I can use shared bikes here as well."

"This trip did not cost more than I expected."

Service blueprint

So now that I understand the idea of the ideal travel journey from the perspective of the traveller experience, the question arises: how does this travel journey work? That is the moment where a service blueprint can be of great use.

What is a service blueprint?
A service blueprint is a tool to map out how a service works from multiple perspectives. On the top level the customer journey phases are shown with the corresponding customer actions per phase. The row below describes the front stage actions that are related to interactions with the customer. Below the line of visibility, the back stage actions are described. These actions happen in the back and are invisible for the customer. The bottom row describes support processes and systems that are needed to fulfil certain front and back stage actions. Arrows are used to show connections between all these different elements.

The service blueprint in figure 33 is an overview of all the actions and systems that are needed to facilitate the future travel journey. I have used the journey phases and customer action from the future customer journey map (figure 32) as a starting point to create the service blueprint.

The front stage actions are now represented by any MaaS app of choice, but in the future customers might access the same functionalities through different technologies if we no longer use smartphones.

The back stage actions are done in the digital back office. This is where all the technical magic happens and all information is aligned, combined and communicated. There are three main support processes and systems needed, which are explained in the next section.

What is a service blueprint?
A service blueprint is a tool to map out how a service works from multiple perspectives. On the top level the customer journey phases are shown with the corresponding customer actions per phase. The row below describes the front stage actions that are related to interactions with the customer. Below the line of visibility, the back stage actions are described. These actions happen in the back and are invisible for the customer. The bottom row describes support processes and systems that are needed to fulfil certain front and back stage actions. Arrows are used to show connections between all these different elements.

Support processes and systems

Transparent European tariff system
In order to determine standard fares for international travel destinations, operators need to work together. A European tariff system must by transparent, so travellers feel in control about their travel costs.

Be-In/Be-Out (BIBO) technology
This technology has the potential to replace all current check in and check out procedures. Based on the travellers' actual locations, this smart technology knows when travellers are in the train and when travellers are out of the train again.

Location-based travel
Travel journeys and costs are based on the actual changes in traveller's locations. These movements are registered and reconstructed to figure out the travel journey and costs afterwards.

Preconditions

For this future travel journey and service blueprint to work as proposed, there are several preconditions that have to be met first. Looking at the current international rail travel system (3.2, page 32), I have identified three preconditions that can be the most problematic if they are not met.

Yield ticketing is removed
The first is related to a transparent European tariff system. The suggestion of standard fares for international train journeys is contradictory with the current yield ticketing system. Operators should therefore drop their yield ticketing in order to be able to offer standard fares.

Train frequency scaled up
The second precondition is related to enabling the traveller to be flexible in his departure time. The traveller can only really be flexible if there are many train options to choose from. Therefore, it is necessary that the current train frequency is scaled up. For example, train frequency should be scaled up to a minimum of once per hour in all international directions.

International rail is integrated in MaaS
The third precondition is that international rail should be integrated as a modality in all MaaS platforms. It is essential that travellers can plan their international train journey with their (national) MaaS app of choice. Therefore, all mobility operators should cooperate and share their data on a European level.

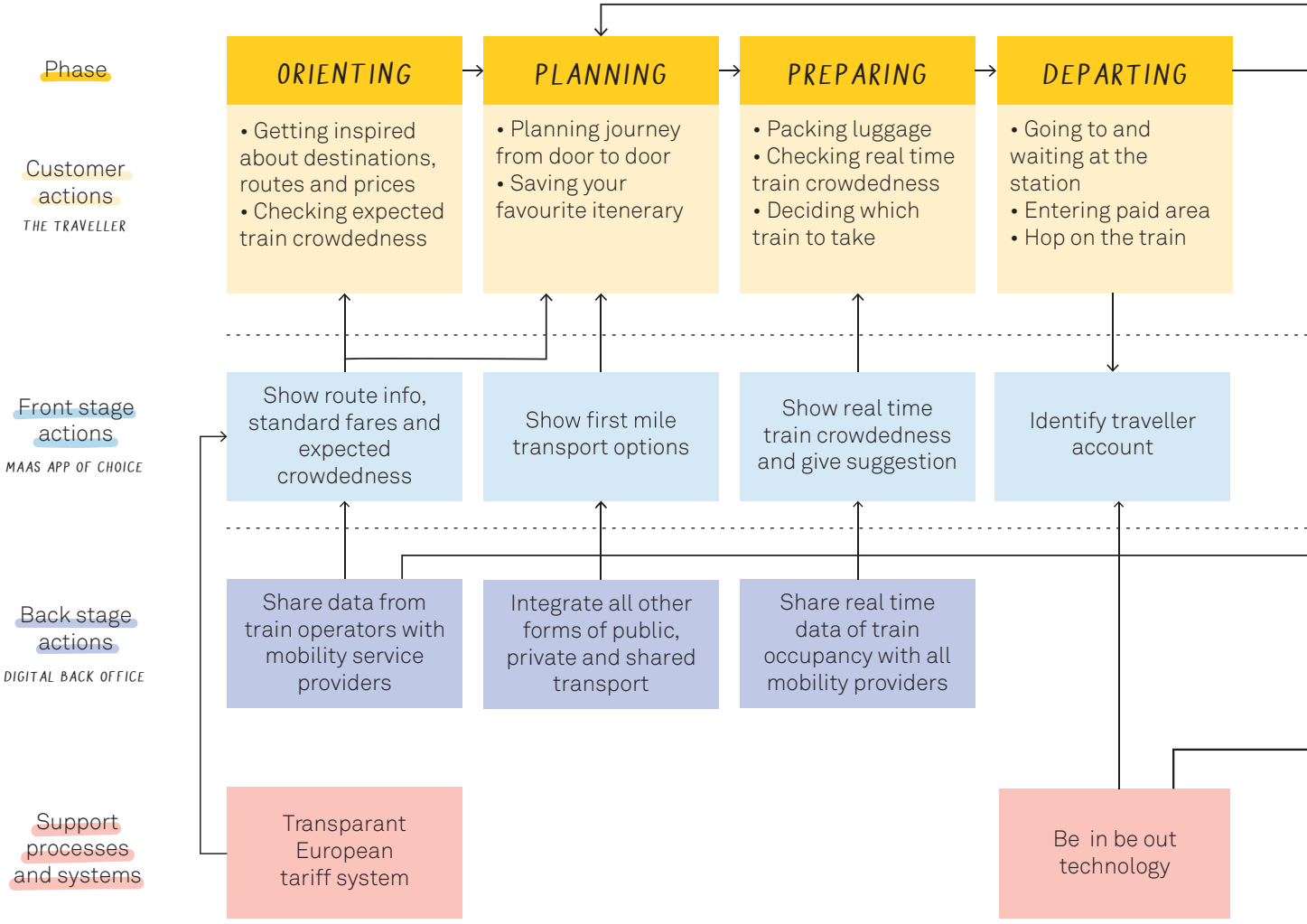
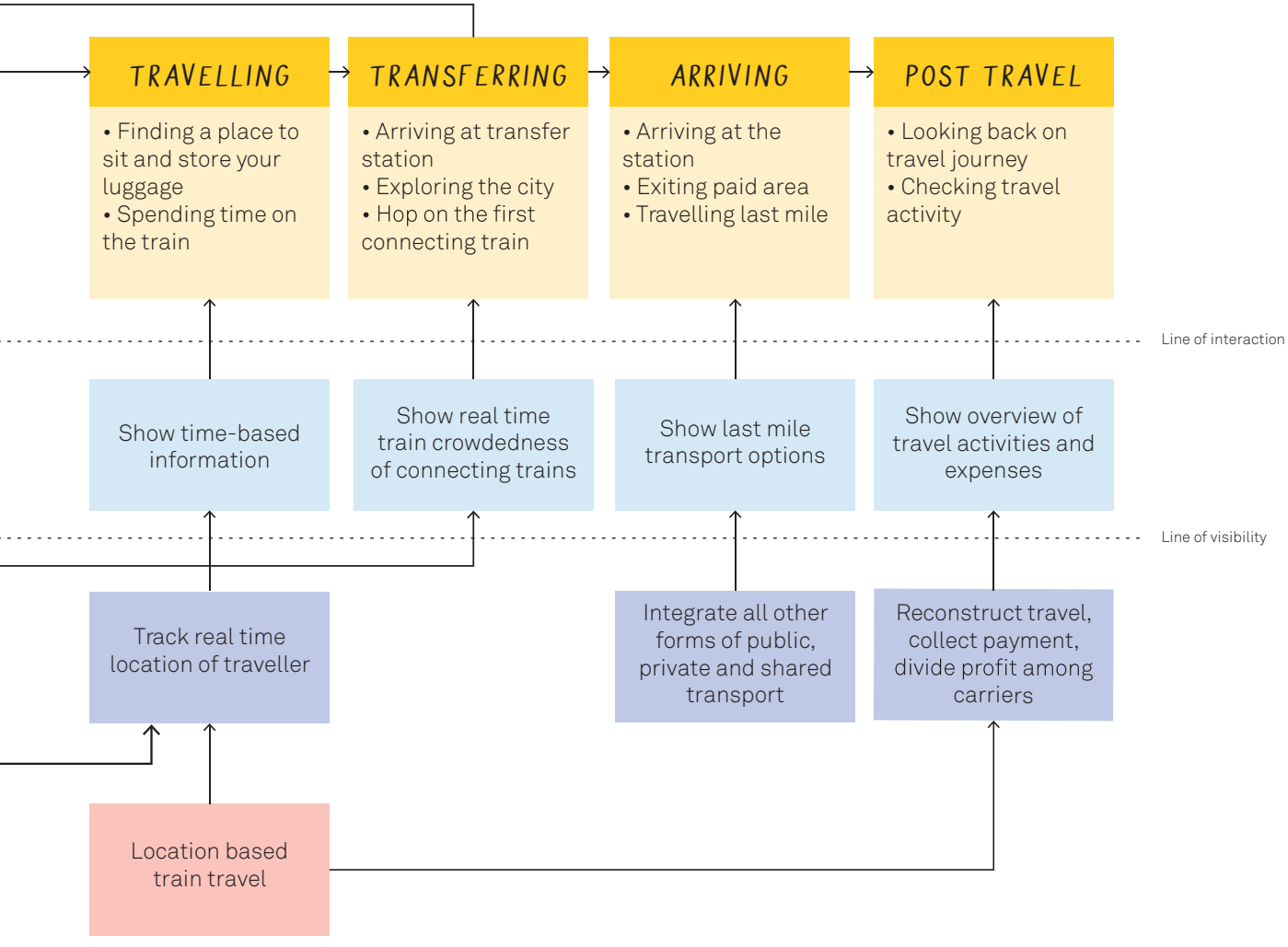


Figure 33: Service blueprint of the future travel journey


TRAVELLING
• Finding a place to sit and store your luggage
• Spending time on the train
TRANSFERRING
• Arriving at transfer station
• Exploring the city
• Hop on the first connecting train
ARRIVING
• Arriving at the station
• Exiting paid area
• Travelling last mile
POST TRAVEL
• Looking back on travel journey
• Checking travel activity
Line of interaction
Show time-based information
Show real time train crowdedness of connecting trains
Show last mile transport options
Show overview of travel activities and expenses
Line of visibility
Track real time location of traveller
Integrate all other forms of public, private and shared transport
Reconstruct travel, collect payment, divide profit among carriers
Location based train travel

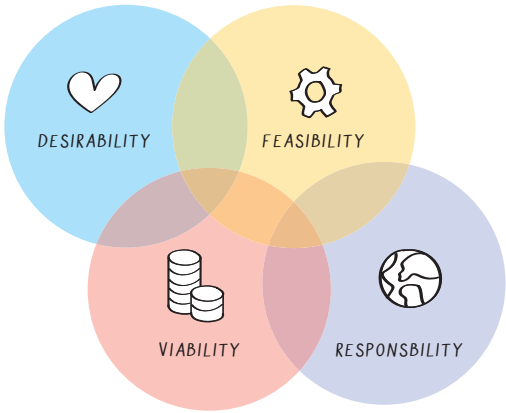
7.2

Conclusion

In conclusion of the conceptualisation phase I will evaluate on the desirability, viability, feasibility and responsibility of the created future vison: seamless European train journeys.

Evaluation on desirability, viability, feasibility and responsibility

I showed the ideal future train journey, service blueprint and the preconditions to the main stakeholders of this project, NSI and IenW. These meetings have led to interesting discussions about my future vision and concept where I tried to discover what actions need to be taken to make this vision a reality for 2040. Insights from these meetings are used to create a roadmap that shows the steps that need to be taken towards this ideal future (7.1, page 124). In the next section I will first evaluate the desirability, viability, feasibility and responsibility of this future vision.



Desirability

The current international rail system is very rigid. Travellers need to plan their journey and book tickets in advance in order to travel by international train. Journeys are becoming more seamless, but only when booked in advance. There is a need for seamless train journeys without booking in advance.

> "Currently the service [North Star] works well for tickets bought in advance, but going forward, the dream is to make buying more spontaneous or "on the move" travel just as seamless." (Fox, 2019, p. 13)

But this future vision is not only about spontaneity of a last minute train trip, but mainly about the flexibility of not booking in advance. Many travellers would love to be more flexible when travelling by international train, as they do not want to predetermine when they want to go exactly. And this flexibility now comes with the high price of last moment ticket fares. Being able to hop on any train for a reasonable standard fare is a desirable situation.

Looking back at the future travel attitudes (figure 34), this future vision best suits the explorer and savvy navigator, since flexibility is the main driver in their planning behaviour. The other two travel attitudes, the deliberate planner and comfort seeker, put bigger value in reliability and are expected to prefer booking a specific train ticket. However, their needs can also be met by providing a trustable system.

Figure 34: Future travel attitudes

One thing that questions the desirability of this concept is that there is currently no guarantee of seats. Especially for longer international journeys it is a very undesirable experience to not have a seat and stand along the entire journey. Besides, a high-speed train full of standing travellers is way too dangerous as well.

Travellers need to be able to trust that there will be an empty seat for them. But as mentioned before, within the current transportation services these expectations differ per carrier and destination. For an intercity to Berlin travellers have more trust in the flexibility and seat availability than for a Thalys to Paris.

Viability

From the perspective of carriers, the most important element for a viable business model is the occupancy of trains and the distribution of travellers. Ideally, trains are always filled completely, so the carrier can fully exploit the train capacity. Therefore, for train frequency to be scaled up, there needs to be enough people that are actually going to take those trains. This supply and demand related dilemma can be viewed in two ways. On one hand, carriers will increase supply after there is a growing demand for trains to destination X. On the other hand, if carriers increase supply, the demand can also grow thanks to the increased supply, because there are now more options to travel by train to destination X.

The potential number of train travellers was calculated to increase from 10 M to 17 M when lifting operational barriers and 23,5 M with the construction of a European HSR network (3.4, page 56). This shows that their is great potential for a growing demand for train journeys.

Carriers might be willing to drop their yield management if this train occupancy can in some way be assured.
From stakeholders, I learned that seat reservations are actually really crucial in this. Because the carriers want to know how many travellers will be in which train in advance. Removing seat reservations from the system is therefore considered to be a bigger bottleneck for carriers than dropping yield management.

However, carriers are not only focussed on high profit margins. There is always a trade-off between commercial goals and customer satisfaction, because it is as important to keep your customers satisfied.

Currently, carriers prefer to distribute their own tickets, because they make more profit and have a direct interaction with the customer. But moving more and more towards international MaaS, where integrated platforms take care of ticketing and payments, carriers might be forced to drop yield management in consensus with these MaaS platforms.

A reasonable standard fare could be based on the current average ticket price, or on a transparent rate per kilometre. To optimize traveller distribution, fares in peak hours could be made higher than off-peak hours, so people are more willing to travel in less crowded trains.

A more transparent and unified European tariff system could also enable new business models, like European loyalty cards or train subscriptions. This could in favour of the carriers lead to more regular customers that would like to travel by train more often.

For the obvious connections, hourly departures are already being implemented or on the agenda of NSI.

Feasibility

The basis of technology of pay as you go and ABT is feasible, because this is already being implemented on a national level.

Be in be out technology is also being experimented with, in a pilot of Invisible Tickets (invisible-tickets.com). One of the biggest concerns around travelling based on location tracking is privacy related. Privacy concerns about the continuous tracking of locations of people form a barrier for this technology to fully succeed. The potential and limitations of this new technology have to be further explored first. This

will be one of the recommendations for further research in chapter 9.

It will be a complex task to merge all European transportation services. It requires a huge digital back office where all data is combined and aligned. Therefore, all data needs to be available for third parties as well. MaaS platforms are working hard to build standards and combine all modalities on a national level, and increasingly internationally as well. The bottleneck in the end will not be of technical matter, but the big question is: how to line everything up and how to make everyone join?

Responsibility

This future vision is socially responsible as it enhances the societal goal of contributing to a more sustainable world. By stimulating more people to travel by sustainable modes of transportation, like trains, we can decrease the carbon footprint of travelling. When seamless European train journeys are realised, it is expected that more people will prefer to travel by train instead of plane or car on short to medium distances.
Moreover, train capacity is on average five times bigger than European flight capacity. One additional train can therefore be substituting five flights to the same destination.

However, this future vision can also be at the expense of responsibility. When European train journeys become more attractive and more accessible for everyone, it can also cause an increase of train travel without a parallel decrease of air travel. If the extra trains are not substituting flights, it will only cause an increase of international travel.

To contribute responsibly, there needs to be a transition towards more sustainable transportation, not only an addition.

Implementation

8

In this chapter I have looked at how the future vision could be implemented. I have imagined four potential scenarios of which I selected the most likely scenario to further detail into a strategic roadmap. This roadmap shows the main steps of how to get to this future vision in three horizons. Subsequently, I have validated the future vision with users and the future vision and strategic roadmap with the main stakeholders and two additional experts.

Potential scenarios

To reach this future vision of seamless European train journeys, there are multiple scenarios imaginable. I have created four different scenarios, which differ in which main actor takes the lead; the government, the carriers, a new entrant or an airline. The four scenarios are described below.

1 | The government
First of all, the European government could have a big compelling role. We have seen an example of such a disruptive intervention in the telecom sector, when roaming fees ended on 15 June 2017 (cc.europa.eu). Europeans travelling within the EU countries could since then roam at no extra charges and use their mobile device paying domestic prices. Through regulations and subsidies, Europe could stir or almost force the railway sector into a preferred direction.

2 | The carriers together
Secondly, the carriers could stimulate the change by close cooperation together. They need to have a shared goal and set their competition and conflicting concerns aside and prioritise the experience of the European train traveller. We have seen successful collaboration among carriers to realise the Interrail ticket. Similarly, carriers could settle on agreements to let travellers seamlessly travel across borders without any additional requirements.

3 | A new entrant disrupter
Thirdly, there could be a third party that takes the lead as a disrupter of the market. It is imaginable that new entrants like Flixtrain or Tranzer, which are young companies with fresh perspectives, are less stuck in current businesses or beliefs. They could be the pioneers of a future travel experience and be the starting point for a new rail travel ecosystem.

4 | Airline
Fourthly, because this vision aspires a future where flights within Europe are replaced by trains, it could be a business opportunity for airlines to step in. Airlines and carriers are already collaborating to some extent, by offering combined air-rail journeys. For example, Lufthansa is collaborating with DB to create more direct train connections to German airports (Lufthansa). The airline could get more involved and offer European train journeys instead of European flights. From the Dutch perspective, KLM might be interested in this as well.

The four potential scenarios are presented as very distinctive cases, but it probably will not be this black and white. The most important aspect is that the railway sector cannot change in the blink of an eye. We have learned in chapter 3 that the international railway sector is very complex, and all stakeholders have to work together to let the system work. Therefore, it is probably going to be some sort of combination of these scenarios with multiple parties acting simultaneously.

8.1

Strategic roadmap

The path towards seamless European train journeys is visualised in the strategic roadmap (page 144). The vision is created for Europe as a whole, but I have developed this roadmap from the perspective of the Netherlands, which is in line with the scope of this project. In other words, the specific product/service is oriented on travellers departing from or travelling to the Netherlands. However, this roadmap could be adjusted and would be very similar if another European country was taken as a starting point.

Roadmap horizons and elements

Roadmap horizons

I have created a time-pacing of three horizons in between the current situation in 2021 and the future vision for 2040. The three horizons are in 2023, 2025 and 2030 respectively. This time-pacing fits the character of the complex railway sector which is normally not so fast at implementing innovations.

Roadmap elements

The roadmap elements are divided into three categories, each containing one or multiple subcategories:

- Product service
    - Scale
- Stakeholders
    - Collaboration
    - Actions
- Developments
    - Major events
    - Technology
    - Trends

Product service

Within this category, the roadmap shows how the product service (the seamless train journey) is developing in each horizon. The idea is to start small and scale up step by step.

Stakeholders

The stakeholders listed in the roadmap are the main parties that fulfil an active role to realise the future vision and create seamless European train journeys for travellers. These stakeholders are; the European Commission, local and national governments, PSO and commercial carriers, MaaS providers and travellers.

Travellers are added as a stakeholder in the roadmap as well, although they will not actively collaborate with the rest of the stakeholders. In a future vision focused on the experience of travellers, they are of course the most important stakeholder of all.

The stakeholders in the roadmap slightly differ compared to the original stakeholder map (3.1, page 26). Infrastructure and stations are left out on the roadmap on purpose because they are not the main decision-making parties in this future vision. Independent distributors are not mentioned in the roadmap either, but they could be seen as the forerunners of MaaS providers.

Developments

The developments in the roadmap are a selection of the previously collected developments on the four layers of the international railway system (3.2, page 32) and the collected trends in the future context analysis (4.1, page 70 and appendix E). Important enabling technologies are added as well.

Interconnected elements

All roadmap elements are interconnected, which is shown within the strategic roadmap by dotted lines. These interconnected roadmap elements form six separate groups. Appendix I contains a reading guide of where these groups are situated in the strategic roadmap.

1. Towards a level playing field
2. Towards the future of rail
3. From MaaS pilots onwards
4. Towards unified services
5. Towards transparent data
6. Towards smart and personal systems

The interconnected elements are explained per group in the next section of this chapter. But first the overarching idea of incremental scale increase for the product service and stakeholder collaboration is clarified.

Disclaimer covid-19

Since it is very hard to predict the long-term consequences of the current covid-19 measures on European travel, I have intentionally left these out of the strategy. The first roadmap steps should therefore be seen as inspiration of how it could go rather than an accurate prediction.

Legenda

- stakeholder action
- action by multiple stakeholders
- development
- → duration
- ····· connection

2021 – Current situation

2023 – Horizon 1

PRODUCT SERVICE

SCALE

Pilot seamless train journeys across borders in Limburg

Seamless train journeys across borders in Limburg

STAKEHOLDERS

COLLABORATION

Stakeholders start collaboration for MaaS pilots on a local scale

Local stakeholders jointly deliver the product service

ACTIONS

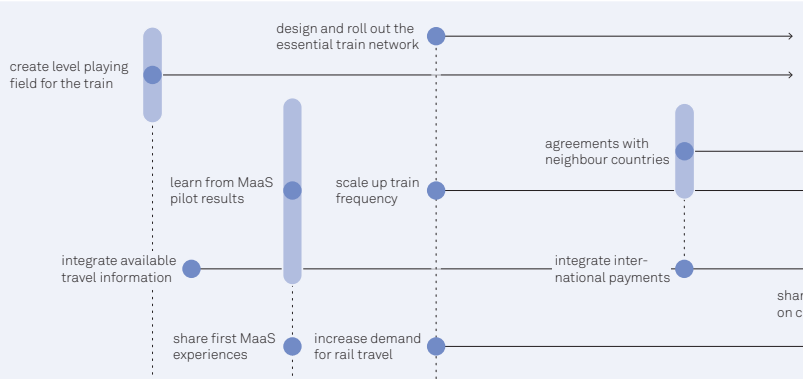
EUROPEAN COMMISSION

LOCAL AND NATIONAL GOVERNMENTS

PSO AND COMMERCIAL CARRIERS

MAAS PROVIDERS

TRAVELLERS

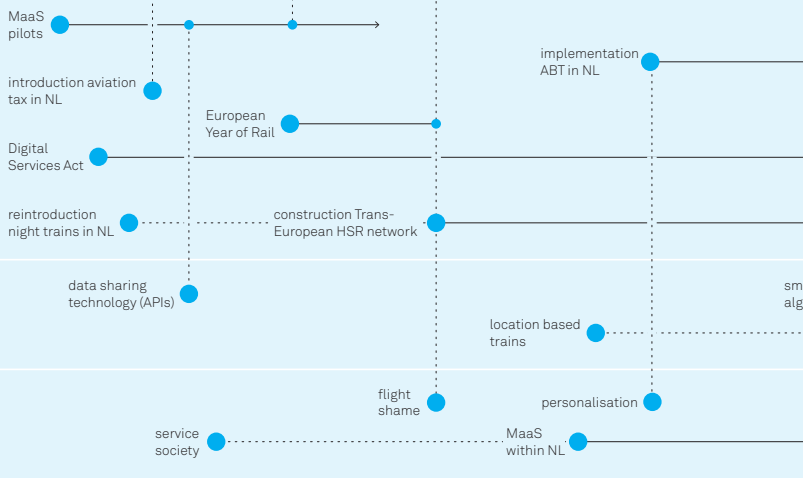


DEVELOPMENTS

MAJOR EVENTS

TECHNOLOGY

TRENDS



2025 – Horizon 2

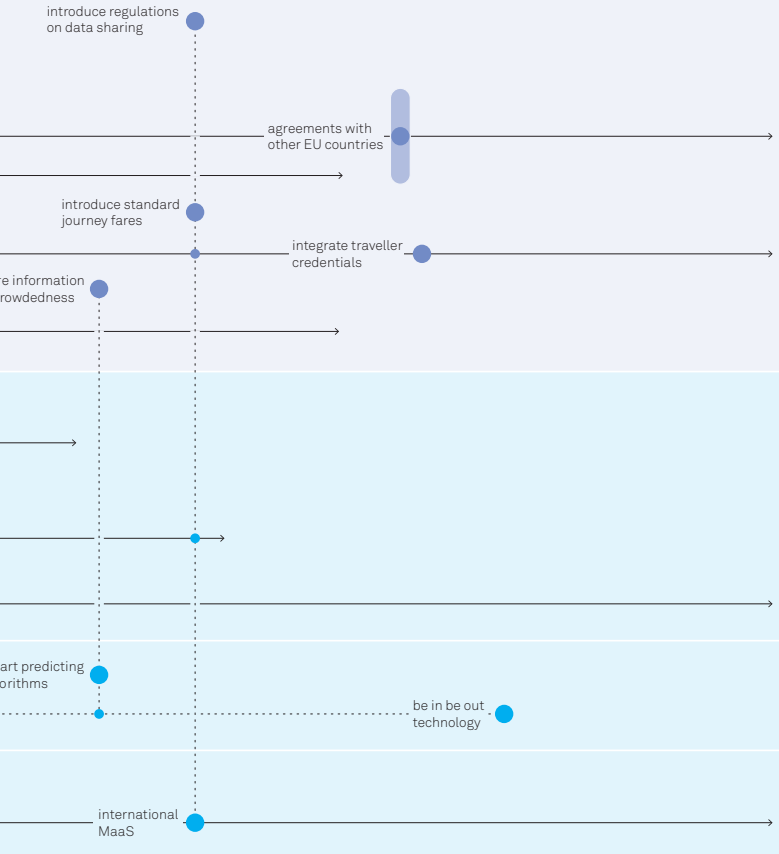
Seamless train journeys
through Germany and Belgium

More stakeholders join to increase
the product service scale

2030 – Horizon 3

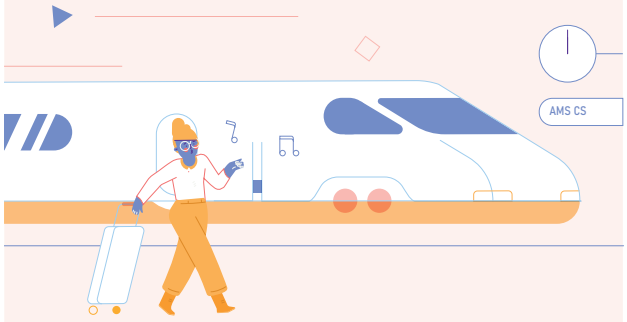
Seamless train journeys
through Western Europe

All stakeholders are part of
the European ecosystem



2040 – FUTURE VISION

Seamless European Train Journeys



Just hop on
the train

Pay as
you go

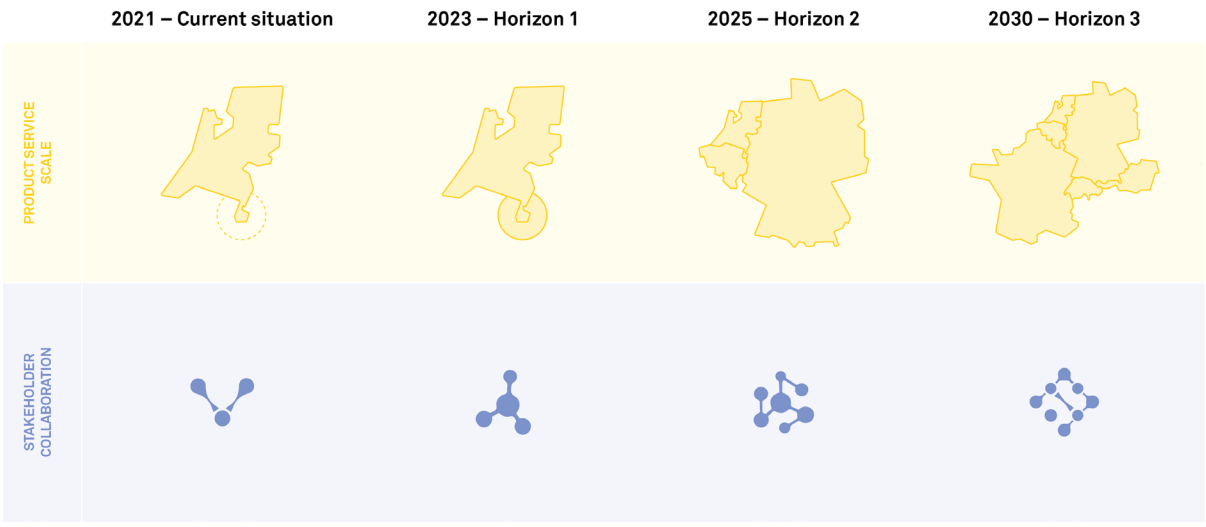
Travel from
door to door

Information on
crowdedness

Standard
journey fares

Personal travel
overview

Incremental scale increase



Product service

In this roadmap, the scale of the product service increases with incremental steps. In the current situation, seamless train journeys across borders in Limburg are experimented with in MaaS pilots. In horizon 1, these seamless train journeys across borders in Limburg should then be established.

When this service is functioning well, and local cross border party collaborations are in place, it should be doable to scale to the entire countries. It could be a next step to integrate the whole of the Netherlands, Germany and Belgium. Therefore, in horizon 2 seamless train journeys through Germany and Belgium are realised.

The next step is to add more countries. Horizon 3 proposes that France, Austria and Switserland are added, realising seamless train journeys through Western Europe. Continuing to add countries this way would result in the product service being implemented in the whole of Europe by 2040.

Stakeholder collaboration

In parallel to the scale increase of the product service, the complexity of the stakeholder collaboration increases. In the current situation, collaborations between governments, carriers and MaaS providers are started for MaaS pilots on a local scale.

In horizon 1, these local stakeholders will effectively collaborate and jointly deliver the product service around Limburg.

In horizon 2, more stakeholders from the three neighbouring countries will join the collaboration to roll out the product service on a national scale. Stepwise, more stakeholders of European countries will be added to increase the product service scale into those countries.

In horizon 3, all active stakeholders take part in a European ecosystem. This ecosystem will be expanded when more European countries join.

Within this collaboration, the European Commission will function as the facilitator of the ecosystem. Its role is a stimulating and guiding role to enable the collaboration between all European countries.

Why incremental steps?

Chapter 3 showed the complexity of the international rail travel system in Europe. With this amount and diversity of stakeholders, it would be very difficult to start collaborating with all European parties from the start. That is why it could be wise to first show proof of concept on a local scale with stakeholders that are already willing to collaborate. This proof of concept could be a good example and starting point for the rest of Europe.

1 – Towards a level playing field

The European Commission and governments should create a level playing field for the train. Especially in terms of ticket prices, rail travel does currently not have a fair position in comparison to air travel (3.4, page 56). To make European train journeys more attractive, other modalities should simultaneously be made less attractive. The introduction of aviation taxes in the Netherlands in January 2021 is a development that positively contributes to this level playing field.

Involved stakeholders:

EUROPEAN COMMISSION

LOCAL AND NATIONAL GOVERNMENTS

Roadmap elements:

- create level playing field for the train
- introduction aviation tax in NL

Contributing to:

Just hop on the train

Standard journey fares

2 – Towards the future of rail

Demand and supply go hand in hand and should be scaled up simultaneously. In order to increase the demand for rail travel among travellers, the train journey possibilities should be improved as well. The rail network and train frequency are of great importance in this. For example, the number of direct train connections can boost the demand. Direct night trains to Vienna will be reintroduced in the Netherlands by the end of 2021 (NS International). This will positively contribute to the increasing demand for rail travel. In order for travellers to also be flexible and just hop on any train, the train frequency needs to be scaled up by the carriers as well. An hourly frequency to all the main destinations is a good aim to start with.

However, it is not only the carriers who are responsible for the European rail network and train frequency. The European Commission should take an active role to design and roll out the essential rail network (Rli, 2020). It should identify the main European travel hubs and set requirements for the connections. With the construction of a Trans-European HSR network, these hubs should have fast and frequent connections.
Besides the improvement of rail network and train frequency, there are also other developments that have a positive impact on the increasing demand for rail travel. The flight shame trend causes people to deliberately choose a train journey over a flight for environmental reasons. Moreover, the European Commission has marked 2021 as the European Year of Rail (cc.europe.eu, 2020). This initiative plans to put rail travel in the spotlight to encourage more people to travel by train and contribute to the EU Green Deal goal.

Involved stakeholders:

EUROPEAN COMMISSION | TRAVELLERS | PSO AND COMMERCIAL CARRIERS

Roadmap elements:

- design and roll out essential network
- scale up train frequency
- increase demand for rail travel
- European year of rail
- reintroduction night trains in NL
- flight shame
- construction Trans-European HSR network

Contributing to:

Just hop on the train

3 – From MaaS pilots onwards

To reach the future vision where travellers can seamlessly travel by train in Europe, current MaaS pilots can be seen as an effective starting point. Especially the MaaS pilot in Limburg is interesting because it focuses on seamless border-crossing and started a collaboration with multiple countries involved (3.2, page 32). To communicate and share data in a coherent way, certain standards are created through data sharing technology like APIs. These standards are important to integrate different systems. Experiments on this local scale could generate valuable insights on how to run such a collaboration and improve the experience for travellers.

When travellers share their first experiences with MaaS, governments, carriers and MaaS providers should learn from the results together. These learnings should be used to jointly improve the product service for the travellers and enable them to just hop on the train, pay as they go and travel from door to door within Europe.

Involved stakeholders:

LOCAL AND NATIONAL GOVERNMENTS | TRAVELLERS | PSO AND COMMERCIAL CARRIERS | MAAS PROVIDERS

Roadmap elements:

- MaaS pilots
- share first MaaS experiences
- data sharing technology (APIs)
- learn from MaaS pilot results

Contributing to:

Just hop on the train

Pay as you go

Travel from door to door

4 – Towards unified services

In order to seamlessly travel across borders, a unified service should be created that lets these borders disappear. MaaS providers play an important role as they are already integrating all available travel information. A next step is to integrate international payments followed by the integration of traveller credentials. In the future vision, travellers can travel across borders and pay as they go without having to identify themselves again in other countries. In order to make this happen, neighbouring countries have to collaborate closely and come to agreements. Carriers should agree on how to serve foreign travellers and how payments are arranged mutually. Besides they should also collaborate to integrate tariffs and introduce standard journey fares. Governments should also come to agreements to better cooperate across borders.

Involved stakeholders:

LOCAL AND NATIONAL GOVERNMENTS

PSO AND COMMERCIAL CARRIERS

MAAS PROVIDERS

Roadmap elements:

- agreements with neighbour countries
- agreements with other EU countries
- integrate available travel information
- integrate inter-national payments
- integrate traveller credentials

Contributing to:

Pay as you go

Standard journey fares

5 – Towards transparent data

Since we are currently living in a service society, where we are getting used to on demand access of the services we need, it is expected that Mobility as a Service will be a big trend in the near future. This will start off on a national level but will be expanding internationally as well. MaaS will contribute to this future vision as it enables travellers to feel greater flexibility in planning their journeys.

To enable MaaS providers to integrate all travel and price information, all this data should be made available. Currently not all information is shared, since special prices are often kept exclusive for direct sales at the carriers (3.2, page 32). The European Commission should introduce stricter regulations on data sharing for a fair level playing field in the sector. The Digital Services Act is in development and will contribute to the transparency of data sharing (European Commission).

Involved stakeholders:

EUROPEAN COMMISSION

MAAS PROVIDERS

PSO AND COMMERCIAL CARRIERS

Roadmap elements:

- introduce regulations on data sharing
- Digital Services Act
- introduce standard journey fares
- service society
- MaaS within NL
- international MaaS

Contributing to:

Just hop on the train

Pay as you go

Standard journey fares

6 – Towards smart and personal systems

With the implementation of Account Based Ticketing (ABT) in the Netherlands, travellers will be able to travel with different travel tokens, like bank cards and mobile phones (3.2, page 32). This development is related to the trend of personalisation as it creates room for the traveller to travel according to his or her personal needs. With ABT, a personal travel overview of the journeys with your account can easily be checked.

Real time information on crowdedness can be shown for location-based trains and the location of travellers. With smart predicting algorithms, it will be possible for MaaS providers to share information on expected crowdedness as well.

In the further future, touchless technologies like Be-In/Be-Out can enable travellers to literally just hop on the train without having to check in at all. Their location can be used as input to start the journey and follow the travelled route.

Involved stakeholders:

MAAS PROVIDERS | TRAVELLERS

Roadmap elements:

- implementation ABT in NL
- personalisation
- share information on crowdedness
- smart predicting algorithms
- location-based trains
- Be-In/Be-Out technology

Contributing to:

- Just hop on the train
- Pay as you go
- Information on crowdedness
- Personal travel overview

8.2

Validation

To validate the future vision and strategic roadmap, users, stakeholders and experts shared their initial reactions. In this section I will explain the main insights from the user, stakeholder and expert validations.

User validation

To validate the desirability of the future vision, I have done nine user interviews with potential travellers. The participants differ in age and stage of life and they currently have different preferences for modality choices. Despite these variations, the participant group is not a well representation of society. Therefore, the user validation results only show qualitative insights, and no statistical conclusions are drawn.

Research set-up

During the interviews I first asked for their favourite or most recent travel journey in Europe (which did not have to be by train) to set the stage. Their experiences were used as points of reference later in the interviews. Subsequently I showed the animation movie that communicates the future vision. Interviewees then first explained in their own words what they noticed, before I repeated the six main vision elements and started asking questions. The interview guide can be found in appendix J. The main insights of the user interviews are summarized in the results section below. A short video compilation of the validation results can be found in appendix J as well.

Results

In general, travellers received the future vision very positively. All participants confirmed that this seamless way of travelling by train is something they want in the future. The vision elements are used to structure their reactions, starting with was validated as the most important vision element.

Just hop on the train

The most important vision element appeared to be that you can just hop on any train, but many other vision elements are interconnected. The travellers motioned many benefits of this experience from which some are named as followed:

- It creates a level of carefreeness
- It enables that you can just go
- It removes worries about transfers
- It reduces stress in general
- It reduces time spent on searching tickets
- It stimulates spontaneity

Travellers can be more relaxed during their entire train journey as they do not have to worry or stress about booking the right tickets or catching the right train anymore.

> "[I would experience] less stress that you need to catch that specific train, because you can take the next train afterwards." – participant 9

Also, it could enable all travellers to be more flexible if this way of travelling would be implemented as the general train journey.

> "There are many fun and spontaneous things in life that you would like to celebrate with each other. It's a pity if you have already pinned out everything or must pin out because you have to live on a small budget each month." – traveller 6

Standard journey fares & pay as you go

In order for travellers to just hop on the train, standard journey fares play a big role. The participants are very enthusiastic about these fixed prices as it is currently experienced as a barrier to book a last-minute train.

> "I really like that the prices here are always the same, that you just know where you stand." – participant 8

These standard journey fares are validated to be essential for giving travellers trust in paying as they go. If you pay as you go travellers don't want to face any surprises in prices.

> "If you know that the most expensive route costs 80 euros … and you know that it cannot just go from 80 to 100 overnight, then you can also travel much more relaxed with a pay as you go concept." – participant 2

Travel from door to door

If we want to convince more travellers to take the train, the vision element of travelling from door to door is very beneficial, because it really one of the strengths of rail travel: that you can reach all the little destinations in Europe as well.

> "Because now we have to go to Bucharest by plane and then you have to take a car for another 3 hours. And I think that you can get to your destination a bit easier with trains." – participant 4

Information on crowdedness
This vision element generated contradictory reactions of travellers. Some travellers preferred to be more carefree and not pay attention to this while others would always use the information to make their decision about when to leave.

> "Yes, I would absolutely pay attention to that. Then I would consider: if I go an hour later, I do have a more comfortable journey." – participant 6

In combination with the vision element "just hop on the train" this information would enable travellers to feel in control about the flexibility.

> "Maybe you could have said: 'Oh then we don't go on Saturday but on Friday or on Thursday night because it is less busy then.'" – participant 1

Personal travel overview
From the user validations it appeared that the personal travel overview is a rather logical or essential element but not the most desirable part of the travel experience. Nevertheless, one interviewee mentioned that it would be very handy to have this overview to send as an invoice to your employer after your journey.

Critical remarks

> "What I would be curious about is how it works with whether or not to reserve and how sure you are of a place on the train that you can sit." – participant 4

It was already mentioned in a preliminary evaluation on desirability (page 135) and here again the main reason not to travel like this is the insecurity about a seat. Many travellers want to have a guaranteed feeling that they will be able to sit. This is of biggest importance for the two traveller attitudes on the reliability side: the deliberate planner and comfort seeker.

> "When you travel and you really have to be there at a certain time, a business trip or something, then I would like to have some kind of sitting guarantee or something… Doesn't necessarily have to be a seat number, but that you have some sort of proof that you are allowed to sit." – participant 1

In order to let this future vision be desirable by all travellers, the new system needs to be so reliable that travellers can trust that there will always be a spot for them. It is also worth considering adding the possibility of reserving a seat (last minute), without having to book a ticket. This aspect is recommended for further development (page 166).

Evaluation on design goal and criteria

The design goal of this project was formulated as followed: *Design a travel experience that makes the international train journey as easy as air and car travel and puts the train as default option for European travel.*
The four design criteria were: flexibility, seamlessness, controll and enjoyment.

During the user validations, travellers confirmed that this travel experience would make it easier to take the train and that they would therefore take the train more often.

> "It would also be much easier for me to travel, because a train is much more accessible." – participant 8

> "If there was such a system that is just easy to find, I would really take the train much more often." – participant 1

Every traveller that chooses the train more often is another step in the direction of the train becoming a more default option for European travel. The train must at least become the default option within the selected impact area (figure 18, page 57).

> "You could say within a certain number of kilometres, then it just has to be cheaper, more comfortable to go by train by definition." – participant 6

From the user validations insights I summarized the evaluation on design goal the in an overview. Figure 35 shows an overview of which vision element contributes to which design criterias.

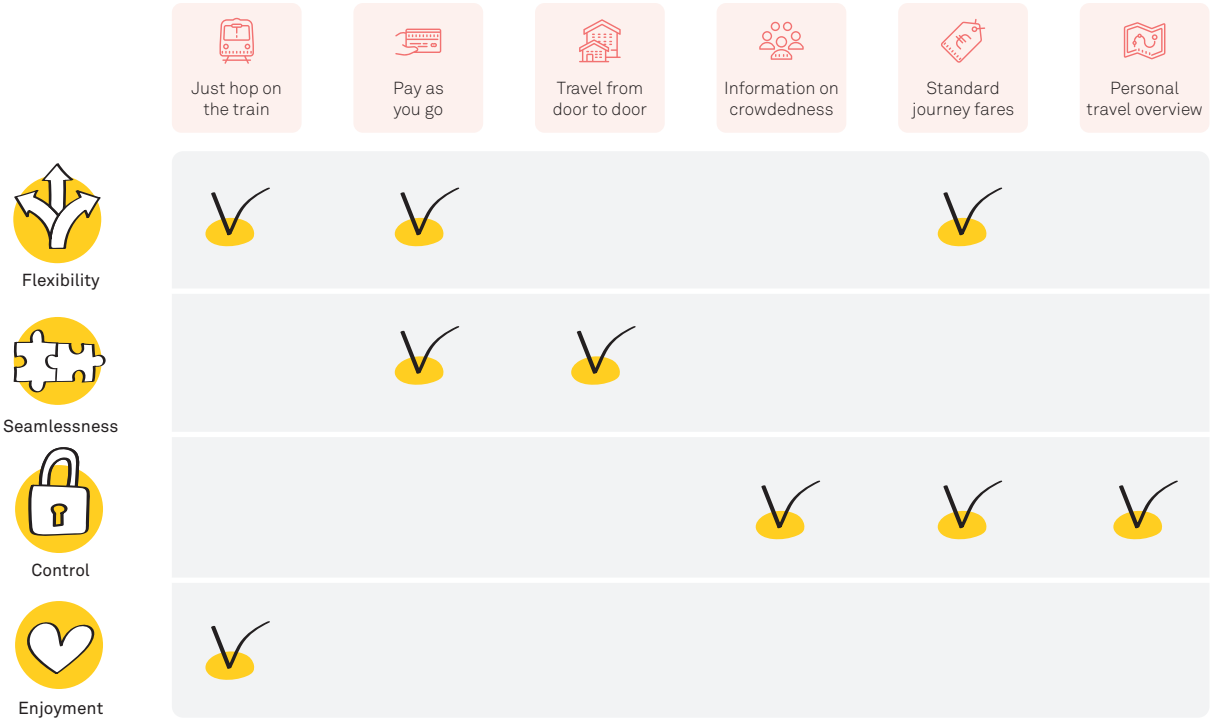


Figure 35: Overview of evaluation on design criteria

Stakeholder validation

The future vision and strategic roadmap were validated with the stakeholders in separate interviews. First, I showed the animation movie of the future vision and subsequently I explained the steps of the roadmap. The interview guide can be found in appendix J.

Future vision

Not only users, but also stakeholders are enthusiastic about this future vision. In 2040, this is what the future of European train journeys should look like.

> "If intelligent systems can solve the problem of crowdedness and no reservations, then this would be the ideal vision on international train journeys. One platform, one system. That is where you actually want to go. I think that many barriers that travellers are still facing will be removed like this." – UX designer, NSI

It is also mentioned that it will be difficult to create a service platform that fits to everyone's preferences, especially with all the cultural differences in Europe.

> "Maybe you have one supporting infrastructure platform, but you can differentiate the service for each country on the cultural differences and traveller needs." – UX designer, NSI

It is crucial for the adoption of travellers that their preferences are met. For example, Germans are expected to be more reliability-oriented and prefer to reserve a seat for international trains.

Scale increase

The choice to gradually increase the scale of the product-service has been validated by most of the stakeholders. The scaling steps are seen as a logical idea and a smart way to also gradually increase the complexity of collaboration. Besides the MaaS pilots in Limburg, NSI is already collaborating with NMBS for cross-border subscriptions.

> "It is hard to tag along other countries in the same way of working. So, it is helpful to start a good example yourself with your neighbour countries (with whom you are already collaborating) and to scale up afterwards. And then to see if you can become dominant in the rest of Europe." – IenW

However, it is questionable if this step-by-step approach is also the most desirable for the traveller. In this roadmap, it will only be in 2030 that travellers can seamlessly travel further than neighbour countries. The train might sooner become an attractive alternative when you start with a more exciting proof of concept of seamless European train journeys.

> "You might want to prove within a certain kilometre range, or on a certain route, that travellers are able to have this flexibility, speed and standard fares on their journey." – UX designer, NSI

We could take a longer route, like Amsterdam to Barcelona via Brussels and Paris, and establish a seamless experience on that route. A proof of concept like this would consequently have a bigger PR value than a seamless experience in Limburg. The reintroduction of the direct night train to Vienna could also be a first step in the increase of awareness among travellers.

Nevertheless, it is important to focus on the local and regional networks as well, and not only on connecting the European capitals. It is a strength of rail travel that you can travel to all the little villages as well. It would therefore be interesting to run local pilots and a European proof of concept in parallel.

Stakeholder collaboration

The collaboration between different stakeholders is seen as one of the biggest bottlenecks in this strategic roadmap. A collaboration among more than two countries has always been hard but may become easier if new countries can join existing collaborations. However, the responsibilities become scattered and it may be difficult to manage the ecosystem. NSI mentioned another approach, namely, to form a strategic project team that formulates a shared vision from the start.

> [redacted]

Such a project team should then be formed with all different stakeholders included, for example not only NS and the PSO carriers from the Railteam alliance (page 37). The

government questions the willingness to collaborate for carriers and MaaS providers. Carriers are each other's competitors and they do not want to share all their price information yet.

> "The one MaaS provider might have a better deal with Eurostar than the other MaaS provider. In the end you will always have the effect of market forces." – Sr. policy officer, IenW

The friction between incumbents and new entrants also plays a role as concluded in 3.2, page 41. FromAtoB, one of the independent distributors, has closed down in January 2020 (ALLRAIL, 2021). In the press release it is stated that the "market dominant state rail incumbents are succeeding in killing off the independent ticketing market" (ALLRAIL, 2021).

However, carriers themselves seem to be open for collaboration with these independent providers in the future, because it will almost be inevitable that they have to collaborate to serve the future needs of travellers. For example, NSI has positive expectations about a future collaboration with Trainline that is beneficial both parties.

European ambition

All interviewed stakeholders highlighted the importance of European guidance. National and European governments should take initiative and facilitate the collaboration by setting requirements and introducing requirements. Carriers themselves admit that Europe should take the lead in guidance to realise this future vision.

> "Carriers need to get a top down policy as they will always act from their commercial objectives." – UX designer, NSI

In order for Europe to act upon this active role, there needs to be enough ambition. Currently, political concerns always seem to be a priority over the ambition. The strive for an open access market is in contradiction with the urge for a guiding governance. It is essential that the ambition to improve European train journeys gets bigger priority on the political agenda and that Europe is not afraid to take the lead.

> "We need a breakthrough on a European level." – Business development, NSI

Disrupter perspective

All the differences between countries and stakeholders make it a tough road towards successful collaboration and realising innovation. Another scenario would be that a disruption takes place by a big tech firm.

> "I can imagine that big tech companies, like Tesla or Google, are able to think along from an innovation perspective and have a more holistic vision on such a problem." – UX designer, NSI

Google maps is well-known by travellers and very powerful in making its way towards a data-driven travel platform. Payments are not included yet, but Google has big potential to realise the ultimate MaaS platform.

> "There are still too few disrupters." – Business development, NSI

Expert validation

Additionally, I have validated the future vision and strategic roadmap with two experts in separate interviews. Expert A works as an associate professor at the TU Delft and contributed to a report on the future of rail (Rli, 2020). Expert B works as consultant sustainable mobility for Royal HaskoningDHV. The meeting set-up is the same as the stakeholder validation and can be found in appendix J.

Furthermore, I did another validation during the knowledge sharing session with the SPM lab. The partners present at this session were Translink, DOVA, RET, 9292, MRDH, CROW, Rover and IenW. All graduation students had 20 minutes to present. I created a Miro board to let all those present give input on the vision and roadmap. Some of their innovative comments are included at the end of this section.

Future vision
The experts agree that this could be an ideal future for European train journeys, but the acceptation of travellers might be the main bottleneck. In this future vision the travellers will have to let go of the security of booking and reserving a seat.

> "With reservations now you experience security at the moment of booking, but a bigger insecurity when your train is delayed. In your vision there is more insecurity or stress in the beginning, so travellers need to trust the system." – Expert A

Also, they should allow location tracking during their journey. Especially in relation to privacy concerns, future research on the interaction with touchless technologies is recommended (see chapter 9).

The expert validation also showed that there are different views on the concept of MaaS. Although one expert saw this future vision as "MaaS in its ultimate form", the other expert was critical about mentioning MaaS.

> "I would call this a well-functioning travel planner, that helps you to be flexible during your journey. Especially because you removed all of the booking, it is not so much related to maaS." – Expert A

Scale increase
One of the experts confirmed that cultural differences have always hindered collaboration among more than two countries, but this may become easier if new countries can join existing collaborations.

> "It would be nice if France and Spain have a collaboration that works, and the Netherlands is also collaborating with France, that we can join the collaboration with Spain as well without having to bridge the cultural differences again." – Expert B

The experts also highlighted the importance of a basic network that should be developed with European initiative.

> "I think that the European Commission should be more active in setting out the basic connections in the market in Europe." – Expert A

In addition to this main network on a European level, larger efforts should be put into the level of local cross-border connections. A responsible entity is missing on this level, so there should really be ambition and a shared vision to improve cross-border services. The MaaS pilot in Limburg is again a good example case to test the collaboration and seamlessness of cross-border train journeys.

Additional comments by SPM lab partners

Among all the comments of the lab partners, a main point of attention lies at how payments will be arranged. There might be a need for a payment system that can be used across the entire continent. Payment service providers are thus important stakeholders that should be included in the collaboration as well. More thought should be put into how multiple carriers will receive their fair share of the income, as this will be a very complex task.

An interesting comparison was made to the banking world and how this could be of inspiration to realise my vision for European train journeys.

> "A few years ago the Single Euro Payments Area (SEPA) has been introduced, which realised seamless transactions across borders in Europe. I see many parallels that you could use in your project." – Translink

For example, European regulations have been introduced about the standardisation of the IBAN, acceptation of payment rapidity, transparency of data and European clearing houses. Similar measures should be made in the public transport sector, enabling international trains to become more seamless.

> "I think that Europe is lagging behind compared to the Netherlands. We should aim for an OV-chip card for the whole of Europe." – MRDH

Another comment was made about the context of my design vision, which showed that the vision inspired parties beyond its initially intended goal.

> "Is there a fundamental difference between seamless travel in Europe by trains and seamless travel in the Netherlands by public transport, or is that actually the same issue? I think your vision is wider applicable than just international trains." – DOVA

In conclusion

The main bottlenecks of the strategic roadmap validated by stakeholders and experts are related to:

- The acceptation of travellers
- The collaboration of stakeholders
- The realisation of the basic network
- The ambition by the EC
- The ownership of the vision

Discussion

9

In this final chapter I have drawn a short conclusion on the project and design goal. I have mentioned limitations to the research and project as well as recommendations for further development and future research.

Summary of design process

The purpose of this project was to inspire and encourage the railway sector, governments and other parties to improve European train journeys by designing a future vision for a seamless international train experience within Europe and a roadmap that amplifies this future vision. In order to reach this goal, the project was executed in five phases: deconstruction, future context, ideation, conceptualisation and implementation.

Deconstruction

During the first phase, I deconstructed the current situation of international rail travel in order to understand the ecosystem, user experience and market potential. This is done from the perspective of stakeholders in the system as well as from the perspective of travellers. In addition, I used car and air travel as a benchmark for rail travel.

Future context

In the second phase, I developed an understanding of the future context of international travel in Europe in 2040 following the Vision in Product design approach. This analysis was concluded with a statement on the future context and a framework with four distinctive future traveller attitudes: savvy navigator, explorer, deliberate planner and comfort seeker.

Subsequently, I formulated my design mission, design goal and four design criteria.

Design mission: *I want to stimulate people who travel more internationally to do so by train in order to reduce the carbon footprint of travelling.*

Design goal: *Design a travel experience that makes European train journeys as easy as air and car travel and puts the train as default option for European travel.*

Design criteria: *flexibility, seamlessness, control and enjoyment*

Ideation

During the ideation phase, I started with an interaction vision: “the magic carpet”. Building on the traveller attitudes, design criteria and this interaction vision I, led three creative sessions to generate ideas and input for the European train journey of the future. I combined ideas into three concept directions and selected the direction “no booking experience” for further detailing.

Conceptualisation

During the fourth phase, I detailed the final future vision “seamless European train journeys”, consisting of six main vision elements, and a commissioned animated video for effective communication. Additionally, I detailed the future European train journey into a customer journey map and service blueprint. To ensure desirability, I validated the future vision with potential travellers.

Implementation

During the fifth and final phase, I created a strategy for how to realise this future vision. I developed a strategic roadmap with stakeholder actions and developments, together showing how my vision could be implemented. To increase the chances of implementation, I have executed validations on the roadmap with stakeholders and experts.

Contributions

Contributions to stakeholders

This thesis provided stakeholders with a user-centred design vision on European train journeys. The experience of the traveller has always been the starting point and the guiding principle for developing the vision. Stakeholders that are dealing with all the current barriers sometimes seem to forget to focus on the traveller experience.

Additionally, the thesis adopted a holistic approach by designing a solution for the system as a whole rather than a solution for one specific stakeholder. The design vision therefore invites all stakeholders to step out of their own bubble and look at the problem from a holistic point of view. This contributes to their awareness of the bigger picture and the urge to collaboratively aim for the best traveller experience possible.

Contribution to knowledge

In most literature, the train is considered to be a sustainable alternative to substitute short distance flights, which results in a focus on improving travel speed for European capital connections. This thesis also emphasized the importance of local and regional network connections. To use the train to its full potential for European travel, we should not only improve capital-to-capital services to compete with the speed of air travel, but also focus on the connections to little towns to compete with the flexibility of car travel. This flexibility was therefore used as a design criteria and enabled the train to be(come) an attractive alternative for air and car travel.

Limitations

The biggest limitations in doing research have been related to the Covid-19 pandemic. I had planned to do field research and experience European train journeys myself as part of the deconstruction phase, but this was not possible with the travel restrictions in place. Moreover, I did not have the chance to observe or talk to people busy in the act of travelling. That is why user interviews were always oriented around previous travel experiences. Due to the lack of field research, I have put additional focus on literature research and expert interviews within the deconstruction phase. With the restrictions to work from home, I have also experimented with different user research methods, like executing a survey on Instagram.

Another limitation in this project has been the Dutch perspective. Since Dutch culture is not representative for the total European culture, the vision and strategy might not be replicable for all European countries. To really unify railway services across Europe, it is necessary to share a vision among the 27 countries and develop a European approach.

Recommendations

Further development

Because of time restrictions, not all aspects of the design vision could be detailed to the same level. Besides, the main purpose of this project was to create a future vision that inspires, not one that is set in stone. To further turn this future vision into a reality, some additional steps need to be taken.

First of all, more thought should be put into how a system can work when all travellers can just hop on any train. Sitting guarantee is important for travellers if they are no longer able to make seat reservations. Travellers might get used to a new system if they can trust that the system will always take care of them. The tension between flexibility and reliability needs to be balanced to satisfy all traveller needs.

Secondly, the potential new business models for carriers should be further developed. In order to introduce standard journey fares, carriers need to introduce a new business model where yield ticketing is removed. You could think of business models with some forms of subscription, like certain kilometre credits, or specific propositions for traveller types, like business or leisure travellers.

Thirdly, it should be further developed how a European system will work at the digital back end. The different roles and tasks of MaaS providers and payment service providers should be clarified. For example, an automatic revenue division among carriers should make sure that everyone receives its fair share of the price.

Fourthly, I recommend to further develop a more attractive proof of concept in parallel to the MaaS pilots and incremental increase of collaboration. This could be done by realising the ultimate seamless train journey on a popular European route, like Amsterdam – Barcelona. To effectively realise this idea, a strategic project team and European subsidy might be needed.

Future (graduation) projects

This project was executed within the Seamless Personal Mobility Lab, in which there is room for new (graduation) projects to be executed. Since this design vision touches upon many elements on a rather general level, there is opportunity to dive into one of these elements more specifically.

An example of an element suitable for such a project is Be-In/Be-Out technology. I have mentioned this touchless technology as part of my future vision, but little is known about the willingness of travellers to travel like this. Especially privacy concerns of sharing your location seem to play a role in this adoption. A future project could be to research the preferred user interaction with this technology.

Another future project could be to focus on the accessibility of international MaaS products. If seamless European train journeys are realised by digital platforms, these should be accessible and easy-to-use for everyone.

Conclusion

Seamless European train journeys

The final result of this project is a future vision for seamless European train journeys. It envisions a future where travellers can just hop on any international train and travel across borders without having to arrange a thing. Travellers can pay as they go because their location is continuously updated behind the scenes. By integrating all travel information and transport options, they can plan and travel from door to door. When planning their trip, they will find reliable information on expected crowdedness to decide their departure time. Standard journey fares enable you to check the costs in advance, so there are no surprises along the way. Finally, at the end of their journey, they can check their personal travel overview.

This future vision successfully addresses the design goal; to design a travel experience that makes the European train journeys as easy as air and car travel and puts the train as default option for European travel. User validations confirmed that with the new service proposition, travellers would experience less barriers and be motivated to take the train in Europe. Therefore, my design mission to stimulate people to travel by international train more often to reduce their carbon footprint of travelling, could be achieved if the future vision becomes a reality.

A strategy to implement the future vision was detailed in the strategic roadmap, which shows the actions that need to be taken. Stakeholder and expert validations confirmed that the roadmap shows a logical increase of scale and stakeholder collaboration but also identified bottlenecks that could hinder the implementation.

In conclusion, the future vision and strategy that are developed in this project, contribute towards the purpose of the thesis to inspire and encourage the railway sector. The future vision inspires the stakeholders with a long-term perspective for seamless European train journeys and the strategy encourages them by showing concrete actions to implement the future vision.

It is hoped that the vision and strategy detailed within this thesis will inspire Europe to start taking action and to make the transition towards more sustainable transportation.

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Appendices

A. Graduation brief

DESIGN for a future

TU Delft

IDE Master Graduation

Project team, Procedural checks and personal Project brief

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

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

USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT
Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

STUDENT DATA & MASTER PROGRAMME

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

family name	van Overhagen
initials	L given name Laura
student number	4361946
street & no.	[redacted]
zipcode & city	[redacted]
country	[redacted]
phone	[redacted]
email	l.vanoverhagen@student.tudelft.nl

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

IDE master(s): ( ) IPD ( ) DfI (x) SPD

2nd non-IDE master: _____

individual programme: - - (give date of approval)

honours programme: ( ) Honours Programme Master

specialisation / annotation: ( ) Medisign ( ) Tech. in Sustainable Design ( ) Entrepeneurship

SUPERVISORY TEAM **

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

** chair	Suzanne Hiemstra-van Mastrigt	dept. / section:	SDE/MD
** mentor	Bart Bluemink	dept. / section:	DOS/MOD
2nd mentor			
organisation:			
city:		country:	

comments (optional): The graduation project will be part of the Seamless Personal Mobility Lab (SPM-Lab), part of the Delft Design Labs.

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

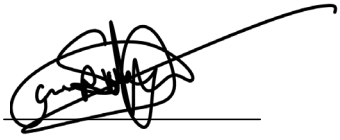
Second mentor only applies in case the assignment is hosted by an external organisation.

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

Procedural Checks - IDE Master Graduation

APPROVAL PROJECT BRIEF

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

chair Suzanne Hiemstra-van Mastrigt date 09 - 09 - 2020 signature 

CHECK STUDY PROGRESS

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

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

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

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

YES all 1st year master courses passed

NO missing 1st year master courses are:

name _____ date - - signature _____

FORMAL APPROVAL GRADUATION PROJECT

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

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

Content: APPROVED NOT APPROVED

Procedure: APPROVED NOT APPROVED

comments

name _____ date - - signature _____

Design Vision for European Passenger Railway Services — project title

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

start date 24 - 08 - 2020 — 29 - 01 - 2021 end date

INTRODUCTION **

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

Because of increasing concerns regarding the environmental impact of air travel (vliegschaamte), in the near future international train travel may become an increasingly popular mode of transport for journeys within Europe. There already seems to be an increasing (returning) interest, both for high speed rail connections as well as for international sleeper trains. For example, Eurostar recently introduced a new high speed rail service from Rotterdam to London (see image 1). This comeback may hopefully be accelerated through Covid-19, since people seem to think more conscious about their travels.

However, current international rail services are not an integrated and supported experience from start to finish. That's one of the reasons why air travel is quite often a more often used mode of transportation. Booking and comparing flights is experienced as easy and understandable, while ticketing for the same destination by train can be so complicated that special companies have to do this for you. Also the journey itself comes with more difficulties when accomplished by train. Moreover, rail travel is often much more expensive, since budget airlines compete with extremely low priced flights. Image 2 shows a comparison of the journey to a similar distination by air and rail travel.

In order to reach this desired shift from air to rail, a European approach is needed to create a seamless experience for international railway passengers. The projected stakeholders are the Ministry of Infrastructure and Water management, NS international and Pro Rail.

The Four Country Platform for Cross Border Passenger Railway services is a collaboration platform with the four ministries responsible for travel and/or mobility from Germany, Belgium, Luxemburg and the Netherlands. They are interested in a European approach that bridges the distinctions between national and international rail services. The current railway sector is mainly focused on operating from a national point of view, which is a limiting factor for seamless cross border travel. According to the Four Country Platform, the most important issues to act upon are adequate services for the international rail passengers, seamless travelling and more specific ticketing (Four Country Platform for Cross Border Passenger Railway services, Final report and recommendations, October 2019). However, a future vision and clear call to action, to inspire and encourage the railway sector to improve cross border passenger services, are missing.

The graduation project will be part of the Seamless Personal Mobility Lab. The SPM-lab explores concepts of future personal mobility in collaboration with public and private partners. Rosa Hendrikx will start a graduation project related to this topic at the SPM-lab at the same time. Her project "Seamless Plane-Train Transfers" will focus on improving transfers from plane to train. Large European airports, like Schiphol Airport, could function as travel hubs connecting air and rail services. Especially for short distance travel within Europe, there is big sustainable potential to make the shift from air to rail. When short flights will be replaced by international trains, more combined journeys will happen.

Finally, this project has some limitations to keep in mind. Conducting field research can be more restricted due to Covid-19. Additionally, doing user research, for example through interviews and creative sessions, might only be possible via online tools.

space available for images / figures on next page

introduction (continued): space for images

image / figure 1: Eurostar provides high speed rail services from Rotterdam to London since April 2018

image / figure 2: Comparison journey from Amsterdam to Copenhagen by plane and train

PROBLEM DEFINITION **

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

The problem experienced by travelers is that current international railway services are not an integrated and supported experience from start to finish.
Some examples of more specific problems that travelers experience are listed below:
- Connections and transfers are far from seamless
- Distinctions exist between national and international services
- Passengers have difficulties with ticketing and payment options

Cross border rail services should be the first choice for international travellers, attracting customers by quality, ease of use and always available at a reasonable price.
This project explores the future of international railway services and delivers a solution that enhances a more seamless travel experience. The project is scoped on international rail services within Europe, with a more specific focus on the Dutch railway sector and the other countries of the Four Country Collaboration Platform.

ASSIGNMENT **

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

Develop a design vision for a seamless international rail travel experience within Europe. To amplify this future vision, create a roadmap illustrated through a product-service concept.

I will first deliver a deconstruction of the current international rail services, understanding the current situation, the stakeholders and the traveler's experience. Besides, a small deconstruction of the current air travel services is done as comparison and for inspiration to improve international rail services.

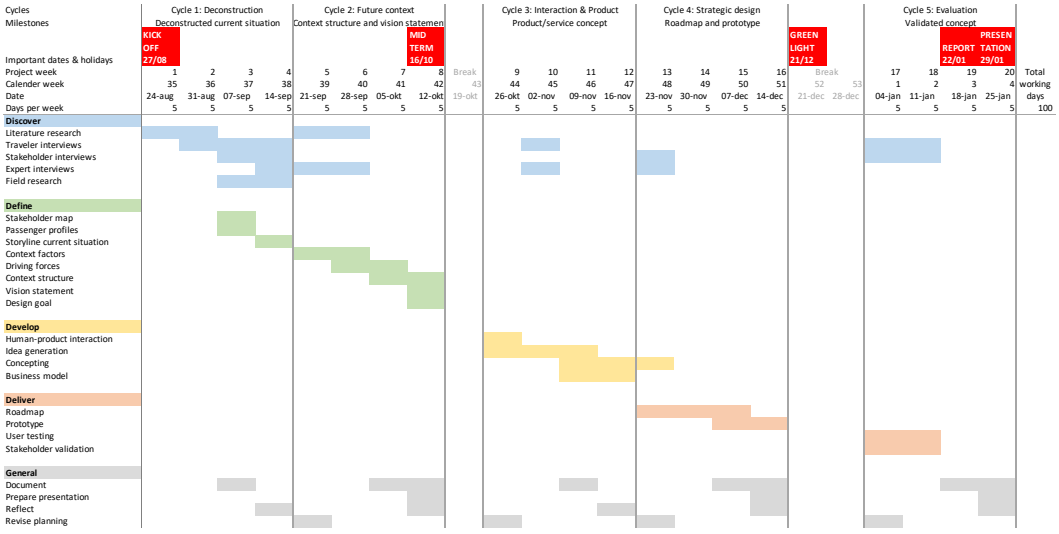
Then I will illustrate a possible future context to inspire and encourage the railway sector to improve cross border passenger services. Besides literature research, experts are consulted to collect context factors to form this future context.

I finally aim to deliver a strategy how to get to this future context, illustrated through a product-service concept. This could for example be an international travel planner or ticketing and payment system.

PLANNING AND APPROACH **

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

start date 24 - 8 - 2020 29 - 1 - 2021 end date



The project is planned for a total amount of 100 working days over a time span of 23 weeks. *This is 20 project weeks plus 3 holiday weeks.* No time is spent on the project in calendar week 43 after the midterm meeting and in week 52 and 53 after the green light meeting.

The planning is divided in 5 cycles that each have a certain milestone to achieve. Throughout the project, elements of the Vision in Product design approach (ViP) will be used.
1. Deconstruction | current situation European Passenger Railway Services (& benchmarking air and car travel)
2. Future context | vision
3. Interaction & Product/Product-Service
4. Strategic design | stakeholders & actions in roadmap
5. Evaluation | concept evaluation (users & stakeholders)

MOTIVATION AND PERSONAL AMBITIONS

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

To let people change their behaviour, and take less flights, railway services should form an equally attractive alternative. I set up this project because I like to help my part in making the shift to more sustainable modes of transportation. I believe that international rail travel has great potential and deserves more attention and innovation.

Some competences I want to learn during this project are:
- reflecting on my work: looking back and forth and staying open minded to be critical.
- filtering information: quickly understanding what is and what's not important or relevant to the project.
- setting boundaries for myself: I tend to be a bit of a perfectionist, so I need to be more realistic in when something is good enough.
- iterating on ideas: don't be afraid to take initiative and share unfinished ideas in the group or iterate on other's ideas. The weekly Mobility Lab meetings are a good place for this.
- strengthening my experience with the Vision in Product design method

I have yet developed some competences that I will use during this project:
- listening to people: I like to collect information through interviews and hear people's stories.
- commitment to a project: especially towards the end I am dedicated to bring the project to a good result
- eye for detail: I am a finisher

Beside the competences I would like to learn and further develop, I have two personal ambitions that I would like to address in this project:
1. Being confident in running and planning an individual design project. Besides the Final Bachelor Project, I have mostly work in project teams. I am curious what it will be like to work individually for 20 weeks and be responsible for all project aspects.
2. Sparking inspiration in a big organisation. The railway sector is very large and does not change overnight. With this project I hope to somehow inspire stakeholders like NS international or the Ministry of Infrastructure and Water management to improve the international rail travel experience.

FINAL COMMENTS

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

Colophon

Student
Laura van Overhagen did her Bachelor of Science in Industrial Design Engineering at the Delft University of Technology. This report is her graduation project for the Strategic Product Design master degree.

Academic Supervisors
Suzanne Hiemstra-van Mastrigt studied Industral Design Engineering (BSc and MSc) at Delft University of Technology, with a specialisation in automotive design. She has performed her PhD research project at TU Delft, faculty of Industrial Design Engineering, on the topic of 'Comfortable passenger seats'. Curently she is the director of the Seamless Personal Mobility Lab.

Bart Bluemink, also an alumnus of the faculty of Industrial Design Engineering at Delft University of Technology. He has a diverse background with experience as a project manager in developing consumer products, as well as founding a strategic design consultancy. Currently conducting his PhD research in the field of servitization.

Project
This project received project funding for Public-Private Partnerships for Research and Development (PPP allowance) from the Dutch Ministry of Economic Affairs and Climate Policy via CLICKNL.

https://delftdesignlabs.org/seamless-personal-mobility/

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


TU Delft

Faculty of Industrial Design Engineering
Landbergstraat 15
2628 CE Delft

www.io.tudelft.nl

Delft Design Labs