SEAMLESS BI-MODAL PASSENGER TRANSFERS

Combining air travel with already available, more sustainable modalities

Building Amsterdam Airport Schiphol towards a Multimodal Transportation Hub

Master's Thesis
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BASIC INFORMATION

Royal Schiphol Group (RSG) and Delft University of Technology (TU Delft) joint forces in focusing on passenger experience and the airport process. Together, they aim to take a creative and accelerated approach to develop new innovative projects and services and solve problems. TU Delft's Faculty of Industrial Design Engineering will offer and develop knowledge in strategic design, and Schiphol will serve as a living laboratory at the airports.

This master thesis is a part of the PhD research of Aniek Toet, which explores Multimodal transport hubs in the future of mobility, with a particular focus on airport hubs, at the faculty of Industrial Design Engineering at Delft University of Technology.

This project falls within the team of Master Planning, which falls within the Strategy and Airport Planning department. Strategy & Airport Planning work on the future of Schiphol. The team of Master Planning develops Royal Schiphol Group's mid-to-long-term spatial plan and investment and explores innovative ideas for the future. RSG aims to create the world's most sustainable and high-quality airport hub. They elaborate spatial initiatives in a master plan in which the future of Schiphol takes shape.

Preface

I welcome you to read my master's thesis that envelops my journey as a Master's student of Strategic product design at the faculty of Industrial design engineering, TU Delft. With this report, I conclude my time at the TU Delft. I look back on an enriching time that was the highlight of my studies. This thesis would only be complete with the support of my supervisory team, my (future) colleagues, family, and friends. I want to take this opportunity to thank them.

I want to thank my supervisory team, who has been motivating, inspirational, and a pleasure to work with on this thesis. Aniek, thank you for your enthusiasm from moment one. You showed me how to enjoy my project, and we enjoyed it together. Suzanne, thank you for your dedication to my project. You had the best for me. Your critical but constructive feedback has been valuable; I greatly appreciate it. And Klaas, your knowledge and enthusiasm helped me get the strength to lift my thesis to the next level; thanks for always being available for a conversation.

This thesis would only have been possible with the collaboration of the Royal Schiphol Group. Innovation Hub, thanks for all the inspiring conversations and your willingness to help. I am thrilled that I can stay working with such inspiring people. I also want to thank all the people that were present during my evaluation sessions. Your input broadened my knowledge and prompted my creative brain.

Family, thanks for your sincere support. Besides that, you still sometimes do not understand what I am doing, but you have always supported me.

And, of course, I want to thank my friends for always encouraging me when needed.

Because of you all, I am proud of the designer I am today.

Enjoy the reading!
Ece

Executive summary

This report contains the master's graduation thesis of Ece Rousian and concludes six months of graduation within the Royal Schiphol Group. This research uses various methods to develop and design an intervention roadmap to enhance bi-modal transfers at Schiphol airport.

Short-haul planes leaving Amsterdam Airport Schiphol (AMS) are criticized and/or disliked by many groups, including society, the government, and Actieagenda trein en luchtvaart 2020 (Rijksoverheid, 2020). Due to public opinion and political pressure, AMS is challenged to improve its sustainability. Since the airport relies heavily on hub-connected flights and has public transport nearby, integrating the buses and trains can help enhance the hub-and-spoke model of Amsterdam Airport Schiphol.

The client is investigated to understand the direction of the outcome. Internal analysis of the owner and operator of AMS, Royal Schiphol Group (RSG), revealed that the airport aims to be the most high-quality airport in the world (Schiphol, 2021). To achieve this, RSG offers commodities that are (related to) infrastructure and facilities that support this infrastructure. With this, the company mainly relies on digitally supported services. This report concludes that facilitating what is within the transfer is the responsibility of RSG as per their current expertise. Additionally, their collaborations show they are committed to knowledge exchange and new business insights, including politics, proving they are "business creators." As a result, this project is shaped around these skills.

To understand how to create seamless passenger transfers, the problem is investigated. The literature review revealed that factors influence passengers' transfer experience: information and signage, distance, ticketing services, safety and security, special services, cleanliness and maintenance, commercial services, baggage services, and environment. To achieve high quality, the passenger has to perceive these as high quality. The research revealed that the less cognitive effort a passenger needs with the factor, the more seamless the travel is. With this in mind, the status quo of AMS is understood via an explorative research approach. This graduation zoomed into the bi-modal product offered by KLM and Thalys.

The information and ticketing services must be improved for quality improvement within the current product. By looking at the offer at three comparable airport hubs, insights into the quality of factors have been gained. After an iteration of these ideas, evaluation sessions are held with internal stakeholders to make the ideas impactful and feasible. Lastly, a session with KLM is held to evaluate the ideas. The evaluation sessions are analyzed to get a deeper understanding of the ideas. The ideas are put on three horizons, each based on priority. As for implementation, the airport depends on the airlines and train operators; the strategy for success is to create a clear, quick, and easily implementable plan. To achieve this, the plan describes responsible parties. The ideas are put on three horizons, each based on priority:
1. Improvements to the current system.
2. Seizing the full potential of the current systems.
3. Changing the system

The ideas are: creating an online boarding pass, putting the departure terminal on the boarding pass, and creating a video to explain the transfer. Integrating the applications will be done, and digital wayfinding will be more feasible later.

The implementation roadmap explains the steps to create more seamless bi-modal passenger transfers. There are two strategies: either waiting for adoption or promoting adoption.

This thesis describes the process I followed for improving the bi-modal journey at AMS and concludes with an implementation roadmap, a conclusion, discussion, limitations, and recommendations.

LIST OF ABBREVIATIONS

AMS	Amsterdam Airport Schiphol
CDG	Paris Charles-de-Gaulle Airport
FRA	Frankfurt Airport
HEL	Helsinki Airport
KLM	Koninklijke Luchtvaart Maatschappij
MTH	Multimodal Transport Hub
MIenW	Ministerie van Infrastructuur en Waterstaat
NS	Nederlandse Spoorwegen
RSG	Royal Schiphol Group
ZYR	Brussel-Midi

LIST OF DEFINITIONS

Air-rail
A trip in which a train ride and a flight are combined. (Hendrikx, 2021)

Bi-modal transportation
An organic combination of two modes of transport. It captures and integrates the advantages of different modes of transportation and is an advanced mode of transportation.

Hub
An airport that connects multiple modalities and act as a main airport or station, other smaller destinations fly to this airport and connect there to other destinations (Elledge, 2014).

Modality
Means of transport, like the train, bus or plane. (Hendrikx, 2021)

Multimodal transport hub
A space in coordination and integration of different modes of transport which helps in the decongestion of roads, reduces journey time, enhances environment, offers greater convenience and easy transfer to the commuters (Chauhan et al., 2021).

Passenger
A person who is traveling in a certain modality. (Hendrikx, 2021)

Stakeholder
An organisation or person that has interest or concern in something. (Hendrikx, 2021)

Seamless
The provision of a smooth, efficient, safe, secure and enjoyable travel experience from a traveller's point of origin to a destination, within the destination, and back again (OECD, n.d.)

Transfer
Changing between modalities of travellers. This can be the same modalities or two different modalities. (Hendrikx, 2021)

Touchpoint
A point of contact or interaction between a service or business and the user. (Hendrikx, 2021)

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1 Introduction: Creating seamless bi-modal passenger transfers

This chapter describes the topic background, the challenge and task assignment that comprise the project brief. Furthermore, it goes on to detail the design strategy used to realize the project's results.

1.1 Topic background

Amsterdam Airport Schiphol (AMS) is one of the largest and busiest airports in the world. This airport handled between 40 and 72 million business and leisure travelers annually over the past ten years. The airport serves airlines that use the Hub-and-spoke model (e.g., KLM and Delta) and point-to-point carriers (e.g., Easyjet and Transavia). Flights in the category of hub connectivity are crucial for Schiphol's hub function. As its name suggests, the airlines use a hub as a transport point to the planned final destination of the journey, and several non-hub airports represent the more viable locations. A passenger departs from a non-hub airport (spoke) and arrives at the central (hub) airport, where he continues to finalize the destination (Figure 1.1) (Zgodavová et al., 2018). Thus, passengers can travel between any two cities in the network, with one stopover in a hub airport. The network of Hub-and-Spoke lines resembles the wheel of a vehicle, with several such structures in one network, where transport is concentrated on one main airport (hub). This system optimally provides air transport to various geographical areas and destinations. Numerous combinations of flights are produced by the model, leading to a significant number of transfers between such flights.

Some short-haul planes leaving AMS travel only 180 kilometers within Europe. (e.g., AMS to BRU). Many groups have already criticized and/or disliked these flights, including society, the government, and Actieagenda trein en luchtvaart 2020 (Rijksoverheid, 2020) The environmental footprint associated with airport operations has grown to be intolerable by these groups (Deloitte, 2021). Passengers want the aviation sector to operate responsibly and ensure transparency along the whole value chain (Deloitte, 2021). Concluding, AMS is challenged to improve its sustainability. To develop a sustainable business model, AMS must reduce the amount of unsustainable travel that leaves the airport hub to the greatest extent currently feasible.

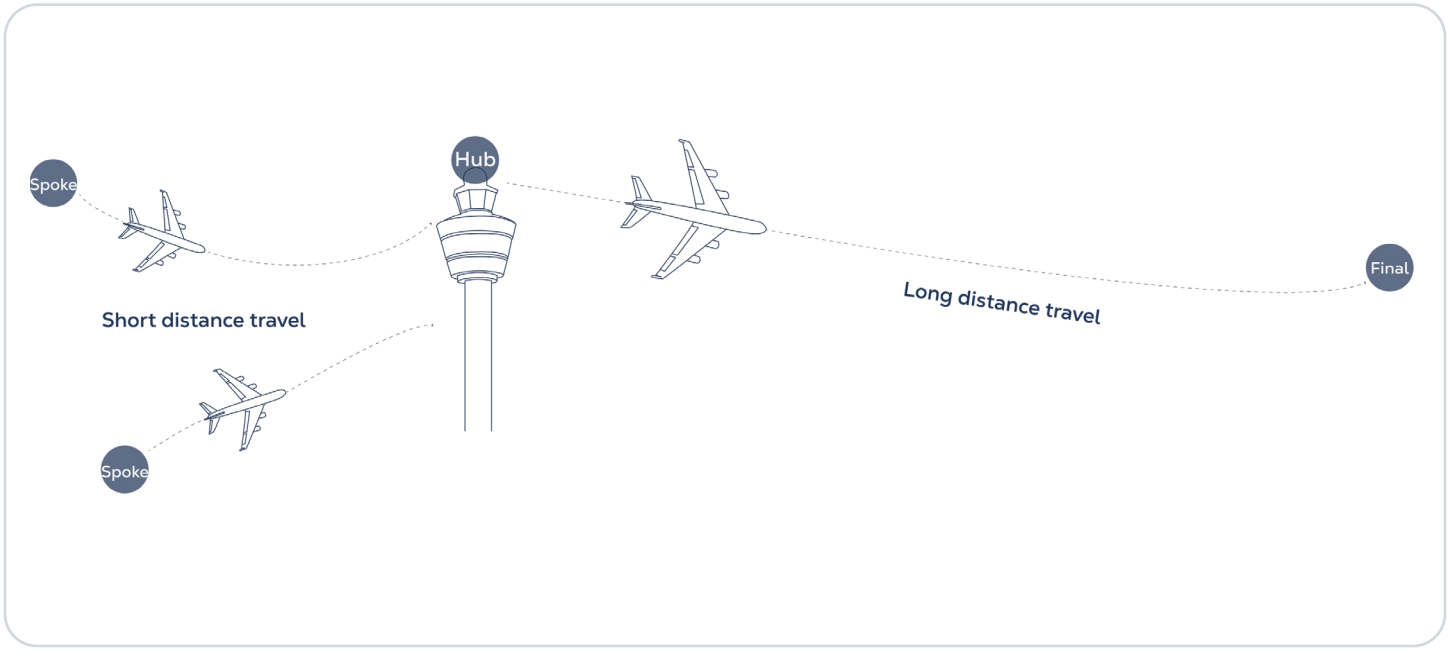


Figure 1.1: Hub-and-spoke model

1.2 The opportunity

Amsterdam Airport Schiphol is very accessible by public transportation. The buses depart close to the airport's Plaza exit, and the train passes underneath the airport's Plaza; the public transit options at the airport are conveniently close by (see Figure 1.2). 47,1 % (pre-COVID, so 2019) of the travelers came to the airport by public transport (Schiphol, n.d.).

A significant opportunity presents itself. Short-haul flights can be substituted for electric buses and trains (e.g., high-speed rail). Since the airport relies heavily on hub-connected flights and has public transport nearby, integrating the buses and trains can help improve Amsterdam Airport Schiphol's hub-and-spoke model. By incorporating these modes of transportation, it may be possible to feed the long-haul planes that depart from Amsterdam Airport Schiphol (see Figure 1.3). As a result, more efficient and sustainable travel will be offered. When airports focus on embracing alternative modes of transportation, they will be able to evolve into a Multimodal Transport Hub (MTH) (Anderson et al., 2017).

Multimodal transportation is "An organic combination of two or more modes of transport. It captures and integrates the advantages of different modes of transportation and is an advanced mode of transportation" (Huang & Mu, 2018, p. 256). Thus, it is an area which is designed to combine the services of multiple modes of transportation given to passengers at specially designated sites. Since the subject of this thesis is the integration of two modes of transportation (a train or bus and an airplane), the term "multimodal transportation" is modified to "bimodal transportation," which refers to the combination of two modes of transportation.

Entering new or improving existing markets is the way to stay relevant and/or grow as a company (Mullins & Walker Jr, 2013). The airlines are the primary stakeholder of the airport. This makes this also relevant for the RSG. RSG can investigate how they can grow their supply from public transport.

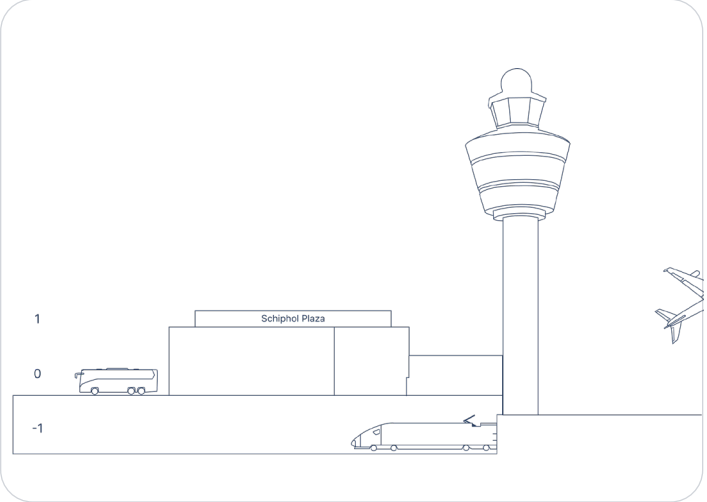


Figure 1.2: Layout of transportation at Amsterdam Airport Schiphol

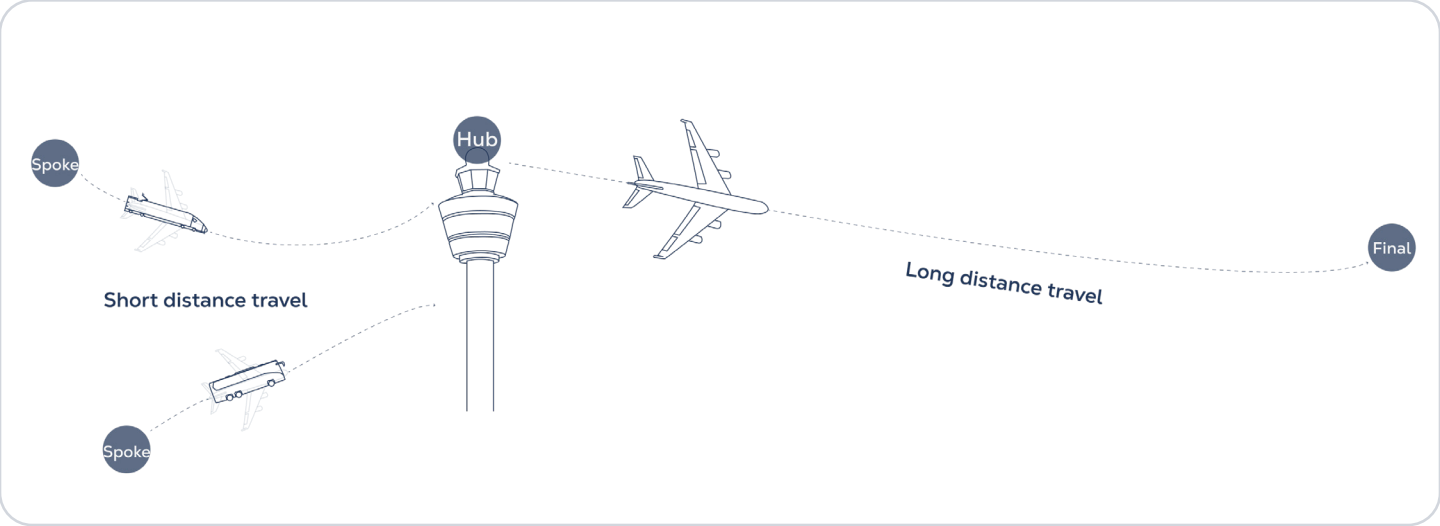


Figure 1.3: The new Hub-and-spoke model

1.3 The current bi-modal offer at AMS

Currently, only one integrated bi-modal travel option exists at AMS. In July 2022, KLM Royal Dutch Airlines (KLM) and Thalys began an Air-Rail pilot for travelers transferring between Amsterdam and Brussels. Passengers travel from the Brussel-South railway on the high-speed train to Amsterdam Airport Schiphol and fly to other places and vice versa. However, airports are currently designed to link one dominant modality, airplanes (Toet et al., 2022). AMS has not changed its current infrastructure or service components to support this integrated bi-modal transport experience.

AMS is not the first to look at integrating infrastructure and service components to facilitate more seamless bi-modal transfers. Other airports are also looking into integrating multimodal trips. Therefore, it is interesting to see what can be learned from other airports. This will aid AMS in making decisions about how to innovate.

1.4 Problem definition

Right now, there is various passenger-centric research on urban bi-modal transfers (Chaniotakis et al., 2022; Loo et al., 2020; Loo & Li, 2016), however, there is very little research that focuses on the integration of bi-modal transportation including air travel. Little is known about what is of influence during the transfer between such modes of transportation. The lack of knowledge about the critical integration factors of a bi-modal transfer including air travel is defined as the knowledge gap of this research.

Therefore, the main research question of this graduation is:

How can AMS facilitate seamless bi-modal passenger transfers?

As a result of this study, the company can learn what to include to offer high-quality transfers. This thesis will increase our understanding of the development of MTHs at airports. This project will enable a better understanding of the roles that airports play in this innovation.

1.5 Project goal

The goal of this report is to create an understanding of problem areas and concerns and the potential solution space. The goal of this project is to develop a user-centered solution to improve passengers' bi-modal transfer experience at AMS. A roadmap will be designed which will guide RSG in integrating different travel modalities to facilitate bi-modal transfers.

1.6 The research and design follow the double diamond process

In order to design a good product or service, the methodology applied in this research benefited from a user-centered approach. This integrates the needs of the users (desirability), the possibilities of technology (feasibility), the requirements for business success (viability), and the needs of society (responsibility). (IDEO, 2009)

This project uses the Double Diamond Design approach, a framework for innovation that helps designers and non-designers tackle some of the most complex social, economic, and environmental problems (Design Council, 2007). The Double Diamond Design approach was considered for this project because it clearly distinguishes the research and design phases. This is preferable because there is no defined direction for this design problem; it instead starts with a project brief. The research phase of this project is much larger than the design phase. This is due to get a comprehensive understanding of the problem. The project's research phase will deliver a design brief. This will guide in creating the final design outcome. A summarized overview of the design process can be seen in Figure 1.4.

The research phase consists of two phases. First, the client, AMS, is understood in terms of the marketing mix and vision to understand the company's strengths and weaknesses and define the quality of service AMS seeks. Second, the product is understood. A literature review is done to help understand bi-modal transfers and their characteristics. Next, a case study will be conducted to investigate the status quo of AMS. Case studies give a thorough understanding of a phenomenon and cover the "why" behind what is researched (Flyvbjerg, 2006, p. 12). Next to this, case studies at other airports will benchmark the status quo of AMS. Based on these findings, a design brief will be created.

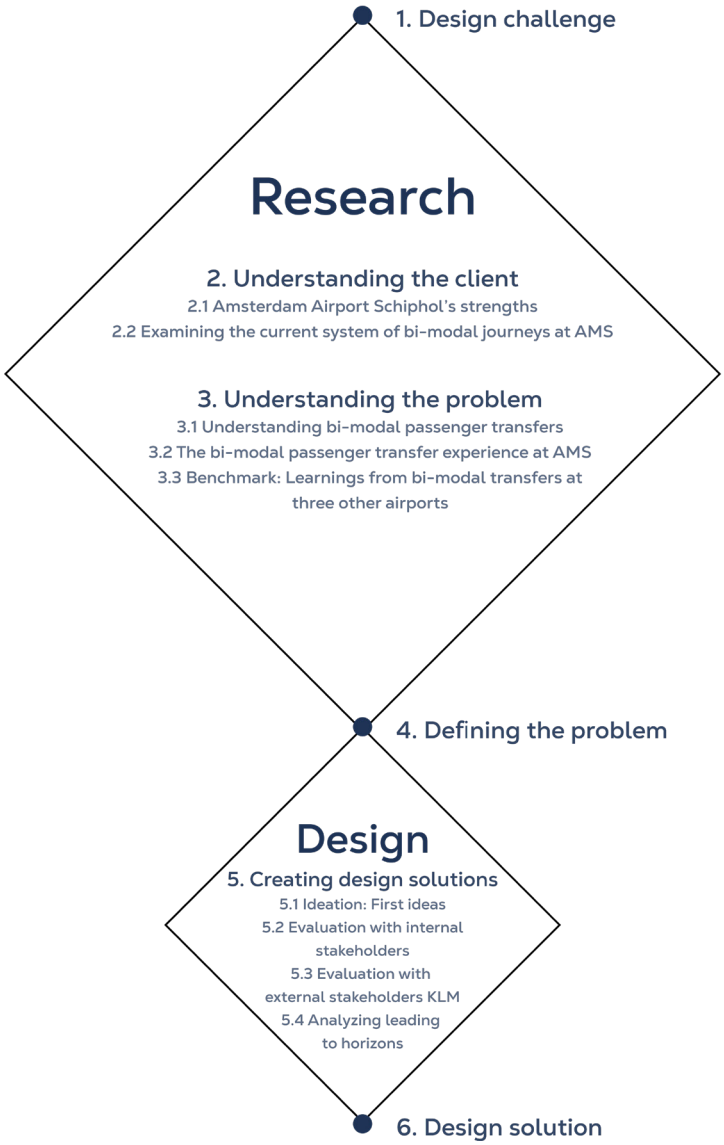


Figure 1.4: Overview of the process with corresponding chapters

The next phase is the design phase. This phase again consists of two phases: the development and delivery phase. The development phase focuses on the ideation of the design brief. Evaluation sessions are held with stakeholders from RSG to select a direction for the concept. The delivery phase involves presenting the final product.

2 Understanding the client: Amsterdam Airport Schiphol

2.1 Amsterdam Airport Schiphol's strengths

Amsterdam Airport Schiphol, including Royal Schiphol Group, is investigated in order to create an understanding of the client. This will guide in creating a design solution that fits the company. As RSG is the owner and operator of AMS, understanding its ambitions and strengths will guide when making decisions that suit RSG.

2.1.1 The marketing mix of AMS

The 2050 vision of Royal Schiphol Group (RSG) focuses on becoming one of the world's most high-quality and sustainable airport hubs. It aims to provide quality of life, network, service, and a safe and robust organization. (Schiphol, 2021). This graduation project compels to RSG as it is improving the quality of life as employing planes instead of trains will reduce air travel, where travel can remain the same. It is strategic mainly because it meets public opinion and the need of customers (both airline and passenger). However, this is not enough reasoning the shape the project. The other cornerstones of the vision will also give shape to the project.

According to RSG, the quality of service is obtained "by orchestrating smooth and inspiring passenger journeys, supported by efficient, digitally enabled airport processes" (Schiphol, 2021). This is recognizable in the following infrastructure and facilities:

- Single terminal: According to Ramakers (2022), any given point can be reached easily. Even between carriers, (air-to-air) transfers are straightforward thanks to the single terminal concept.

- Clear wayfinding (focussed on a single modality, i.e., the airport being an airport): Amsterdam Airport Schiphol has a widely praised wayfinding system throughout the airport, the best known of which is the color-coding system of signage by Mijksenaar (see Figure 2.1) (Van Beem & Van Haagen, n.d.).

- Accelerated flow: Modern technology is used for border security, customs, and check-in. (Daifuku Airport Technologies, 2020)

- Food and beverages: Amsterdam Airport Schiphol has an extensive array of dining options. (Ramakers, 2022)

Figure 2.1: Signage at AMS by Mijksenaar (Van Beem & Van Haagen, n.d)


Figure 2.2: Modern technology at AMS (Daifuku Airport Technologies, 2020)

Figure 2.3: Food and beverages at AMS (Murphy's Irish Pub, n.d.)

These facilities are leading the quality that AMS aims to provide. Next to this, future projects should also be taken into account. RSG decided that more capacity was required because the number of people using public transportation has greatly expanded over the past ten years (Projectmanager bi-modal transport RSG, personal conversation, 3 November 2022). Additional improvements to make a more spacious and high-quality hub are being designed. To do this, they have created the "Multimodale Knoop Schiphol" project, which comprises five smaller projects that all contribute to developing enough capacity (see Figure 2.4).

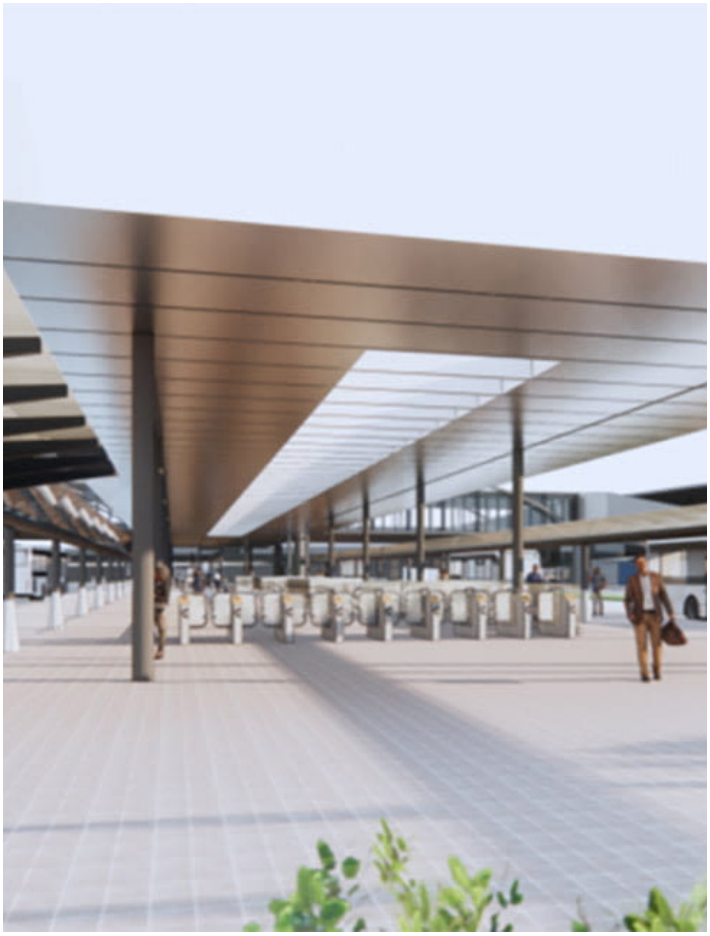


Figure 2.4: Multimodal Hub Schiphol at AMS (Schiphol, n.d.)

One of those projects is that they will build a new bus platform because they believe it will give passengers more space and comfort. (Schiphol, n.d.)

The current marketing mix gives requirements for this project. The cornerstones tell us that it is essential to keep the Quality of Service to remain the first choice of the passengers and airlines (which also have the quality of service as a primary driver). They try to achieve this by improving their infrastructure, customer services, and wayfinding in a sense where the passenger has the most convenience. Next to this, commercial services are created to represent luxury. Looking at and concluding the cornerstones of the bi-modal development, AMS should create a seamless journey with a high-quality passenger experience that feels healthy and safe for all. While designing future concepts, the "Multimodale Knoop Schiphol" project should be considered since MHS results in a far more calm and spacious environment.

2.1.2 Domain and business landscape

Schiphol Group's Dutch airports are the Amsterdam Airport Schiphol, Rotterdam The Hague Airport, and Lelystad Airport, and has a majority stake in Eindhoven Airport (Schiphol, n.d.). Next to this, RSG is an international airport operator. An overview of their business domain can be seen in Figure 2.5. They are internationally active to strengthen their position as an international hub and airport operator. (Schiphol, n.d.).

RSG's shareholders are all public authorities (national and regional), so RSG primarily has a public task. There are two missions that RSG performs: the heavily regulated sport (handling aircraft, in which they have a monopoly) and the commercial branch of sport (where they compete in the world market, which works on commerce and foreign investment). This "dual-till" makes them politically influenced as well. (Projectmanager bi-modal transport RSG, personal conversation, 3 November 2022)

The business divisions of RSG are Aviation, Schiphol Commercial, and Alliances & Participations (Schiphol , 2021). Next to investing in infrastructure and facilities, the airport charges, and Schiphol Commercial generates turnover (by renting the commercial services to Starbucks, Burger King, etc.). At the same time, the global

reach is strengthened by their regional airports and international alliances and participation. When we examine these business divisions more deeply, we see two things. First, RSG is investing to achieve technological advancements. Second, they strongly believe in collaboration across the aviation industry (Schiphol, n.d.).

When one examines those above, at first glance, it appears that RSG is a "facilitator of flights." However, when one examines this more closely, it can be seen that they offer commodities that are (related to) infrastructure and facilities that support this infrastructure, making it evident that they are "facilitators" rather than just "facilitators of flights." Due to this, looking at the bi-modal journeys, facilitating what is within the transfer can be seen as the responsibility of RSG as per their current expertise. Additionally, their collaborations show that they are committed to knowledge exchange and new business insights, including politics, proving that they are "business creators". As a result, this project should be shaped around these skills.

Figure 2.5: Business domain of RSG (Schiphol, n.d.).

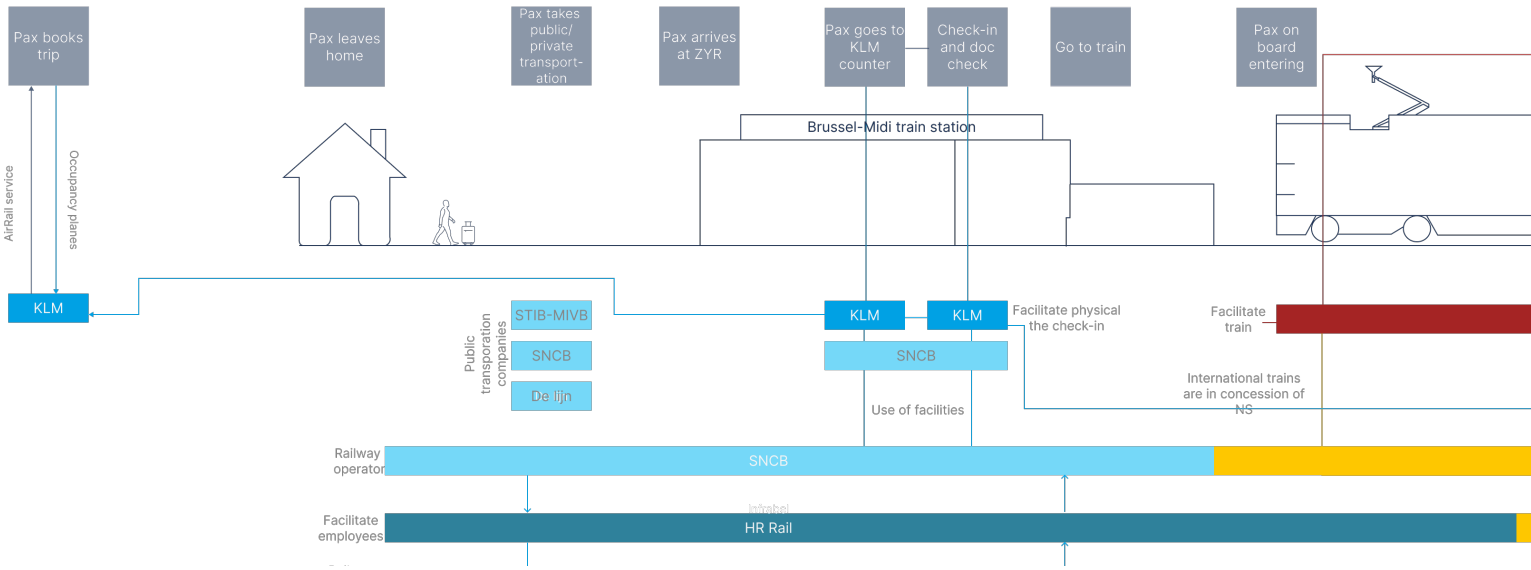
2.2 Examining the current system of bi-modal journeys at AMS

The currently available bi-modal product at AMS will be looked into in order to get an understanding of the role of the client. An overview of the insights is provided in this chapter.

For AMS, the main benefit of offering seamless bi-modal transfers is that it adds value because the company has the mission to become the most sustainable, high-quality integrated airport hub (Projectmanager bi-modal transport RSG, personal conversation, 3 November 2022). Long-term, more travelers, and therefore also airlines, would prefer this airport, which will eventually increase revenue.

The stakeholders involved in the current bi-modal journey of the pilot of KLM are shown in Figure 2.6. The Ministry of Infrastructure and Water Management (IenW), Amsterdam Airport Schiphol, ProRail, KLM, and NS are the parties who actively aim to promote the choice of international trains on medium distances (up to 700 kilometers) (Rijksoverhied, 2020). The parties may have set the same goal but have different interests. The interest streams are summarized in Figure 2.7. This figure shows the actively involved parties. However, if you zoom into this innovation, it has even more complex due to the involvement of even more stakeholders. This figure only captures a part of the complexity of this innovation. (Rijksoverheid, 2020)

This complexity is further understood during a co-creation session at Delft University of Technology. KLM, together with a graduate student from the Seamless Personal Mobility Lab (Fiona Taniguchi) and the company Beautiful Lives organized this co-creation event. The session revolved around the future baggage system within the air-rail journey. Several professionals were present among the stakeholders. The difficulty of working together due to the different interests came to light. However, looking at the conversations within this session, this process can be more straightforward when the stakeholders take more ownership. Parties are looking at each other to innovate, and the stakeholders should take responsibility for what they can do to innovate, whether or not it directly involves their business. Therefore, with RSG's strengths described in 2.1.2 in mind, they can take responsibility for communicating and stimulating the outcomes of this research. KLM can take responsibility for communicating and stimulating the outcomes of the research of Fiona Taniguchi and Beautiful Lives.



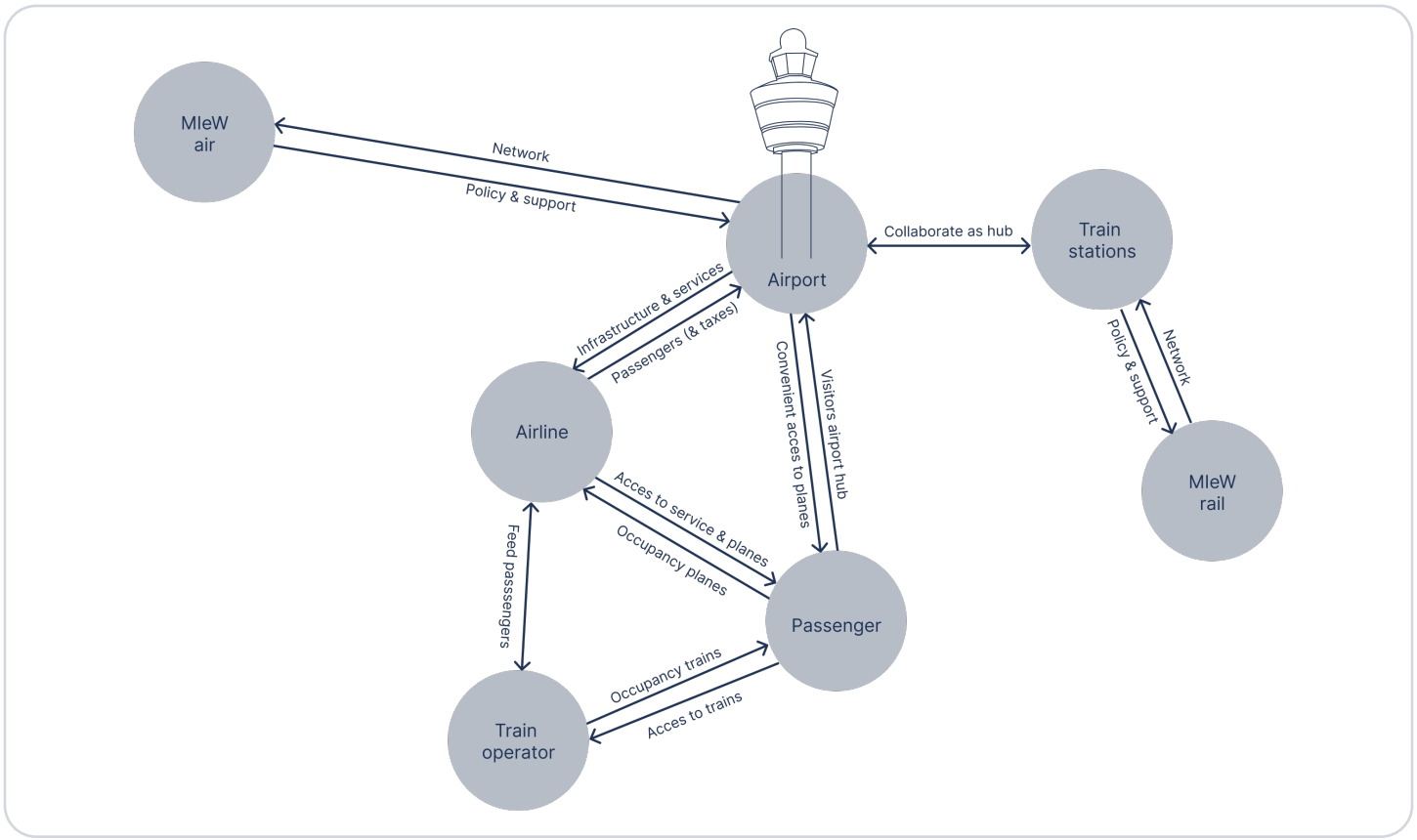


Figure 2.7: Interest streams between the bi-modal journey which transfers at AMS

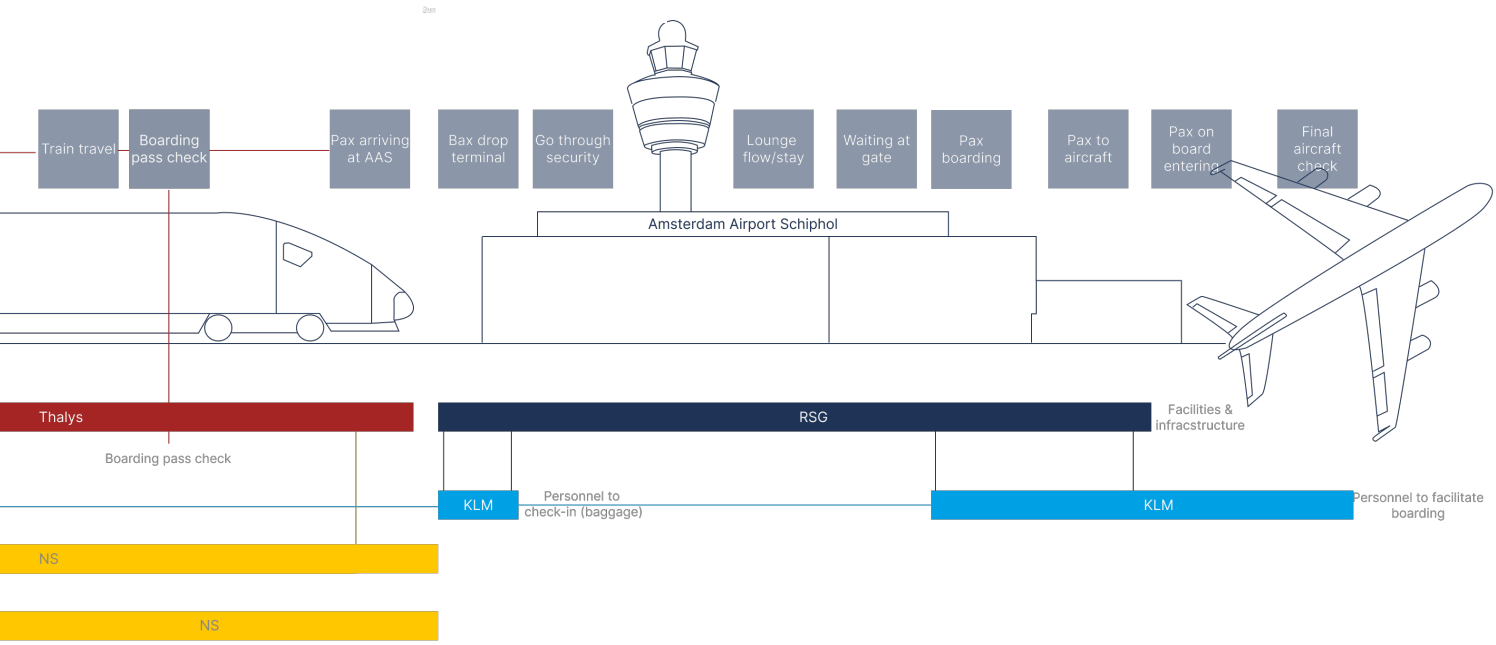


Figure 2.6: Stakeholders of the bi-modal journey which transfers at AMS

3 Understanding the product: Bi-modal passenger transfers

An understanding of the product is created by looking at literature to understand bi-modal transfers, conducting a bi-modal transfer at AMS, and benchmarking other airports. This chapter gives an overview of the key insights.

3.1 Understanding bi-modal passenger transfers

This section aims to explore and understand the context of the bi-modal transfer. It introduces bi-modal transfers, and how successful ones are created, then it goes deeper into what influences the passenger experience. Lastly, the research is scoped down with these insights. Literature was obtained through the ID550X Research Elective, cited as Rousian (2022). Next, the method for identifying and locating resources involved accessing Scopus, which combines a comprehensive, curated abstract and citation database (Scopus, n.d.). Additionally, literature suggested by the supervisory team is included. To further grasp the environment of bi-modal transportation, the context is established with current trends and developments (Giffi et al., 2019).

3.1.1 An introduction to bi-modal transfers

Transferring passengers spend time and energy on out-of-vehicle walking and waiting, which plays into their perceived burden of transit travel. During the transfer, passengers alight from one vehicle, move to a new stop or platform, wait for another transfer vehicle, and board that vehicle (Iseki & Taylor, 2010). An hub provides a space to coordinate and integrate different modes of transport. This helps decongest roads, reduces journey time, enhances the environment, and offers greater convenience and easy transfer to commuters (Chauhan et al., 2021). Different modes of transport can be integrated within an hub: air, rail, metro, bus, and so on.

Prior research states that successful hubs integrate infrastructure and service elements (Bell, 2019; Monzon et al., 2016; Chauhan et al., 2021, as cited by Toet et al., 2022). Infrastructure integration refers to the facilities required to operate the transport modalities (such as railways, highways, and runways) and connecting elements such as buildings and moving walkways (Li & Loo, 2016; Canale et al., 2019). The service quality of hubs from the passenger perspective refers to services that facilitate a seamless interchange between multiple modes of transport, like "..transfer environment, accessibility, signposting, safety, security, public utilities, comfort & convenience, etc." (Chauhan et al., 2021, p. 48 as cited by Toet et al., 2022). Veeneman et al. (2020), as cited by Toet et al. (2020), state that high-quality service can be achieved when service components such as ticketing, reservation, information, and planning are integrated.

3.1.2 Innovating mobility services

One example of integrated service components is MaaS. MaaS proposes a future mobility system that offers a subscription where passengers can

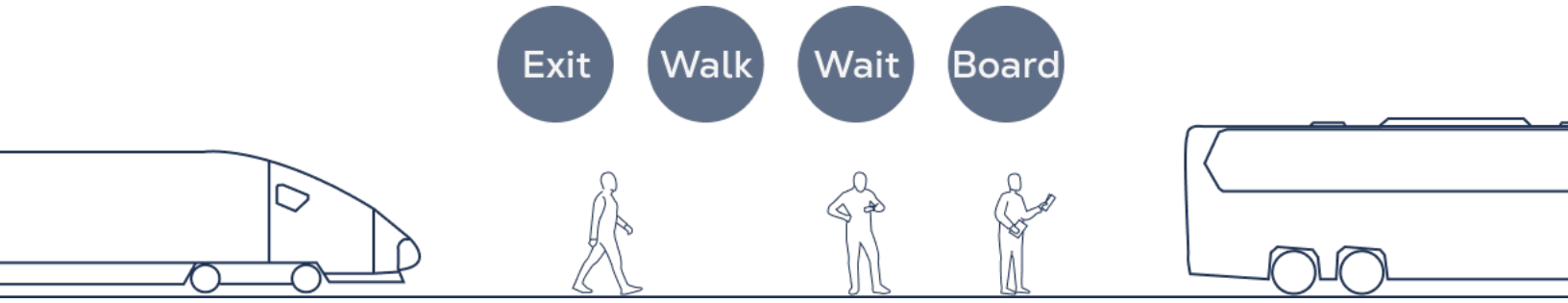


Figure 3.1: A transfer

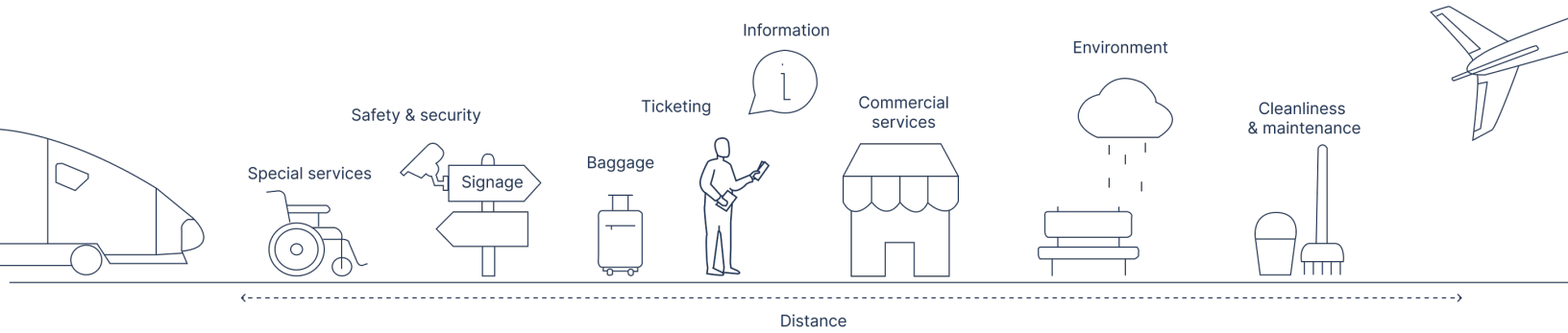


Figure 3.2: Overall touchpoints of the transfer (Rousian, 2022)

book a personalized service in which a range of travel modalities are bundled (Canale et al., 2019). Under the MaaS proposition, "transport will be increasingly organized around the 'service' of mobility rather than the 'medium' (modality) to be used" (Canale et al., 2019, p. 7 as cited by Toet et al., 2022).

MaaS is a disruptive innovation and shows that the technology to improve existing services is already here. It is a development of new capabilities and businesses. Traditional analysis suggests that Horizon 3 innovations take years to develop, but this is no longer true today. Disruptive Horizon 3 ideas can be delivered as quickly as Horizon 1 ideas (which provide continuous innovation to a company's existing business model and core capabilities)(Blank, 2019).

3.1.3 Influences on the passenger experience

Zooming into the transfer, from a passenger perspective, various touchpoints influence how they experience the transfer. An understanding of these touchpoints will help in the next section. It will help to understand seamless bi-modal passenger transfers. An overview of all of these is described by (Rousian, 2022). The categories are information and signage, distance and accessibility, time coordination, ticketing services, safety and security, substitute services, cleanliness and maintenance, commercial services, and environment. This research has a constrained scope when it comes to including air travel. No literature is found on bi-modal transfers in which an airplane is one of the modalities. The literature is compared to two other cases to determine missing factors. This paper contrasted with air-air transfers (de Barros et al., 2007; Fakfare et al., 2021) to include the airport hub setting, and air-rail journeys (Zhang et al., 2022; Li & Loo, 2016), in order to include the air transfer. After the clustering revealed that they play a more prominent role in air transfers than bi-modal transfers, baggage services are considered a new cluster. The adjusted model from Rousian (2022) is shown in Figure 3.2. These categories should be viewed as performance indicators of a bi-modal transfer. Every category can have a certain level of quality. Below, for every category, some examples are mentioned shortly.

Information and signage: Interchange signage, information timeliness at stations, accessibility of hubs, and so forth.

Distance: Walking distance, transfer time, number of level changes, and so forth.

Ticketing: Ticket purchase, ticket inspection, and fare/service ratio.

Baggage: Baggage processing facilities, luggage charts, and so forth.

Safety and security: Overall safety, easiness of security check, and so forth.

Environment: Walking environment, design and public realm, integration with other modalities, etc.

Commercial services: Services, facilities and entertainment for all.

Cleanliness and maintenance: Of all places.

Special services: Staff assistance, and facilities for disabled.

These examples do not define the term; the factors should be taken into the broadest sense possible. The complete overview can be found in Rousian (2022), and as said before, for the baggage services, the papers mentioned above are used.

3.1.4 The correlation between user effort and seamless travel

Looking further at these factors, Li & Loo (2016) prioritize these factors into levels. They call this the "integration ladder." According to their explanation, the lowest level of integration involves integrating information (such as signage and the provision of information), and the moderate level involves the integration of facilities and services (such as the ability to deliver luggage and the walking distance of the transfer). The highest level involves integrating ticketing and fares (e.g., ticket purchase). Taking the integration ladder proposed by Li & Loo (2016) as a starting point, and focusing it on the transfer elements of the journey, the lowest level of integration would cover the integration of information and signage, the moderate level of integration would cover environment, cleanliness and maintenance, distance, special services, safety & security, baggage, and commercial services and the highest level of integration would cover ticketing (see Figure 3.3).

Next, Lyons et al. (2019) propose Levels of MaaS Integration taxonomy (see Figure 3.4), which shows different levels of integration of each factor. I observe that the more integrated the factor is, the less cognitive effort the users require. In light of those mentioned above, less user effort leads to more seamless travel. This information is valuable

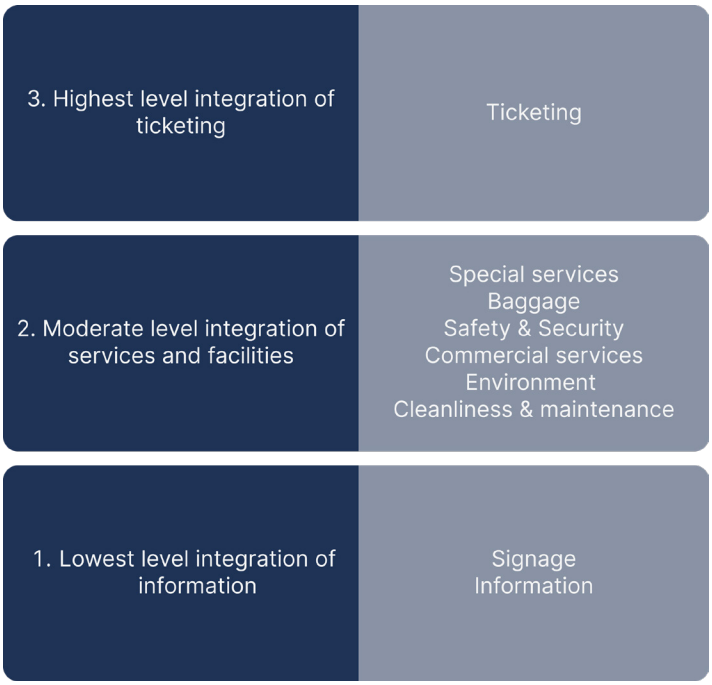


Figure 3.3: Integration ladder for bi-modal transfers, derived from Li&Loo (2016)

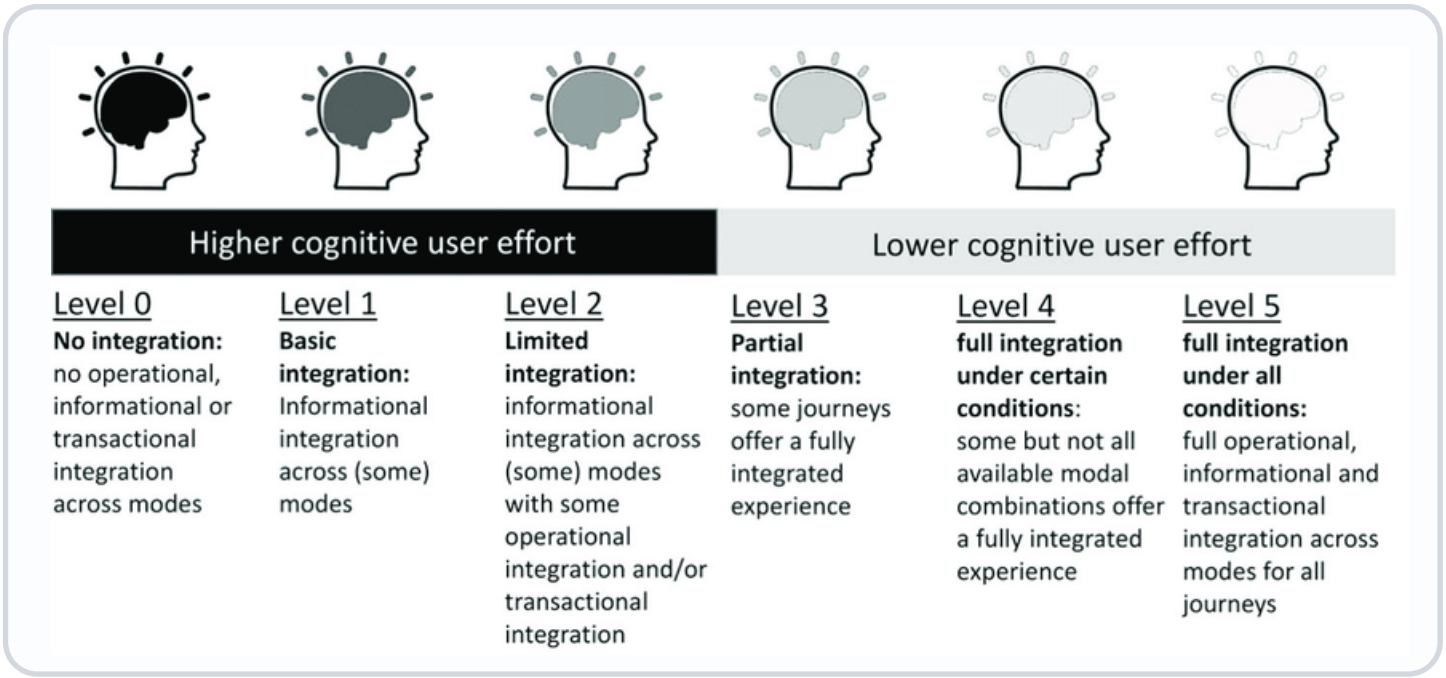


Figure 3.4: Levels of MaaS Integration taxonomy (Lyons et al., 2019)

3.1.5 Scope

As this project is limited in time and budget, this project focuses on the one-way journey of a short-haul modality (train or bus) to a long-haul modality (airplane). Based on the previous factors mentioned, it is assumed that there would be more hassles when the long-distance aircraft arrives after the transfer, e.g., the passenger has to go through security and check-in (baggage). Next, assuming that trains operate more frequently than airplanes, the idea of missing the airplane would be much more stressful for the passenger. Missing the airplane also creates a bigger hassle for operators than missing a more frequently operating train. All of these aspects can influence the stress level of the passenger and, therefore, negatively influence the journey. With this in mind, the research is scoped down. Next to this, making the journey the other way around would be hard to represent as this project is restricted to Europe. It would not make a strong depiction of the actual journey (e.g., the fatigue and differences in cultures would not be considered). In the case of the short-haul to long-haul flight, I assume that this matters less.

3.2 The bi-modal passenger transfer experience at Amsterdam Airport Schiphol

This chapter describes the bi-modal transfer at Amsterdam Airport Schiphol. The aim of this is to gain an understanding of the bi-modal transfer at AMS. A case study is conducted to set the status quo.

3.2.1 The aim and research questions

Conducting a case study at AMS will help to determine the status quo. To determine what significantly affects the transfer experience, the factors described in Chapter 3.1.3 will be used as a basis for analyzing the passenger experience. Given that the researcher does not require specific special services, it is assumed that it will be challenging to understand them. The focus is set on the other aspects.

The central question of this case study is:

How does AMS currently facilitate bi-modal passenger transfers?

The sub-questions will help to answer the main question:

- Which factors do passengers encounter?
- How do the factors influence the passenger experience?
    - How is the overall transfer experience?
    - Which factors enhance the transfer experience?
    - Which factors are lacking in quality?

3.2.2 Data collection

A bi-modal journey, which transfers at AMS, is taken to gather data. It is interesting to look at journeys that already focus on creating some form of integration to get the most out of it. As described before KLM Royal Dutch Airlines and Thalys began

Figure 3.5: Travel schedule for or AMS case study (ZYR-BER via AMS)

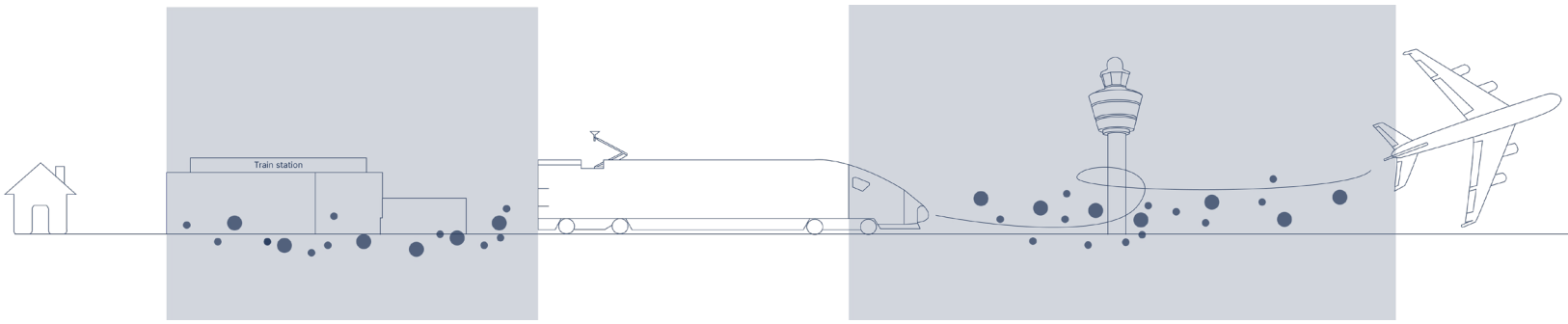


Figure 3.6: Collected data

an Air-Rail pilot in July 2022, where their focus was on providing an integrated bi-modal journey. Looking at this journey would be most interesting.

To accurately depict the transfer experience, the journey involved taking the train to the airport first, followed by a flight to another destination. In December 2022, Amsterdam Airport Schiphol (2 hours and 10 minutes) was visited.

Amsterdam Airport Schiphol was visited, going from Brussel-South railway station to Amsterdam Airport Schiphol to Berlin Brandenburg Airport (Figure 3.5).

Data gathering occurs during the transfer (Figure 3.6). Data is nevertheless gathered before boarding the train because, in some cases, the check-in process takes place there rather than at the airport.

The method used to extract the needed information to answer the research questions is explained below.

Action research: Own experience of the transfer was an important part and critical to understanding the transfer experience and the factors influencing this. Insights were gained by being a user of the transfer myself. Observations and findings were audio recorded, photographed, and noted. To give this some structure, the background of the researcher's phone was changed into a table, including the touchpoints of the journey stated in Chapter 3.1.3. This will help create a complete story, evaluate it, and find reasons for their evaluations.

The choice of this technique is determined by the amount of time available for the transfer. As a result, only some methods could have been used. For instance, passenger interviews are not included because they take time. Additionally, passenger interviews could also have impacted the individual experience.

During the study, I am categorizing myself as a transfer passenger. A report from (RSG Department of Customer Insights, presentation, 1 November 2022) states that 76% of transfer passengers have checked baggage. 1,03 pieces of checked baggage are checked in on average. 1,39 is the hand baggage factor. Additionally, some airlines only allow one piece of hand baggage (like, SWISS (n.d.)). I will thus only bring one piece of hand baggage next to my checked baggage.

3.2.3 Data analysis

To analyze the data thoroughly, the recorded data is first transcribed. The notes and images were saved

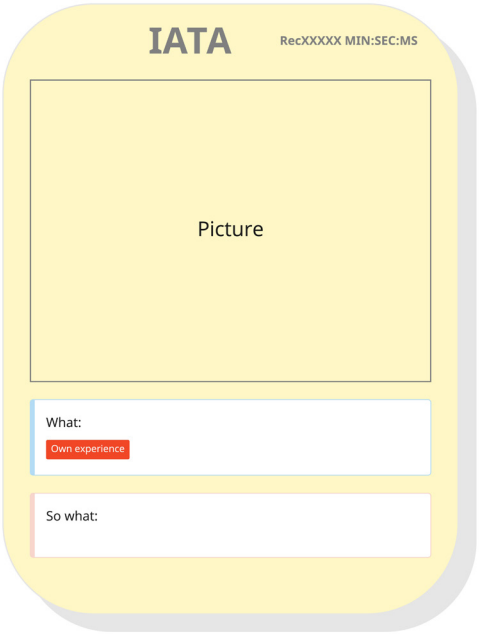


Figure 3.7: Example statement cards

as raw data. Next, the most important findings of the data were made into statement cards (Sanders & Stappers, 2012). As the data was recorded through different media, such as photos, notes, and audio recordings, a standardized representation of the findings is needed to structure and cluster the obtained data. These cards (Figure 3.7) contain an illustrative image of the finding (optional), a statement that describes the photographed finding, or a quote from the audio recordings (what) and the interpretation of this finding (so what). To distinguish and trace the origin of the data, each card's title includes the timestamp, the name of the source file, and the location of the chosen research study.

A customer journey map (Nielsen Norman Group, 2016) was created based on the retrieved data from the auto-ethnographic research. This customer journey map illustrates the steps in the journey and the experiences that were discovered. The statement cards are clustered and summarized to identify the journey's strengths and weaknesses.

3.2.4 Context of the travel

The journey was booked on the KLM website.
KLM asserts that travelers will find their flight extremely comparable to the air-to-air transfer they are used to. For example, KLM allows passengers to check in for their entire journey. They can board

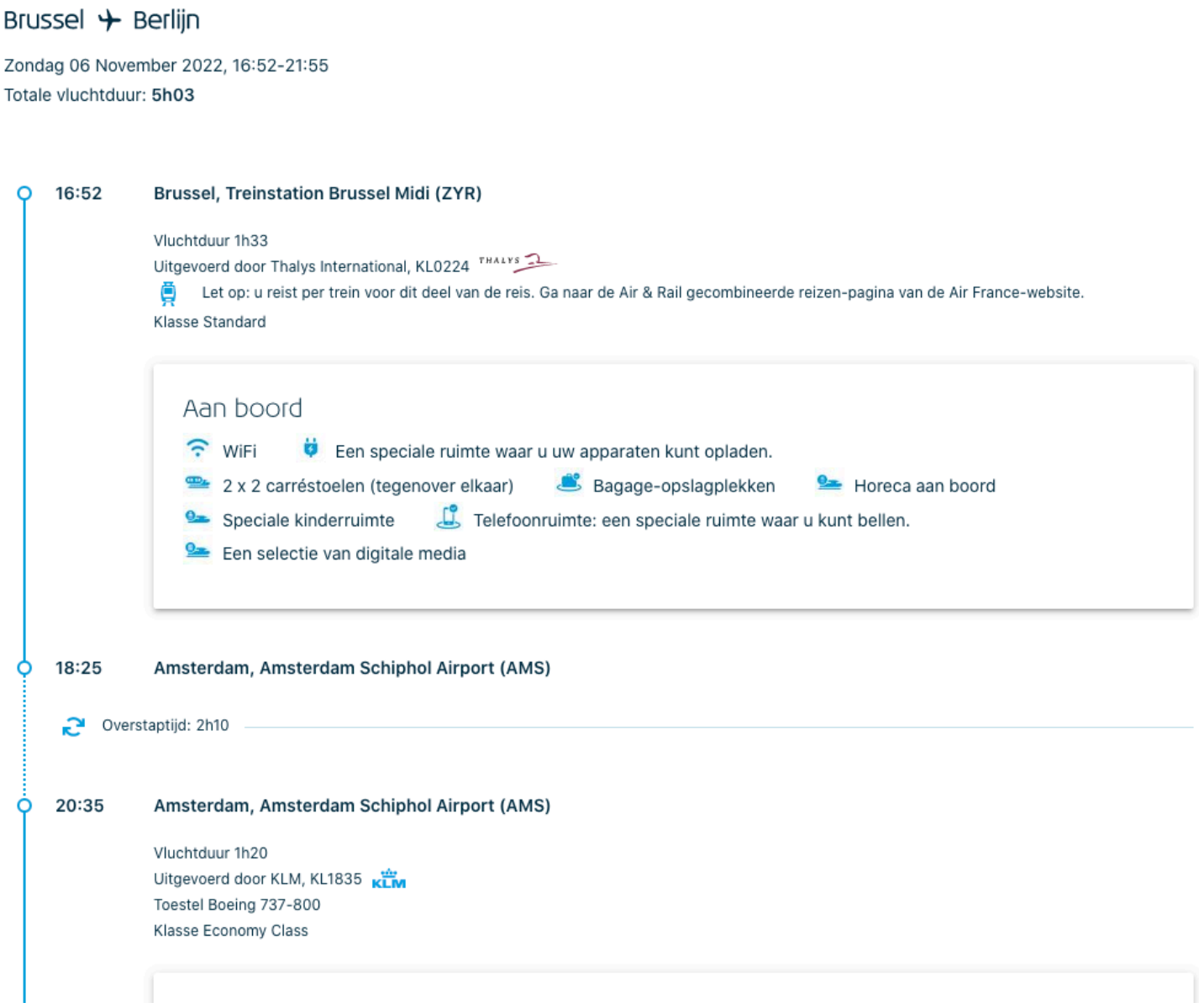


Figure 3.8: Air-rail journey information Amsterdam Airport Schiphol operated by KLM and Thalys

the flight and the train using the same boarding pass. Additionally, KLM will provide travelers with up-to-date travel information. (KLM Royal Dutch Airlines, 2022)

3.2.5 Pre-travel information

The information obtained before the trip is displayed in Figure 3.8 (The full version can be seen in Appendix A). The email that sent this information also included payment information and a question-and-answer section. The same data was displayed on the KLM app as well. Furthermore, before this journey, no information was sent or looked up.

3.2.6 Prior knowledge

Some aspects will affect the auto-ethnographic research I conducted at AMS. These should to be mentioned. The following influences are identified:

- I am Dutch and speak Dutch
- I am a frequent traveler and have used public transit.
- I have visited the airport itself numerous times.
- I've taken KLM flights previously.
- I have used AMS for a bi-modal transfer (via national train services). However, there was no service integration in this bi-modal transfer.

Figure 3.9: Atmosphere impression of the journey transferring at Amsterdam Airport Schiphol operated by KLM and Thalys

3.2.7 The travel

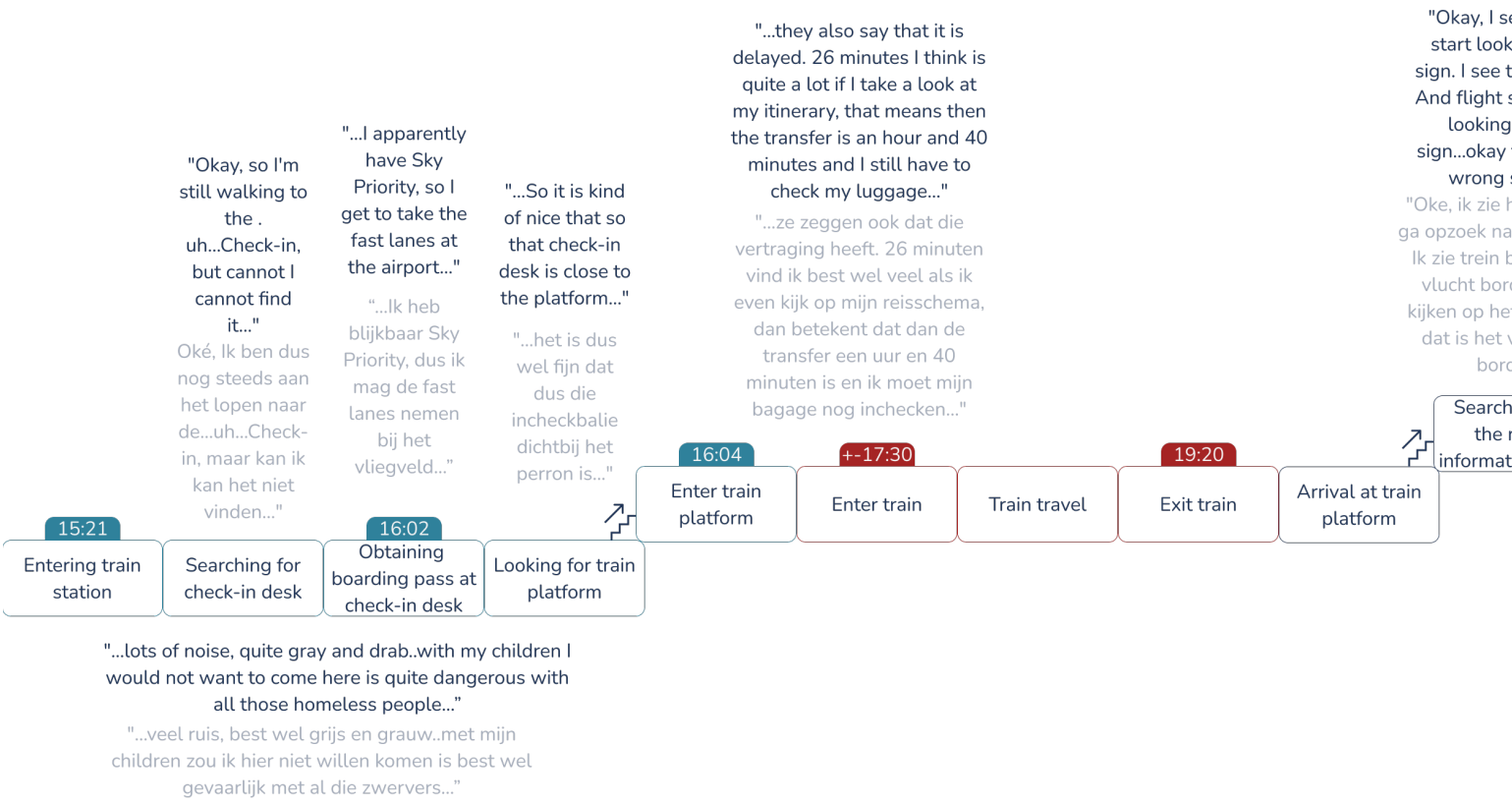
At 15:21, I arrived at the Brussel-Midi train station. I had to pick up my boarding pass at the train station, so I arrived so early. The train was supposed to arrive at 16:52. The train did, however, arrive with a significant delay; it did so at 17:21. At 19:20, the train arrived at AMS. At 20:35, the plane was scheduled to take off. This gave a transfer time of 1 hour and 15 minutes. Which, I also had to check in my baggage. I arrived at the gate to board at 19:51. It took me 31 minutes to get to the gate of the flight. A more elaborate version of the timing is found in Figure 3.10.

3.2.8 Information used during the travel

The information on the application (as shown in Figure 3.8) and the information available at the train station and airport (e.g., screens, signs, fellow travelers, and service personnel) were the sources of the information used.

3.2.9 The customer journey

Figure 3.11 illustrates the steps of the journey. The journey steps including the statement cards can be found in Appendix B. The complete transcript can be found in Appendix C.



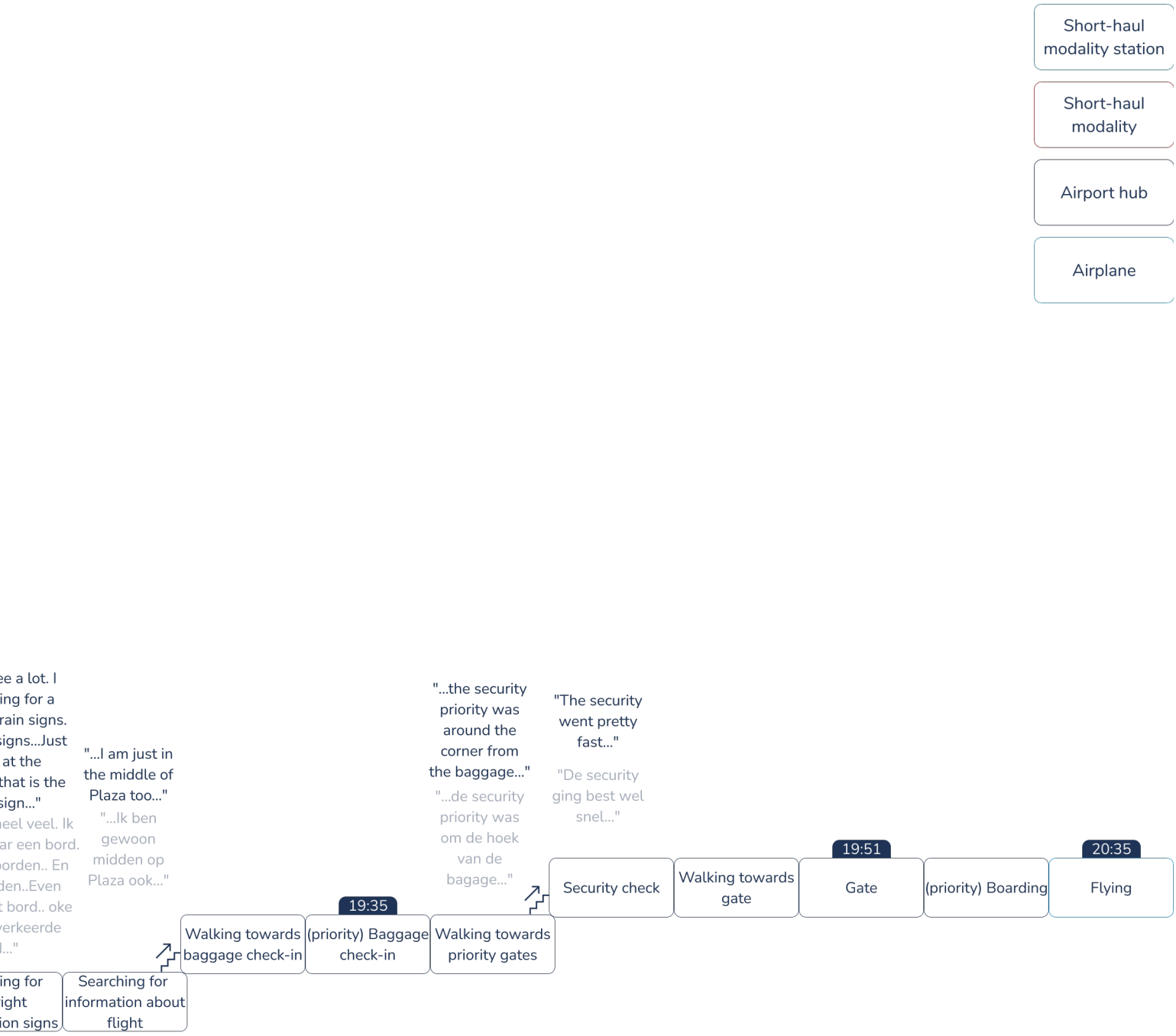


Figure 3.10: Air-rail journey steps Amsterdam Airport Schiphol operated by KLM

3.2.10 Key insights of the transfer

Insights are gained after the raw data is put in statement cards and clustered. The clusters are in Appendix D.

The check-in at the train station is uncomfortable due to the time wasted before the start of the journey

You are not able to obtain a boarding pass before the trip. I checked in at the train station. For this, I had to go to the service desk. The desk was hidden in the back, away from all the other service/ticketing desks (however, it was close to the train platform). It took me around thirty minutes to find this desk (from the moment I walked out of the train), even though the service personnel at the other service/ticketing desks tried to explain where to find it. This time frame felt rather lengthy. Furthermore, it was unpleasant.

Time spent at the train station should be as little as possible

The train station is not very comfortable. The presence of so many homeless people there makes the area uneasy.

There is no frame of transfer

There was no uniform(ity in) signage between Air and Rail. The Air-Rail branding was challenging to find at the train station, but it was there (as seen in Figure 3.11); nevertheless, it was not at the airport. This made it confusing and challenging to know what to look for when traveling.

Seamless arrival at Schiphol Plaza

Stepping out of the train at AMS and into the escalator is seamless as there is only one way to go, and the flow of people is going towards the escalator. (Figure 3.12)

The walk from the train station to the terminal is short and, therefore, convenient

The terminal is only a 5-10 minute indoor walk from Schiphol Plaza, which is above the train platform.

Everything is everywhere all at once at Schiphol Plaza: it is not clear what to do when arriving at Plaza

It is unclear where to head to when arriving at Schiphol Plaza. The big yellow signs explain the way toward the different departures, arrivals, and check-in (see Figure 3.13). However, I had no prior information on the departure terminal or gate; for me, it was pretty confusing what the next step was. Trying to find something (e.g., the Flight Information Displays) that explains what to do next while many people pass by you increases stress. In addition, there was no indication of the time during the trip, the walking distance, the busyness, or the amount of time I had left—the uncertainty of whether I had enough time added to my tension.

There is some unclarity of included services as they have not been previously mentioned

Travelers are authorized to use AMS's Sky Priority service during transfer. Before the trip, these services' inclusion was unclear. It was also unclear what services this Sky Priority service offered. It became obvious after consulting with service personnel and doing web research. The inclusion of these services was not fully necessary as the airport was not busy.

Later on, it is understood that these services were included due to the airport's overcrowding and were not standard in the journey. (Projectmanager bi-modal transport KLM, presentation, 1 november 2022)

There service personnel at the airport is helpful

The KLM staff at the baggage check-in were accommodating in explaining what Sky Priority meant and where I needed to go. My trip from the baggage check-in to the security check was shortened and more convenient.

Their environment, safety and security, cleanliness and maintenance, and commercial services are of high quality.

According to my personal experience, the above services were of high quality. However, there was little time to use these services at the airport due to the delayed train. Most of the time was spent walking.

Figure 3.11: Check-in counter at Brussel-Midi trian station


Figure 3.12: Seamless walkway from trainplatform to elevator (Schiphol, n.d.)

Figure 3.13: Going up with the walkway entering Plaza

Concluding, some of the factors have already hit a high level of quality. The modalities at AMS are close by. This infrastructure creates convenience for passengers while bringing them to their final destination. Next to this, the environmental elements, including safety & security, commercial services, and cleanliness and maintenance, are of a high standard, which creates a high-quality experience for the passengers. When I evaluate the factors, I observe that the most significant barriers are the quality of the signage, information, and ticketing. Next, AMS had no service for the baggage (rather than the currently available drop-off at AMS).

3.3 Benchmark: Learnings from bi-modal transfers at three other airports

AMS is not the first to integrate other forms of transportation besides flying. Integrated services for bi-modal travel exist at other airports. This chapter summarizes what happens at different airports within Europe. It contains the critical insights of my action research and lays the foundation of my design brief and proposals.

This research only explores airport hubs in Europe via field studies due to budget, time, and COVID-19 uncertainties and to limit the environmental impact.

3.3.1 Comparable hubs

To get the most out of the learning experience, the bi-modal transfers at other airports must be comparable to those at AMS. The hub connectivity of airports is investigated since the hub-and-spoke network serves as the foundation for AMS. Hub connectivity is a crucial metric for any airport hub, big or small (Airport Council International, 2022). It measures the number of connecting flights the airport hub can facilitate. This evaluates if the airport hub functions as a transfer hub like AMS does. Next, the number of passengers per year is investigated to understand the size of the hub (pre-covid, so 2019). This way, airport hubs comparable in terms of complexity to AMS are selected.

Following the scoping, ten comparable airport hubs in Europe, based on hub connectivity and size (in passengers), are considered for this study (as shown in Figure 3.14)(Airport Council International, 2022).

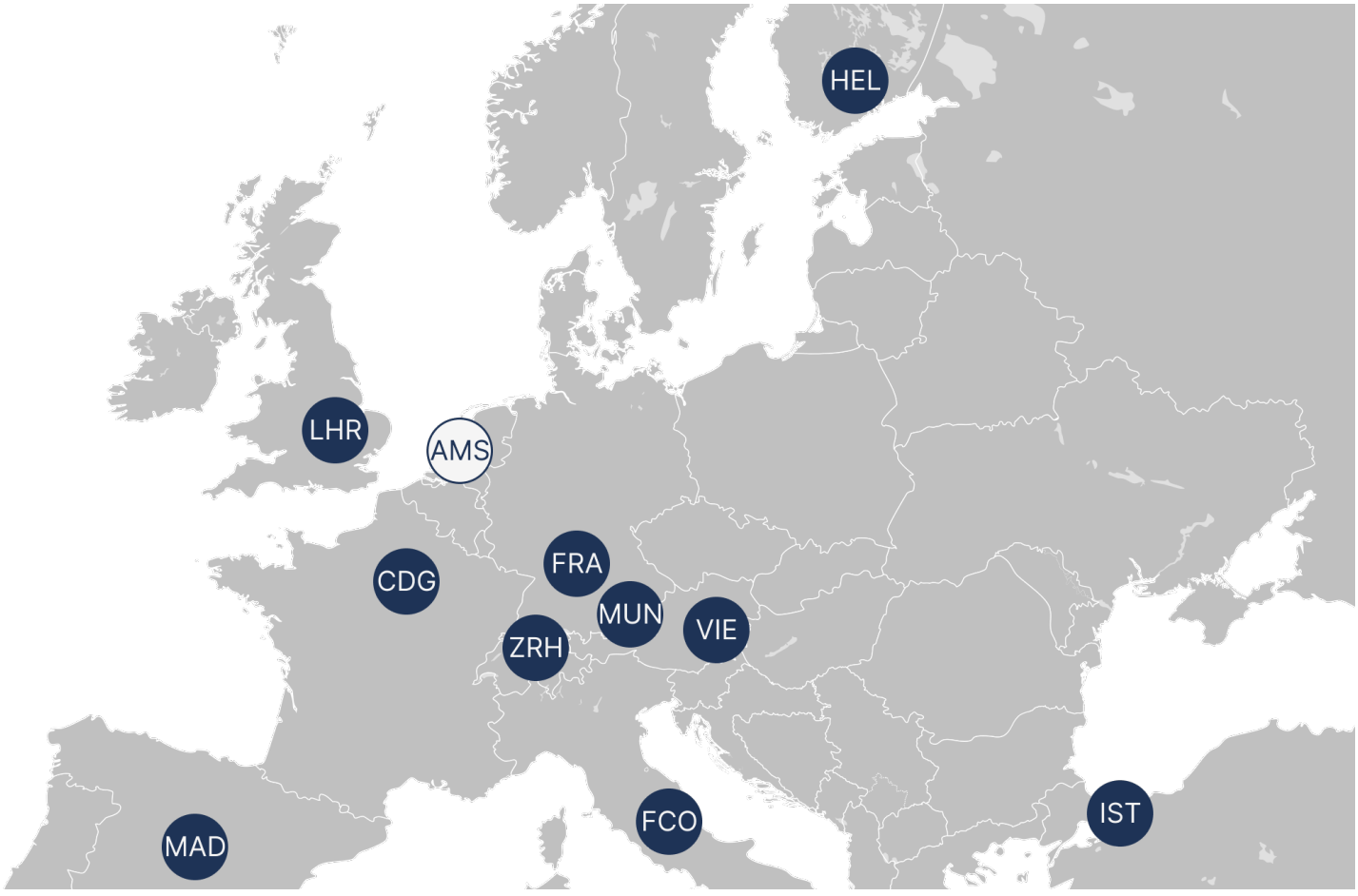


Figure 3.14: Airport hubs [in Europe] comparable to Amsterdam Airport Schiphol

The bi-modal journeys that occur at those airport hubs are investigated and evaluated. Desk research is used to look for services related to the factors outlined in Chapter 3.1.3. The purpose is to identify intriguing cases that AMS can use to guide the creation of the proposals. Information was only available for some factors. A judgment is made regarding the services that were. The services listed in Table 3.1 are an array of the services present in the selected airport hubs. A more comprehensive overview of these airport hubs and the bi-modal journeys which transfer at that airport can be found in Appendix E.

Looking at the discovered services, CDG, FRA, and HEL are interesting to look at as they have the most services present. At first glance, it would be interesting to look at VIE, as it offers luggage drop-off. However, this drop-off is in the city center, and it takes 16 minutes to get to Vienna Airport, so it would not be able to represent a short-haul train journey corresponding with an existing air route. Concluding, this airport is out of scope.

Airport hub location	Integrated ticketing	Delay and cancellation services	Complete baggage handling services	Baggage priority services	Fast lanes	Lounge
AMS	yes	yes	no	no	no	yes
CDG	yes	yes	no	no	no	yes
FRA	yes	yes	no	yes, terminal	yes, terminal	no
ZUR	yes	yes	no	no	no	no
HEL	yes	yes	no	yes	yes	no
VIE	yes	yes	yes	no	no	no
MUN	yes	yes	no	no	no	no
IST	no	no	no	no	no	no
LHR	no	no	no	no	no	no
MAD	no	no	no	no	no	no
FCO	no	no	no	no	no	no

Table 3.1: Airport hubs [in Europe] comparable to Amsterdam Airport Schiphol with bi-modal services, summarized from Appendix E.

3.3.2 Selected airport hubs

This chapter has presented a range of existing bi-modal journeys. Analyzing the different journeys has shown the included services. The inclusion and exclusion criteria are stated below.

Inclusion criteria:
- The hub functions according to the Hub-and-Spoke model
- The transfer location is in Europe
- Compared to other airport hubs, the airport hub has a rather high hub connectivity
- The hub's size (in terms of passengers) is comparable to AMS

- The transfer location is at the airport hub
- The journey has currently existing on an air route

Exclusion criteria:
- Similar cases
- Cases with few integrated services (compared to the other airport hubs)

The selected airport hubs are Frankfurt Airport, Paris Charles-de-Gaulle Airport and Helsinki Airport.

3.3.3 Research setup

Researching CDG, FRA, and HEL will show how the services within that case (shown in Table 5.1) influence the transfer experience. To determine what significantly affects the transfer experience, the other aspects described in Chapter 3.1.3, just like in Chapter 3.2, will also be analyzed. By identifying the differences in the context factors, this research creates an overview of the opportunities and pitfalls for implementing bi-modal transfers at AMS.

Therefore the central question of the case study is:

How do the three selected airports facilitate bi-modal passenger transfers compared to AMS?

Furthermore, the sub-questions, data collection and data analysis re the same as the ones described in Chapter 3.2.
In December 2022, Frankfurt Airport (2 hours and 26 minutes), Paris Charles-de-Gaulle Airport (3 hours and 18 minutes), and Helsinki Airport (1 hour and 20 minutes) were visited. Frankfurt Airport, Charles-de-Gaulle Airport, and Helsinki Airport are visited in one week. The journey is shown in Figure 3.15.

You can find the overview of the investigation and analysis in Appendix F, J, and N.

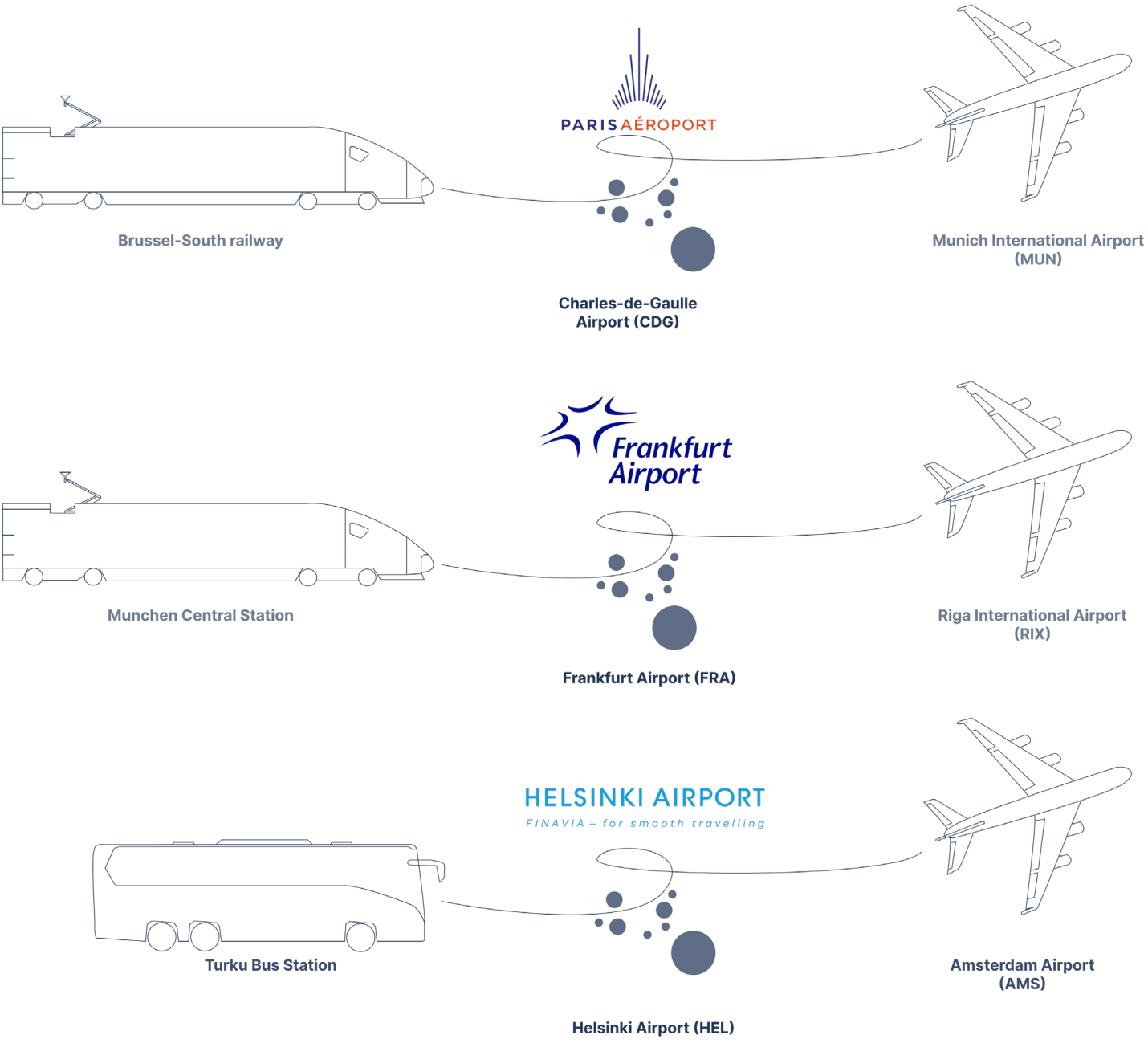


Figure 3.15: Overview of the journeys

3.3.4 Key learnings of the journeys

During the case study trips, an array of key learnings are found. The learnings that will help elevate the bi-modal transfer experience at AMS are described below. Appendix R, S, and T provide a more comprehensive overview of the key learnings at every transfer.

Time spent at the train and bus stations should be as little as possible

All train and bus stations during the travel were not very comfortable. They are out in the open and therefore are chilly and feel unsafe (Figure 3.16).

Checking-in at the train station is uncomfortable.

On some trips, I could not check in prior to the trip. The boarding pass should be obtained at the train station. For this, you must go to the train station's service desk. I arrived earlier as I had to pick up my boarding pass at the train station. The extra time to search for the check-in desk felt wasted.

Quicker and more convenient journey with an online boarding pass

Already having an online boarding pass makes your trip shorter. You do not have to spend much time at the train or bus station. A hop-on and hop-off experience are created. This convenience could make the journey a more attractive choice.

A clear and calm transfer begins with general directions to the airport and moves on to more detailed information about the flights once the airport has been located.

The information at the transfer at CDG starts briefly. The first icons you see are of different modalities (Figure 3.17). The further you walk toward those icons, the more detailed it gets. This signage is why it was easy to understand the airport hub.

Poor communication about extra services creates more confusion than the convenience the additional benefits are supposed to give you.

Next to the wayfinding, the included services should be transparent. For some of the trips, these services were very unclear due to poor communication from the airlines. Not knowing what to expect from the journey created stress.

The communication with the passengers should be clear and personal, so the passengers know what to expect and feel guided.

General information and signs about the trip and transfer can create an easily understandable and calm transfer; however, with growing travel options creating many different small target groups, this can be hard to achieve. More personalized options can be offered to create clearance.

Figure 3.16: Bus at Turku bus station

Figure 3.17: General signage at trian exit in CDG

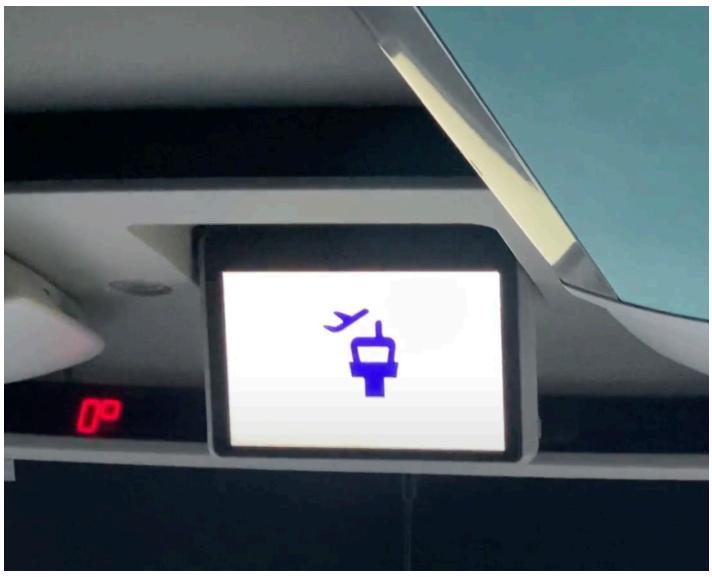


Figure 3.18: Instruction video in bus

The application was a leading travel buddy as it explained every step of the journey.
The Finnair app guided me during my journey. The app provides all information you need in a user-friendly way. Each step of the trip is broken down into separate screens. This made the journey very manageable (Figure 519).
Expectations of the transfer are managed due to displaying a video in the first mode of transportation.
Next to this, to create a more included offer (digital inclusivity), other resources can be used to create clearance for the passenger. Close to the end of the first modality, a video was shown to explain which steps you had to follow at the HEL (Figure 5.5). This video gave a focus to the journey and made it more confident.

A baggage check-in at the train station creates a level of convenience
It was practical not to bring your luggage into the train and have it with you during the transfer. Due to this, the transfer was quite convenient as the only thing that had to be done there was going through a security check.

An AiRail Terminal is inflexible and, therefore, a liability
The AiRail terminal at FRA is where passengers traveling with the train can quickly and conveniently drop off their baggage and check-in for their flight near the train exit (Lufthansa, n.d.). When I visited, this was out of service. As it was out of service, there was no other alternative than me having to walk a long way toward the "normal" baggage check-in. This made the trip less enjoyable. Next, the journey was confusing as signs still pointed at the AiRail terminal (Figure 3.20).
Building environment should be considered carefully as the lead time at airports is slow, and it is unclear which modalities will become obsolete. *Besides this, building an AiRail terminal would also mean that the airport must create a new terminal for every new modality. Building (a static) infrastructure for a modality that may even become obsolete in ten to thirty years is not a strategic move for airports.*

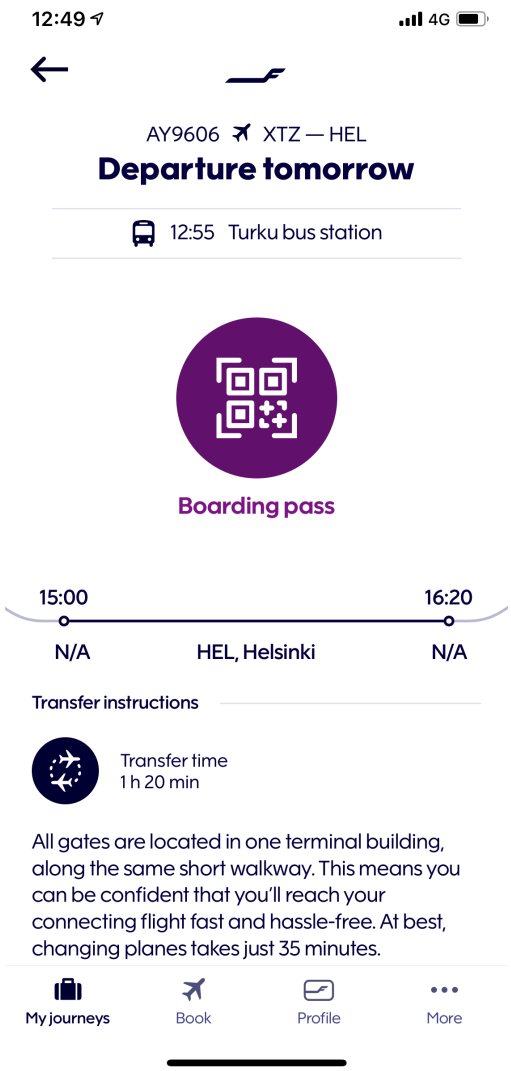


Figure 3.19: Air-rail journey transferring at Helsinki Airport operated by Finnair

Figure 3.20: Signage after regular baggage check-in leading back at the AiRail terminal

4 Defining the problem: Improving bi-modal passenger transfers

This chapter will discuss the comprehension of the research leading to the problem definition, vision, and mission.

4.1 Scoping with a focus on success

As described in Chapter 3.2, within the bi-modal journey of KLM and Thalys which transfers at AMS the information, ticketing, signage, and baggage services have a low or no level of integration. This makes the system ask for effort from the passenger which results in an inconvenient travel experience.

Information (and signage= communication)
The most stressful process at AMS was from when you stepped out of the train until the check-in. There needs to be a higher level of integration of information between trains and airplanes. It is, therefore, unclear what the steps are when leaving the train until the baggage check-in and/ or security check. A transfer where an overview of the journey steps was given, including a video before transferring (both given at HEL) resulted in a much more secure transfer.

Ticketing
There is some level of integration of your ticket within the journey of KLM and Thalys, as you can pick up your tickets for both modalities at one desk. However, passengers are not able to check in prior to the trip. The case studies showed that the time spent at the train and bus stations should be as little. The journeys which included an online boarding pass were much more satisfactory.

Baggage
While it was not mentioned as a barrier during the travel at AMS, during the travel at CDG, it was noticed that a high level of convenience arises when having no luggage during the transfer. At AMS, there is currently no integrated baggage service for passengers that travel bi-modal (rather than the currently available drop-off at AMS). The passenger is responsible (e.g., has to carry and look out for) their baggage till the baggage check-in at the airport; this results in an inconvenient travel experience.

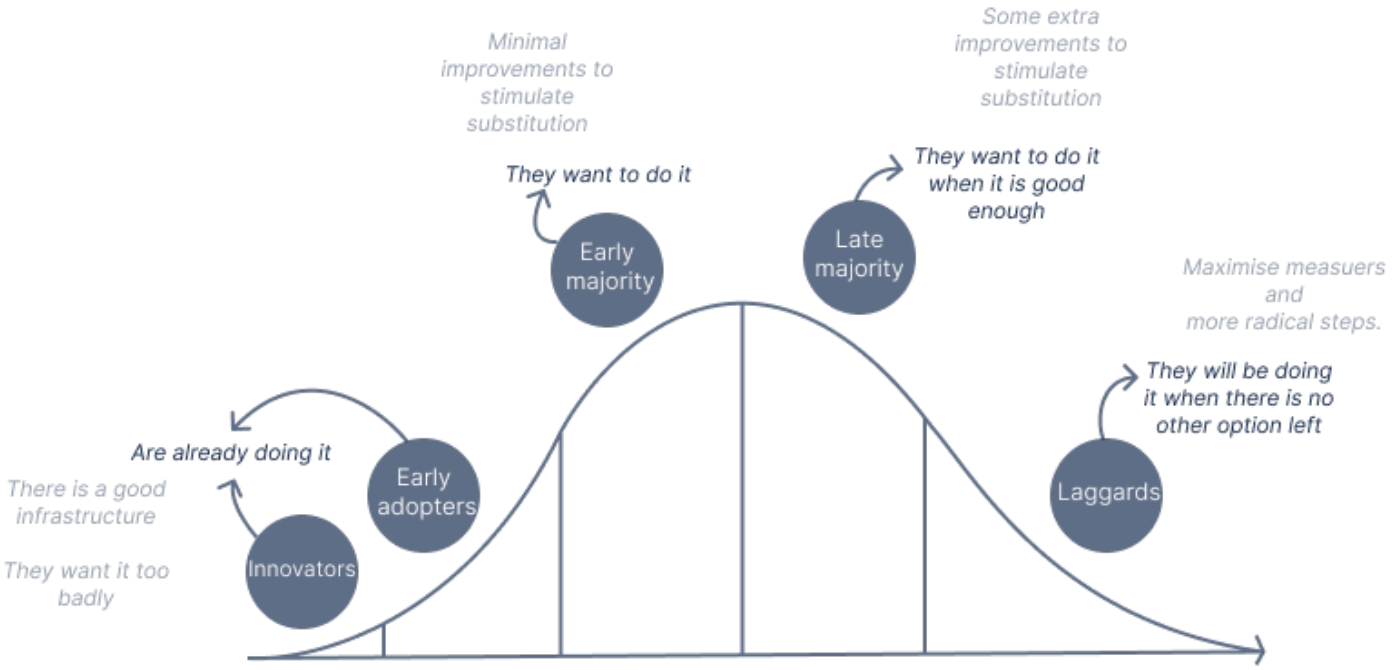


Figure 4.1: Curve of Innovation converted to bi-modal transfers

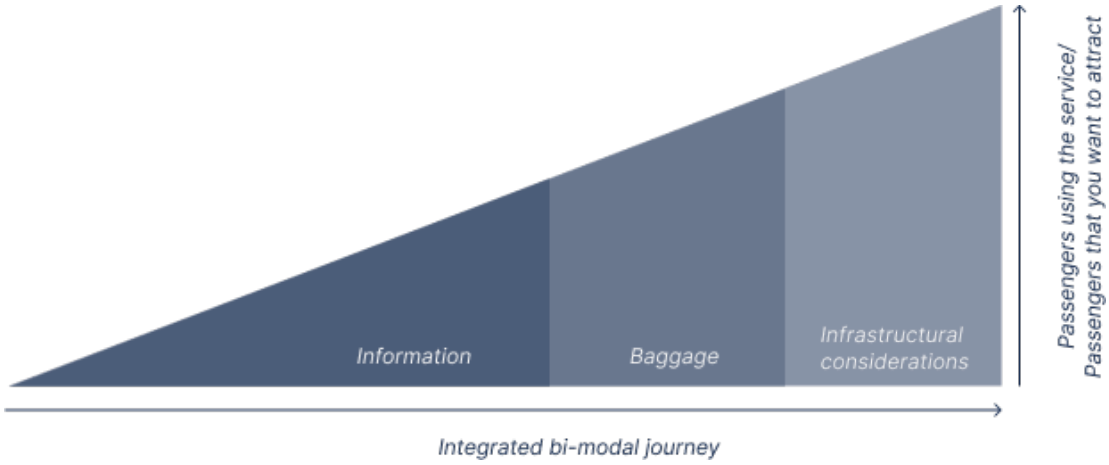


Figure 4.2: Model for innovating services within bi-modal transfers

Looking back at the integration ladder described by Li & Loo (2016) in Chapter 3.1.4, some services are already (partially) integrated (such as ticketing), while the first level of integration still needs to be integrated (i.e., information). The lack of integration of information caused the biggest hurdle of the journey. Next, the ticketing caused much hassle. Therefore, these are must-haves to improve within the bi-modal journey. As baggage integration was not mentioned, this is considered nice to have.

Looking at the Curve of Innovation (which was first proposed by Rogers in 1962), this scoping can be argued to be successful (see Figure 4.1). Looking back at the origin of this problem, the environmental impact, the passenger's willingness is great to adopt this kind of journey as this concept (partially) arose from society. Travelers have already been adopting (non-integrated) bi-modal travel for sustainability. This means that an acceptable product should be created to convince more people to use this product. Looking at Figure 4.1, the group that has to be convinced is the early adopters. They have to be convinced that this innovation is convenient enough to take it. Due to this, making clear information, signage, and ticketing and promoting this in this way could yield and satisfy them while trying this bi-modal travel. Yielding and satisfying (the rest of the early majority and) the late majority will happen when they see that the early majority has convenient journeys. Next, integrated baggage systems will help the last ones to be pushed over the edge. However, taking the approach described before can be seen if baggage integration is necessary to convince the passengers. As in my case study, the absence of baggage integration was not even noticed; this could also be the case for others. The laggards will be the last ones to use this service. When deciding to use this service, a whole new environment probably has to be built as there are too many people traveling bi-modal, and the capacity at Schiphol Plaza needs to be more to serve those people.

The number of users of this service should influence the steps that should be made within this innovation (see Figure 4.2). The more people that use the service or the more people RSG wants to use this innovation, the more improvements should be made to this service. The approach involves either waiting for adoption or encouraging adoption. Right now, there is a low level of passengers using this service so the investments can be low. RSG must invest if they want more passengers to use the service. The focus should therefore be on improving information and ticketing. These are things that can be of high or lower investment. It is interesting to see how much investment must be made to achieve more passengers using the service. This is something that I will take as a challenge. Infrastructure upgrades can be considered when the majority of passengers use this service. I say "consideration" since it does not have to be an AiRail Terminal per se. It would be wiser to avoid building an infrastructure intended for one mode

of transportation if the existing services offer seamless travel. Suppose RSG does build an infrastructure like an AiRail Terminal. In that case, RSG must create a different infrastructure for each modality and will run into issues whenever a new modality emerges or becomes obsolete.

Concluding, this thesis will focus on improving information and ticketing. This will be most impactful in elevating the service to the next level.

4.2 Problem definition

The challenge of this graduation was that passengers transferring at the airport hub should experience a seamless transfer between two modalities. Before and during the journey, only a little was mentioned about the transfer. When arriving at Schiphol Plaza, it was therefore unknown what the next step was (i.e., which direction to go towards). As Schiphol Plaza is a public space (i.e., a train station and one of the airport's entrances simultaneously), people walking from every side can be overwhelming. To recreate the feeling of this, a video is made to show the feeling during the transfer. Next, another major hurdle is that a passenger must check in at the service desk at the train station, as it is impossible to check in before the trip.

The problem definition for this thesis is taken from the status quo at AMS and defined as follows:

The journey is inconvenient as certain responsibilities are expected from the passenger. These are twofold:

1. The check-in process must be done at the train station. This causes unnecessary hassles for the passenger.

2. It is unclear to the passenger what is expected from them from when they leave the train until they are at the check-in counter. This causes uncertainty while transferring to the airport.

4.3 Design requirements

Design requirements are "specifications of the functions, features, and quality of a design" (Spacey, n.d.). The design requirements come forth from the research phase.

Fit RSG
The design obtains the quality of service RSG aims to provide "by orchestrating smooth and inspiring passenger journeys, supported by efficient, digitally enabled airport processes" (Schiphol, 2021)
- The design should overcome the main hurdles of the passenger journey without extra fuss

Passenger first
The design is built on creating a seamless experience for the passenger.
- The design should create efficiency for the passenger
- The design should create secure feeling
- The design should create a more enjoyable journey

Flexible
The design should be able to change with the world of mobility. The design must be flexible to include several modalities in the concept.
- The design should be modifiable to include and exclude different modalities

Care for the environment
Since the project's origins result from an environmental problem, the concept should have a minimal environmental impact.
- The design should not create extra unnecessary products

Feasible
As the stakeholder environment is complex, a design that should be easily implementable should be chosen.
- The design should be as easy as possible to implement.

5 Creating design solutions to improve AMS' bi-modal transfer

After creating the problem definition, ideation started. Ideas are generated using the case study insights and are further ideated—next, internal stakeholders and an internal stakeholder enriched and evaluated these ideas in different sessions. An overview of this proces can be seen in Figure 5.1

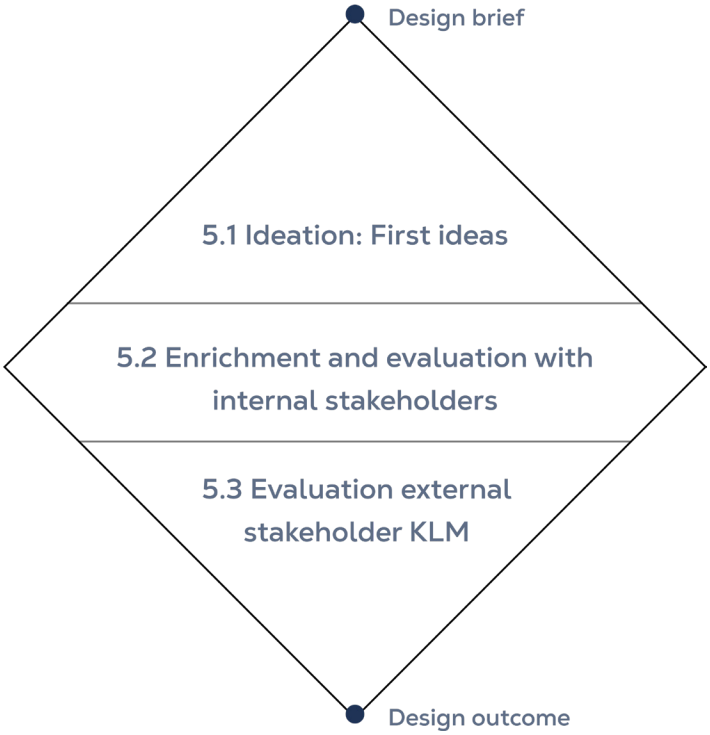


Figure 5.1: Design proces of the design outcome

5.1 Ideation: First ideas

By studying the case studies possibilities are opened up. The ideation started with a cross-case analysis of the case studies. An overview of this can be seen in Appendix U. The clusters of the statement cards are used to find possibilities. These solutions are taken and some of them are taken to a higher level by ideating around them. The Delft Design Guide's "SCAMPER" method is applied in this case (Boeijen et al., 2020). SCAMPER is a collection of thought sparkers or provocations that encourage you to reimagine a present reality (product, service, or situation) by applying new perspectives. An overview of this can be found in Appendix V.

5.2 Evaluation with internal stakeholders

After ideation the ideas are evaluated with internal stakeholders. These sessions aimed to evaluate the current ideas, ideate further and pick the most feasibile and impactful ideas. In this way the stakeholders are included in the proces and responsibilities can be discussed. Thus, the roadmap can be filled with ideas which can be taken furhter by the company.

5.2.1 Method

Internal RSG stakeholders who shared an interest in this topic or were responsible for some of the aspects of the problem were met for a session. These stakeholders were a range of seniors, all of whom differ in function: operations manager, customer experience, landside expert, strategic advisor airport master planning, and so on.

The session consisted of three parts. The ideas from the individual ideation phase were presented first. It was then up to the participants to assess these ideas on feasibility and potential impact. In the last part of the session, the participants discussed their insights and new ideas emerged.

There were in total 3 sessions and 11 internal stakeholders. The sessions were held in-person and online, and participants were asked to use the digital platform Miro to stimulate a hybrid brainstorming environment.

The ideas generated during the previous session are taken to the subsequent session after each.

5.2.2 Results

The results of the workshop are a range of categorized ideas on three different matrixes (as there were three different sessions). One brainstormsession is displayed in Appendix W. The insights of all the sessions were summarized into one board. The ideas with the most potential are shown in Figure 5.2.

The ideas with the most potential are mapped at the top right of the axis; these ideas are the most feasible and impactful: creating an online boarding pass, putting the departure terminal on the boarding pass, and creating a video to explain the transfer. Next, integrating the applications and digital wayfinding was most feasible and impactful. These ideas will be taken and set as the basis of the roadmap.

5.3 Evaluation external stakeholder KLM

To further evaluate the feasibility and desirability of these ideas, I proposed the ideas with most potential to KLM's current bi-modal project owner. This section discusses the method and key insights.

5.3.1 Method

Following a presentation about the ideas, there was a discussion about these ideas and the possibility of implementing these. Here, the goal was to let the project owner (bi-modal transport) of KLM talk the most. In this way KLM's viewpoint on this implementation and why can be understood.

5.3.2 Takeaways

My ideas sat well with the vision KLM had for bi-modal journeys. The idea to create a video to explain the transfer was mainly something that gave a positive reaction and is also decided to be developed (together with RSG). From now, this project will become a joint responsibility of RSG and KLM. Concluding, the current ideas are all kept. First, the most feasible ideas will be implemented with RSG, and next will be looked at the integration of the applications, and digital wayfinding will be.

Furthermore, what was noticed, is that the creation of a seamless bi-modal journey lies more in stakeholder management than conceptualization.

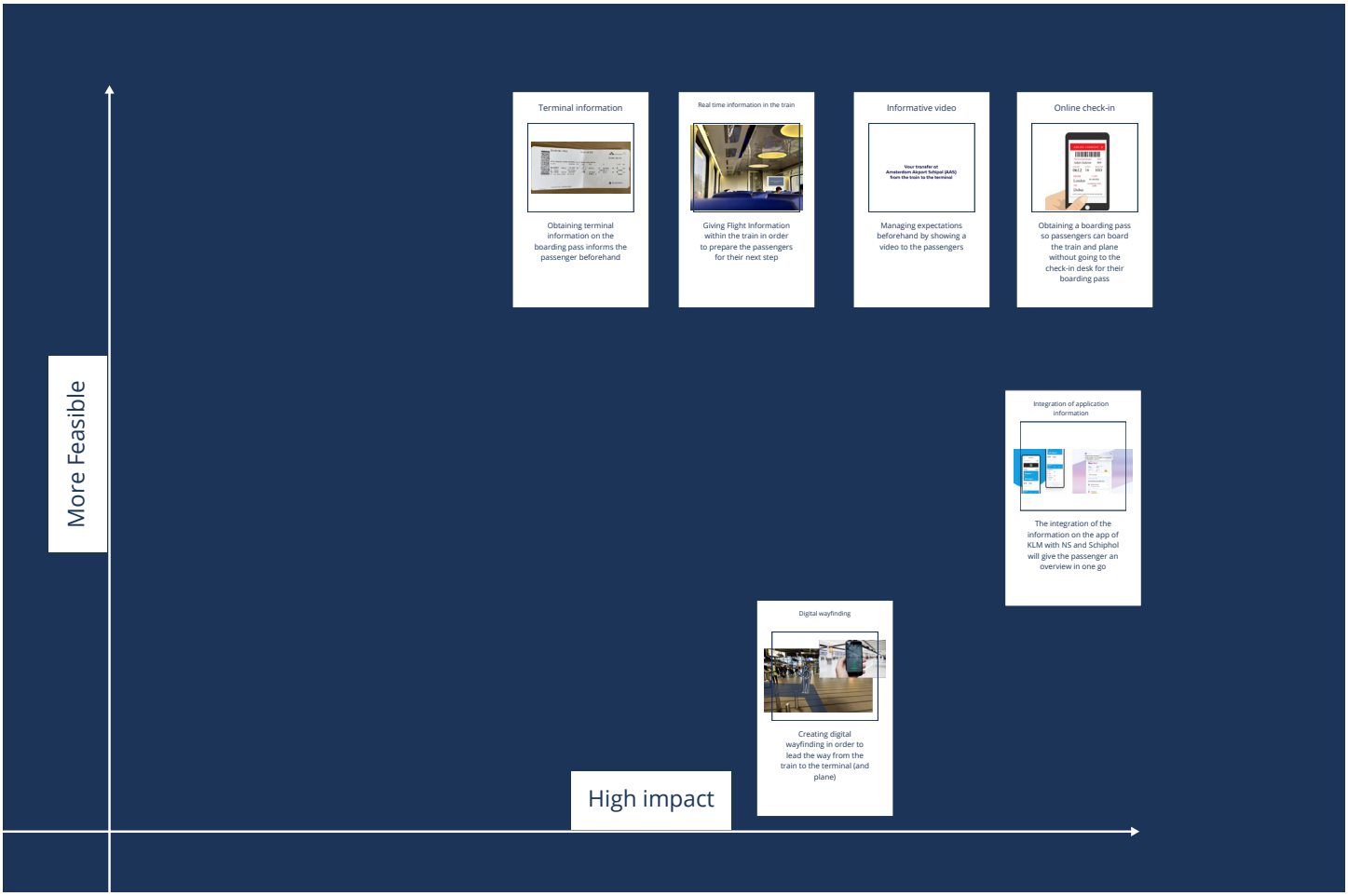


Figure 5.2: Ideas with most potential

The stakeholder was interested in the concepts. However, conversations about what should be done, who should do it, and when it should be done should be led by the one who sees the opportunity rather than who is responsible. As this study has insight in this, the outcome of this project, the roadmap, will show who takes responsibility for which part.

5.4 Analyzing leading to horizons

The evaluation sessions are analyzed to get a deeper understanding of the ideas. The ideas from Figure 5.2 can be put in three levels, each based on priority (see Figure 5.3). The most feasible ideas are improvements to the current system rather than changing the current system. The least feasible ideas are the ones that are changing the system to come to the end goal: creating seamless transfers. This chapter provides an overview of these levels by introducing them.

5.4.1 Context

First, the system is improved to ease the transfer at AMS. Second, structural improvements are proposed, elevating the bi-modal service to a new level. At the highest level, the "Service" will lead the passenger. The passenger does not have to make any effort. This would be a seamless transfer.

1. Getting the basics right: Correcting the current system.
First, the current system's opportunities should be improved to create a more seamless experience. These are: creating an online boarding pass, putting the departure terminal on the boarding pass, and creating a video to explain the transfer.

2. Moderate level integration: Seizing the full potential of the current systems.
The next layer is seizing the full potential of the currently existing services. It is about creating structural improvements within the current system. Being guided by information creates convenience for the passenger. The Amsterdam Airport Schiphol application explains step by step to the passenger what is expected from them, including real-time notifications of this. This concept should be integrated into the airline's applications to create passenger convenience.

3. Highest level integration: Creating system which leads the passenger.
The last layer is about creating a feeling of intuition, i.e., putting the service in the passenger's lead. The passenger will not have to put effort into finding the way anymore. This will relieve the passenger as it is taking responsibility away from the passenger.

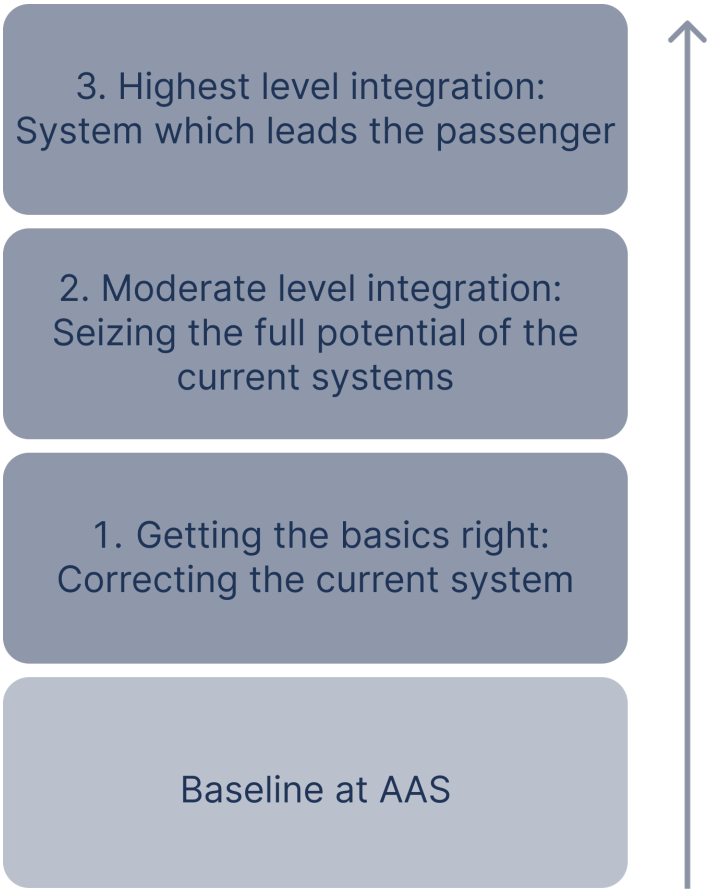


Figure 5.3: Levels to create seamless passenger transfers

6 An implementation roadmap for Amsterdam Airport Schiphol to create seamless bi-modal passenger transfers

This chapter describes how the insights from the previous chapter, including the three levels, can best be represented in practice. This is done through a roadmap. The roadmap explains how to create more seamless bi-modal passenger transfers.

6.1 The purpose and added value

A roadmap is created for AMS. The airport hub can add value to its bi-modal transfers by implementing the principles. There are two strategies, as was previously discussed in Chapter 4: either waiting for adoption or promoting adoption.

Business owners of RSG can use the roadmap to see when they can implement which ideas. It gives focus on who is the responsible party and for what. In this way, it gives an overview of what every party has to do.

On the next page the roadmap is shown.

Horizon 1 - Now

Business

Value proposition

Correcting the current system:
The transfer is made more accessible and manageable by removing the unnecessary and explaining what the passenger should expect.

Seizing
Structural
will give the
therefore

Trends

Values

Passengers

A convenient journey

Shortening the travel time

A secure feeling

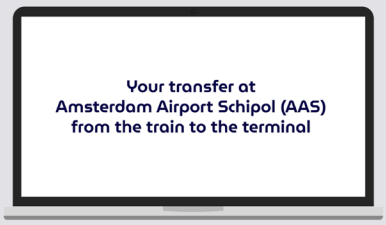
Airport

Overcoming the main hurdles of the passenger journey without extra fuss

Orchestratin
supported by

Product - service

Product



Online boarding pass

Explanation video

Implementation

Airlines

In application

On the screens in the airplane

In application

On the screens in the airplane

Airport

Stimulating stakeholders

Providing information (API)

Stimulating stakeholders

Creating video

On website

Railway operators

On the screens in the train

On the screens in the train

Horizon 2 - Later

the full potential of the current systems:
improvements within the current system
passenger an overview of the journey and,
will guide them and create convenience.

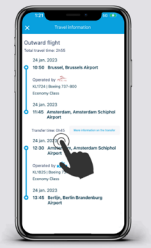
Digital travel buddy

A convenient journey

Efficient processes

A secure feeling

g smooth and inspiring passenger journeys,
efficient, digitally enabled airport processes



Integration of application

In application

Stimulating stakeholders

Providing information (API)

Horizon 3 - Next

System which leads the passenger:
Creating a system that puts the service in the passenger's lead will guide the passenger throughout the transfer.

Digital travel buddy

Service over medium

A convenient journey

Efficient processes

A comfortable journey

Orchestrating smooth and inspiring passenger journeys, supported by efficient, digitally enabled airport processes

A product which is modifiable to include and exclude different modalities

Digital wayfinding

In application

On smartwatch

Stimulating stakeholders

Providing information (API)

6.2 Horizon 1: Correcting the current system

First, some opportunities within the current system will create a more seamless experience. These are: creating an online boarding pass, putting the departure terminal on the boarding pass, and creating a video to explain the transfer. The current system should be improved to give passengers a product without unnecessary hassles. Therefore, the ideas that are improving the current system are as feasible as possible.

This chapter explains every concept.

6.2.1 Idea 1: Online check-in

The first concept is creating an online boarding pass for bi-modal passengers.

6.2.1.1 The purpose and values

An online boarding pass creates a hop-on and hop-off experience at the short-haul modality. This concept aims to create a more convenient journey for the passenger and shorten the time before the departure when traveling bi-modal (when the first modality is the short-haul one). I can see this decrease in time as a competitive advantage instead of going on an air-air transfer where the passenger has to be at the airport at least 2 hours in advance.

The concept is valuable for the passenger experience as it shortens the total travel time, which adds value to the passenger, the airport, and the airlines.

In the case of KLM and RSG, they both have passenger experience in their mission statement, which means this will add value to their core business.

6.2.1.2 Implementation

As all journeys include booking and ticketing, this concept applies to every bi-modal journey and will create that hop-on and hop-off experience.

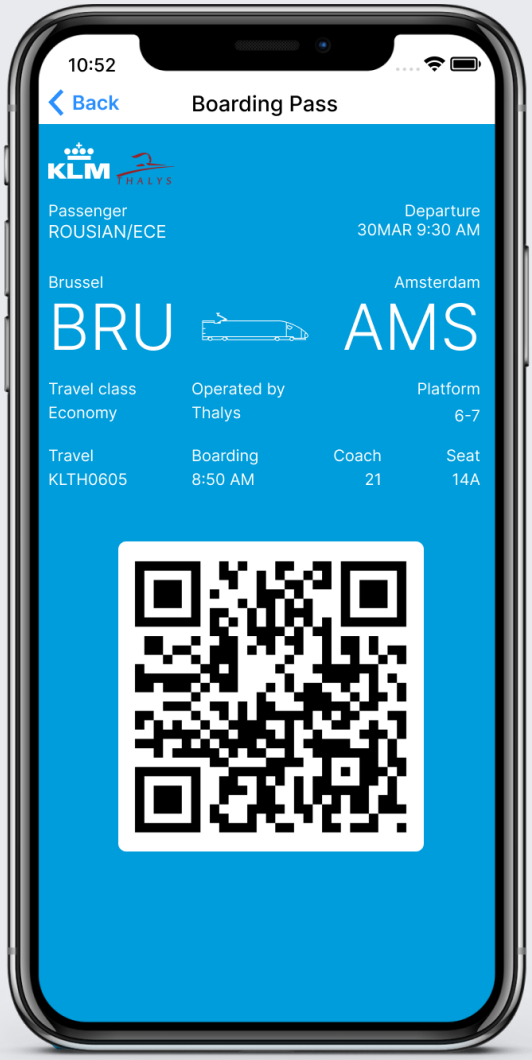
This concept is to be implemented in the environment of the airlines as this is where the passenger currently makes their booking. However, as RSG has obtained these insights, they should stimulate the airlines to implement this.

This is a product that already exists for air-to-air transfers. Therefore it can be implemented immediately and should get priority to be implemented immediately to create a more convenient journey for the passenger.

6.2.1.3 Barriers

The airlines want to guarantee whether the passenger took the short-haul modality to travel. Tickets are often cheaper abroad because of the higher tax rate in the Netherlands. Therefore AMS-NYE is more expensive than BRU-NYE. With the online boarding pass, passengers living in AMS can buy BRU-NYE and skip the first part (BRU-AMS) and still go to the airport to only take the long-haul flight. This affects the airline's business. We can solve this when airlines ask for the passengers' location once to check whether they are on the train or to send a message asking whether they are on the train (and can send a picture, for instance).

The following page is an example of how this concept could look.



ONLINE BOARDING PASS

An online boarding pass gives the passenger the ability to hop-on and hop-off the train.

6.2.2 Idea 2: Putting the terminal of departure on the boarding pass and the train

The passenger should receive information on the departure terminal before leaving the train. AMS generally fixes the departure terminal (e.g. KLM goes to terminals 1-2). Due to this, the passenger has some information about the next step in their journey.

6.2.2.1 The purpose and values

The departure terminal lets the passenger know which way to go when they go up to the elevator from the train at AMS. The passenger can directly go to their terminal of departure. Giving this information removes hesitation and creates a more secure feeling for the passenger.

The concept is valuable for the passenger experience, adding value to the passengers, the airport, and the airlines.

In the case of KLM and RSG, they both have passenger experience in their mission statement, which means this will add value to their core business.

6.2.1.2 Implementation

This concept will be shown on the boarding pass or the screens on the train. The information on the boarding pass is to be developed by KLM in coordination with RSG. As this information will be on the boarding pass, it is logical that KLM again develops this. The information on the screens within the train is to be developed by Thalys in coordination with KLM and RSG. As these concepts create convenience at the transfer, RSG is responsible for this. RSG should stimulate and facilitate this information. RSG has an API that gives information about every flight's departure terminal. They should stimulate KLM to implement this into their application.

The information exists, and it is implementable within the current environment of the airline application. Therefore, it should take a little technical effort to implement this.

6.2.1.3 Barriers

The barrier to this concept is that the airlines and train companies have to implement this information, and the airport has no further impact on whether this is done. However, in the case of KLM and RSG, as both businesses have passenger experience as their core value, RSG should stimulate this within the discussion.

The following pages are examples of how this could look.

TERMINAL OF DEPARTURE

The terminal of departure is fixed information that prepares the passenger as they will know which way they have to go when they go up to the elevator from the train at AMS.

TERMINAL OF DEPARTURE

The terminal of departure is fixed information that prepares the passenger as they will know which way they have to go when they go up to the elevator from the train at AMS.

6.2.3: A video which explains the transfer

The third concept is about creating a video that explains the transfer steps to the passenger.

6.2.3.1 The purpose and values

This link leads to the MVP of this video. This video manages the passengers' expectations and will give the passenger a secure feeling. It shows the passenger where to look and where to go. Due to this video, the passenger gains a focus on the transfer. They know where they have to go as they have seen this before. A more convenient and efficient journey will be the result of this video.

The concept is valuable for the passenger experience as it makes the journey more understandable, adding value to the passengers, the airport, and the airlines.

In the case of KLM and RSG, they both have passenger experience in their mission statement, which means this will add value to their core business.

6.2.3.2 Implementation

For transfers at AMS, one general video or multiple shorter videos can be made; for every travel modality and end destination. They could choose the right video with the right flight according to the departure terminal. This would be the clearest to passengers; however, making one video keeps the consistency and lower price.

This concept is to be developed by the airport, as the airport has taken chiefly up the role of being the facilitator and is also responsible for the seamless flow at the airport. There are different ways to implement it:

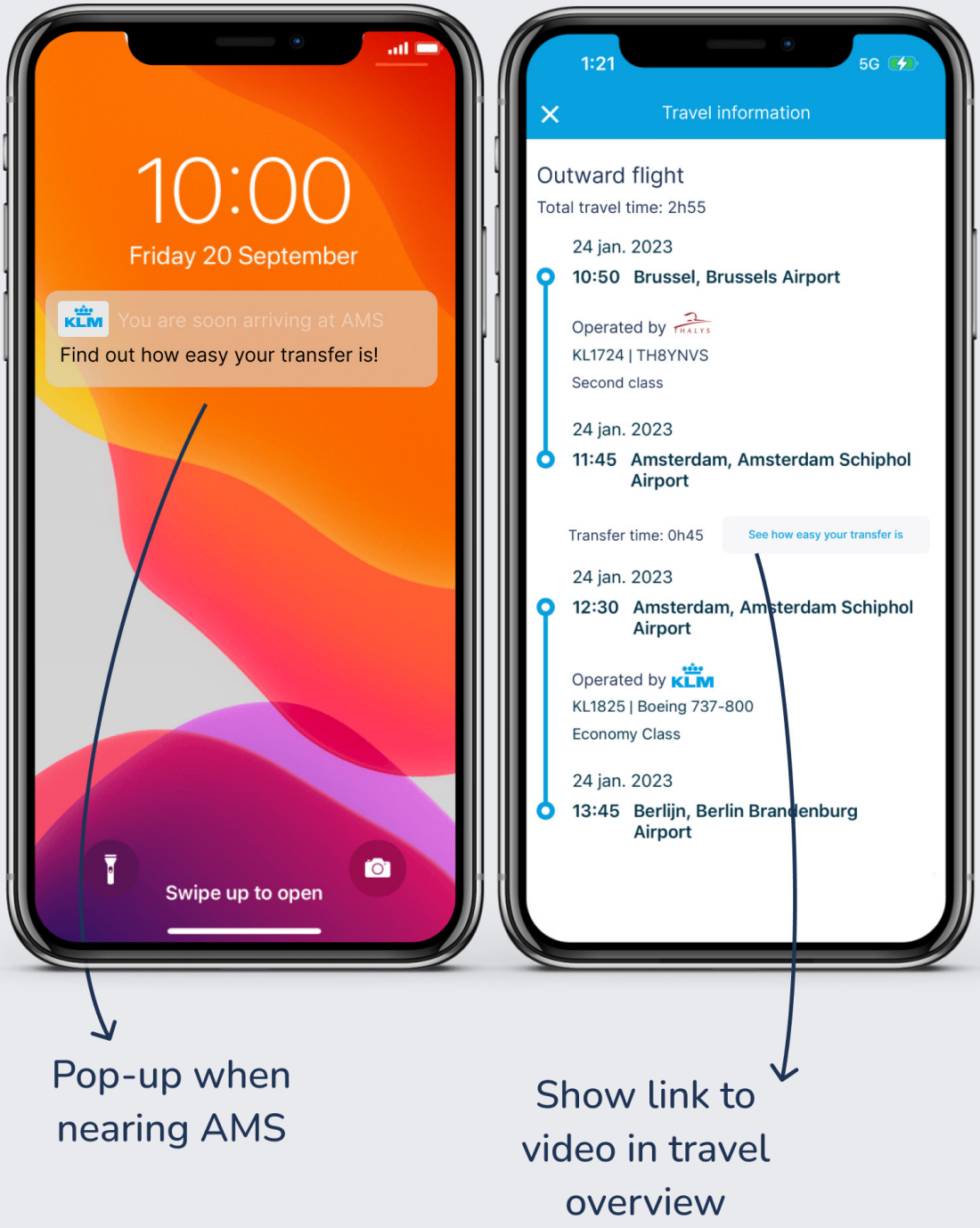
1. The airport can stimulate the airline's directing the passengers in the application (or e-mail) to the video. As for passengers, the airline is the primary touchpoint when booking this type of journey.
2. In collaboration with KLM and RSG, Thalys can show a more general video on the trains that travel internationally.
3. The airport can promote this service to attract passengers to use it on its website.

This video can be directly created as no additional changes to the current system must be made. The most crucial part is creating the video and arranging the channels to put the video on.

6.2.3.3 Barriers

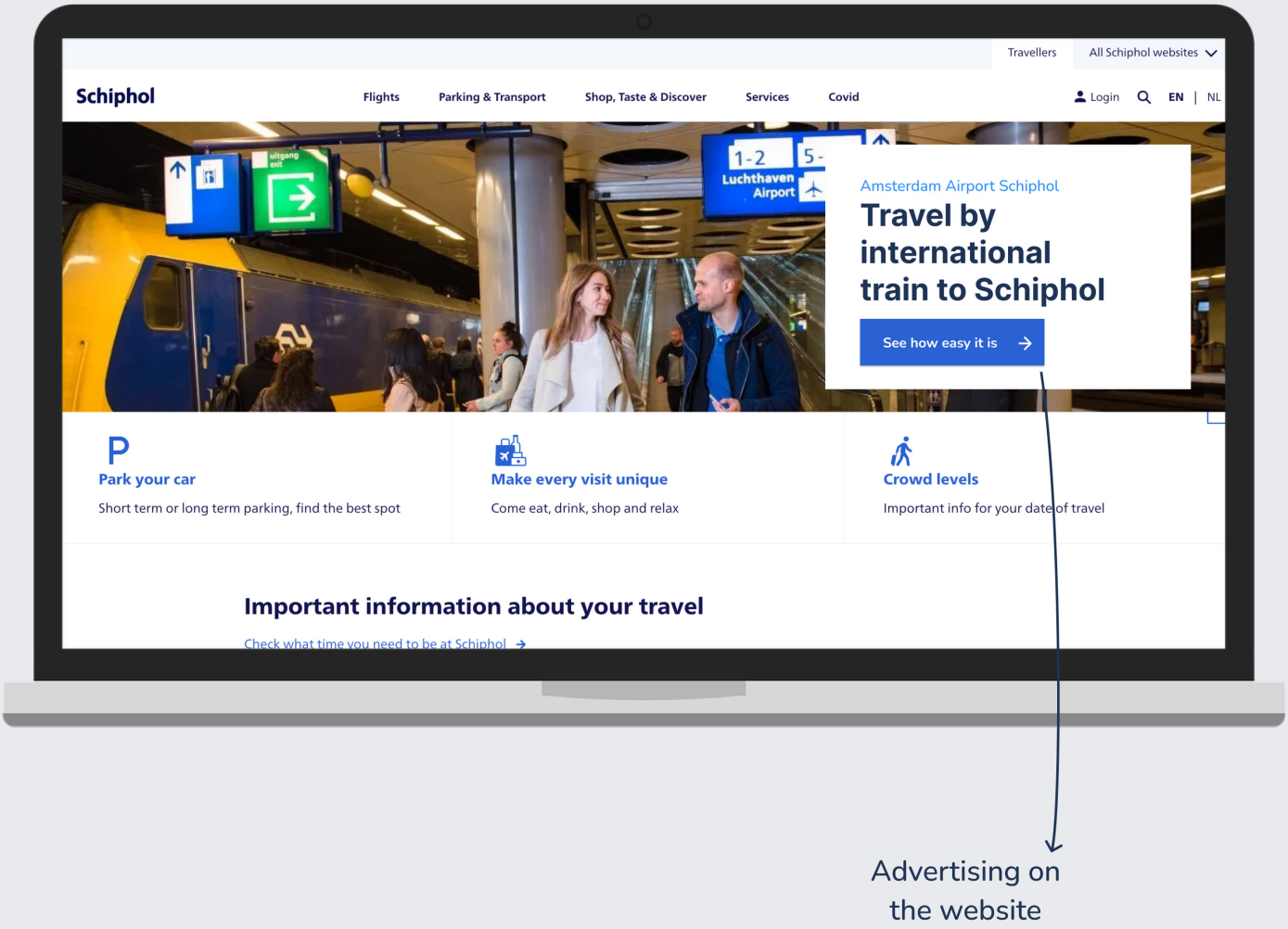
The barrier to this concept is that airlines and train providers have to implement this information, and the airport has no further impact on whether the airlines and train providers do this. However, as the businesses have passenger experience as their core value, it can stimulate the discussion by the airport. If this does not work out, RSG can still put the video on its channels (e.g., within its application and website).

The following pages are examples of how this could look.



EXPLANATION VIDEO

A general video explaining the transfer would manage the passenger's expectations of the journey and give it a focus.



EXPLANATION VIDEO

A general video explaining the transfer would manage the passenger's expectations of the journey and give it a focus.

EXPLANATION VIDEO

A general video explaining the transfer would manage the passenger's expectations of the journey and give it a focus.

6.3 Horizon 2: Seizing the full potential of the current

The next layer is seizing the full potential of the currently existing services. It is about creating structural improvements within the current system.

6.3.1 Idea 1: Integration of information

The concept is about integrating the currently available information at the Schiphol Amsterdam Airport application with the airline's applications. Being guided by information creates convenience for the passenger. The Amsterdam Airport Schiphol application explains step by step to the passenger what is expected from them, including realtime notifications. This overview will give the passengers a convenient and efficient journey and a secure feeling about what is expected.

6.3.1.1 The purpose and values

This integration is about creating a clear overview for the passenger by integrating the currently available information. Showcasing the steps to the passenger leads the passenger through the journey. Realtime pop-ups will stimulate the passenger about the action they have to take, creating a specific vision of the transfer. The passenger has to think less about what to do.

The concept creates smooth journeys supported by efficient, digitally enabled processes, which the airports have as a core value.

6.3.1.2 Implementation

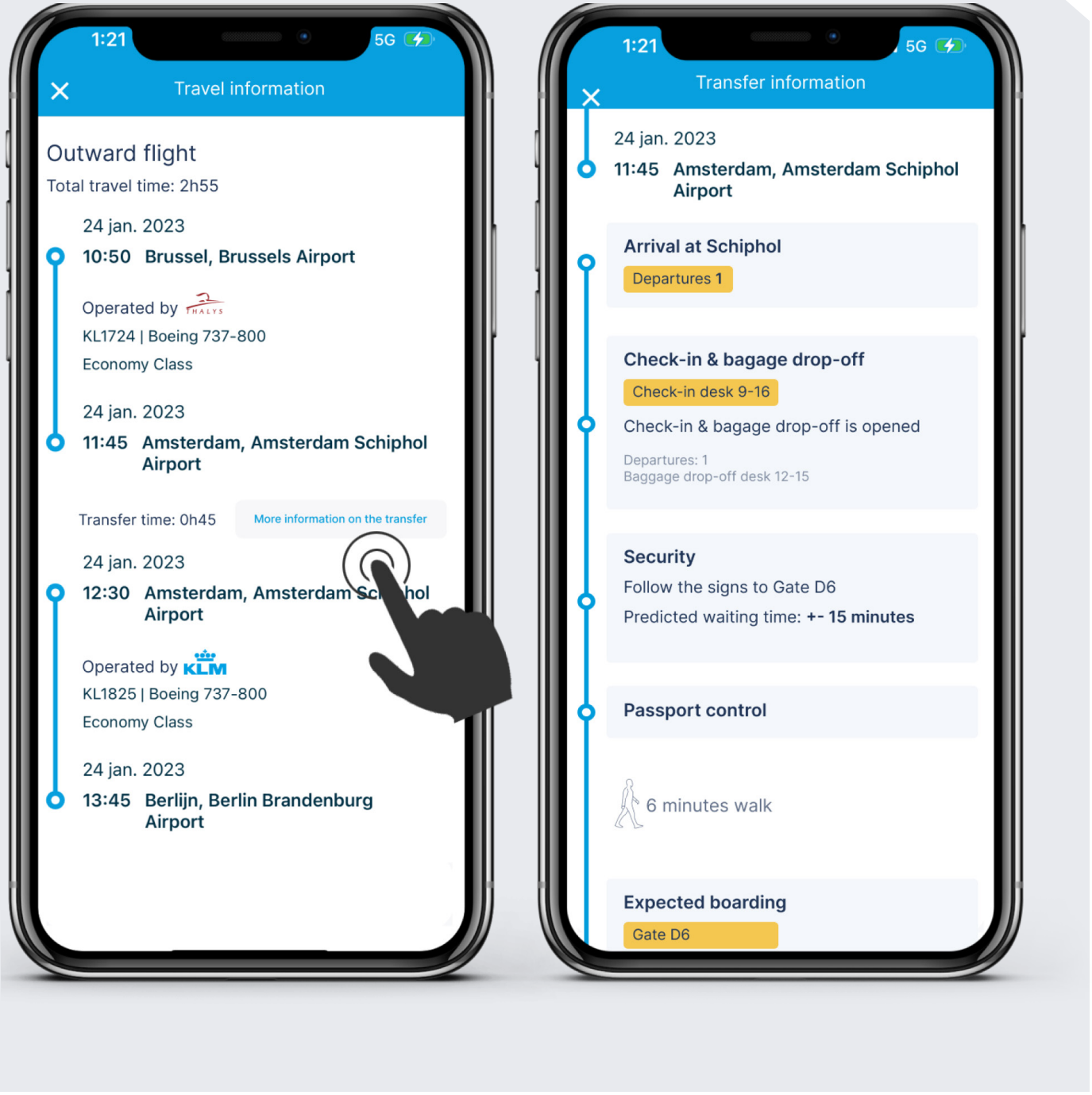
This concept is universal and can be implemented by every interested party (e.g., airline). This concept is to be developed by the airport and the interested airlines. The airport is responsible for the seamless flow of the airport. The Amsterdam Airport Schiphol application currently has mapped out the steps for the passenger in their application. The airport can make this information (e.g., their API) available to the airlines. The airport is the facilitator. Next, the airport has to stimulate the airlines to implement this API.

The input for this idea is already available at RSG (e.g., their API). However, the product must still be implemented within the airline's application, which can take some time. This will take little effort as no new environment has to be created, and it can be put in the airline's application. After correcting the current system, this should be the next priority on the list of improvements.

6.3.1.3 Barriers

The barrier to this concept is that the airlines must implement this information, and the airport has no further impact on whether the airlines will do this. RSG has to convince the businesses that it is essential to implement this to increase the passenger experience. It will help if the airport makes the implementation easy for the airlines.

The following page is an example of how this could look.



INTEGRATION OF INFORMATION

By integrating the information currently available and the information in the applications of the airlines the passenger is guided throughout the transfer.

6.4 Horizon 3: A system which leads the passenger

The last layer is about putting the service in the passenger's lead. The passenger will not have to put effort into finding the way anymore. This will create convenience, efficiency, and comfort for the passenger as it takes responsibility away from them.

6.4.1 Idea 1: Intuitive digital wayfinding

The concept is about integrating digital wayfinding with the airline's applications. The passenger is nudged by vibrations which will lead the passenger in the right direction. At the same time, the passenger will receive a message to inform them.

6.4.1.1 The purpose and values

This integration is about creating low cognitive effort for the passenger. A digitally enabled process creates a smooth and inspiring journey. The passenger does not have to put in the cognitive effort to be at its location. The concept creates total convenience for the passenger by 'taking them by the hand'. Realtime pop-ups will stimulate the passenger about the action they have to take, creating a specific vision of the transfer.

The concept creates a seamless experience that increases the passenger experience, which is valuable for passengers, airlines, and airports.

The concept is valuable for the airport as they do not have to change their infrastructure to create a sense of intuitive wayfinding for bi-modal and, eventually, multimodal transfers.

6.4.1.2 Implementation

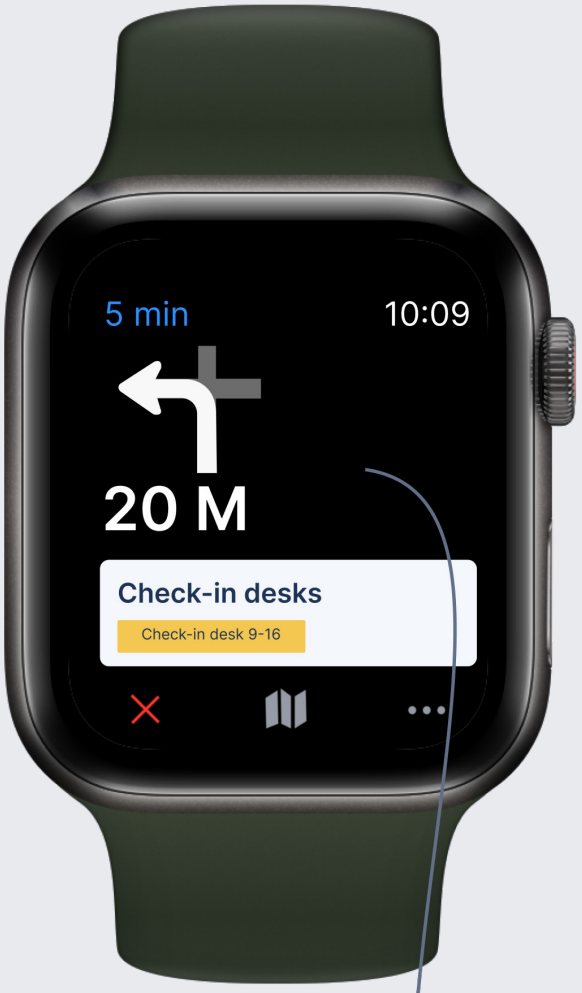
This concept is to be developed by the airport and implemented by the interested airlines. The airport already has wayfinding information available (i.e., wayfinding API). The airport has to optimize this API and make the API public for airlines. As the passenger's primary touchpoint of the journey is the airline, this concept has to be implemented within the airline's application. This concept is universal and can be implemented by every interested party (e.g., airline).

The input for this idea is already partially available at RSG (e.g., their API). This has to be further developed to be made usable for airlines. This will take some time. Next, the product has to be implemented within the airline's environment. The service should be developed when the offer of integrated bi-modal journeys grows. Due to the various options, passengers will need personalized travel.

6.4.1.3 Barriers

This information is currently available, but it still needs to be implemented. The barrier to this concept is that the airlines must implement this information while improving the airport facilities. However, it is improving the passenger experience. Therefore, RSG has to convince the businesses that it is essential to implement this to increase the passenger experience. It will help if the airport makes the implementation easy for the airlines.

The following page is an example of how this could look.



Vibrates when you have to go a certain direction

Real time pop-up

INTUITIVE DIGITAL WAYFINDING

By integrating the information currently available and the information in the applications of the airlines the passenger is guided throughout the transfer.

7 Discussions and conclusion

This chapter draws and discusses the conclusion of the project. In addition,it discusses the limitations and recommendations of the project.

7.1 Conclusion

The overarching research question of this thesis was: “How can AMS facilitate seamless bi-modal passenger transfers?”

The research question consisted of understanding the client and the company. I had little knowledge of the company’s background and the problem, so I started with understanding the company and bi-modal transfers. Through business analysis and many conversations with my company mentor, I understood how the company works and its values. Through a literature study, I understood the phenomenon and learned more about the influences of these transfers. With these factors, I used an explorative research approach to find out the problem. The solution space is understood by looking at the offer at other airports. By evaluation with stakeholders, feasible and impactful ideas are selected, and meaning is gained within the assignment. An implementation plan with the most feasible and impactful ideas is created.

All these insights brought me to the core of the problem, and I defined the problem’s challenge. Along the way, it became clear that this question was more complex than I thought. It is a broad challenge that also has a complex stakeholder environment. Therefore, a particular focus and approach are chosen for this project. For this, the Curve of Innovation is used to back it up. A prioritization of improvements is made.

The challenge consisted of several elements. First, the check-in process at the train station causes unnecessary hassles for the passenger. Currently, online check-in is impossible; therefore, you must pick up your boarding pass at the train station. Next, it is unclear to the passenger what is expected when they leave the train until they are at the check-in counter. This causes uncertainty while transferring to the airport.

During the creation of ideas, it has been a priority that the design must meet the design criteria. First of all, the plan aimed to create a better passenger experience. It sought to remove unnecessary hassles and tilt the service to the next level. It has been in the back of my mind that the design must be flexible in the long term, as the mobility environment could be changing. The design outcome was also crucial to avoid creating unnecessary extra products or infrastructure, as this would not contribute to the sustainable service offered. Next, the product had to fit the company’s strategy and marketing mix. This would give a higher implementation chance of the ideas. Therefore, digital solutions are selected. The business insight helped create the right ideas, and evaluation sessions helped set the most feasible ideas.

These insights resulted in the implementation roadmap for seamless bi-modal passenger transfers. It proposes ideas that will enhance the transfer experience of the passenger. It starts with correcting the current system, then seizing the existing systems’ full potential, and next, it proposes a system that leads the passenger and creates seamless transfers. The ideas are: creating an online boarding pass, putting the departure terminal on the boarding pass, and creating a video to explain the transfer. Next, integrating the applications will be done, and later digital wayfinding will be more feasible.

The project’s final design aims to create more seamless passenger transfers, which of course, several limitations and recommendations indicate that it is not perfect. However, in the scope of this assignment, to answer the question “How can AMS facilitate seamless bi-modal passenger transfers?” this project prioritizes ideas, and the roadmap gives an approach to those prioritized ideas. This thesis proposes an implementation roadmap. Furthermore, it describes the responsible parties. The value is found in that a plan is made, which is quick and easy to implement. This is a practical approach to take in an environment with a complex stakeholder environment.

7.2 Discussion

The discussion section discusses how the concept by looking at the design criteria.

The research set-up
This research uses case studies to investigate the status quo of AMS. According to Flyvbjerg (2006, p. 12), one of the big misunderstandings of case studies is assuming that one cannot generalize case studies and that a case study cannot contribute to scientific development. However, Flyvbjerg (2006) explains the opposite. Flyvbjerg (2006, p. 12) explains, “One can often generalize based on a single case, and the case study may be

central to scientific development via generalization as a supplement or alternative to other methods." Case studies help to get a deeper understanding of the phenomenon. The case studies at AMS helped to understand the root of the problem and the why behind this. The benchmarking helped to understand the solution area. Due to this, the solution tackles the basis of the problem. This approach, therefore, seems to be the one that gives the right solution to the problem.

Enhancing passenger experience
When looking realistically at the design outcome, some proposed innovations are more a luxury than a necessity. Currently, passengers can transfer at AMS easily due to the convenient integration of infrastructure. However, these extra services proposed in this thesis become necessary as the airport aims to become the most high-quality airport.

The bi-modal product
The project focused on bi-modal journeys in general. However, there is currently not a broad offer of bi-modal journeys. Therefore it has chosen to focus on the currently available journeys. It is assumed that aspects are interchangeable between bi-modal journeys. However, there will be aspects that differ as well. Therefore the research outcome also focuses on the current situation and has to be revised when more bi-modal journeys are offered.

Besides the fact that this thesis was focused on the transfer, the focus of the development of the bi-modal product should focus on the whole journey. As this research mentioned, ticketing is a crucial part of what must be improved: this is something other than what falls into the transfer. However, if this part is not being improved, improving the transfer will not be noticed as only the negative side of the journey will be noticed.

Fit RSG
The concepts which are presented are all in line with the vision of RSG, as they are all coming forward from multiple internal evaluation sessions.

Feasibility
This research results in an implementation plan that is quick and easy to implement. The implementation is simple in terms of operational barriers. Existing services are used to implement the service. However, the implementation can be challenging in terms of stakeholder management. Collaboration is complex because the stakeholders work differently and put themselves first. Choosing as feasible as possible ideas lowers the barrier to trying them out. Next, the responsibilities of the companies are also described and can be held accountable. This has shown to be a good strategy as one of the ideas in the first horizon is taken up by RSG and KLM (i.e., the information video).

7.3 Limitations and recommendations

The limitation and recommendation section explains how the concept could better meet the design criteria.

The research set-up
This thesis is based on the passenger experience of n=1. Where this was grounded, the ideas should still be evaluated before implementation. I would recommend creating MVPs for the three horizons and putting a student on every level to determine the influence of the MVP on the journey. The influence of the MVP can be measured.

Enhancing passenger experience
This thesis will focus on yielding this first group of the early majority to use this service. Another Seamless Personal Mobility Lab graduate student, Fiona Taniguchi, is conducting additional research on baggage services. A direction for baggage integration did pop up during the case studies. This is given as recommendations in Appendix X. Next to this, it is recommended that a student with an architectural background looks at potential infrastructure improvements.

Fit to RSG
The framework and concepts are not universal and applicable to all (comparable) airport hubs. This thesis was conducted in the assignment of RSG; it is shaped toward their strengths. These insights can be used for other airport hubs. However, it is recommended to investigate the airport hub before further shaping this concept. The proposed ideas are shaped around RSG's aim and skills and selected by internal stakeholders of RSG. Different ideas could be more fitting if other airports had different strengths and priorities.

Feasibility
Implementing the concepts may still require more attention, as more obstacles always arise in practice.

Next, this thesis only grasps a part of understanding the stakeholder environment. For implementation, the airport depends on the airlines and train operators. As said before, the stakeholders should take more initiative. More research should be done to understand how initiatives can be implemented even when stakeholders are not interested.

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