BRIDGING THE INSIGHTS GAP

Elevating rail-bus transfers at Schiphol

Schiphol

Master thesis Design For Interaction
Faculty of Industrial Design Engineering
Samuel Bronkhorst

TU Delft

AUTHOR

S. I. Bronkhorst (Samuel)
4554574

MASTER THESIS

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IN COLLABORATION WITH

Royal Schiphol Group

GRADUATION BOARD

Prof. mr. dr. ir. S.C. Santema	Chair
Ir. A.S. Toet	Mentor
Ir. K. Boersma	Company Mentor

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PREFACE

DEAR READER,

I feel honoured that you have taken the time to read my thesis. After months of hard work, the completion of this project marks the end of my master's Design for Interaction and my time at the faculty of Industrial Design Engineering at the TU Delft. I hope to provide you with a clear and concise overview of the design I have created for Schiphol. Before delving into the content of this report, I want to thank my graduation board for their dedication and pleasant guidance.

Aniek, you always prioritized my well-being and enjoyment more than the progress of the project, something I value very much. You always knew when to be serious and when to keep things light-hearted. Thank you for your personal style of guidance, the many enjoyable conversations we've had, and helping me to feel at home at Schiphol.

Klaas, your enthusiasm and expression of confidence have, on many occasions throughout the project, provided me with extra direction and assurance when I felt stuck. I hope to have a similarly positive influence on my colleagues and work environment later in my career, something I greatly admire about you.

Sicco, your unique ability to know exactly what to say to make me take one step back so I could take five steps forward has helped me significantly. Thank you for assisting me when you realized I required guidance, especially outside of our scheduled meetings.

I would also like to express my gratitude to all the Schiphol employees who welcomed me into their work environment, especially the colleagues of Master Planning and the Innovation Hub. You made sure that I came to the office with joy and got to experience what it's like to operate in this interesting company.

Lastly, I would like to thank my friends and family who have helped and supported me throughout this project. Your distractions or brief conversations about the process have contributed a lot. A listening ear and subtle input have always had a significant impact.

ENJOY THE READ!

- SAMUEL

EXECUTIVE SUMMARY

In the era of increasing global connectivity, Schiphol Airport aims to transform into a Multimodal Transport Hub (MTH) to meet the growing demand for seamless travel experiences. This shift from the traditional hub-and-spoke model to an MTH not only enhances passenger satisfaction but also positions Schiphol as a leader in the aviation industry and the Dutch global city region.

The transition to an MTH aligns with the global trend of promoting sustainable transportation alternatives, emphasizing the importance of integrating various transport modes to create efficient and user-friendly connections. Royal Schiphol Group (RSG) is committed to develop the world's most sustainable and high-quality airports, reflecting the societal push for responsible transport systems.

The mobility industry's increasing focus on the intersections of various transport subsystems emphasizes the need for integrated services and a seamless journey experience. By adopting the role of an MTH, Schiphol can meet the evolving expectations of travellers.

However, implementing a multimodal service and infrastructure is complex, and understanding passenger dynamics, constraints, and needs during intermodal transfers is crucial. Schiphol already serves as a hub between various transport modes, but there is a lack of insights into non-air travellers, including as bus and train travellers.

To bridge this knowledge gap and enhance rail-bus transfers, this project aims to design a support system for the S&AP department of RSG. This system will provide valuable insights into traveller needs and desires during rail-bus transfers. These insights will serve as argumentation for decision-making in construction projects. Through these insights, Schiphol can make well-informed decisions to enhance passenger satisfaction, streamline the rail-bus transfer process, and ultimately solidify its position as a customer-centric MTH.

The core objective of this project is the development of a support system that utilizes analysed data to present traveller preferences. To achieve this goal, various aspects require comprehensive understanding, which is categorized into three key themes,

First, the support system needs to create value for RSG by providing insights relevant to the organization and ensuring these insights contribute to the company's objectives.
Secondly, the support system must be optimized for usability and interaction, ensuring that RSG employees can easily access the desired insights.
Lastly, there needs to be a seamless integration of the support system into RSG's workflow, system operation and digital environment.

The support system should provide valuable insights but must avoid overloading users with information. Therefore, it focuses on three key aspects: differences between travellers, their needs and desires, and the transfer direction between bus and train. The system's architecture enables users to specify their preferences and receive insights tailored to their criteria. To strike a balance between providing in-depth insights and maintaining a clear overview, the system categorizes traveller needs and desires into six main categories, with the option to explore detailed insights within each category.

The system design has been validated through usability studies and consultations with relevant departments, aligning with the organization's workflow. In conclusion, the project has successfully met all criteria, indicating that the support system adds substantial value to RSG.

LIST OF ABBREVIATIONS AND DEFINITIONS

MTH

Multimodal Transport Hub

RSG

Royal Schiphol Group

S&AP

Strategy & Airport Planning department of Royal Schiphol Group. This department develops the vision and strategy for the mid and long term.

LIST OF DEFINITIONS

AIR-RELATED TRANSFER

A transfer in which at least one of the modalities is an airplane.

MODALITY

Means of transport, like the train, bus or plane.

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).

OD-TRAVELLER

Origin destination traveller, a traveller that is traveling from one place to another without transferring. This term is ofter used for airplane travellers that have no overlay.

RAIL-BUS JOURNEY

A trip in which a train ride and a bus ride are combined.

RAIL-BUS TRANSFER

The transfer from bus to train, and from train to bus.

SEAMLESS

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

TRANSFER

Transitioning between modalities as a traveller. This can involve staying within the same modality or switching between two different ones.

USER EXPERIENCE

A person's perceptions and responses that result from the use and/or anticipated use of a system, product or service (ISO, 2019)

TABLE OF CONTENT

THE FOUNDATION

1

THE RESEARCH FOUNDATION

1.1 APPROACH

AN ITERATIVE EXPLORATION OF TRAVELLER PERSPECTIVES.

This research is characterized by an exploratory approach, allowing me to gradually delve deeper into the subject of a Multimodal Transport Hub (MTH) at Schiphol Airport. This approach has resulted in an iterative research process, where I repeatedly adjusted my scope and research question. I am grateful to my graduation committee for having given me the confidence to take this freedom, allowing me to arrive at the final scope and outcome.

The starting point of this research is my interest in the MTH concept at Schiphol, the main theme of Aniek Toet's PhD of which this project is a part. Since my knowledge and understanding of this subject were limited, I began with a general exploration of this topic. I gained information and insights through literature, reports, and most importantly, my presence at discussions and daily conversations at the Royal Schiphol Group office.

This initial exploration exposed me to various aspects of the MTH concept, including the dynamics of Schiphol Airport itself, different modes of transportation, and the challenges of transfers for travellers. As I gained more insight, I started asking more targeted questions and revising my research question. An overview of the progression of my scope and research questions can be found in Chapter 14.1

To provide structure to the project, I utilized the Odyssey Design Framework, a methodology that emphasizes continuously adjusting your approach based on evolving insights. It consists of five phases, each dedicated to specific activities and objectives to ensure a thorough and user-centered design process. You will find an explanation of this framework on the next page and in Figure 1.1.

This process of gradual refinement and redefinition has resulted in a solid research foundation that serves as the basis for the subsequent stages of my research. It has enabled me to clearly define my research objectives and structure my approach to generate valuable insights regarding travellers' perspectives at Schiphol Airport.

1.2 THE ODYSSEY DESIGN FRAMEWORK

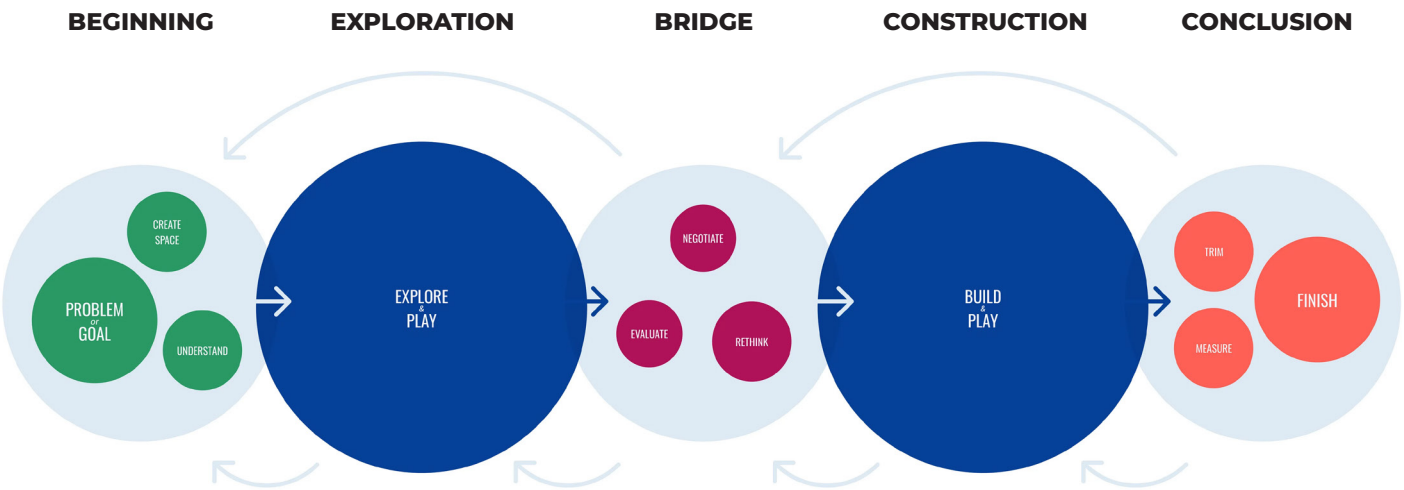


Figure 1.1: The Odyssey Design Framework (Ford, 2022)

BEGINNING

The identification of the goal. Through research, data, and conversations an understanding is developed about the topic and the research space. How do we make the project of value and what is needed to do so?

What are we trying to do and why?

EXPLORATION

The early designs and ideas come up, but freedom should play a big role. It is about exploring possibilities and getting the right knowledge to elaborate on opportunities. Boundaries exist to keep the work focused, but ideas should be stressed.

How might we get to where we want to go?

BRIDGE

Explorations are challenged and criticized by stakeholders or the client. Here, it should be assessed whether the existing opportunities are useful and achievable. It may be necessary to go back in the process to explore other options.

Are we doing things right?

CONSTRUCTION

In this phase the design is further developed, with the focus is on the final concept. It involves collaboration with stakeholders and the client to review and refine the design, but it should remain playful to allow changes to be made.

How can we push ahead together?

CONCLUSION

The concept is assessed whether the final goal has been achieved, and a critical review is conducted once again to ensure that the scope aligns with the final outcome. Does the final design adequately help to achieve the goal? It is important to maintain a critical mindset during this evaluation.

What does ‘done’ look like?

1.3 READING GUIDE

All the insights in this project have been derived from literature research, conversations with various RSG employees, and conducted studies. The literature insights are indicated by APA references, with the complete source provided in Chapter 14. Throughout the report, you will find orange boxes, as shown in Figure 1.2. These boxes present a summary of the various studies I conducted during my project. The insights from these studies are sometimes applicable to different chapters and are not always used in chronological order. By referring to these 'research boxes', I can mention only the insights that are relevant in each chapter without explaining the entire research, which aids in streamlined reading of the report. The Appendix provides a more detailed explanation of the execution of some of the studies in the research boxes. Figure 1.5 on the next page shows an overview of the various studies I have conducted. The letters are based on the chronology of conducting the research. Literature research is not placed in research boxes and the overview. Also, conversations with various RSG employees and research that not involved other people are left out of the research boxes and overview. This mainly involves brainstorming sessions and discussions.

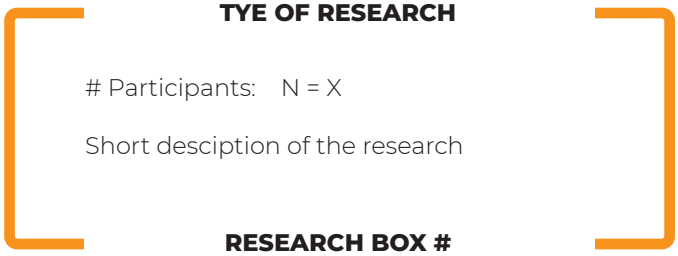


Figure 1.2 Example of Research Box

For the majority of the studies, the Delft Design Guide served as the basis for the chosen methodology (van Boeijen, et al., 2020). In Figure 1.5, each study is accompanied by the respective research method. Often, a variation of the original methodology is applied, which is encouraged by professors at the IDE faculty Loyd and Van Der Bijl in their podcast (2019). They state that methodology should function as a tool which you deploy in the way you make it useful for yourself when you need support, rather than fixed rules to be worked within.

" It is about life jackets, rather than strait jackets. "

- Loyd & Van Der Bijl (2019)

REFLECTION BOXES

Throughout the report, you will find gray boxes, as shown in Figure 1.3. These boxes present reflective thoughts about the process related to the corresponding chapter. They assist the reader in better understanding the underlying thoughts and choices made, while reading the report.

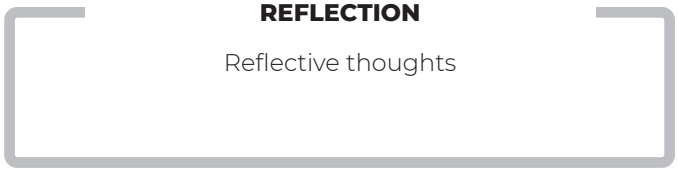


Figure 1.3 Example of Reflection Box

CONCLUSION FRAMES

Throughout the report, you will find orange frames, as shown in Figure 1.4. In these frames, the conclusions of the above text that influence the design are briefly mentioned. The orange frames provide the reasoning behind why certain design choices have been made.

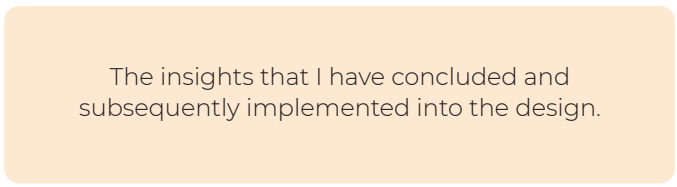


Figure 1.4 Example of Conclusion frame

Short description of reserarch	Research Box	Number of participants	Research method	Delft Design Guide page
Workshop - S&AP	A	3	Focus Group	p. 95
Survey - Plaza	B	54	Questionnaire	p. 93
Interviews - Bliptrack	C	2	Interview	p. 91
Brainstorm + Workshop - Design Students	D	2	- How-To's - Focus Group	p. 175 p. 95
Interview - Customer Insights	E	1	Interview	p. 91
Workshop - Experienced travellers	F	3	Role-Playing	p. 197
Interview - SharePoint	G	2	Interview	p. 91
Observation Research	H		User Observation	p. 89
Self Experience research	I			Not in guide
Comprehensive Questionnaire - Travellers	J	16	Questionnaire	p. 93
Questionnaire - Master planning	K	4	Questionnaire	p. 93
Usability studie	L	11	- Cognitive Walkthrough - Questionnaire	Not in guide p. 93
Interview - Power BI expert	M	1	Interview	p. 91
Interview - Customer Insigh	N	1	Interview	p. 91

Figure 1.5 Research overview. Description linked to resrach box and Delft Design Guide

REFLECTION

Some of the insights from conducted studies are not included in the report. This is because the purpose of this report is to present the final product and the underlying reasoning as clearly as possible. Therefore, all insights that only contributed to the design process and that are not directly relevant to the final design have been omitted. This focus is also why in this report, the boxes are used in a different order than the chronological one in which they were conducted, like is shown in Figure 1.5

1.4 TOPIC BACKGROUND

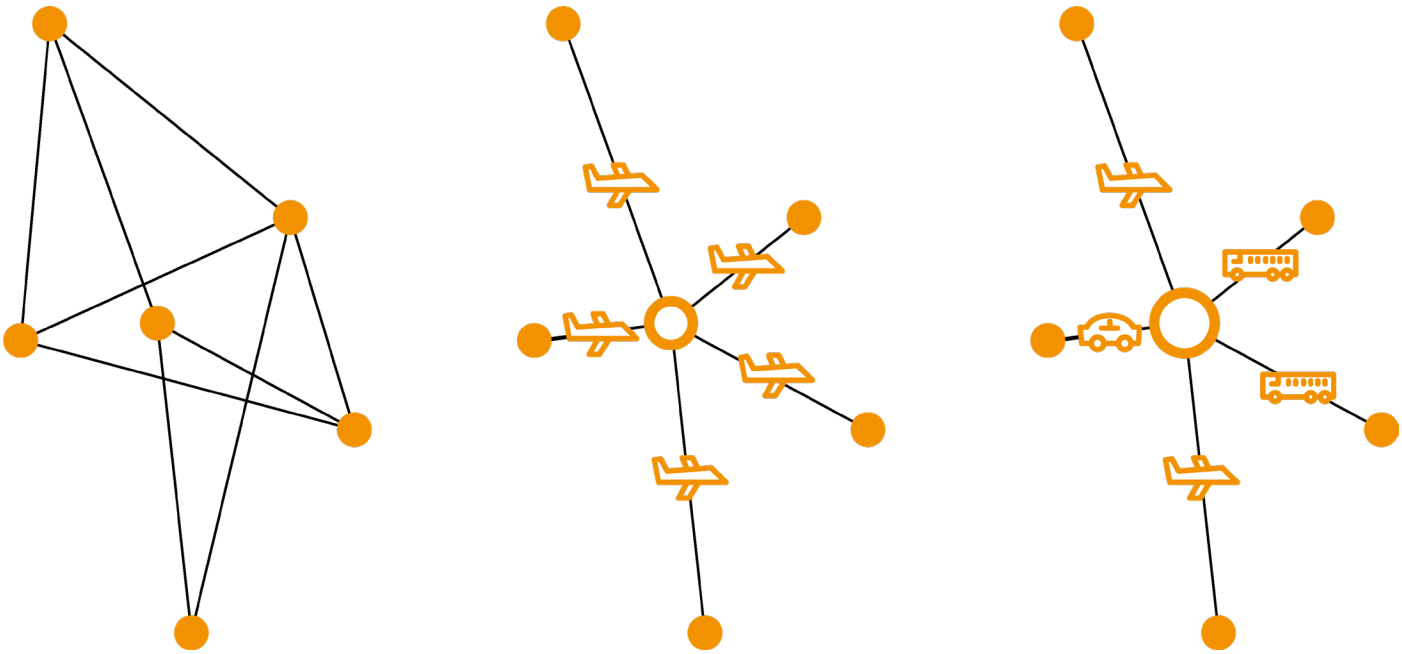
CURRENT WAY OF TRAVEL

In an era of increasing global connectivity, airports play a pivotal role in facilitating seamless travel experiences for millions of travellers worldwide. In this interconnected world, the hub-and-spoke model has emerged as a strategy employed by airlines. It contributes to efficiently manage the flow of travellers and streamline air travel operations. In a hub-and-spoke model, passengers travel from their local airport to an airport hub, where they transfer to a flight to another destination.

The advantage of this model is that it increases efficiency by merging multiple flights at one location allowing airlines to offer more frequent and better-coordinated connections. This enables travellers to reach more destinations with just one transfer while requiring less variety of flights for airports. Airports that serve as a hub, aim to provide excellent facilities and services to accommodate these transfers.

MULTIMODAL TRANSPORT HUB

As the demand for global travel continues to grow, along with an increasing expectation for a higher travel experience, there is a notable trend towards the development of MTHs (Li & Xu, 2019)(Pshinko, et al., 2022). Besides that, the current focus of airport hubs on airplanes and the need for sustainable alternatives due to societal pressure indicate the importance of the service integration and of new transport modalities (Toet, 2022). The concept of a MTH involves the integration of different transportation modes, such as air, rail, road, and even cycling networks, into a cohesive and interconnected system (Anderson et al., 2017). This is visualised in Figure 1.6. The passenger oriented MTHs aim to streamline transfers, reduce travel times, and improve overall passenger experience by providing seamless interchanges between the modalities. The creation of MTHs is encouraged by the EU Commission, which stated that "...airports, ports, railway, metro and bus stations, should increasingly be linked and transformed into multimodal connection platforms for passengers." (European Commission, 2011).



POINT-TO-POINT | **HUB-AND-SPOKE MODEL** | **MULTIMODAL TRANSPORT HUB**

Figure 1.6. Different transport models

BACK TO THE LEADING INTERNATIONAL AIRPORT

Schiphol Airport has emerged as a prominent player in the aviation industry, securing the third position in terms of air transport movements in Europe in 2019 (Schiphol Group's Annual Report, 2020). The top priority of Royal Schiphol Group (RSG), the parent company that owns and operates Schiphol Airport, is to re-establish Schiphol's reputation as a leading international airport (Schiphol Group's Annual Report, 2022). As one of the largest airports in Europe and major connector of the Netherlands, Schiphol Airport has the potential to develop as a MTH and reach its goal by providing seamless connectivity between air, rail, and road transport modes.

By shifting from the use of the hub-and-spoke model towards becoming an MTH, Schiphol is able to serve a broader range of travellers and provide an enhanced travel experience for all non-air related transfers too. This increases the appeal of Schiphol as a travel hub and strengthens its competitive position in the aviation industry. Ultimately this strengthens the Dutch global city region, by enhancing connectivity on all scales which in turn enables Dutch citizens to explore the world and for vice-versa.

IN LINE WITH SUSTAINABLE AMBITIONS

There is a significant societal push to reduce air travel and promote sustainable transportation options (European Commission, 2020). For airports to remain relevant in the changing landscape and contribute to a more responsible transport system, they need to broaden their scope and reshape into MTHs (Toet, 2022). RSG's ambition to create the world's most sustainable and high-quality airports, is fully in line with this global trend (Schiphol Group's Annual Report, 2022) and is therefore incorporated in the 5 cornerstones of RSG (See Chapter 2.1 for further elaboration). By integrating different transportation subsystems, Schiphol can offer comprehensive services beyond air travel. This integration contributes to more efficient and sustainable connections in which short-haul flights can be replaced by alternatives such as trains or electric buses (Rousian, 2023). In the current sustainable era, a transition to an MTH is nearly inevitable.

THE INTEGRATION OF SUBSYSTEMS

The mobility industry comprises multiple transport subsystems based on various modalities such as planes, trains, buses, and bicycles. As travellers frequently switch between these modes at transit hubs, there is a growing emphasis on the intersections of these subsystems. (Li & Xu, 2019; Rongen, 2020; Toet, 2022). Travellers expect integrated services and a seamless journey experience. By transforming into an MTH, Schiphol can meet these evolving customer expectations and provide comprehensive services such as integrated ticketing, real-time information, and synchronized schedules across multiple modes of transportation, enhancing the overall travel experience (Graham, 2003).

There are many complexities involved in fully implementing a multimodal service and infrastructure. Babić, et al. (2022) have provided an overview of the differences between fully integrated intermodal and multimodal hubs, as depicted in Figure 1.7.

Non- or Partially Coordinated - Intermodal Transport	Fully Coordinated - Multimodal Transport
Seperate tickets	Single tickets
Timetables—non-synchronized arrival/departure times causing longer waiting times at transfer points	Timetables - synchronized arrival/departure times among transport operators, enabling shorter waiting times at transfer points
Longer walking distance between terminals during transfer due to current location of terminals and stops	Better location of terminals and stops—shorter walking distance between terminals during transfer
Multiple information sources	Single information platform
Responsibility of passenger or transport operator involved (each mode independently)	Responsibility of passenger or responsibility shared among transport operators involved
Luggage check-in at the airport	Possibility of remote luggage check-in
Access facilities (elevators, ramps, vertical and horizontal escalators, automated people movers)	Additional access facilities at transfer between terminals and stations for all modes of transport

Figure 1.7 Non-coordinated or partially coordinated VS. Fully coordinated transport service attributes. (Babić, et al., 2022)

THE LACK OF BUS AND TRAIN TRANSFER INSIGHTS AT SCHIPHOL

One of the essential aspects of functioning as an MTH is creating a perfect seamless passenger flow during the transfer between modalities. Understanding the dynamics, constraints, and traveller needs during these intermodal transfers is crucial for enhancing the overall travel experience and the development of a MTH.

Schiphol already serves as a hub between different kind of modalities, with airplanes, trains, buses, and cars being the four biggest ones. Cars are almost exclusively used for transfers involving airplanes, while buses, trains and airplanes facilitate both multimodal transfers and transfers with the same mode. The department within RSG responsible for mapping traveller insights has a clear focus on air travellers and overlooks all non-air passengers like bus and train travellers (SharePoint interview, 2023)(Experts from RSG, personal conversations, 2023).

In the transition to a well-functioning MTH, obtaining insights into traveller perspectives on all multimodal transfers is of significant value for Schiphol. It provides a clear understanding of the factors to consider in the planning of the future MTH construction. With Schiphol's current focus primarily centred around air travel and related services, there is a lack of insights regarding transfers between trains and buses.

Except for gaining these insights, it is key that the insights are easily accessible to RSG employees responsible for MTH developments. At present, there is a notable absence of a comprehensive overview of traveller experiences between multimodal transfers. At RSG, there is currently a lack of a system to gather insights with the necessary knowledge in this crucial area.

1.5 PROBLEM STATEMENT

SCHIPHOL LACKS A COMPREHENSIVE OVERVIEW

RSG lacks insights into the needs, preferences, and challenges faced by travellers transferring between buses and trains. Furthermore, RSG lacks a concise overview to communicate these insights to the employees responsible for MTH developments. These employees can effectively utilize the insights as supporting argumentation when making decisions about future construction projects within the transition to a well-functioning MTH.

The absence of insights into user needs, pain points and operational bottlenecks during transfers, can hinder Schiphol's ability to identify areas for improvement. By gaining insights into traveller preferences, Schiphol can identify areas where improvements are needed. These improvements may involve seamless wayfinding, integrated physical and digital systems, or enhanced facilities to better serve travellers' diverse needs. This way, Schiphol can optimize the transfer process, enhance passenger satisfaction, and solidify its position as a seamless customer-centric MTH.

1.6 PROJECT GOAL

The goal is to design a support system for the S&AP department of Royal Schiphol Group that provides insights into the needs and desires of their rail-bus travellers. These insights serve as argumentation for decision-making in construction projects. The support system will contribute to the development of a seamless travel experience for transfers between rail and bus at multimodal transport hub Schiphol.

PROJECT GOAL ELABORATION

The support system is intended to be a tool or resource that uses analyzed data to present insights related to traveller preferences, expectations, and pain points. These insights can be used as an argument in discussions, brainstorms and prioritization. It helps in construction projects aimed at creating a seamless travel experience for travellers transitioning between trains and buses. This system contributes to the overall objective of making travel more efficient, comfortable, and satisfying for travellers. It achieves this by ensuring that traveller preferences and requirements are taken into consideration during the decision-making in construction processes. These projects involve the creation, modification, or renovation of physical structures, facilities, buildings, and infrastructure.

1.7 PROJECT CRITERIA

Project criteria are specific requirements that help define the parameters and characteristics that the design must meet to be considered successful. These criteria provide a clear framework for evaluating the effectiveness of the design.
Project Criteria are requirements that my graduation project must meet to achieve a well-functioning design.

The requirements are an addition to my project goal and help to assess it's achievement. If all Project Criteria are met, it signifies that the support system operates effectively and the project goal is met.
The Project Criteria are formulated true discussions I held during the preliminary research with employees from RSG and my graduation board.

PROJECT CRITERIA	✓/✗
Usability & User-friendliness	
S&AP employees can understand how the self-explanatory support system works.	☐
S&AP employees can locate and use all functions of the self-explanatory support system	☐
S&AP employees can utilize the insights from the self-explanatory support system.	☐
Measurable impact on decisions	
The support system positively contributes to decision-making in construction projects.	☐
Added value	
The employees of S&AP perceive the support system as an added value to their work.	☐
Data collection	
There is a method for collecting and analysing traveller data as input for the support system.	☐
The method for collecting and analysing data aligns with RSG's workflow and can be implemented within their current system.	☐

1.8 DESIGN REQUESTS

INCORPORATING ADDITIONAL FUNCTIONALITY WISHES

The project criteria can confirm whether the project goal has been completed. However, during the research, various preferences and wishes from RSG have also been expressed. These all focus on the functionalities and implementation of the support system. To incorporate these preferences from RSG into the design, I have formulated design requests.
Design requests are preferences or wishes the design must meet to become as useful as possible for RSG. If all project criteria and design requests are met, it signifies that the support system operates effectively and aligns with all of Schiphol's preferences.

This would imply that the decision support can be implemented by RSG. To provide the project with sufficient direction and depth, it is essential that my scope is not too broad. Therefore, I have decided in advance not to work on three of the requests. This decision is made in consultation with my graduation board.
The Design Request are formulated through the researches described in Research Box A, E & G, and all linked to the department that has expressed this preference. The project's objective is to meet as many requests as possible. To assess this, a final validation will take place.

WORKSHOP - S&AP

Participants: N = 3
Prioritisation of modalities + Mapping of project purpose and requirements.

RESEARCH BOX - A

INTERVIEW - CUSTOMER INSIGHTS

Gaining insights on the current way of gathering data, analysing data, and translating these insights to RSG staff. + Workflow for implementation of own system.

RESEARCH BOX - E

INTERVIEW - SHAREPOINT

Understand how the front-and back-end of the internal system operates. + How to make use of SharePoint and Microsoft 365 and what key aspects to consider.

RESEARCH BOX - G

DESIGN REQUESTS

✓/✗

Proritize ····· S&AP ☐
The support system prioritises needs by types of travellers.

Relevance of needs ····· S&AP ☐
The support system indicates a difference in relevance between various needs or traveller types.

Data security ····· SharePoint ☐
The support system does not operate on servers other than those of RSG due to data sensitivity.

Lifespan ····· S&AP ☐
The support system continuously refreshes insights based on periodic new data inputs.

3rd party tooling ····· SharePoint ☐
No third-party tooling is used due to the complex security procedures involved.

Implementation ····· SharePoint ☐
The support system is easily implementable within the current workflow and digital system of RSG.

Shareable ····· Custmer Insights ☐
The insights are easily shareable, exportable, and printable.

Capacity ····· SharePoint ☐
The system can handle the capacity when all S&AP employees use the system simultaneously.

Open to Improvement ····· SharePoint ☐
The system enables the option to report errors to the developer for any potential issues within the system.

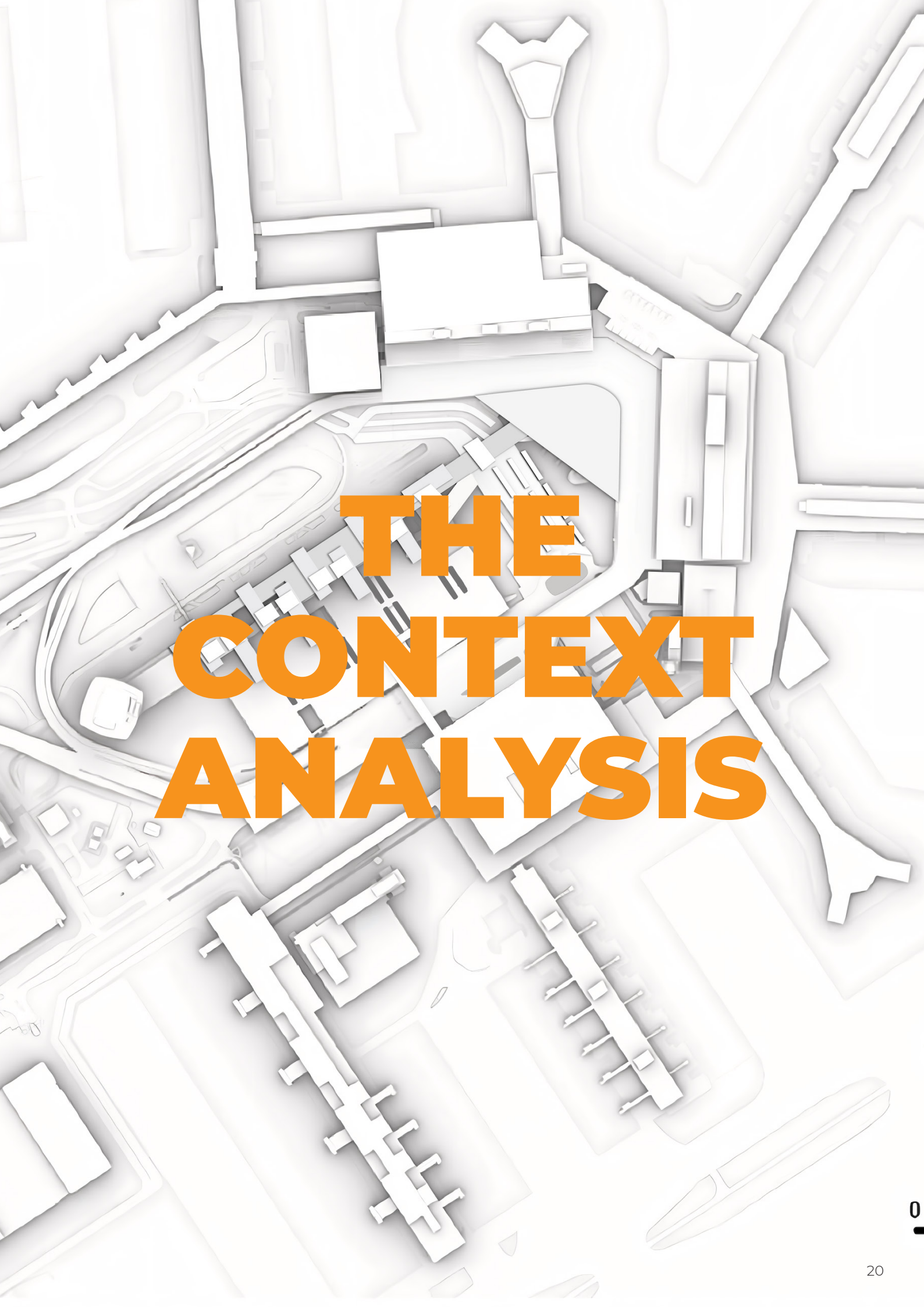
Adaptable ····· SharePoint ☐
The system is able to add, remove, or modify features within the system.

OUT OF SCOPE

Modalities ····· S&AP ☐
The system shows differences in insights between different modalities.

Proportions ····· S&AP ☐
The support system indicates the differences in size between types of travellers.

Current implementation ····· S&AP ☐
The support system indicates whether there is an existing integrated application/service within Schiphol for the different needs.



THE CONTEXT ANALYSIS

2

CONTEXT BACKGROUND

2.1 SCHIPHOL AIRPORT

SCHIPHOL'S HISTORY

Schiphol Airport, officially known as Amsterdam Airport Schiphol, is the largest, busiest and main airport in the Netherlands. Located in the municipality of Haarlemmermeer, near Amsterdam, it serves as an international mega hub connecting millions of travellers, facilitating global air travel.

Schiphol Airport traces its origins back to 1916 when it was established as a military airbase. However, it wasn't until 1920 that Schiphol opened as a civilian airport, serving as a base for KLM Royal Dutch Airlines. In 1926, Jan Dellaert developed a visionary plan for the airport, focusing on safety, capacity, and accommodating evolving technologies. This plan laid the foundation for Schiphol's future success and its ability to meet the needs of a changing aviation landscape (Schiphol Airport history, 2023). Over the years, Schiphol has undergone significant expansions and developments to meet the increasing demands of air travel.

In the 1980s, Schiphol embraced the hub-and-spoke concept, capitalizing on the increasing competition in the industry. As one of the major European hubs, Schiphol became a vital link in the global air travel network. Recognizing its significance, the central government designated Schiphol as a 'Mainport,' highlighting its role as an international air, road, and rail hub and a key driver of the Dutch economy (Schiphol Airport history, 2023) (Merchant, 2022).

Picture: Archief Luchthaven Schiphol

CURRENT ROLE

Today, Schiphol plays a crucial role in the Netherlands' aviation and transport landscape and serves as a major gateway for both domestic and international travel. Schiphol is not only an essential transport hub but also a significant contributor to the Dutch economy. It serves as a catalyst for business, tourism, and trade, facilitating connections between companies and attracting international visitors to the Netherlands (RSG Annual report, 2022). Schiphol has set its sights on becoming the world's most sustainable and high-quality airport by 2050, focusing on five cornerstones as shown in Figure 2.1

QUALITY OF NETWORK: OUTSTANDING CONNECTIVITY

"We will continue to develop our network in order to maintain outstanding connectivity to the major economic, political and cultural centres in the world. In this way, we 'connect your world'. " - (RSG vision 2050 storyline, 2022)

QUALITY OF LIFE: WE CARE ABOUT PEOPLE AND THE PLANET

"As outlined by our Most Sustainable Airports roadmap, Schiphol Group aims to operate zero-emissions and zero-waste airports by 2030. We also aim to uphold the principles of sustainable aviation and ensure a healthy living environment for local residents." - (RSG Annual report 2022)

QUALITY OF SERVICE: CUSTOMERS FIRST

"As a globally leading airport group, our Passenger Journey is seamless and we inspire via highly personalized and memorable experiences." "A high level of service is essential to maintaining our reputation as a major hub airport, and therefore our license to grow and operate." (RSG vision 2050 storyline, 2022)

SAFETY FIRST

"Safety is our highest priority, and we aim for air travel to remain the safest means of transport. This key priority for our license to operate requires an open culture in which all safety deviations can be reported, in which improvements are made in a timely fashion and in which everyone working in the sector is committed to following the highest standards." - (RSG vision 2050 storyline, 2022)

ROBUST ORGANISATION

"Building a robust organisation is an evolving process. It involves responding to a changing environment, navigating uncertainty and disruption, and understanding and addressing mistakes when they occur." - (RSG Annual report 2022)

Figure 2.1: the five cornerstones of RSG, Images: (RSG Annual report, 2022)

2.2 TRANSFERS AT SCHIPHOL

PRIORITISATION OF MODALITITES

To gain insights into people's transfer experiences, it is important to examine how modalities are interconnected at Schiphol. In Figure 2.3, the locations of all the different modes of transportation at Schiphol are depicted. The placement of the bus and the train are relatively close to each other, reducing the distance that needs to be covered compared to transfers involving, for example, airplanes or parked cars.
When theoretically considering all possible transfers at Schiphol, a distorted image emerges due to significant variations in the relevance of each transfer. For instance, the transfer between airplane and bicycle is negligible compared to the transfer between airplane and train.
In a workshop with the S&AP employees (Research Box A, on the next page), it became apparent which transfers at Schiphol are most prominent. Additionally, it was indicated which transfers are the most important or the most underexposed. It is clear that airplanes, trains, buses, and cars have the most significant role at Schiphol. The car is only relevant for transfers involving airplanes, and transfers between buses, trains, and airplanes are relevant in all cases.

This conclusion has contributed to my focus on rail-bus transfers, while excluding air-related transfers because there are already many more insights available in this area.

The results from this workshop are shown in Figure 2.2. In Appendix 2-D, the Miro pages used during the workshop are displayed. Appendix 2-A will provide in-depth insights about all the different modalities shown in Figure 2.2. Appendix 2-B will provide in-depth insights about differences between transportation types, like shared, public or private transportation.

Modalities (arrival x departure)	Airplane	Train (National)	Metro	Bus (Public)	Bus (Tour)	Train (Int.)	Car (Park)	Car (Rental)	Car (kiss & ride)	Uber/Taxi	Bicycle / Mopet	Walking
Airplane	X	X	X	I	I		I		I	I		
Train (National)	X	X		I								X
Metro	X	I		I								I
Bus (Public)	X	I	I	I								I
Bus (Tour)	I											
Train (Int.)												
Car (Park)	I											
Car (Rental)												
Car (kiss & ride)	I											
Uber/Taxi	I											
Bicycle / Mopet												
Walking		X	I	I								
Other												

X = Most common
I = Common
Blue = Most important for RSG
Yellow = Most underexposed for RSG

Figure 2.2. Prioritisation of modalities for RSG

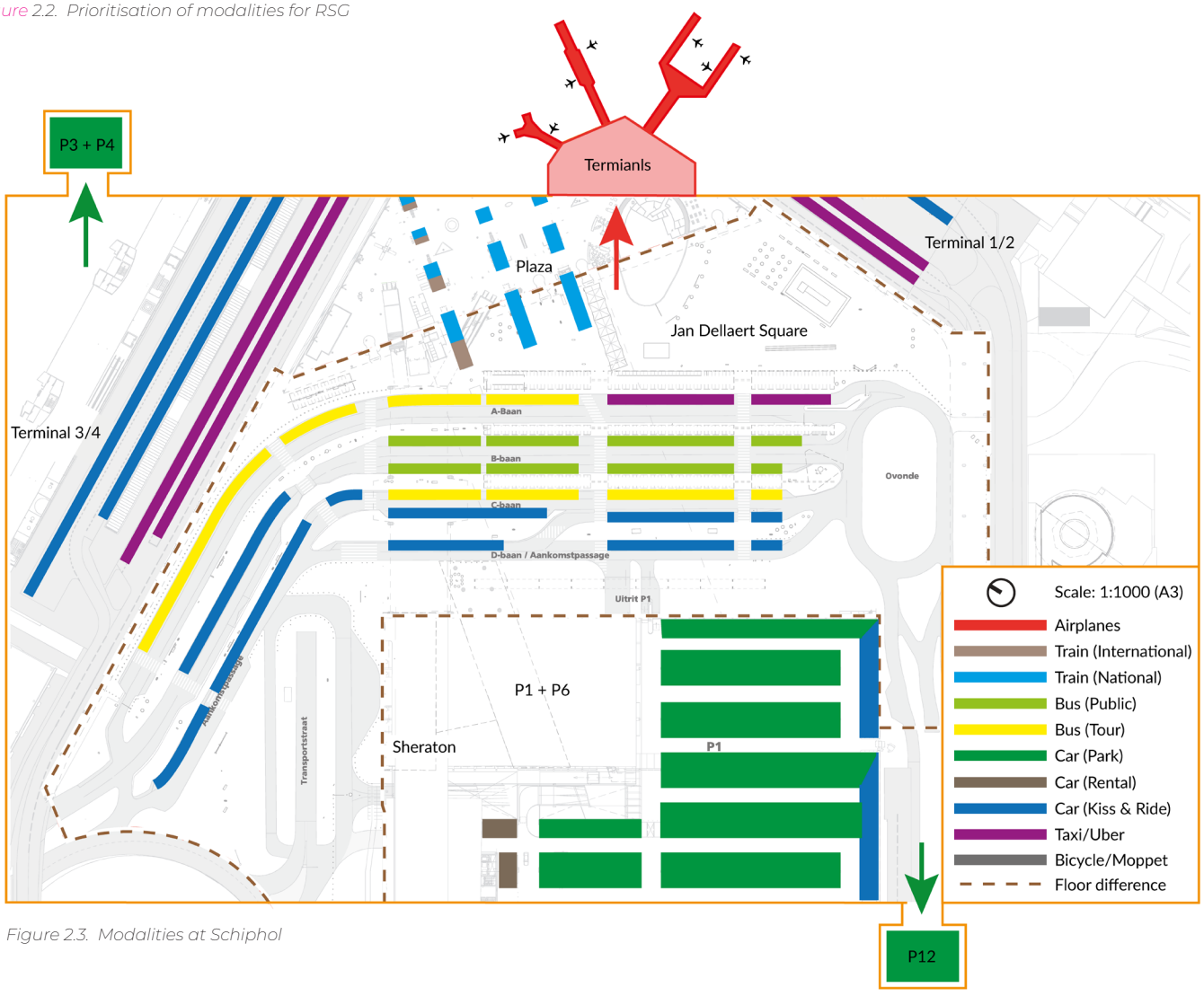


Figure 2.3. Modalities at Schiphol

TRANSFER VOLUMES

To assess the accuracy of RSG employees' estimations, an attempt was made to obtain a realistic view of transfer volumes. Therefore, as much data as possible is obtained from RSG's digital work environment and various employees. However, due to the sources focusing on specific situations such as OD passengers instead of all passengers, or disregarding alternative routes in passenger-flow counts, definitive conclusions can not be drawn. An approximation, including the calculations can be found in Appendix 2-C.

MISSING DATA

First and foremost, it becomes apparent that nearly all the data RSG has regarding traveller and transfer numbers is based on air-related travel. There has been no mapping of the numbers for non-air transfers. This conclusion confirms the opportunity introduced in Chapter 1.4, which highlights Schiphol's current focus on primarily air travel and associated services. The goal of this numeric research is to validate the estimation of the size of transfer-flows from the S&AP department, but it appears to not be possible due to the missing data regarding the transfers. RSG is committed to the idea of working towards a MTH where transitions between all various modalities should seamlessly integrate.

The fact that even the correct data isn't available within RSG to determine the different transfer volumes, demonstrates that there is still much to gain in terms of understanding the various transfers.

REFLECTION

Processing the accurate number of travellers making the transfer between the bus and train would be a valuable addition to the support system. I have chosen to exclude this from the scope because it would be time-consuming, and I prefer to focus on qualitative data rather than quantitative data. This aligns much better with my Master's Design For Interaction.

WORKSHOP - S&AP

Participants: N = 3
Prioritisation of modalities + Mapping of project purpose and requirements.

RESEARCH BOX - A

2.3 TRANSFER FLOWS IN PLAZA

PEDESTRIAN FLOWS IN PLAZA

To gain a better understanding of the overall context in which all rail-bus travellers are situated, it is interesting to examine pedestrian flows in and around Schiphol Plaza. Figure 2.4 illustrates the locations of different modes of transportation and how travellers that pass Plaza navigate through the facility.
To get an idea of the transfer volumes, access is provided to the datasets of the internal sensor system BlipTrack (Research Box C).

BlipTrack measures the number of travellers entering or exiting Schiphol Plaza through all the various entrances. This analysis allows for differentiation between travellers traveling by airplane, train, Car's parked at the Central Parking (P1 + P6) and those accessing the Jan Dellaert Square (Bus, car, or taxi). Figure 2.5 and Figure 2.6 on the next page show the proportions of passenger flows at Schiphol Plaza.

INTERVIEWS - BLIPTRACK

Participants: N = 2
Insights about avalible passenger flows and numbers. Insights in Bliptrack platform with Plaza sensor calculations.

RESEARCH BOX - C

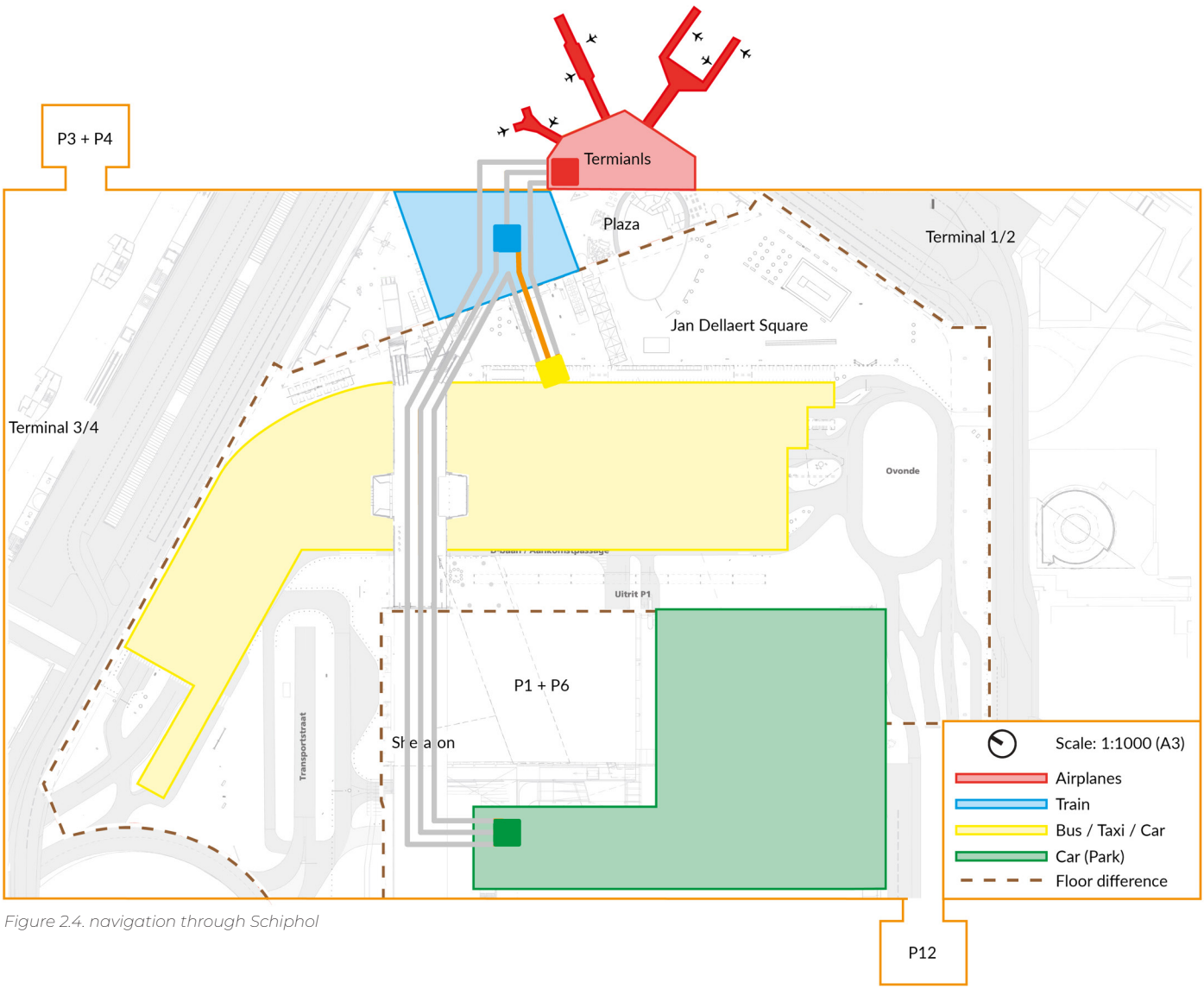


Figure 2.4. navigation through Schiphol

It is calculated that 13.4% (6.2 + 7.2) of the travellers moving through Plaza use transfers between the train and a modality at the Jan Dellaert Square. This amounts to more than 1 in 8 travellers. Unfortunately, this percentage does not reveal how many of these travellers specifically use the bus. When comparing this percentage to the millions of travellers present at Schiphol annually, it can be concluded that rail-bus transfers are a very relevant connection for Schiphol.

In Appendix 2-C, you will find additional insights into pedestrian flows within the terminals and Plaza, and insights into the transfers of all different employees working at Schiphol.

	Jan Dellaert Squa	Train	Terminal	P1 + P6	Total
Jan Dellaert Square	2,4%	7,2%	11,3%	1,0%	21,9%
Train	6,2%	5,3%	14,3%	1,0%	26,7%
Terminal	16,4%	11,5%	9,3%	5,7%	43,0%
P1 + P6	0,9%	1,3%	4,7%	1,4%	8,3%
Total	25,9%	25,3%	39,6%	9,2%	100,0%

Figure 2.5. The distribution of passenger flows through Schiphol
** It is possible to move between the Jan Dellaert Square and WTC/Centre parking without passing through Plaza. Therefore, the percentages may be slightly distorted.*

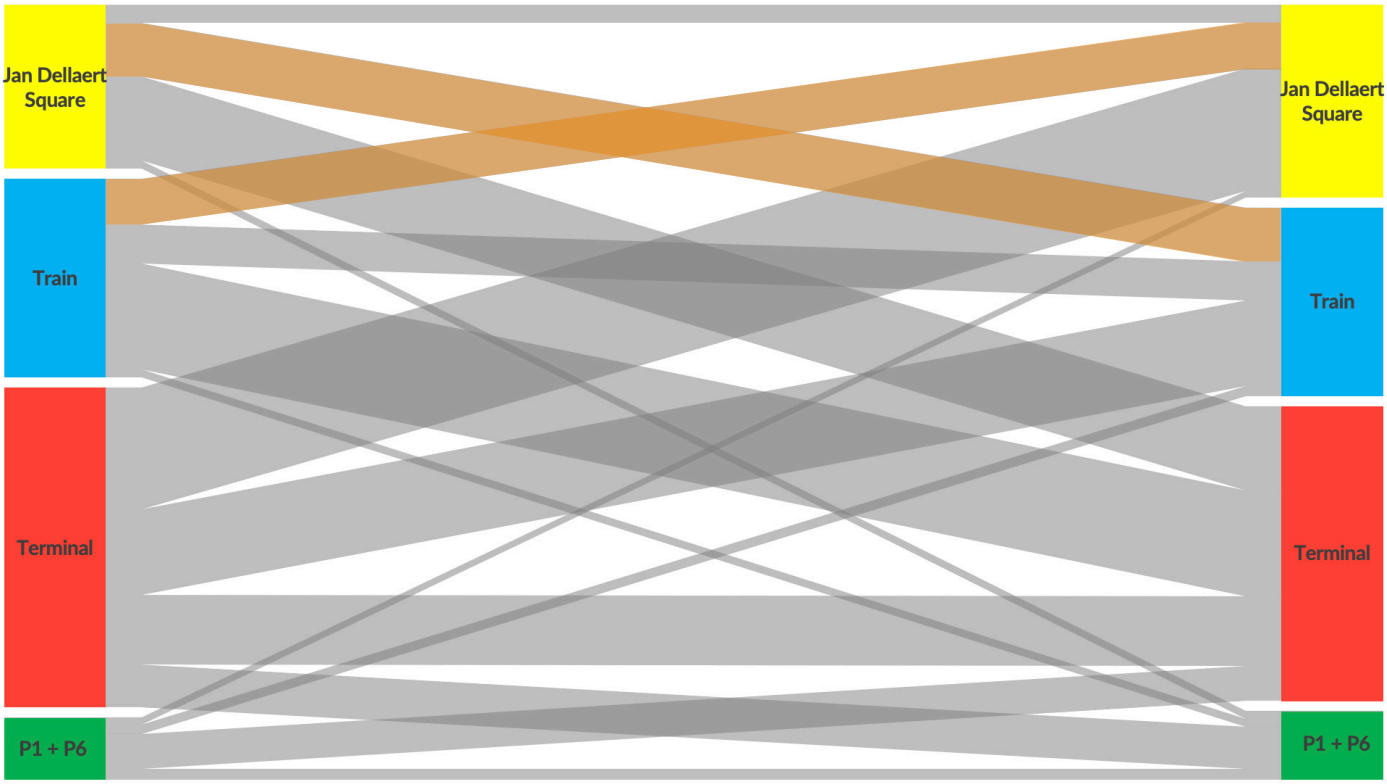


Figure 2.6. Visual representation of passenger flows through Schiphol Plaza

THE SUPPORT SYSTEM

3

THE APPROACH

3.1 RESEARCH STRUCTURE

THREE THEMES

As defined in the project goal in Chapter 1.6, the result of this research is a support system that uses analyzed data to present insights related to traveller preferences. To be able to design, test, and ultimately implement this system, various aspects need to be understood. These different aspects are divided into three themes, as illustrated in Figure 3.1.
Firstly, the system must be valuable to RSG by providing insights that are relevant to them and ensuring that these insights add value to the company. Additionally, it's important that the system is optimized for usage and interaction so that RSG employees can easily gather the insights they need. Finally, it's crucial that the system can be implemented smoothly into RSG's workflow, both in terms of data gathering and system functionality.

These three themes form the basis of developing the support system. In the upcoming chapters, I will delve into the themes of 'Use' and 'Content.' Each section starts with an orange page that focuses on the 'Use', providing a detailed explanation of how the design functions. Following these orange pages, I will explore the rationale behind the design choices in the subsequent sections, providing insights into the 'Content' of the design. After covering the entire design, Chapter 9 and 10 will delve into more detail on how the system works and provide insights about the 'Implementation'. This will encompass all three themes of my research within this report.

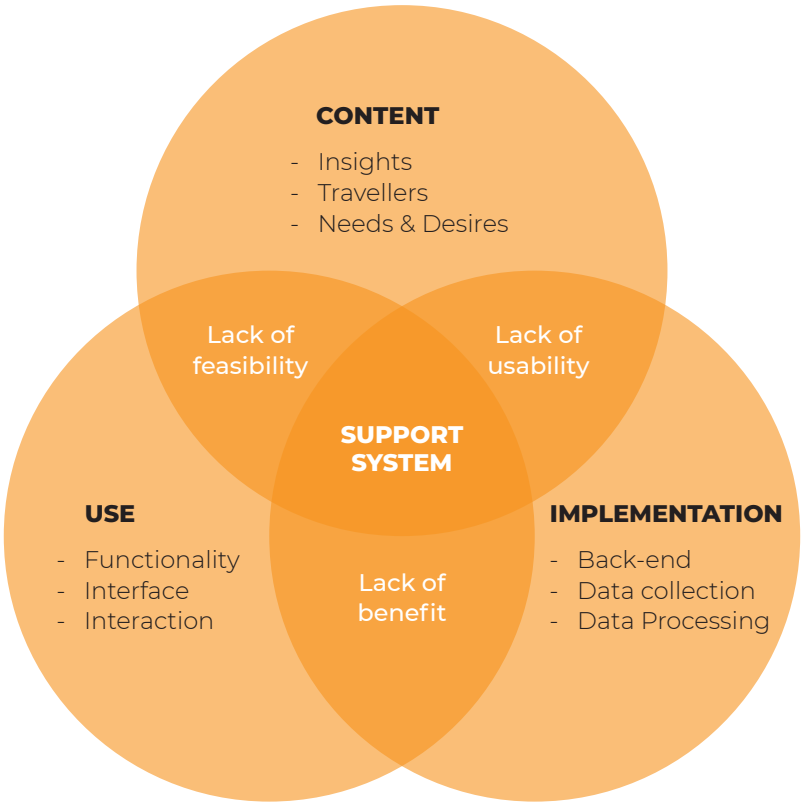


Figure 3.1. Project structure with the three themes

3.2 THE USER

STRATEGY & AIRPORT PLANNING

To achieve the ultimate goal of becoming a MTH, the design must be utilized by the individuals responsible for shaping Schiphol's future plans. After all, they are accountable for how the transition to an MTH will unfold.
The end users of the design are all employees of RSG working under the Strategy & Airport Planning department (S&AP). This department develops the vision and strategy for the mid and long term. They also explore innovative ideas that lie further in the future. The central focus is on the ambition to create the most sustainable and high-quality airports in the world (Schiphol Sharepoint, 2023).

S&AP consists of five sub-departments, all involved in innovation and future planning (See Figure 3.2). The development of the MTH is allocated to the 'Airport Masterplanning' sub-department. While this sub-department directly benefits from the insights provided, the system can also provide positive value to other sub-departments. In the future, the MTH implementation will become a more widely embraced project. Gradually, the other sub-departments will also have the need to utilize supporting insights regarding the transition to an MTH. That's why the entire S&AP department is chosen as the end-user.

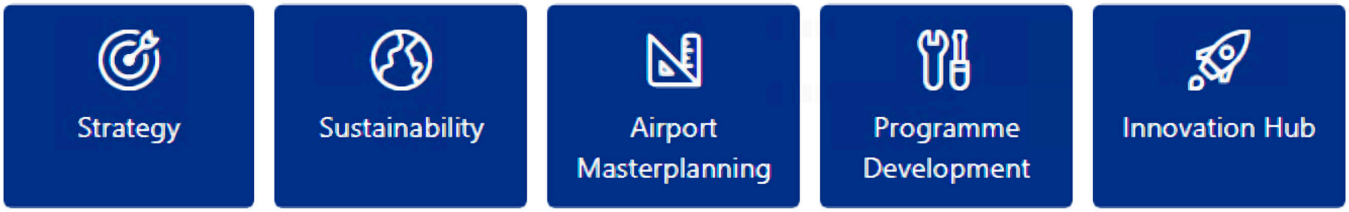


Figure 3.2 The five departments of S&AP, (Schiphol Sharepoint, 2023)

REFLECTION

During the project, I have been a part of the Airport Masterplanning sub-department and have attended all the weekly meetings. This has provided me with a comprehensive understanding of the various ongoing projects and the challenges that the employees encounter. This has greatly clarified how the support system can ultimately be used.

3.3 DESIGN PRINCIPLES

THE PRINCIPLES

To provide guidance during the design phase, I have formulated design principles. They are based on the many conversations I had during the preliminary research with employees from RSG, and the studies described in Research Box A and D. Design principles are guidelines that inform the overall approach and philosophy of the design. They guide the decision-making process and provide a framework for making choices that align with the intended goals and values of the project. The design principles can be found in Appendix 3-A.

REFLECTION

Throughout the process, the guidelines served me as a reference point for making decisions and seeking inspiration, especially in the design phase.

WORKSHOP - S&AP

Participants: N = 3
Prioritisation of modalities + Mapping of project purpose and requirements.

RESEARCH BOX - A

BRAINSTORM + WORKSHOP - DESIGN STUDENTS

Participants: N = 2
Unrestricted view of possible expression of insights. + Brainstorm on user experiences and usability. + Content restructuring.

RESEARCH BOX - D

3.4 THE PURPOSE

THREE ASPECTS

The objective of this study is to support RSG in its transition to becoming an MTH by improving the rail-bus transfers. Preliminary research indicates that to make this transition, there is a lack of insights into the preferences of travellers making this rail-bus transfer at Schiphol Airport. In this project, I propose a solution for this issue in the form of a support system. The system aims to present insights in a manner that maximizes the benefits for Schiphol and improves the rail-bus transfers.

While there are numerous interesting aspects to explore among travellers, it is crucial to only incorporate useful information into the system. There are three key aspects that should be integrated into the support system (see Figure 3.3). The way in which these aspects are applied in the support system will be explained in the following chapters. I will elaborate on the relevant information that needs to be used in the support system and the way it should be incorporated in the design.

TRAVELLERS

An analysis is required regarding the various travellers who transfer between buses and trains at Schiphol Airport. By providing the ability to categorize travellers, it becomes possible to examine specific scenarios in a targeted manner. This allows for comparisons between different target groups. It provides the rationale for targeting specific traveller types and scenarios.

NEEDS & DESIRES

Based on an analysis of the various needs that travellers have, it can be assessed which types of needs are relevant to the S&AP department. By effectively structuring and representing these needs, they can serve as valuable argumentation for the development of construction projects.

TRANSFER

The direction of the transfer between bus and train results in different perspectives from the passengers. By categorizing the insights according to the transfer direction, it becomes possible to focus on specific scenarios for construction projects. Differences or similarities serve as explanation for possible scenarios and provide argumentation.

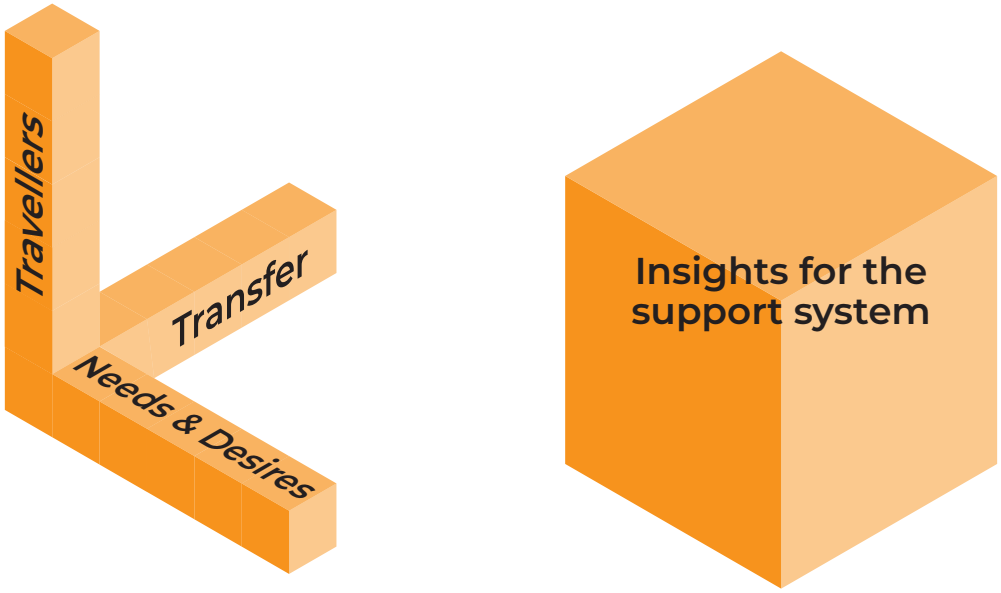


Figure 3.3. System structure with the three key aspects for the insights

4

THE FRAMEWORK

4.1 The framework

4.1 THE FRAMEWORK

FRAMEWORK

The support system can be accessed through SharePoint , RSG's digital environment. All S&AP employees have access to it via an internet connection. Opening the support system leads to the main screen where all the most commonly used functions are visible. The screen is divided into five frames, collectively representing the three mentioned aspects, labeled as A, B and C in Figure 4.1 and 4.2. Frame A displays the 'Transfer Direction,' frame B displays the 'Traveller Options,' and frames C1, C2 and C3 display the 'Needs & Desires'. 'Needs & Desires' are divided into three screens. C1 serves as the main screen, continuously visualizing the most important insights. C2 and C3 provide additional insights and are only displayed after specifying a desired category, which can be clicked on in C1.
The user can specify which insights should be visible in 'Needs & Desires' by changing the settings in 'Transfer Direction' and 'Traveller Options.' Frames A and B thus function as input for the system, where the user can set their preferences. The C frames serve as the system's output, displaying the insights linked to the input provided in frames A and B. If you modify the input in either 'Transfer Direction' or 'Traveller Options,' different insights will be shown in 'Needs & Desires.' They operate independently but are interconnected. The explanation of the system operation can be found in Chapter 9 and 10.

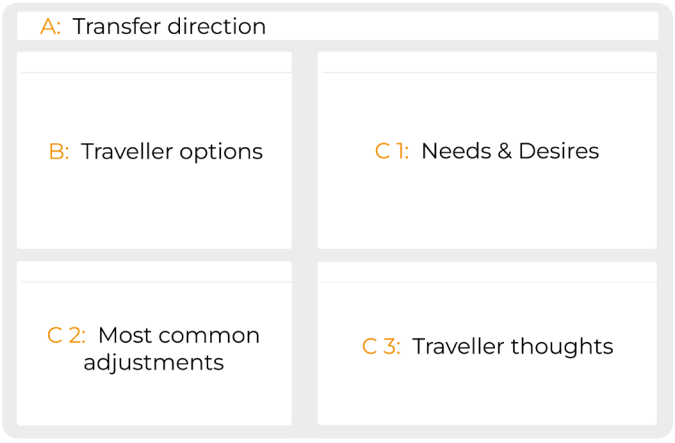


Figure 4.1 Placement of the 5 frames in the Support System.

ONE MAIN SCREEN

Using a main screen where all insights are immediately visible, eliminates the need for users to navigate back and forth to draw different comparisons. Only the additional functions appear in an overlay screen, presented as pop-ups. The additional functions include sharing insights, reporting issues, obtaining extra information about the insights, and providing additional system explanation.

SELF-EXPLANATORY

When the support system is activated, a screen will appear with instructions on how to utilize it. These will be shown in Chapter 8. The system is self-explanatory, enabling anyone to use the system autonomously. To avoid a very long explanation, the system has been made as intuitive as possible so that after a single use, there is no need to revisit the instructions. In the system, all clickable buttons feature a 3D shadow effect to make them stand out as interactive elements.

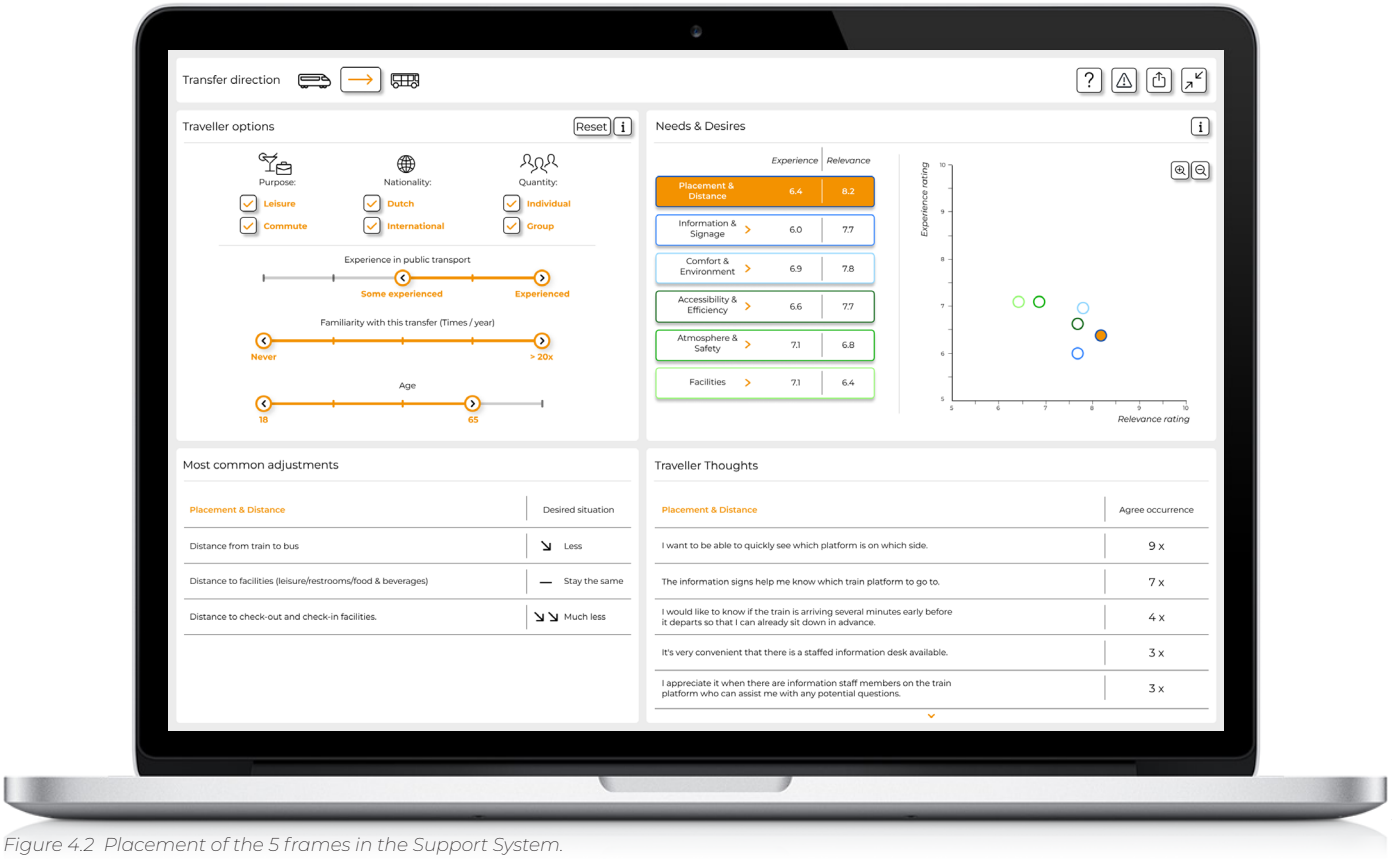


Figure 4.2 Placement of the 5 frames in the Support System.

5

TRANSFER DIRECTION

5.1 The transfer direction

5.1 TRANSFER DIRECTION

DESIGN & USE

At the top of the support system, the direction of the transfer is indicated. This is done through an icon of a bus and a train, with an arrow in between pointing the direction. The direction of the transfer can be changed by clicking on the arrow. After clicking, the train and bus icons will swap positions, and the system will show the insights related to the new transfer direction.

TRANSFER OR MODALITY FOCUS

In the support system, the choice was made to display insights based on the transfer between the bus and train modalities. Another option was to present insights based on the single modality, either bus or train, not linked to the transfer on arrival or departure. When providing arguments for a construction project, such as a renovation for bus stops or train platforms, these renovations often affect both the arrival and departure experience. This could be a reason to organize insights based on the modality rather than the transfer.

The support system focusses on the transfer between modalities because there are clear differences in insights related to the transfer direction. If these were combined, it could lead to confusion about arguments that only apply to one of the two directions. Additionally, there are arguments that only apply to transfers between the train and the bus. If insights were visualized based on a single modality, these insight could be confused with other modalities to which they do not relate.

REFLECTION

It might be potentially interesting to combine these two ways of presenting insights. Within the visualization of all insights for a single modality, an additional subdivision can be made for the direction from the bus to the train, from the train to the bus, or a combination of both. Unfortunately, I haven't further explored this possibility, and it could serve as a promising topic for future research.

6

TRAVELLER OPTIONS

6.1 TRAVELLER OPTIONS

THE DESIGN

To distinguish between different travellers, two ways are integrated into the system that can be used. Firstly, there are checkboxes. This allows travellers to be selected/excluded based on three aspects:

Purpose:
- Leisure
- Commuter

Nationality:
- Dutch
- International

Quantity:
- Individual
- Group

In all three aspects, there are two options in which travellers can be part of. These are indicated by the checkboxes. All travellers belong to one of the two options, so the user can select the first option, the second option, or both options if no distinction needs to be made.

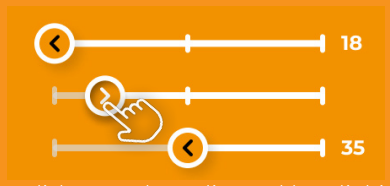
Secondly, there are sliders. There are three aspects in which the user can exclude or select a target group:

- The amount of experience in public transport
- The familiarity with the specific transfer
- The age

In all three aspects, users can specify a range for the type of traveller for which they want to see insights. All travellers are spread across the range on the slider. If no distinction needs to be made, the entire slider should be selected to ensure that no travellers are excluded.

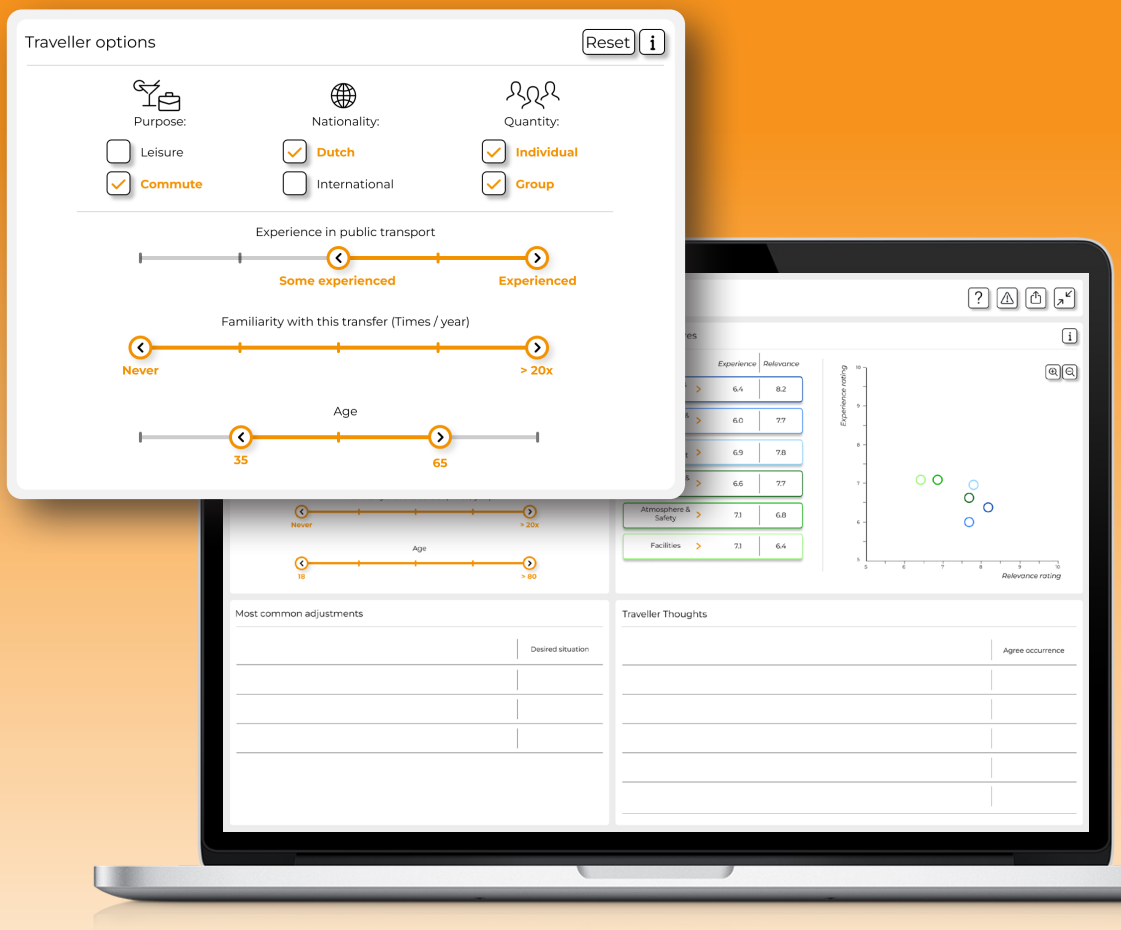
THE USE

Clicking on a checkbox allows the user to either select or deselect it. It's important to note that at least one of the two checkboxes must always be selected.



The slider can be adjusted by clicking and holding down the circles located at the edges of the axis, and then moving them along the axis.

To reset all checkboxes and sliders to their default selections, the user can click on 'Reset.' For further explanations regarding the checkboxes and axes, the user can click on 'Information.'



6.2 EXPLANATION OF FUNCTIONALITIES

INTRODUCTION

The previous page presents the design that enables the selection of different types of travellers in the system. To develop this design, extensive research was conducted. In the following sections, the choice for the final design will be further elaborated based on two conducted studies (Research Boxes J & K). These studies will explain the selection of the final axes and checkboxes.

Subsequently, in Chapter 6.3 and 6.4, I will explain the insights I have gathered from literature and internal research and the conducted research in Research Boxes E & F. These insights have laid the foundation for the axis and checkboxes in the final design. Therefore, they will be referenced in the following sections already.

COMPREHENSIVE QUESTIONNAIRE - TRAVELLERS

Participants: N = 16
Collecting specific data used in the support system + Trying out 9 different axes for optimal distribution.

RESEARCH BOX - J

QUESTIONNAIRE - MASTER PLANNING

Participants: N = 4
Insights into the distribution of traveller types by the user of the support system + Confirmation of the selection of 3 axes.

RESEARCH BOX - K

INTERVIEW - CUSTOMER INSIGHTS

Gaining insights on the current way of gathering data, analysing data, and translating these insights to RSG staff. + Workflow for implementation of own system.

RESEARCH BOX - E

WORKSHOP - EXPERIENCED TRAVELLERS

Participants: N = 3
Differences in travel experience among different travellers by comparing the customer journeys. + Creating categorization

RESEARCH BOX - F

SITUATION-DEPENDENT OUTCOMES

One of the clearly expressed desires voiced by Schiphol employees (see Chapter 1.7) is the ability to obtain situation-dependent outcomes. This means that the system's results are tailored to possible scenarios the user is interested in.
The goal is clear: to contribute to the development of a seamless travel experience for rail-bus transfers at Schiphol. This requires not only a deep understanding of traveller needs but also the recognition that different types of travellers have unique expectations and requirements. Identifying various types of travellers that are using the rail-bus transfer has resulted in a unique way of selecting travellers in the system. To select travellers, a range on axes in combination with checkboxes is used. This allows S&AP employees to be more specific about the desired target audience of a scenario, thereby receiving more valuable insights.

AN OPEN RANGE INSTEAD OF PREDEFINED PROFILES

The idea of selecting axes stemmed from insights gained during a workshop I organized with various experienced travellers (Research Box F). In this workshop, we created six customer journeys (See Appendix 6-A), representing different types of travellers and compared them through a discussion. During this discussion, we examined the different rail-bus travellers and explored possible ways to categorize them effectively. From the analysis of traveller distributions in the literature and internally at RSG (Chapter 6.3 and 6.4), it becomes clear that they universally use predefined and fixed profiles. Placing all travellers under predefined profiles could result in misalignment, as they might not perfectly fit one specific category. It's also possible that some travellers might align well with multiple profiles, leading to uncertainty about which profile to assign them to. Furthermore, there may be more significant variations in the needs of travellers within the same profile than between travellers from different profiles. In the support system, the goal is to distinguish between different types of travellers to address their unique needs. If there are less substantial differences in their needs, categorizing travellers into these profiles would not be beneficial.

In the support system, axes and checkboxes are used instead of predefined traveller profiles. This allows travellers to be placed in a more accurate target group that aligns with their characteristics. As a result, there is greater differentiation in insights because travellers have less overlap.

THE MOST USEFUL AXES

To make the support system as insightful as possible, the selection of axes is very important.
From the research conducted in Literature (Chapter 6.4) and Research Box E and F, many insights have been gained regarding the way the axes should be designed. I conducted specific research on the two most crucial insights that emerged from my preliminary analysis.

Firstly, the selection of axes that are as relevant as possible for traveller selection for construction projects. Secondly, the selection of axes that provide the best possible distribution and dispersion of all travellers making the rail-bus transfer.

RELEVANCE

The support system is used to assist in decision-making regarding construction projects, so it's crucial to choose axes that allow the user to select travellers in a way relevant to this. To select the most relevant axes, I conducted a questionnaire among the Master Planning employees (Sub-department of S&AP) (Research Box K). I presented them with nine potential axes for the support system, which can be found in Appendix 6-B. I asked for their preferences among these nine options and their opinions on the categorization method.
The questionnaire results are available in Appendix 6-B. three final axes emerged as the most relevant for selecting travellers for construction projects from the questionnaire.

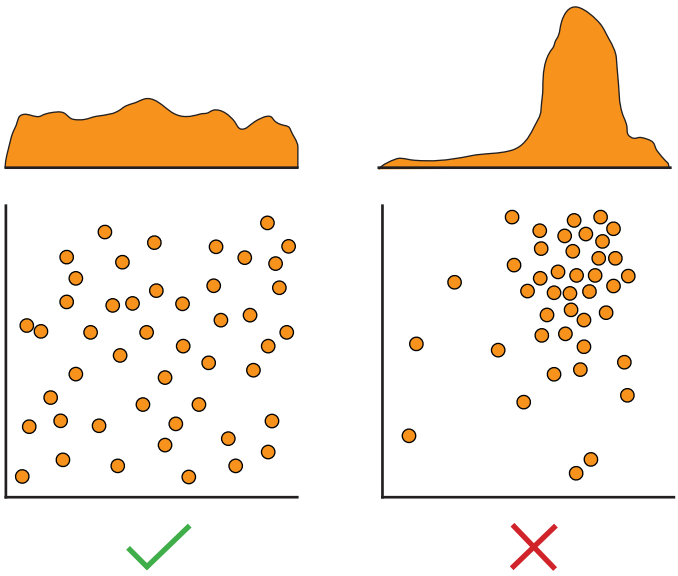
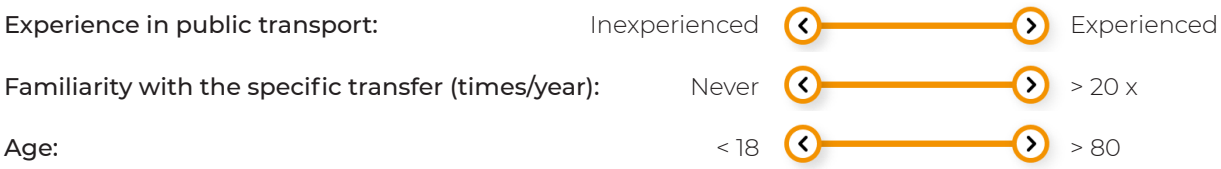


Figure 6.1 A scattered distrobution VS a concentrated distribution.



DISTRIBUTION

It's important to distribute travellers in an evident and scattered way across the entire axis. It can be inconvenient if almost all travellers are concentrated in one small section of the axis, leaving the rest of the axis with limited insights. This is illustrated in Figure 6.1. Furthermore, it is essential that the axes have a clear distinction without overlapping, ensuring that they provide independent insights, as concluded from the workshop at the top of this page with experienced travellers (Research Box F). To determine which axes provide the best distribution of travellers, I used the same 9 axes as in the study on relevance. I asked various travellers who use the rail-bus transfer to position themselves on all 9 axes. I concluded that with the 3 selected axes from the Master Planning study, there is a good and clear distribution of travellers. The insights can be found in Research Box J.

THE CHECKBOXES

In the above research on relevance among the Master Planning department, I also asked for their opinion on the method of categorization. It was mentioned that with the selected axes, there might be a certain need for specification that is not incorporated into the axes. This pertains to the purpose of the journey, the nationality of the traveller, and the traveller group size. To accommodate this need in the support system, the checkboxes were designed. In this regard, a choice was made for each of these three elements, offering two options to categorize travellers.

REFLECTION

I would have liked to conduct more research on the distribution of the checkboxes. The idea for this implementation emerged later in the process, which is why I did conduct less research on it compared to the axes.

6.3 CUSTOMER INSIGHTS ANALYSIS

CUSTOMER INSIGHTS

At RSG, the Customer Insights department is responsible for customer research and data about the customers. This department has been utilizing traveller categorisations for many years. Within Customer Insights, traveller insights are presented to employees through two primary methods. Firstly, a 'Passenger Experience Dashboard' where employees can set their preferences for the insights they are interested in. Here the use two different methods for distributing travellers. Additionally, Customer Insights releases summary 'Factsheets' to quickly deliver the key insights to employees. In all three cases, different categorisations of travellers are made.

Passenger experience dashboard Section A:
- Gender (Male / Female)
- Domicile (Dutch / Foreign)
- Age (<30 / 30-60 / >61)
- Flight frequency (First / 1-3 / 4-10 / 10+)
- Pier of departure (All different piers)
- Travel motive (Business / Leisure)
- Type of passenger (OD / Transfer)

This categorisation is quite diverse and insightful. However, the problem here is that all insights (ratings on a scale of 1-10 given for various topics) can only be viewed based on one of the aspects. You can only choose one category, such as 'business' or 'male,' without the ability to combine them.

In the support system, multiple aspects can be selected simultaneously. This functionality allows for more in depth scenarios by combining various aspects, which is a critical requirement for the system's effectiveness.

Passenger experience dashboard Section B:
- OD Dutch Business
- OD Dutch Leisure
- OD Foreign Business
- OD Foreign Leisure
- Transfer business
- Transfer leisure

In some insights (section B), combined aspects have indeed been used. However, these combinations are quite limited. The only types of travellers Customer Insights combines are based on the aspects of Domicile, Travel Motive, and Type of Passenger. This results in only 6 types of travellers.

In the support system, users can personally select the combination of aspects. There are no limitations on specific predefined target groups, and a broader range of scenarios can be visualized.

Summarizing factsheets:
- Chinese passengers
- Business passengers
- Leisure passengers
- Departing passengers
- Transfer passengers

It is important to consider the specific goals of the user. From an interview with Customer Insights (Research Box E) it appears that this distribution is, among other things, based on contributions to the financial flow at RSG. Chinese travellers have a significant financial contribution although only 2% of all travellers at Schiphol are Chinese. It seems crucial to have a clear understanding of the user's objective so that you can maximize the utility of the system.

The support system is designed with the objective of the S&AP department in mind. The utility in construction projects is facilitated in this regard.

CURRENT FOCUS ON AIR-TRANSFERS

A noticeable insight is that the distribution of all travellers is purely based on air-transfers. One of the seven categories from the Dashboard section A includes the 'Pier of departure,' for which insights cannot even be collected from non-air travellers.
Customer Insights (see Research Box E), told me that the data they collect is gathered as late as possible in the travel process, which is at the gates. This ensures that the insights are based on as much of the Schiphol travel experience as possible. Unfortunately, as a result, many insights are based on the locations and experiences at Schiphol that are only encountered by air travellers. Insights about either the train or the bus are therefore scarce, and experiences specifically related to the transfer between train and bus are completely absent.

In my design, the choices for the axes and checkboxes are based on travellers dealing with rail-bus transfers. Since Customer Insights currently focuses exclusively on airplanes, their categorizations couldn't be adopted, and I had to create a new distribution.

REFLECTION

Gathering data on travel experiences is much easier for airplane-related transfers than for rail-bus connections. Travellers have less presence to form an opinion about the transfer, and because the transfer time is shorter, they pay less attention to it. It is also more challenging to find travellers willing to take the time to participate in a survey because they have a short transfer time.

6.4 LITERATURE ANALYSIS

INTRODUCTION

In the literature, a lot of different things has been written about various methods of categorizing travellers. I discuss three different approaches, each of which distinguishes travellers based on different reasoning:

- Factual and characteristic type distribution
- Need based type distribution
- Motivation based type distribution

One of the studies is executed entirely independent of Schiphol, one is internally conducted by Schiphol, and one is commissioned by Schiphol. All three studies are centered around travellers using MTHs, and they all also examine factors that include air travellers.

FACTUAL AND CHARACTERISTIC TYPE DISTRIBUTION

To gain an understanding of the passenger of the future, the European Commission conducted research on travel behavior, influencing factors, and their future developments (Hullah et al., 2016). From this research, 6 types of travellers have emerged, each categorized based on 9 aspects, as illustrated in Figure 6.2. The more detailed elaboration of the archetypes (Hullah et al., 2016) can be found in Appendix 6-C.
This factual way of categorizing travellers is more commonly used in the literature and even this specific way is used in other research (Babić et al., 2022).
The advantage of this method is that it has a very small margin of error because it is very clear which traveller belongs to which category. However, a challenging aspect of this categorization method is that travellers are quickly placed into a specific category, which may not necessarily align with their needs. The category a traveller falls into can vary from one trip to another (difference in way of access, travel party size or luggage). This results in the fact that the needs between all categories tend to be more balanced compared to when travellers are categorized based on more personal aspects. This personal approach could potentially provide more insights for the support system.

	Passenger archetype					
	Cultural Seeker	**Family and Holiday Traveller**	**Single Traveller**	**Best Agers (Next Generation)**	**Environmental Traveller**	**Digital Native Business Traveller**
Main travel purpose	Private	Private	Private	Private	Bleisure[1]	Business
Age group	15-65	30-50, and children under 15	44+	65+	30-44	24-64
Trips per year per capita	0.5-1.5	0.5-1.5	0.25-0.5	0.5	0.5	0.5-1.5
Travel party size (number of people)	1-2	2-3	1	1-2	1-2	1-2
Income level	Medium-high	Medium-high	Low-medium	Medium	Medium	Medium-high
Travel expenditure	Low-medium	Medium	Low	Medium	Low	Medium-high
Use of mobile devices and retrieval of information	High frequency	Medium frequency	Medium frequency	Medium frequency	Low-medium frequency	High frequency
Airport access mode	Public transport, taxi, car sharing	Public transport, car (park and travel)	Public transport, kiss & fly[2]	Car (park and travel), kiss & fly[2]	Public transport, car sharing, cycling	Public transport, taxi, car sharing
Luggage	Usually hand luggage	Usually check-in	Usually hand luggage	Usually check-in	Usually hand luggage	Usually hand luggage

[1] *Bleisure: Business trips combines with leisure.* [2]*Drop-off and pick-up by freinds and relatives*
Figure 6.2 Future passenger profiles identified in DATASET 2050. (Hullah et al., 2016):

The traveller data is retrieved in the system in a way that it's not a problem if travellers are placed in a different preset depending on the specific transfer they make. Since the data is situation-dependent and the axis and checkboxes are based on a combination of personal and factual aspects, travellers are not immediately categorized within fixed types. The method of data retrieval in the system is discussed in Chaper 10. Therefore it was important to keep a balance between not over-categorizing (placing travellers too quickly into a group they might not belong to), and providing sufficient clarity (user should be able to make targeted selections).

NEED BASED TYPE DISTRIBUTION

From the research conducted by Hendrikx (2021), six different types of travellers have also emerged. However, in this study, these different types are not based on the factual and other primary characteristics of travellers as is done by the European Commission. Instead, they are based on the pains, gains, drivers, and user needs of travellers, which represent more emotional motivators. These motivators were derived from insights obtained through interviews using morphological psychology (Koos Service Design, 2020). The various traveller types are categorized based on the six most significant motivators for travellers, which can be found in Appendix 6-D. The six different types of travellers have been identified and described in Figure 6.3. Further details on the various traveller types can be found in Appendix 6-D. The insights I have extracted from this need-based distribution are described on the next page.

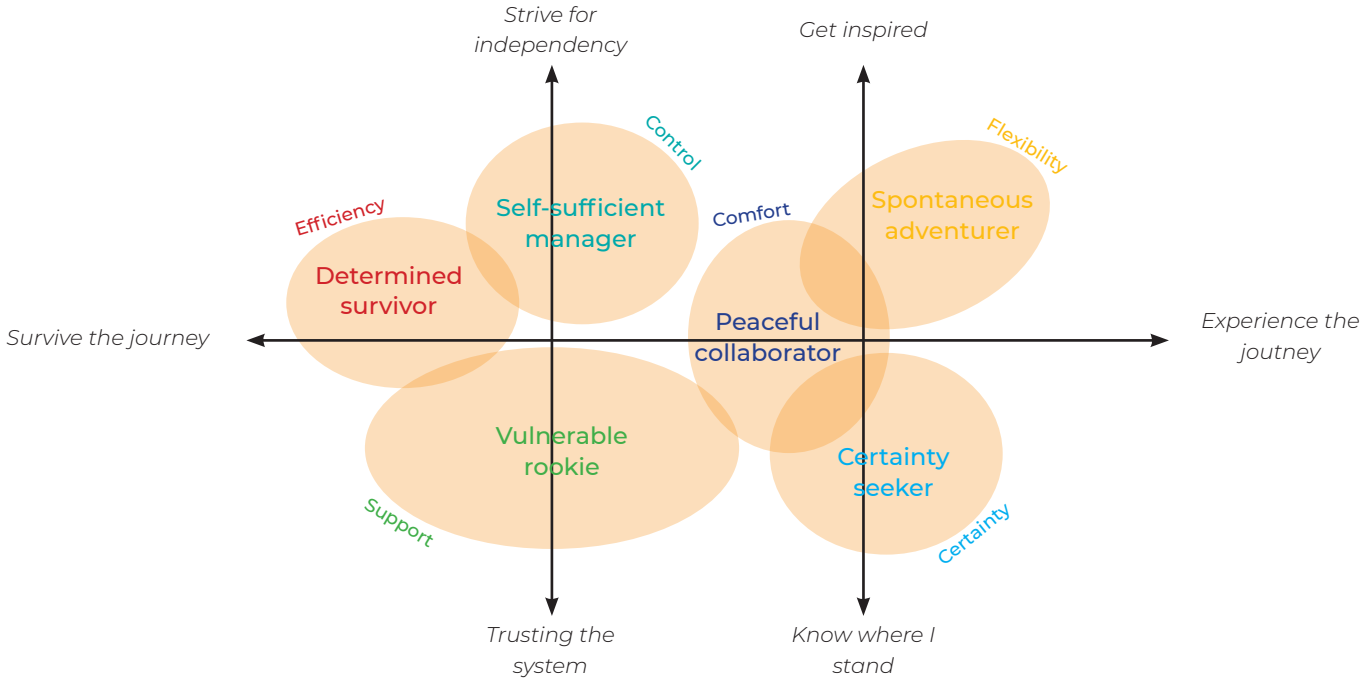


Figure 6.3. The need based personas Hendrikx (2021)

MOTIVATION BASED TYPE DISTRIBUTION

To develop a strategy to become Europe's number one passenger-preferred airport (See Chapter 2.1), RSG enlisted the assistance of Beautiful Lives. Beautiful Lives is an innovation and strategy firm that bases its approach on the principles of Design Thinking (Beautiful Lives, 2023).

In this context, the categorization of traveller types is primarily based on the variety of motivations among travellers. The research indicates that the 'Motivational Strategy' is the primary driver of behavior and the overall travel experience. Figure 6.4 illustrates a motivational reference framework formed by two behavior-explaining axes.

The x-axis represents how travellers' behavior is influenced by environmental factors, such as social context and people their reactions to it. The y-axis represents how travellers personally address the need to make their experience as smooth and relaxed as possible while navigating necessary procedures and activities. The intersection of these two axes creates four areas, leading to the categorization of four different types of travellers, viewed as motivation strategies in the research.

It's worth emphasizing that in the research, travellers rarely have just one strategy but often unconsciously employ two strategies depending on the experience or the crowd in their surroundings. Additional explanations

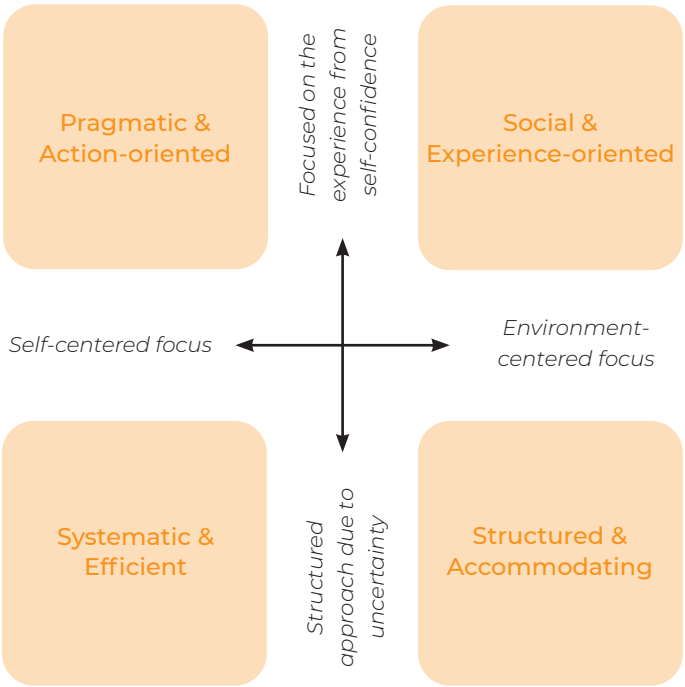


Figure 6.4. Traveller Motivation Strategies

of the four types of travellers can be found in Appendix 6-E. The insights I have extracted from this motivation-based type distribution are described on the following page.

NEED BASED AND MOTIVATION BASED TYPE DISTRIBUTION INSIGHTS

In my design, I have moved away from defining traveller types, as is discussed at Customer Insights and the and factual and characteristic type distribution. Once again, in the needs-based and motivation-based categorization, fixed types were chosen. As a result, I couldn't use this method of allocation either.

Something I did utilize is the underlying concept of using axes as a basis, and using more personal aspects as a basis of distribution. In both cases, needs-based and motivation-based categorization served as a good example for my own design.

An important insight is that it is crucial for the categories to be easily understood by the user. With the distribution used in the need- and motivation-based categories, the user will struggle to select the desired target groups because they do not know which characteristics correspond to the categories. In my design, I have, therefore, chosen for axes and checkboxes that are immediately understandable and accessible to the users. Additionally, if the axes or checkboxes are unclear, users can request additional explanations within the support system.

From the fact that in my analysis already six different methods are used to allocate travellers, it can be concluded that a distribution is highly dependent on the specific application. The methods used to categorize travellers vary significantly across both internal usage and the literature. For my own design, I have therefore chosen not to use any of the analyzed distributions and instead focus on creating my own method for selecting travellers to specify insights.

REFLECTION

Based on the analysis, I didn't become convinced that any of the examined methods would perfectly align with my own objectives. As a result, I started conducting my own research to arrive at the optimal distribution of types. I have used the numerous insights from the analysis as a starting point and incorporated them into my research and design.

7

TRAVELLER NEEDS & DESIRES

7.1 NEEDS AND DESIRES

DESIGN

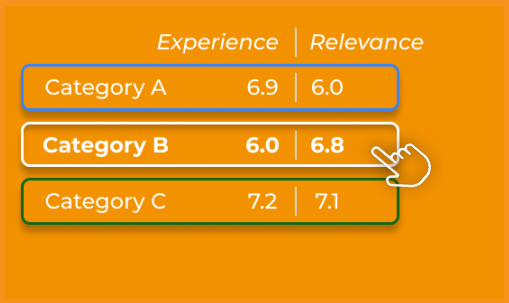
To maintain an overview, all the needs and desires of travellers have been classified into six categories. These categories represent the most useful division based on extensive research, including both literature and self-conducted studies. All researched needs of travellers have been classified into one of the six categories.

Within each category, two ratings have been assigned. Based on all the conducted research, it was concluded that these two aspects provide the most insights for the S&AP employee.
Firstly, there is the rating that shows to the overall experience of the category; called 'Experience.'
This score (1-10) indicates how satisfied or dissatisfied travellers are with the transfer experience related to this category.

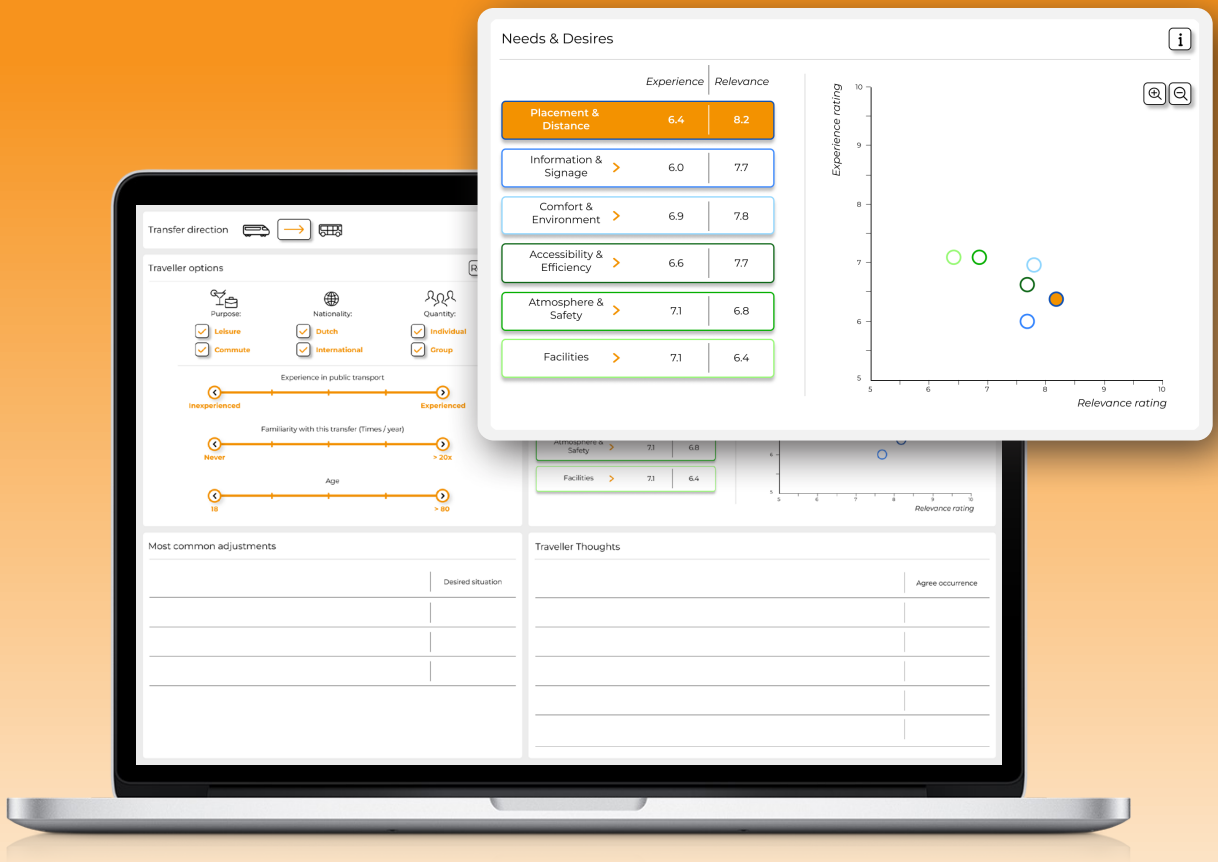
Secondly, there is the rating that reflects the importance and relevance of the category' called 'Relevance'. This score (1-10) indicates how (un)important travellers consider this category and how much impact it has on their transfer experience.

To facilitate quick comparisons, these two ratings have been plotted against each other on a coordinate system. By visually representing the values, it becomes easy to see how the categories relate to one another. This visual representation also allows for rapid comparisons when the target audience or transfer direction is changed. Research has shown that it's not necessarily the precise values that matter, but rather the differences between categories or target groups.

USE



By clicking on the plus and minus symbols, the user can zoom in and out on the coordinate system. By clicking on the 'I' of Information, a more detailed explanation is provided about the meanings of the various categories.



7.2 MOST COMMON ADJUSTMENTS

DESIGN

Clicking on each category of traveller needs provides access to additional information. This information is divided into 'Most common adjustments' and 'Traveller thoughts.'
The 'Most common adjustments' feature presents the modifications that travellers would most prefer to see implemented in construction projects. RSG feels the need to have insight into the user perspectives for potential adjustments that directly affect construction projects. Since not all construction projects are predetermined, they therefore cannot be specifically inquired about. Therefore, the decision is made to have the most common aspects assessed within each category.

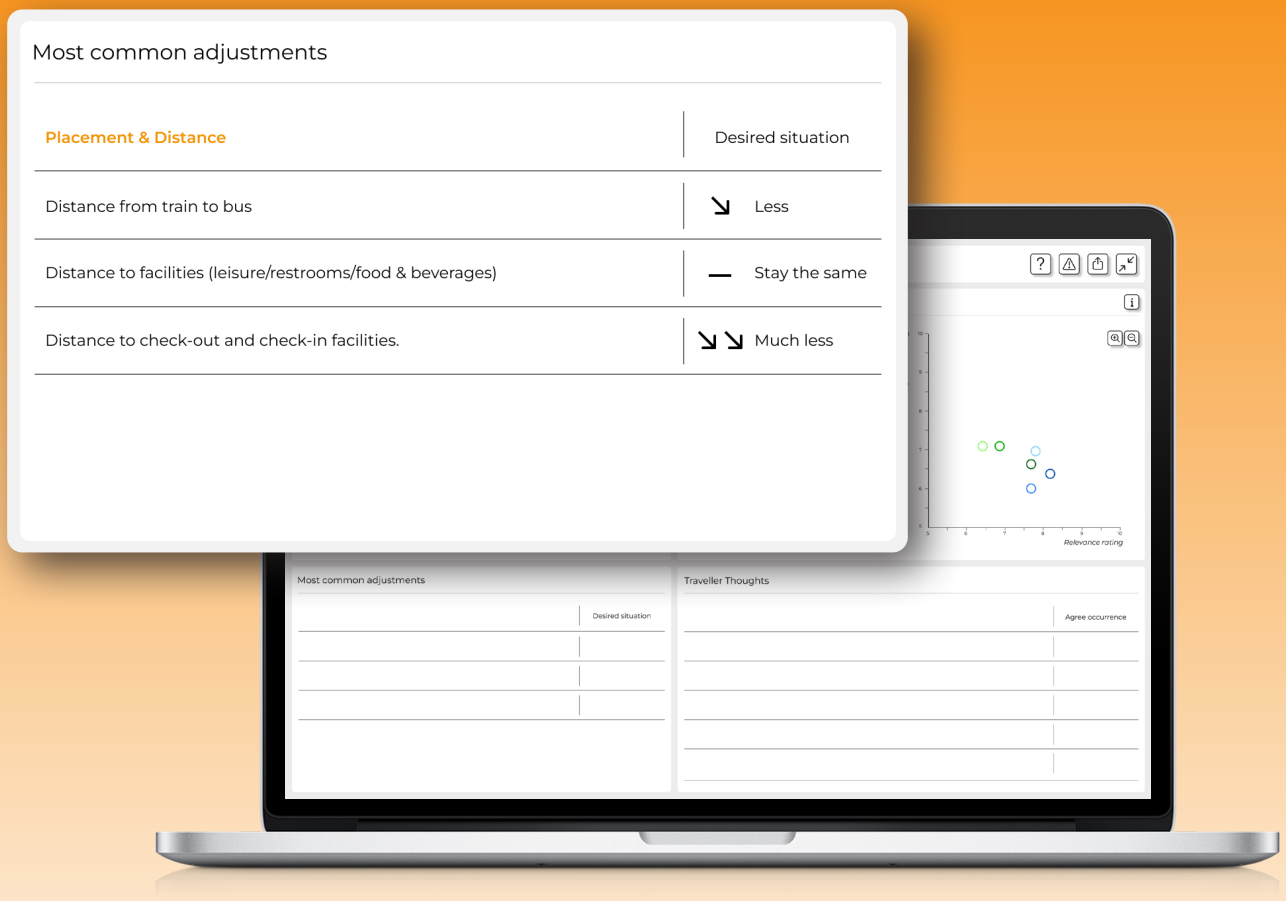
The most common adjustments are pre-set and vary by category. They are based on all the insights found from the studies in Researchboxes B, H and I, see Chapter 7.4.

All adjustments are translated into a statement that can be indicated by an increase or decrease. No numerical values or scores are used. Research has shown that travellers find it challenging to assign values to potential adjustments (Research Box J). With just an increase or decrease indication, the way of evaluation is more accessible. From a conversation with a S&AP employee can be concluded that the users gain sufficient insights from this method of assessment.
The adjustments are represented through both textual and visual displays. It distinguishes between a significant increase or decrease, a regular increase or decrease, or keeping the possible adjustment (distance/quantity) the same.
There is no established boundary between a single or double arrow. The single or double arrows only indicate how 'strongly' travellers feel about the adjustment and how they have indicated it themselves.

USE

The single and double arrows indicate the desire for an increase or decrease in the adjustment. A dash indicates when travellers are satisfied with the current situation. The number of adjustments varies by category.

	Desired situation
Adjustment A	↘
Adjustment B	—
Adjustment C	↗↗



7.3 TRAVELLER THOUGHTS

DESIGN

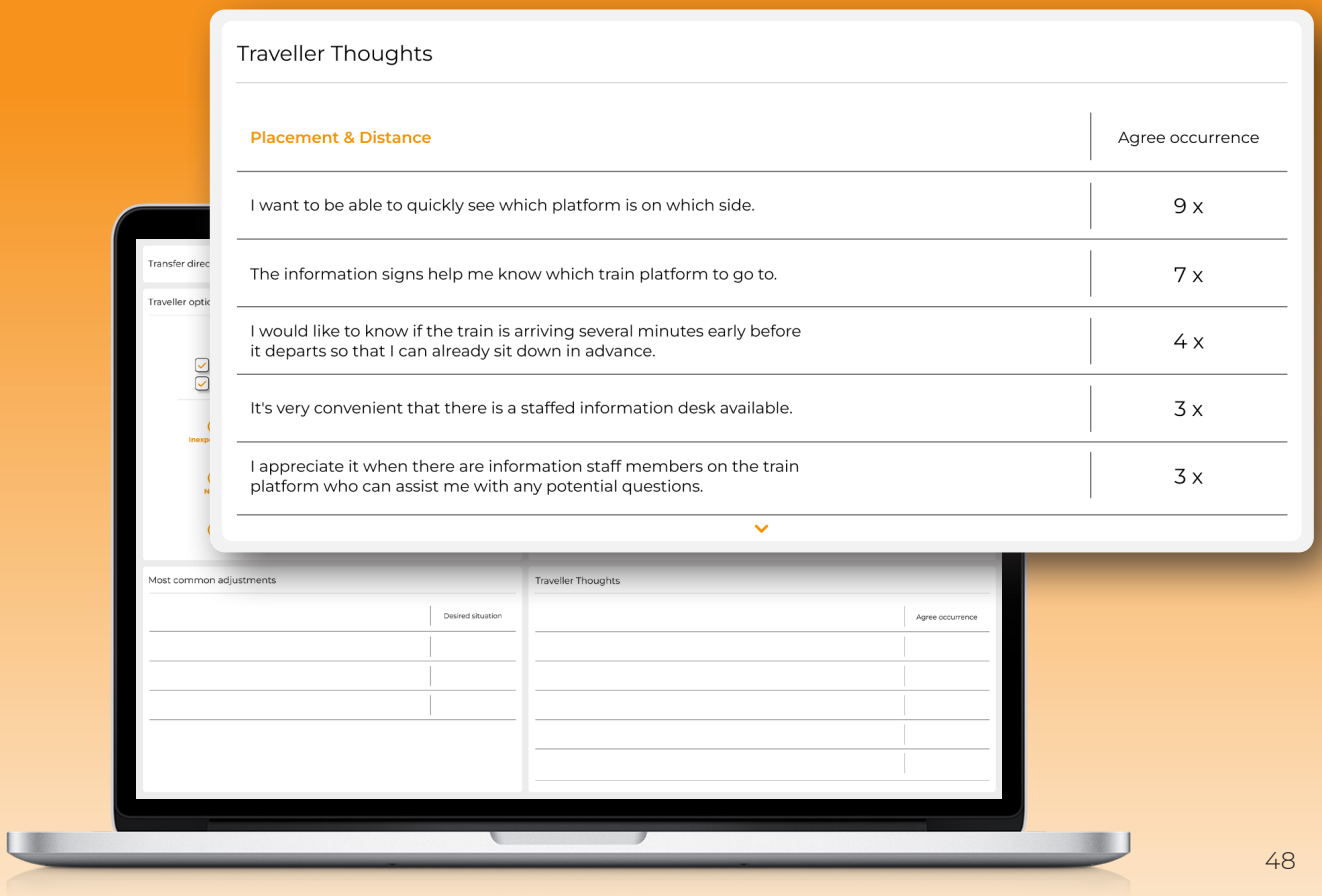
The ‘Traveller thoughts’ feature presents the various unspoilt needs and desires of travellers regarding their transfers. Research has shown the importance of allowing travellers to express their needs freely (See chapter 7.6) . This is because some of the needs that travellers have cannot be predetermined. Therefore, relying solely on predefined possible needs is not feasible, and a ‘free input’ approach is adopted. The most common freely expressed needs are presented in the system and sorted by artificial intelligence.

Since travellers share their own experiences, there are also positive ‘thoughts’ that come up. (see Chapter 7.6) For the user of the system, these positive thoughts can be used as examples and arguments for aspects that travellers are satisfied with. they can, for example, be effectively used as references.

USE

The number behind each insight indicates how many different travellers have mentioned this same need, and are sorted by prevalence. Scrolling down reveals more indicated thoughts.

	Agree occurrence
Insight A	9 x
Insight B	7 x
Insight C	4 x



7.4 EXPLANATION OF FUNCTIONALITIES

INTRODUCTION

One of the essential aspects of this research is mapping out the various needs and desires of travellers. These needs and desires serve as the outcome visualized by the support system. The insights that S&AP employees use for argumentation in construction projects can be directly derived from it. The following sections are about identifying the different needs and desires that travellers have and the optimal way to translate them into the support system.

First, I will explain how the functionalities, as examined in the three previous pages, were selected. To arrive at this design, several other research efforts preceded it. The conducted literature analysis and the three studies carried out to gather traveller data will be discussed in the subsequent sections.

TWO-TIER INSIGHTS

To be as useful as possible, it is important that the system provides in-depth insights. These insights need to be visualized in an organized manner, so the insights are easy to read and understand. One of the challenges in designing the support system is striking a balance between the depth of information and keeping a clear overview. To maintain this balance, I chose to group all individual needs into separate categories. The main screen of the support system will only show the insights of these 6 categories. Within each category, the ratings and relevance provided by travellers based on their experience are displayed. If there is a need for more in-depth insights there is the option to click on each category to display detailed insights, like is shown in the three previous pages.

By using the 'second-tier' insights system, a balance has been achieved between maintaining an overview and providing more in-depth insights for each category.

CREATING CATEGORIES

To establish the categories for the support system, I collected a large variety of different needs and desires. This includes needs and desires of rail-bus travellers as well as travellers that use other modalities, to identify potential differences. The collection of these needs comes from the research conducted in Research Box B, H, and I (Next page). After careful consideration, I established a distribution of 16 different categories that include all the identified needs and desires. However, to prevent the support system to lose its overview, these 16 categories were further merged into the final 6 categories. This process involved trial and error, as depicted in Figure 7.1. I drew inspiration from the categories found in the literature and the categories I had previously developed during the preliminary research, discussed on the next pages. Overlap has been avoided. The following categories have been chosen as the optimal and final distribution:

Figure 7.1. Trying out different categosies

- Placement & Distance
- Accessibility & Efficiency
- Information & Signage
- Atmosphere & Safety
- Comfort & Environment
- Facilities

REFLECTION

When creating categories, careful consideration was given to the number of arguments per category and the frequency with which an argument appeared in the analyses. Although an attempt was made to distribute this as evenly as possible, a more popular category is evident in 'Information & Signage' and 'Comfort and Environment'.

RELEVANCE OF NEEDS

The most fundamental need for travellers is to be guided from point A to point B in a good manner. This is the main task that Schiphol strives to perform to the best of its ability. In addition to receiving guidance in the right direction, travellers want to approach their journey with relaxation and confidence, knowing that they will arrive at their destination on time. They aim to encounter as few uncertainties and obstacles as possible that might induce tension. Time perception is a crucial factor influencing the customer journey experience and can lead to the experience of stress. Waiting, passing the time, and constantly keeping track of time are among the most significant stress points for travellers (Passenger Journey 2022 – RSG, Customer Insights). When these core needs of travellers are fulfilled, they consider it a great bonus for their expectations to be exceeded. A touch of added comfort, entertainment, and amazement can positively surprise travellers and contribute to an even better travel experience. This is how Schiphol can distinguish itself from other hubs (Passenger Journey 2022 – RSG, Customer Insights). Figure 7.2 shows a visual perception of the different traveller needs.

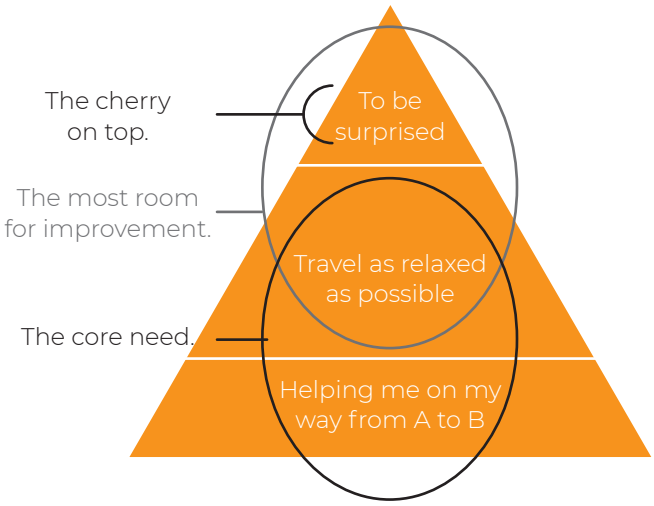


Figure 7.2. Traveller needs pyramid

It is very valuable to look at the whole picture and not just focus on the core needs or 'cherry' needs. However, when working with different needs, it's important to keep in mind the differences in relevance. It illustrates that there is a difference in priority among the needs, something that should be implemented in the support system. The addition of an element that displays the relevance of the needs has already been identified as a request by the S&AP employees, as shown in the Design Request (Chapter 1.8).

I choose for a 1-10 scale rating for the reviewing the relevance in the support system. I choose to not use the pyramid model as a rating because this model is unfamiliar to users and could lead to confusion. Additionally, it only represents three levels of relevance, whereas a scale of 1-10 provides a much more specific indication of how relevant a category is.

SURVEY - PLAZA

Participants: N = 54
Analysis about the needs, barriers and requirements during the transfer experience.

RESEARCH BOX - B

OBSERVATION RESEARCH

New method of analysing travellers. + Gaining new insights. + Confirming the current collection of insights.

RESEARCH BOX - H

SELF EXPERIENCE RESEARCH

New method of analysing travellers. + Gaining new insights. + Confirming the current collection of insights.

RESEARCH BOX - I

7.5 LITERATURE ANALYSIS

CATEGORIES IN LITERATURE

In the literature, there are numerous sources discussing the needs of travellers during their travel experience with an MTH. Rousian, Hiemstra-van Mastrigt & Toet (2022) examined 39 of these studies and made a selection of studies specifically focusing on the transfer experience. From this, 6 studies emerged, each with a diverse modalities distribution. The studies and modalities distribution can be found in Table 7.3.
All the needs that emerged from the 6 papers have been combined and clustered into 9 categories:

- Environment
- Distance and accessibility
- Information and signage
- Substitute Services
- Safety and security
- Commercial services
- Time coordination
- Cleanliness and maintenance
- Ticketing services

Authors + year	Modes of transport
Loo et al. (2020)	High-speed rail with metro, bus, and taxis
Chaniotakis et al. (2022)	Metro rail system with other modes
Hernandez & Monzon (2016)	Metro rail system with other modes
Hickman et al. (2015)	High-speed rail with train
Iseki & Taylor (2010)	Rail and bus
Eboli & Mazzulla (2012)	Air - rail, mainly focus on rail

Table 7.3. Overview of modes of transport (Rousian, Hiemstra-van Mastrigt & Toet, 2022)

One of the aspects highlighted in the paper is that there is no agreement on the prioritization of various needs in all the studies. This can be inferred from the text in Quote 7.4. his conclusion aligns perfectly with the analysis of the Traveller Needs Pyramid on the previous page.
Unfortunately, I cannot use the categories derived from the six different literature studies shown in Table 7.3 because they do not align directly with the objective for the rail-bus transfers in construction projects.I did consider these categories when creating my own.

" Loo et al. (2020) claimed that one of the most crucial factors throughout the transfer was the walking environment. According to Iseki and Taylor (2010), the most crucial factors of the transfer are connectivity and reliability. Other studies found different factors to be the most important, and some did not state any. As a result, it is unclear whether there is any overlap in the importance of the factors. "

Quote 7.4 Rousian, Hiemstra-van Mastrigt & Toet, 2022, page 9

7.6 TRAVELLER ANALYSIS

NEEDS AT PLAZA

To gain insight into the various needs at Schiphol, I conducted a survey with 54 travellers who had different transfers (See Research Box B). Participants were asked to rate their transfer experience on a scale of 1 to 10. The results of this survey are shown in Figure 7.5. The distribution of transfers, the ratings given for each transfer, and the number of participants for each transfer can all be found in Appendix 7-B.
The interesting aspect of asking for a rating is that besides having an idea about their experience, you can then delve into the reasons for their rating. Participants were asked about their overall transfer experience, the key elements important to them during a transfer, and how Schiphol could further enhance their transfer experience. All the needs and desires that emerged from the results have been sorted into different sub-categories and afterwards merged into 6 main categories, as shown in Figure 7.6.
When clustering, I made a distinction between positive and negative arguments. This can be very interesting for the support system as it doesn't only need to focus on aspects that can be improved but also on aspects that are already working very well for certain transfers. It's also possible to estimate what the prioritization among these factors is by looking at the number of arguments, although this conclusion might still be premature.

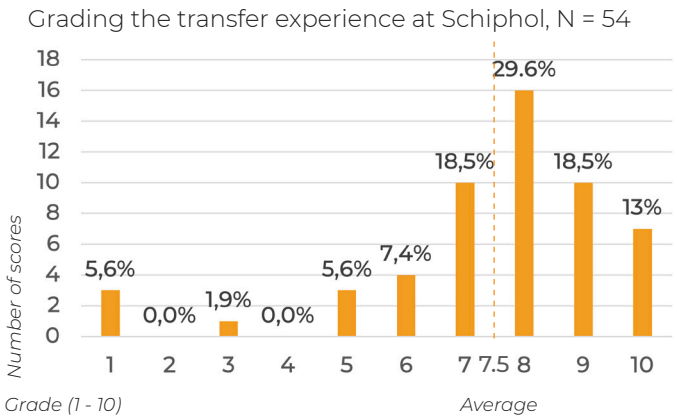


Figure 7.5. Grades that the participants gave their transfer experience

Categories	+	-
Duration and Efficiency	11	12
Atmosphere and personal experience	10	4
Facilities (Physical)	7	7
Clairity	15	6
Seamless pass-through, Hub function	10	4
Accessibility	8	3

Figure 7.6. Categories after clustering, including a positive or negative experience

OBSERVING AND SELF-EXPERIENCING THE RAIL-BUS TRANSFER

After examining the distribution of needs from the literature and different transfers at Schiphol, I obtained transfer insights specifically between Rail and Bus. To implement diversity in the various research approaches to collect insights, I chose two different approaches than before. Instead of directly questioning travellers, I first observed the transfers with the aim of identifying different new needs (See Research Box H). Afterwards I actively experienced the transfer myself to obtain even more new needs (See Research Box I).
During this process, I documented each step and the potential needs associated with it. I identified numerous new needs, mainly related to information provision and navigation between modalities.
All the needs identified during the observation and self-experience studies were categorized once again. This time, they resulted in four main factors, as shown in Figure 7.7.
One noticeable observation was the diversity among types of travellers. For instance, mostly adults and seniors were looking at the travel information screens at the Jan Dellaert Square, while young adults and students hurried past looking at their phones, presumably to look up travel information.

This is a strong confirmation that age is a good factor for distinguishing between different traveller groups as described in Chapter 6.

Another noticeable insight is the clear difference in the experience depending on the direction of the transfer. The travel experience is distinctly different when the transfer direction is reversed, accompanied by different needs that emerged.

This is a strong confirmation that the function to change the transfer direction is an important functionality in the support system, like described in Chapter 5.

The analysis of transfer needs at Plaza, the observational study, and the self-experience research have all contributed to mapping a wide range of needs and desires. These insights were used in clustering the final categories utilized in the support system, as described in Chapter 7.1.

	Bus to Train		Train to Bus	
Categories	+	-	+	-
- Information & Navigation	1	6	4	2
- Accessibility & Infrastructure	2	4	3	2
- Behaviour of travellers	0	4	0	5
- Emotional aspects	2	2	4	1

Figure 7.7 Number of positive and negative factors per transfer

Free insights can be both positive and negative. In the support system, it is particularly interesting to include both, so that apart from improvements, there are also examples of things that are going well, especially in categories that have a high score in 'Experience'. I chose not to specify in the design whether each insight is positive or negative, as I did in the analysis. This is not always very clear, and as a result, insights can be pigeonholed too much.

REFLECTION

Although many needs that were previously known were confirmed, no clear new needs emerged from the Observation research. This could be attributed to some factors being more easily recognizable (e.g., time coordination) than others (e.g., the sense of security). This could also confirm that I had already found a wide variety of needs and desires.

UNPREDICTABILITY

Customer Insights currently collects their data based on pre-determined topics. When conducting questionnaires to gather insights, they ask about specific aspects of the travel experience and do not provide the opportunity for 'open' responses.
One thing that stands out when analysing the various needs and desires is that some of them are quite unpredictable. It suggests that there are many thoughts among travellers that RSG may not be able to predict in advance. This unpredictability is a realistic phenomenon, considering the world around us. People's various needs will continue to evolve, and it's important to adapt to them in the support system.

In the method of collecting insights for the support system, it is made possible to request data from travellers in a free manner, without categorizing it into predefined factors. This allows the surveyed travellers who will ultimately provide the system data, to think freely and express their thoughts without constraints. This aspect is schematically represented in Figure 7.8 This method of data collection will be discussed in Chapter 10.

Figure 7.8 The ever-changing needs of travellers.

8

ADDITIONAL FUNCTIONS

8.1 Additional functions

8.1 ADDITIONAL FUNCTIONS

EXPLANATION

By clicking on the question mark, explanatory screens appear, detailing all the features of the support system. These are the same explanation screens that appear when the support system is opened for the first time. The screens can be found on the next page.

SHARE

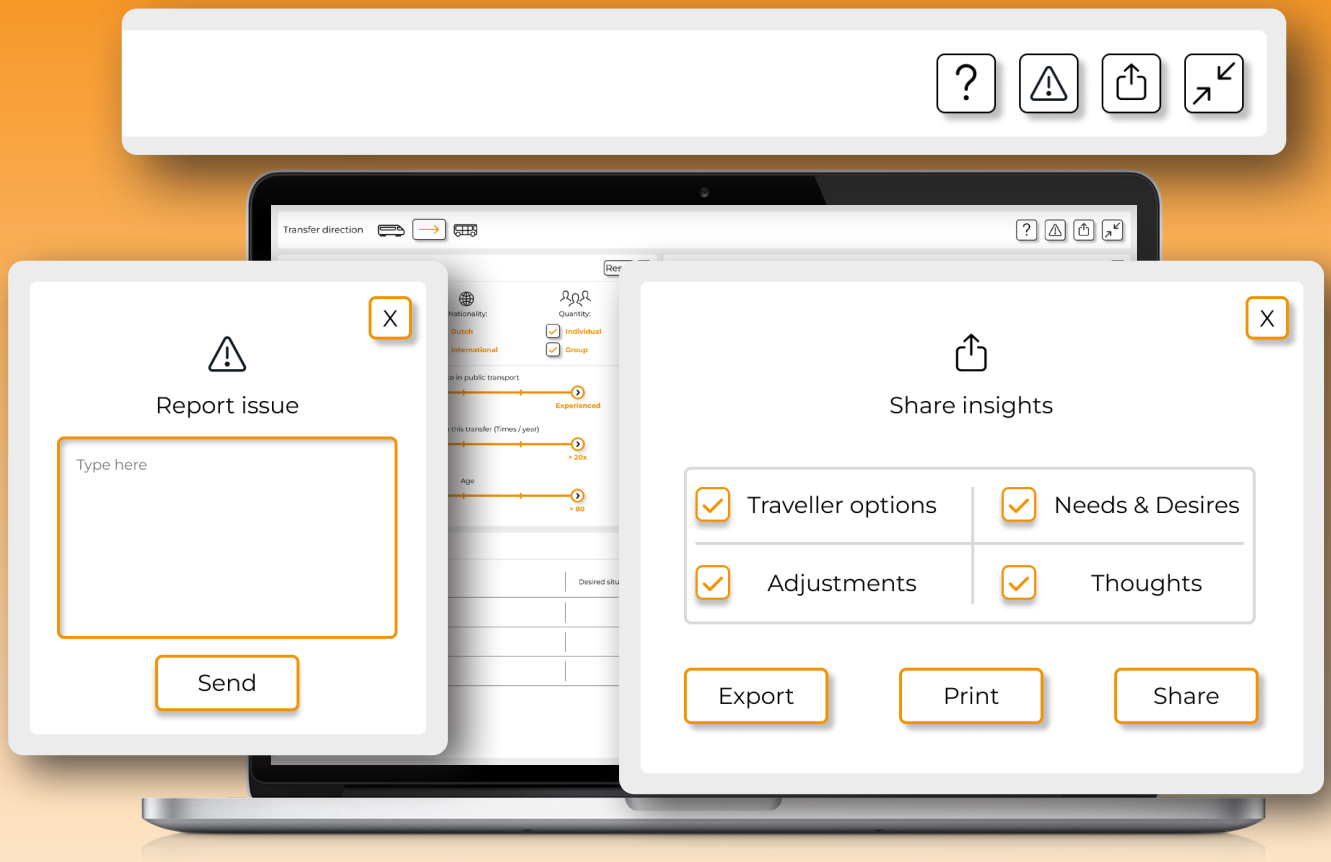
Clicking on the share icon brings up a screen where the user can choose how to share the insights. There are three options available (See screen at the bottom of the page). The insights can be exported as a file and saved to the user's account. Additionally, the insights can be sent directly to the printer connected to the user's account. Lastly, the insights can be shared through the digital environment used by RSG, for example with Outlook and Microsoft Teams. Chapter 9.2 provides further information about this digital environment.
Because it's not always necessary to share all insights, it is possible to indicate which insights should or should not be shared using checkboxes.

REPORT ISSUE

By clicking on the exclamation mark, the user can report an issue with the system. This report will be sent to the Microsoft 365 & SharePoint department of RSG, who can then make adjustments to the system or forward it to the relevant person who can resolve the issue. More information about the various departments and roles is discussed in Chapter XXX.

FULL-SCREEN

By clicking on the inward or outward-pointing arrows, the user can open or close the support system in full-screen mode. The full-screen mode provides a larger display.



When opening the system, a series of screens explain how the functionalities work. This makes the system self-explanatory.

X

Welcome to the Bus-Rail Transfer Support System

This system provides insights into the needs and desires of all the different travellers who make bus-rail transfers at Schiphol Airport.

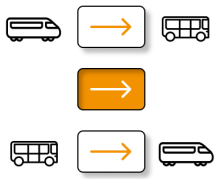
Click the button to proceed to the explanation.

›

X

Explanation (1/5)

Change the direction of the transfer by clicking on the arrow.



‹ ›

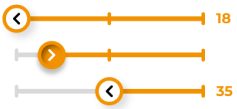
X

Explanation (2/5)

In "Traveller Options," you set preferences for the type of travellers you want insights on.

You can select or exclude travelers by checking or unchecking the option boxes and adjusting the range on the three axes. By clicking the Reset button, your preferences will be cleared, and all options will be selected again. This is also the default setting.

In the option boxes, distinctions are made based on travel purpose, nationality, and group size.



On the axes, you can select a range based on general experience with public transportation, familiarity with the specific transfer, and age.

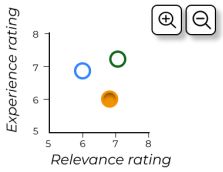
‹ ›

X

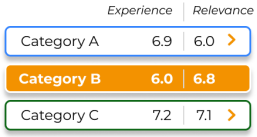
Explanation (3/5)

In "Needs & Desires," you see the insights based on the traveller preferences you just set.

You see 6 categories that encompass all traveler needs. Within each category, there are two scores (1-10). Under 'Experience,' you see the score that travellers give the category based on their experience. Under 'Relevance,' you see a score indicating how important travelers find this category in general. The same values are represented on the axis system.



You can click on both the circles and the categories. Click the plus and minus signs to zoom.



Selecting a category provides additional information about 'Thoughts' and 'Most common adjustments.'

‹ ›

X

Explanation (4/5)

After clicking on a category, two types of insights about this category appear.

Most common adjustments

	Desired situation
Adjustment A	↘
Adjustment B	—
Adjustment C	↗↗

Under 'Most common adjustment,' you find the most common modifications that can be made. The arrows indicate whether travelers prefer a higher, lower, or the same number of the given adjustments.

Traveller Thoughts

	Agree occurrence
Insight A	9 x
Insight B	7 x
Insight C	4 x

Under 'Thoughts,' you find general thoughts that travelers have within this category. A number is provided next to each expression to indicate how frequently travelers have expressed these thoughts.

‹ ›

X

Explanation (5/5)

Click on the question mark to reopen this explanation. Click on the exclamation mark to report an issue. Click on the share symbol to export, share, or print your insights. Click on the arrows symbol enter or leave the fullscreen mode.

Click on the information symbol for additional details about the various depicted aspects.

‹ ✓

THE IMPLEMENTATION

9

BACK-END

9.1 THE DEPARTMENTS

We now know how the support system will function using interchanges between differences in travellers and categorised needs. To bring all this together, there needs to be a method to collect, translate and deliver this data to its users in a usable way. As stated in the project criteria (Chapter 1.7), the system must be easy to implement into the system and workflow of RSG. Therefore, the chosen implementation is based on the current research system of the Customer Insights department and the current digital system of the SharePoint department. By precisely meeting the requirements of these two departments, the system ensures it can be implemented.

CUSTOMER INSIGHTS

The Customer Insights department is responsible for the collection, analysis, and understanding of data and information related to customers. They work on conducting research, surveys, and in-depth analyses to gain insights into the needs, preferences, and behaviours of customers. They provide data and insights to various departments within the organization to help them make informed decisions regarding marketing, product development, customer service, and more.

To maximize the chances of implementing the support system, I align the implementation as closely as possible with the working methods of Customer Insights. They are likely to be responsible if the Support System is indeed put into use.
All insights about customer insights were obtained from an interview with them, as shown in Research Box E.

SHAREPOINT - MICROSOFT 365

The Microsoft 365 & SharePoint department is responsible for managing, configuring, and supporting the internal websites and digital environments (Intranet) within RSG. The Intranet is named SharePoint. They manage user rights and access levels on SharePoint and ensure the security of sensitive information. They are also responsible for integrating with other company systems and processes for seamless data exchange.

Microsoft 365 is the name for all productivity tools and cloud-based services offered by Microsoft. Microsoft 365's role within SharePoint includes offering various tools and features that enhance and extend functionality and usability. Examples of these include email integration, calendar and scheduling tools, productivity apps like Word, Excel, and PowerPoint, and team collaboration tools like Microsoft Teams.

To implement the support system at RSG, it should be done through SharePoint's workflow, with a strong preference for integrating it into the Microsoft 365 systems.
All insights about the system integration and SharePoint were obtained from interviews with SharePoint, as shown in Research Box G.

INTERVIEW - CUSTOMER INSIGHTS

Gaining insights on the current way of gathering data, analysing data, and translating these insights to RSG staff. + Workflow for implementation of own system.

RESEARCH BOX - E

INTERVIEW - SHAREPOINT

Understand how the front-and back-end of the internal system operates. + How to make use of SharePoint and Microsoft 365 and what key aspects to consider.

RESEARCH BOX - G

9.2 THE SYSTEM

IMPLEMENTATION OF THE SYSTEM

The support system should be usable by S&AP employees and easy to find. Placing the system on the SharePoint page of the department can easily be done by the system administrators. The administrators are able to give access to the system either for S&AP employees only or for all RSG employees.
There is a strong preference to run the system on Microsoft 365 and develop the system using Power BI. Power BI is a powerful business intelligence (BI) tool that allows users to visualize, analyse, and share data. Power BI offers the advantage of seamless data integration within the broader Microsoft infrastructure, such as direct export to Outlook, Microsoft Teams, or Excel. Additionally, this ensures extra security and data storage since the software package is already fully known within RSG, and there is no need to use third-party tools. Third-party tools would result additional work related to data security and program screening and are therefore attempted to be avoided.

POWER BI

In addition to basic programming functions, the system is going to use interactive buttons and interactive charts. This can be achieved through the 'Drill-through' function. The drill-through functionality allows the system to display detailed information when users click on specific data elements. This enables users to delve deeper into the data and view more detailed information. This function is needed to make the categories in the coordinate system clickable. Power BI provides the capability to set up custom interactions between different visuals. This allows users to determine how visuals respond to each other when a user interact with one of them. For example, when a user clicks on a specific chart, it can affect other charts on the same page. This functionality is needed for both the sliders, checkboxes and categories in de support system. The implementation of these functions makes Power BI the preferred tool for developing the support system. Figure 9.1 displays a screenshot of what PowerBI looks like.

PowerBI supports all the different functions that need to be used in the system. This was confirmed in a validation session with an experienced PowerBI programmer, see Research Box M.

INTERVIEW - POWER BI EXPERT

Get a validation from a PowerBI expert to confirm that the different functions that are needed in the support system, are possible to build within PowerBI.

RESEARCH BOX - M

REFLECTION

Due to time constraints and the lack of programming knowledge, I was unable to build the support system myself in PowerBI. This would have made the prototype more credible.

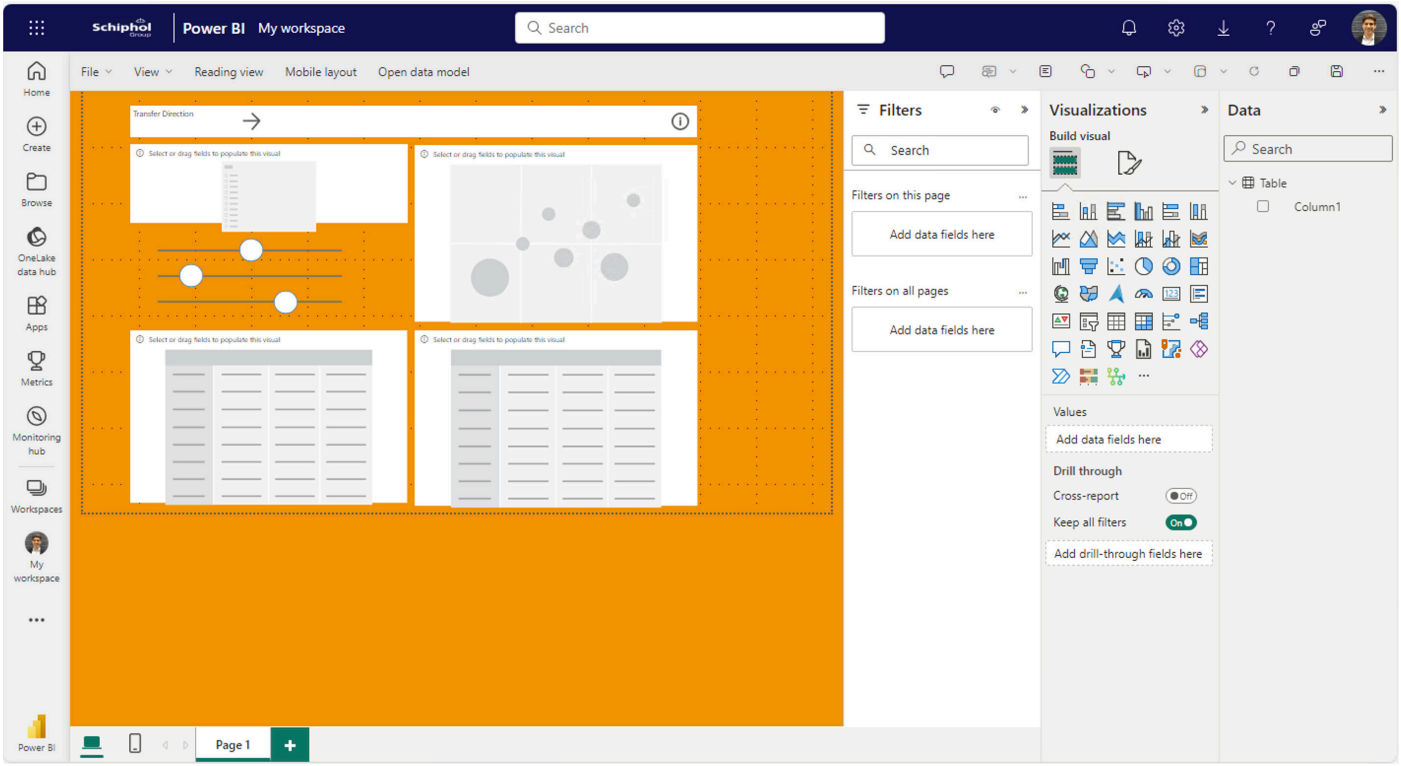


Figure 9.1. Example of building an system in PowerBI.

10

DATA

10.1 DATA STRUCTURE

POSSIBILITIES

The insights presented by the support system are a visual representation of an analysis of gathered data. As indicated, the system is situation-dependent, utilizing input from the user. This input consists of two components: the transfer direction and the type of traveller. The user can adjust these two aspects of input to filter the necessary insights according to their preferences. The 'output' of the system must, in turn, be linked to the two mentioned input variables, both of which are interconnected. There are two input options for the transfer direction. Traveller types consist of 3 axes with 5 positions, each of which can provide for 10 different options of settings. In addition, there are three sets of checkboxes, each of which can provide for 3 options of settings. Together, this amounts to 54,000 different input possibilities. It should be noted that many of these options will yield the same output, and there won't always be a difference. Each input has 35 different insights as output. All in all, it's an extremely informative system.

This can already be achieved by asking travellers about just 7 aspects of their journey that function as input variables (the transfer, the 3 axes, and the 3 options). This is schematically depicted in Figure 10.1.

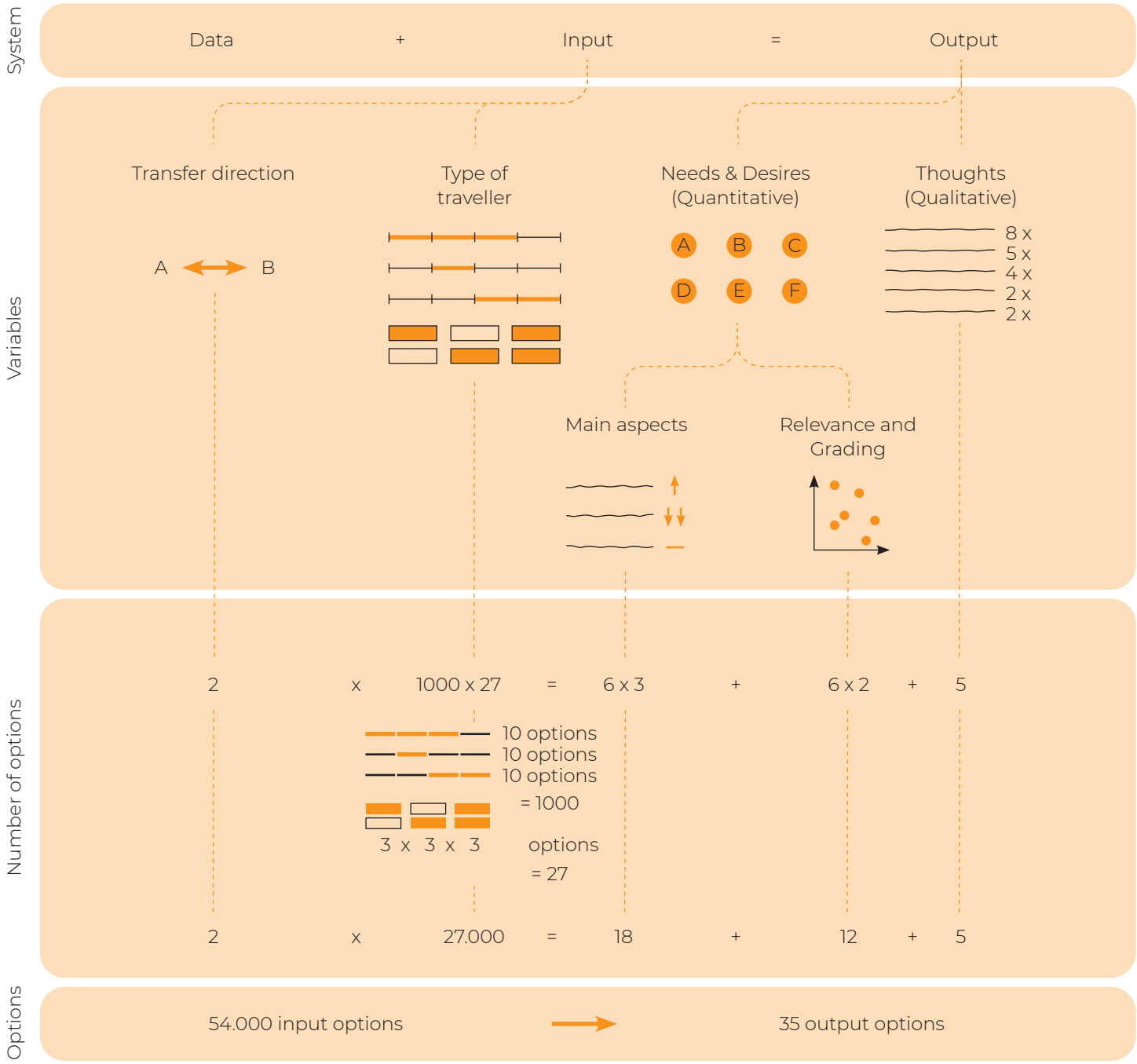


Figure 10.1. Schematic representation of the variable input and output

10.2 DATA TO INSIGHTS

COLLECTING DATA

The Customer Insights department typically collects their data by using research agencies that ask the questions to travellers to gather the data. For the support system, this process will be the same. Schiphol provides questionnaires to research agencies, and the researchers approach travellers on-site. Travellers will then fill out a questionnaire via tablets, or they can provide answers to the researchers during conversations. The researchers will then enter the results into tablets. This results in a large dataset that encompasses a wide range of traveller needs and desires. Schiphol only needs to provide a questionnaire and a list of requirements to the research agencies. The list of requirements can include preferences for location and target audience. For the support system, it will be specified that the focus should be on transfers between buses and trains. The questionnaire with the questions to gather all the necessary data can be found in Appendix 10-A.

THE ANALYSIS OF DATA INTO INSIGHTS

For the data analysis, tools and software applications are used, including SPSS. SPSS allows for statistical analysis, trend identification, and pattern discovery in the collected data. The research agencies process the data into both quantitative and qualitative insights. Quantitative insights are obtained through statistically significant findings. Qualitative insights are obtained by sorting the data that is answered on open questions, using an easy Artificial Intelligence (AI) prompt based on statements. The AI ensures that if different words are used but the same argument is presented, the arguments are still grouped together. This is then translated into the same argument that has been entered multiple times. The results are sent to the client, in this case RSG, in large Excel files. RSG's only task is to place this analyzed data into the support system using PowerBI. By labeling all the data into categories, new data can be easily added to the database periodically.

PERSONAL REFLECTION ON THE CHALLENGE FOR RESEARCH AGENCIES

Collecting the data may be more challenging than usual for the research agencies. Their research expertise at Schiphol is based on air travellers, who may be less rushed during their entry and exit procedure. They normally conduct research at the end of the travel experience, such as at the gates or in and around Plaza (including bus and train stations). In the case of the transfer between bus and train, people may be less willing to cooperate due to the limited time available during the transfer. To ensure time efficiency, the questionnaire can be divided into shorter versions, with different travellers answering different sets of short versions.

Furthermore, compared with their air-related research, people may pay less attention to the rail-bus transfer because it is more brief and routine for some. Their mood may have a greater influence on their responses to the questions rather than their general transfer experience. Another point of discussion is that certain types of travellers may be more willing to participate in such questionnaires than others, potentially skewing the results. However, this is a challenge encountered in any research, and Customer Insights has been dealing with it for years.

10.3 USING THE INSIGHTS

THE VISUALIZATION OF INSIGHTS

The support system functions as an interactive tool and ensures that the collected insights are presented in a clear and understandable manner. The results of data analysis are inputted into the support system by linking the data with the appropriate button, slider or graph within PowerBI using linked labels. These interactive aspects in the support system can retrieve various labels with data, causing the system's output to change continuously. The visualizations that emerge serve as the core of the support system and provide S&AP employees with an intuitive and accessible way to see the relevant information.

ACCESSIBILITY TO THE INSIGHTS

The support system is available on Schiphol's intranet (SharePoint) and can be accessed after employees log in to their Schiphol accounts. This provides seamless and secure access to the valuable insights collected from traveller data.

10.4 THE SYSTEM FLOW

To make the system operate, various parties and departments are required to exchange data among each other. For RSG itself, this mainly involves investing time and money in the initial system development and setup. Once the system is in place, it will primarily require the time of the contracted research agencies to continue gathering data and keep the system up to date. This incurs a constant stream of expenses for RSG. The interaction between departments to keep the system running is depicted in Figure 10.2.

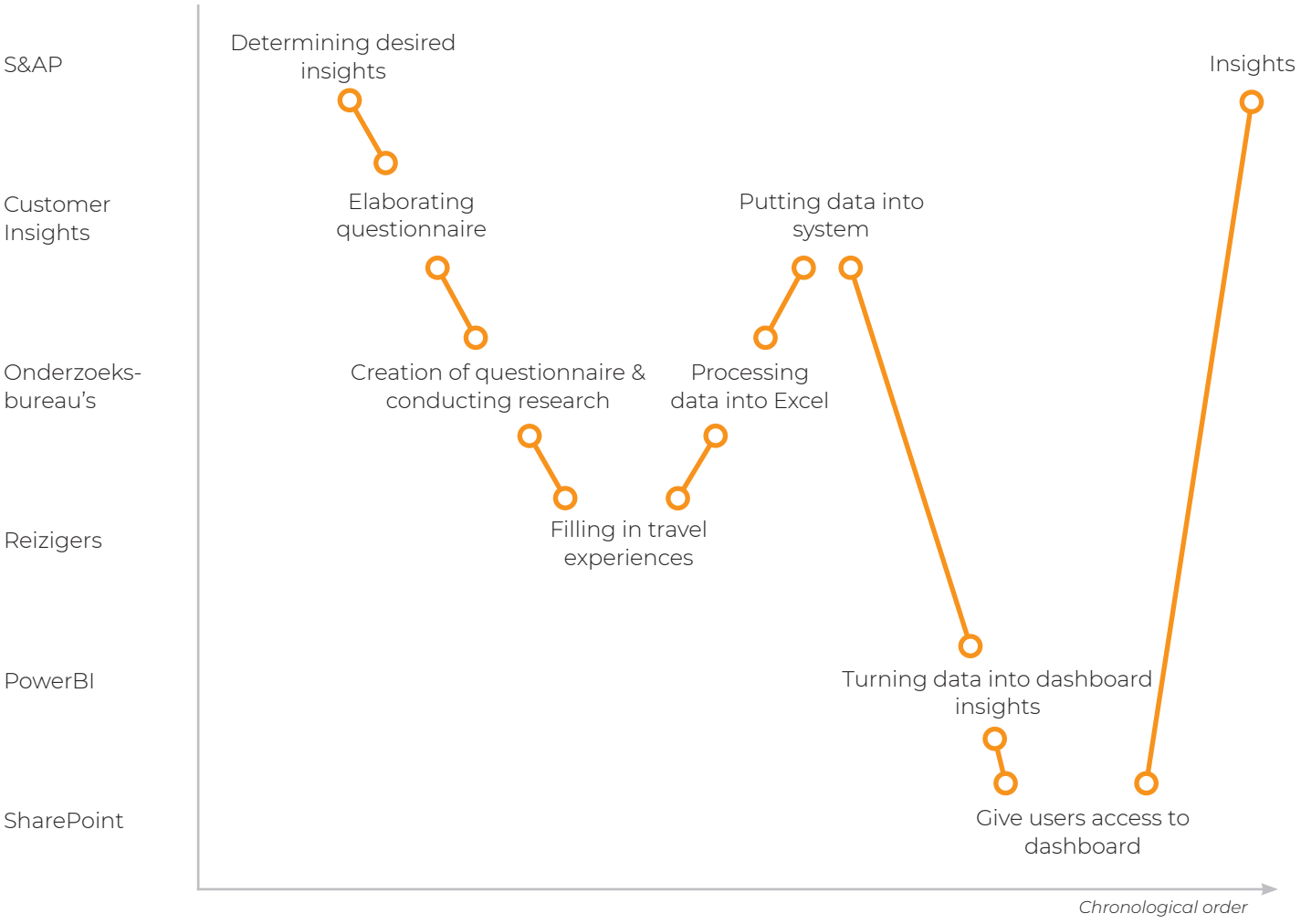


Figure 10.2 The system flow to operate

THE CONCLUSION

11

VALIDATION

11.1 VALIDATION

INTRODUCTION

The support system has been designed based on insights gathered from various research conducted with departments within RSG. Nevertheless, I carried out specific studies to validate the functionalities and design. To assess the success of the design, I established Project Criteria and Design Requests throughout the process (Chapter 1.7 and 1.8). To validate these criteria and requests, I caried out evaluation studies with two RSG departments. First, I did a usability study with 11 employees from the S&AP department. (See Research Box L). Afterwards I confirmed the last criteria and requests that were not confirmed yet in a conversation with Customer Insights (See Research Box N). Furthermore, I consulted a PowerBI programmer to validate that the functionalities could be implemented using PowerBI, as confirmed in Chapter 9.2. Additionally, I conducted a study to ensure that the questionnaire, which will be administered by the research agencies, is sufficient in obtaining the required data (See Research Box J).

USABILITY STUDY - S&AP

Participants: N = 11
Insights into the interface and functionality of the support system design + Validation of project requirements.

RESEARCH BOX - L

INTERVIEW - CUSTOMER INSIGHTS

Evaluate the data collection method that will be used to gather all the necessary insight for in the support system.

RESEARCH BOX - N

QUESTIONNAIRE - TRAVELLERS

Participants: N = 16
Collecting specific data used in the support system + Trying out 9 different axes for optimal distribution.

RESEARCH BOX - J

CUSTOMER INSIGHTS CONFIRMATION

To confirm the validity of the described method for supplying the system with data, I presented the design to the Customer Insights department (Research Box N). They were very positive about the design. During the conversation, there was a long discussion about the future of the department and how they are currently primarily focused on on-demand data collection. They indicated that it is important for the department to also consider the future because their field always evolves in line with the needs within RSG. If other modalities within an MTH start to play a more significant role, their focus will clearly shift from aviation to more diverse modalities.
Thinking ahead is something that is not done much within the department and is something that could potentially be implemented more.

Customer Insights confirmed that the described method indeed aligns with the workflow used within RSG's system. They also indicated that it is likely to become the responsibility of Customer Insights to develop and maintain the system. However, they emphasized that it must first be clearly demonstrated that the demand for this system justifies the investment and effort to set it up.

QUESTIONNAIRE CONFIRMATION

To obtain insights for the support system, the research agencies will collect data from travellers using a questionnaire. To validate the effectiveness of this process, I developed the questionnaire required for data collection. I conducted a study among travellers to assess the comprehensibility of the questions and to ensure that the outcomes align with the necessary data for the system. The questionnaire can be found in Appendix 10-A. The insights gathered from the questionnaire were used to provide data for the prototype that is used in the final usability study, discussed on the next page.

The questionnaire proves to be adequate in providing the necessary data.

REFLECTION

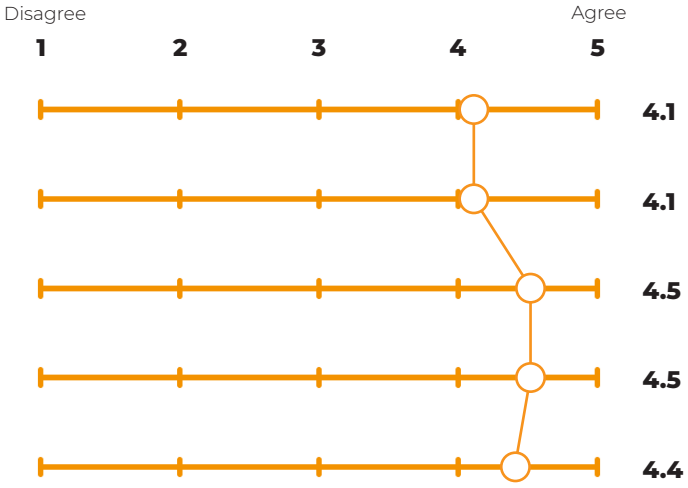
It would have been better if I had used an existing scientific research method, such as the System Usability Scale (SUS), which could have worked well for my design (Brooke, (1996).

11.2 USABILITY STUDY

STUDY SET UP

To assess the functionality of the support system and confirm the achievement of the project's goals, I conducted a final study. This study is a simplified version of a Cognitive Walkthrough method (Spencer, 2000) commonly used to evaluate the usability and user experience of a design.
During the study (N = 11), I provided participants with narrative-based tasks to use all the different features of the system. A prototype via Figma.com is used to simulate the functionalities. During the study, I did not provide any guidance, and observed how participants interacted with the system. In addition to observing, I asked questions about the functionalities and implementation. Afterwards I asked all participants to fill in a questionnaire about their experience. The results are shown below. The final study is conducted using an older version than the one described in this report. However, the core functionalities on which the primary assessments are based did not change significantly. The older design used during the study, and a more detailed description of this study can be found in Appendix 11-A. This research is shown in Research Box L.

USAGE



1. I have succeeded in carrying out the tasks without asking any additional questions.

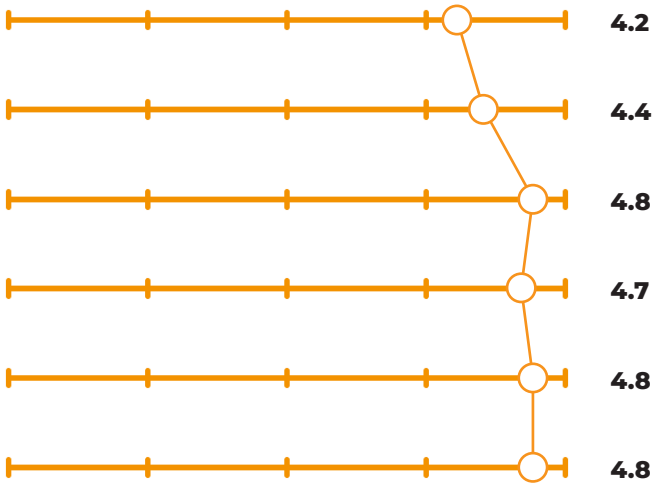
2. I have successfully located all the different functions of the system without asking any additional questions.

3. I have the feeling I can use the system to get insights in an easy way

4. If all the data in the system is filled in, the system positively contributes to gather insights for my projects.

5. If all the data in the system is filled in, the system has a positive impact on my job at RSG.

FUNCTIONS



6. The system is intuative

7. The system is self explanatory.

8. The system allows for specifying different target audiences.

9. The system displays a difference in relevance between different categories of insights.

10. The system allows for sharing insights (exporting/printing).

11.. The system allows for indicating possible errors.

11.3 USABILITY EVALUATION

IMPRESSION

For the overall impression, the participants provide positive feedback. They describe the design as clear, straightforward, and useful. The participants are interested in the ultimate goal and think that the functionality aligns well with the application. A portion (N=6) of the respondents had already heard of the concept's function, and in two cases, had even seen the design before, but several (N=5) had neither heard of it nor seen the design previously. There is no remarkable distinction in the results between these two groups.

CONCLUSION

In the results, it's evident that the average rating for each question is above 4, indicating that users agree with all the statements. However, three questions received lower ratings compared to the rest: questions 1, 2, and 6.
For questions 1 and 2, lower ratings were given by the participants because they asked questions about tasks during the study. Although the answers were not provided, in some cases, I had to explicitly repeat the task instructions to clarify what tasks needed to be performed. Question 6 received two ratings of 3, suggesting that users don't necessarily find the system highly intuitive but also don't find it terribly difficult to use. I've incorporated much of the feedback into the new design, paying attention to icon usage, placement, and user cues. The final design provides more clarity and comes across as more intuitive.

Throughout the entire study, only one rating of 2 is given, and it is for question 1. This participant had difficulty completing one of the tasks and asked multiple times for clarification on what was expected. The person eventually found the solution on their own after I repeated the task instructions multiple times.

While the scores are highly positive, there have also been many suggestions for improvements, primarily in terms of interaction. All good suggestions have been incorporated into the final design.

DISCUSSION ON USABILITY STUDY

Participants
The 11 participants are all part of S&AP, divided over 4 different sub-departments. A larger sample group would have been even better, but because the 11 participants often agreed with each other, the results are still quite representative.

Scenario-based tasks
The research is conducted using scenario-based tasks rather than realistic workflows in which the system will be used. It would be very interesting to conduct research where the system can be used in an undefined context, where it can directly impact current projects within Schiphol.

Prototype limitations
During the use of the prototype, not all buttons worked. Some of the buttons that were not needed for the scenarios have been programmed, but not all of them. As a result, participants couldn't freely 'play' with the system. This did not have a direct negative impact on the tasks but limited participants from exploring the system more freely.

Environment
Ultimately, the support system will primarily be used on a computer. The research is conducted on an iPad, which provides a different clicking experience than on a laptop. During the study, I switched from using a finger to using a stylus to simulate a more realistic clicking experience (See Figure 11.1), however a computer would have been better.

Diversity of the participants
One aspect that has emerged is that the design may be primarily aimed at 'Beta' personalities due to the use of numbers and graphs. It may be worth considering a new version for more 'Alpha' personalities.

Outdated
I did not conduct a new usability study with the final design of the support system. While this final research has already confirmed that the system functions well, a new study would provide a more realistic view of what the S&AP employees think of the final design.

Figure 11.1 Test participant engaged in research

11.4 THE REQUIREMENTS

PROJECT CRITERIA ✓/✗

Usability & User-friendliness
S&AP employees can understand how the self-explanatory support system works. ☑

S&AP employees can locate and use all functions of self-explanatory support system ☑

S&AP employees can utilize the insights from the self-explanatory support system. ☑

Measurable impact on decisions
The support system positively contributes to decision-making in construction projects. ☑

Added value
The employees of S&AP perceive the support system as an added value to their work. ☑

Data collection
There is a method for collecting and analysing traveller data as input for the support system. ☑

The method for collecting and analysing data aligns with RSG's workflow and can be implemented within their current system. ☑

DESIGN REQUESTS ✓/✗

Proritize ..... S&AP ☑
The support system prioritises needs by types of travellers.

Relevance of needs ..... S&AP ☑
The support system indicates a difference in relevance between various needs or traveller types.

Data security ..... SharePoint ☑
The support system does not operate on servers other than those of RSG due to data sensitivity.

Lifespan ..... S&AP ☑
The support system continuously refreshes insights based on periodic new data inputs.

3rd party tooling ..... SharePoint ☑
No third-party tooling is used due to the complex security procedures involved.

Implementation ..... SharePoint ☑
The support system is easily implementable within the current workflow and digital system of RSG.

Shareable ..... Custmer Insights ☑
The insights are easily shareable, exportable, and printable.

Capacity ..... SharePoint ☑
The system can handle the capacity when all S&AP employees use the system simultaneously.

Open to Improvement ..... SharePoint ☑
The system enables the option to report errors to the developer for any potential issues within the system.

Adaptable ..... SharePoint ☑
The system is able to add, remove, or modify features within the system.

11.5 VALIDATION OF THE REQUIREMENTS

VALIDATION

The questions in the questionnaire used during the usability study have been formulated to apply to both testing and confirming criteria and requests. To gain additional insights for future research, I opted for a rating scale of 1-5 instead of simple yes-no questions. This makes it more clear where additional attention is needed. I consider an aspect achieved if it receives an average score of at least 3.5 out of 5 in the relevant question.

Most criteria and requests can be conclusively determined from the usability study. A few of them are self-verified with a clear yes or no, and some have been assessed by the Customer Insights department.

OUT OF SCOPE

Three of the Design Requests have fallen outside the scope and were, therefore, not included in the final validation. These are the following three requests:

Modalities
The system shows differences in insights between different modalities.

Proportions
The support system indicates the differences in size between types of travellers.

Current implementation
The support system indicates whether there is an existing integrated application/service within Schiphol for the different needs.

In all three cases, an active decision was made not to incorporate these requests into the scope because it would have otherwise become too extensive given the project's time constraints. The project focusses on the bus-rail transfers and construction projects. When implementing other modalities or using the system for services in follow-up research, these requests could be valuable.

11.6 PROJECT CONCLUSION

CONCLUSION

To make the objective of this project measurable, project criteria and design requests have been established. Achieving these requirements indicates the successful completion of the project.

It can be concluded that 7 out of the 7 project criteria have been met, which means that the project has been successfully completed.

It can be concluded that 10 out of the 10 design requests have been met, which means that that the support system adds sufficient value to RSG.

12

RECOMMENDATIONS

12.1 Recommendations

12.1 RECOMMENDATIONS

INTRODUCTION

In the previous chapter, it is mentioned that the project has been successfully completed. This conclusion was drawn based on the project's defined goal, which emerged from the chosen scope. Chapter 11.5 also reveals that a part of Schiphol's investigated Design Requests fell outside the project's scope. This project is part of a larger overarching goal within RSG, namely the transition to an MTH. To further contribute to this overarching goal, there are various opportunities to enhance the design. Achieving the investigated Design Requests that fell outside the scope represents the first step in making these additional improvements. For all three of the design requests that fell outside the scope, I have provided a basic outline of how the support system would appear if they were to be implemented.

THE ADDITION OF MULTIPLE MODALITIES

An additional functionality that may seem obvious but would have a significant impact, is the implementation of other modalities. Instead of solely analysing rail-bus transfers, the same can be done for transfers between other modalities, such as taxis, private cars, airplanes, and potentially even the subway in the future. This addition allows for a broader range of transfer-related traveller needs to be understood, enabling comparisons between differences or similarities in needs across different modalities. To implement multiple modalities, careful consideration of the checkboxes and axes in 'Traveller Options' and the chosen six categories in 'Needs and Desires' is required. These elements are based on travellers and the needs of rail-bus transfers and may need adjustment when including other modalities. Figure 12.1 provides an example of how the design might appear when multiple modalities are added. In Appendix 2A, 2B, 2C, 2D, and 2E, interesting insights are presented related to various modalities, beyond trains and buses.

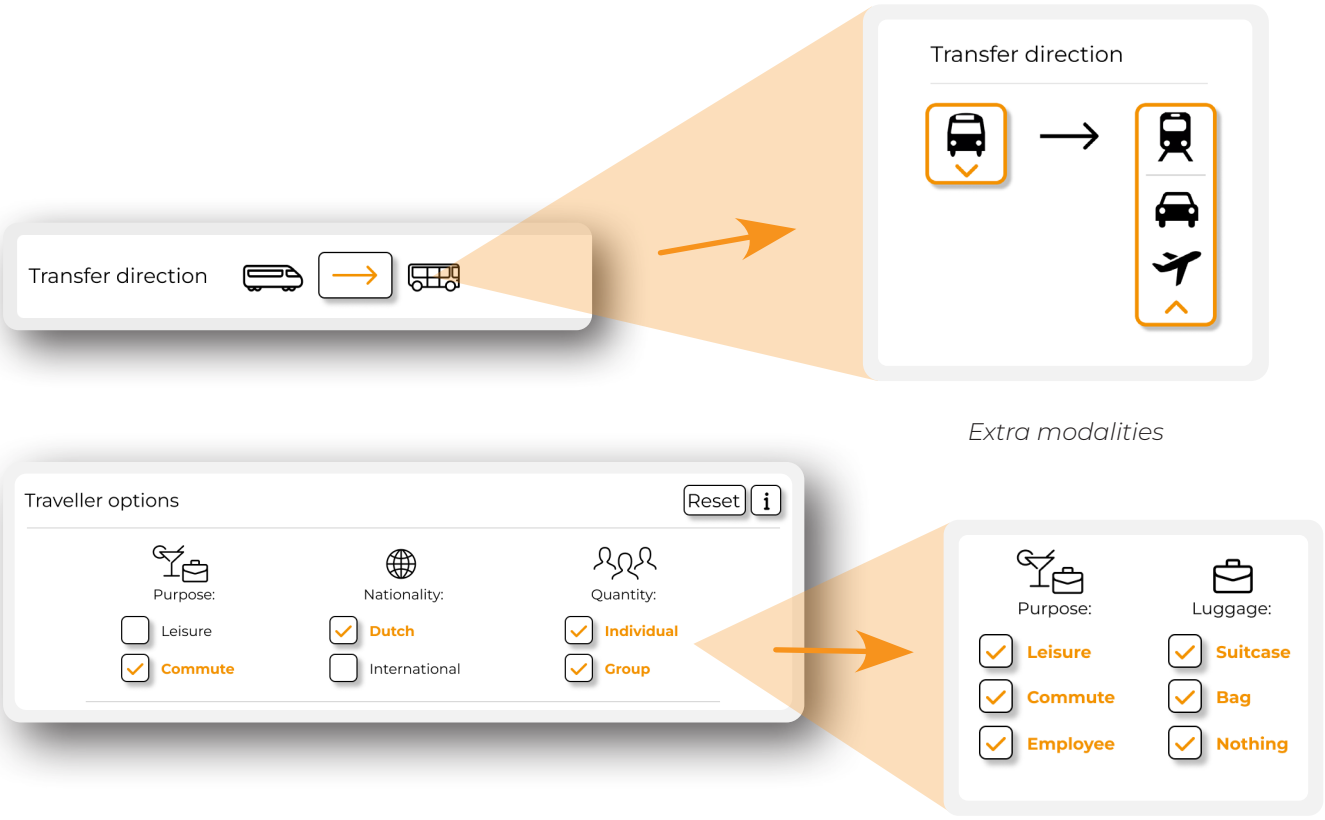


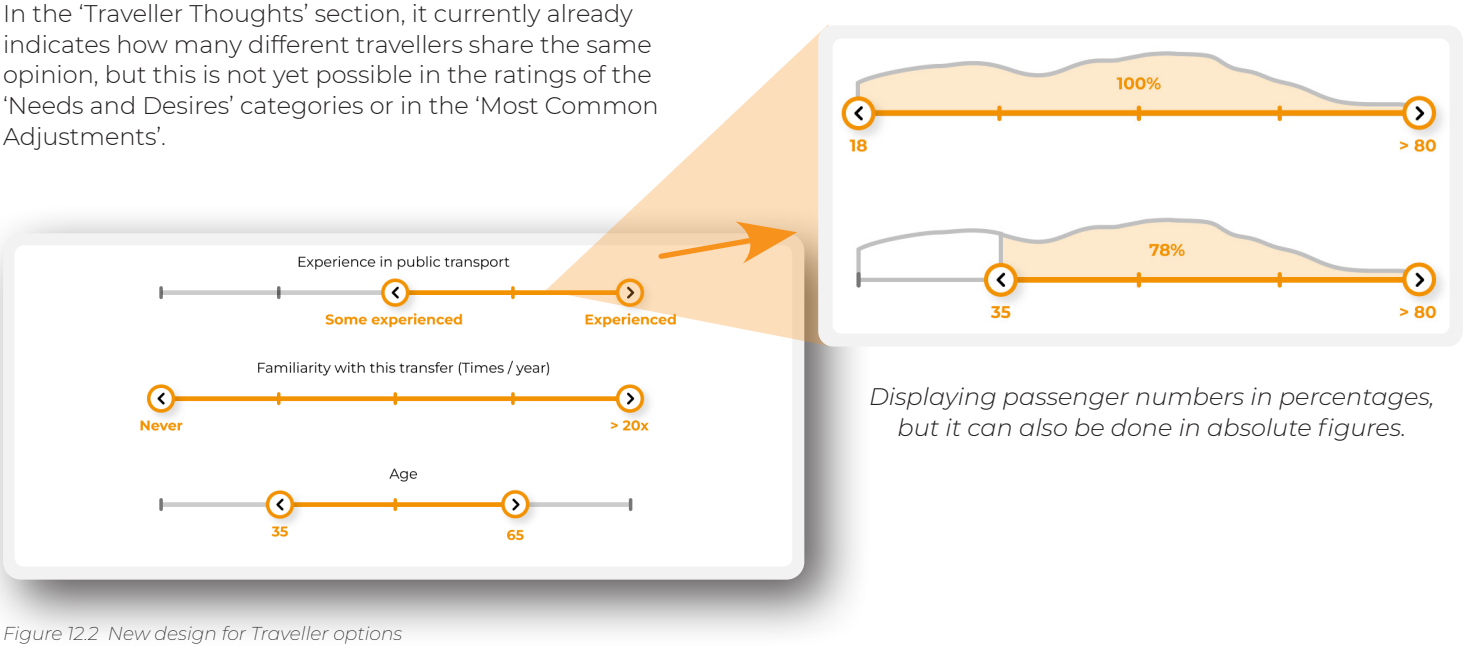
Figure 12.1 New design for transfer direction and Traveller options

12.1 RECOMMENDATIONS

THE ADDITION OF PASSENGER NUMBERS

Another functionality that can provide valuable insights is making the number of travellers using trains and buses visible. By associating these numbers with the 'Traveller Options' in the support system, it becomes possible to immediately identify the scale of the insights. It's possible that certain ratings are assigned to categories based on a relatively small group of travellers. This significantly contributes to assessing the relevance of potential needs.
In the 'Traveller Thoughts' section, it currently already indicates how many different travellers share the same opinion, but this is not yet possible in the ratings of the 'Needs and Desires' categories or in the 'Most Common Adjustments'.

This new feature would work very well in combination with the previous recommendation. In this case, the differences in passenger numbers between modalities for all transfers could be visualized. Figure 12.2 provides an example of how this might appear in the support system.

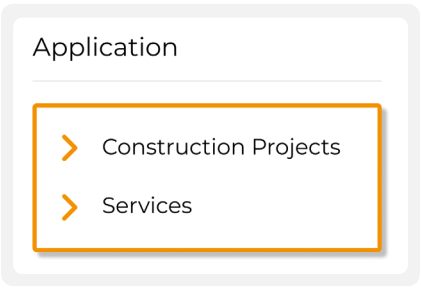


Displaying passenger numbers in percentages, but it can also be done in absolute figures.

Figure 12.2 New design for Traveller options

THE ADDITION OF AN INDICATION OF EXISTING SERVICES

A valuable addition to the design is the indication of whether existing services or applications are already in use at Schiphol, but in a different location or context. This requirement, expressed by Schiphol, stems from the idea that the support system can be used not only for construction projects but also for offering services. In this context, for identified needs, reference can be made to an existing implementation already in use at Schiphol. This implementation can then be replicated in the specific location where the need applies. This functionality could also be extended to existing services outside Schiphol, where there might be good ideas for the identified needs of travellers. To implement this functionality, it is necessary to have knowledge of the possible services provided by Schiphol. Given the huge amount of data involved and the challenge of linking all potential existing services to expressed needs in a dataset, artificial intelligence is the only viable option to carry out this task. Using AI with extensive knowledge of all the services available at Schiphol, it can automatically provide potential solutions for the expressed needs. In the support system, this may appear as shown in Figure 12.3.



Multiple options for the purpose of the insights

A button to go to a page with possible existing options for the need

Figure 12.3 New design for Traveller options

13

REFLECTION

13.1 Reflection

13.1 REFLECTION

Throughout the project, I have provided brief reflections on the process in the reflection boxes. In this final reflection, I highlight the two major overarching challenges I encountered in the project. Interestingly, both aspects may somewhat contradict each other. Firstly, it's about structurally and effectively documenting my process. Secondly, it's about being able to let go of structure and navigate the free and unclear path.

STRUCTURING THE FINDINGS

This report aims to provide a clear and concise explanation of the support system. It should serve as a justification for the design choices made for people that are interested in the support system. However, the process leading to this design was far more iterative and varied than this report might suggest. Numerous researches and scope-attempts were conducted to explore and investigate different directions.
In figure 13.1 on the next page, you can see the sequence of my scope that have become increasingly specific throughout the process. This exploratory research method aligns well with the chosen Odyssey Design Framework, as discussed in Chapter 1.2. A portion of the diversity of research ultimately did not find its way into the report or may have been placed in the Appendix. The focus of this report was on the final product rather than the design process. Consequently, any research that contributed solely to the process and did not directly enhance the support system has been omitted. While omitting such content was occasionally challenging, I am content with how I have presented the report. Its structure is guided by a striking quote from my professor, Sicco Santema:
"*From Chronological to Logical*."
I believe this to be the most logical manner to present the support system, and that is the ultimate objective of this report.
To provide an insight into the exploratory process I went through, I have created a visual overview on the next page (see Table 13.2). This overview displays all the various research efforts in chronological order, side by side. The overview indicates the points in the process where I made specific choices and how the final scope evolved. The research boxes in the report are labelled according to this chronological order, yet in the report, they have been used in a completely non-chronological manner to support my narrative. I believe this is a distinctive reflection of how my process unfolded.
I am grateful that my graduation board challenged me to restructure my report and focus on this new way of writing after receiving my green light. Since typing texts is not my greatest strength, it was very educational to attempt to truly detect and filter what is important and what is not.

EMBRACING THE PROCESS

During this project, the most significant challenge I faced was the interplay between structure and freedom. Although I know I prefer to approach my projects in a structured manner, I actively chose a more open approach for this project. In both my bachelor's and master's, projects were often well-framed, and I would start with a defined problem. In this project, I wanted to do things differently. I decided not to start with a predefined problem. I walked into Schiphol without a clear direction, only carrying the theme of MTH in the back of my mind, even though I wasn't entirely sure what it meant.
This relatively unstructured project with no predefined boundaries was a significant challenge for me. When I wasn't sure what the next step should be, I quickly reverted to creating structure. My mentor, Aniek, sharply pointed this out and told me to stop making 'yet another' new planning because the project would evolve differently. While this may have been challenging for me, I think it was a signature moment in the process. I had to learn to let go of a structure or idea I had in mind and not be afraid of uncertainty. For me this was difficult, especially in such an 'important' final graduation project where you want everything to go as planned.
Halfway through the project, I found myself stuck in the chosen direction, but changing course so late in the process first seemed foolish. I needed reassurance from all three of my mentors that it wasn't a problem at all, as long as I believed that a change would yield a better result.
During the project, my professor asked me the question, 'What would a designer do?' Although the question was somewhat rhetorical, I found myself asking this question more frequently in the months that followed whenever I faced challenges. Creative use of the knowledge I have in the situation I find myself in, has always proven to be the outcome.
Having the courage to embrace this lack of clarity is what I've gained the most during this project. In the end, I successfully finished a very exploratory and iterative project, guiding my path to the final product based on the evolving insights from various research efforts. Because the project may have fallen a bit outside my comfort zone, I am proud that I was able to successfully complete it this way.

Multimodal Transport Hub

"How can I be of value to RSG in the MTH theme?"

Transfers between modalities

Transfers at MTH Schiphol

"How can I improve the transfer experience at Schiphol by focusing more on an MTH?"

There is no overview of all knowledge about transfers at Schiphol.

Transfer overview

"How can I best create an overview that RSG can use to provide insights about the transfers?"

There are overviews available, but they all focus exclusively on air travellers.

Overview of non-aviation related transfers

"How can I best create an overview to help non-air-related transfers become a more seriously addressed topic?"

Specific data and knowledge are lacking within RSG regarding the numbers and needs of travellers at all non-airport transfers

Overview of travellers' needs regarding non-aviation related transfers

"How can I effectively communicate travellers' needs to RSG employees so they can use them as arguments during the transition to an MTH?"

This scope is too broad to conduct targeted research on outcomes.

Overview of travellers' needs regarding transfers between bus and train contributing to construction projects

"How can I use insights into rail-bus-related traveller needs to assist employees with arguments for construction projects during the MTH transition?"

My final goal, which can be divided into the three themes: Content, Use, and Implementation.

Figure 13.1 Chronological overview of my increasingly specific scope

RESEARCH TIMELINE	Literature research on MTHs.	Researching and mapping modalities, their placement, and transportation	Conversations with RSG employees bout potential directions	Researching internal documentation & data regarding Schiphol transfers	Discussions with Board (Kick-off)	Literature research on travellers.	Research with S&AP employees on modalities and prioritizing	Literature research on traveller needs and desires	Traveller research at Plaza regarding needs during transfers (N=54)	Research on transfer flows (numbers) based on internal documentation
RESEARCH BOX							A		B	
CONCEPT	MTH as main theme		OVCP, Metros, MKS, Kiss&Ride, etc.		Guideline in poster form.		Interactive guideline	‘Circle’-design concept		
MODALITIES	All various modalities				Focus on transfers between modalities rather than the modalities themselves		Prioritization of the 9 most important modalities for RSG			There’s a lack of an overview of data within RSG
TRAVELLERS	Not yet considered				Travellers in general, No specification				There are clear distinctions among travellers. A categorization needs to be established	
NEEDS & DESIRES	Not yet considered						Exploration of diverse traveller needs on the radar	Understanding various methods of categorization	Many new traveller needs and a own categorization	
REQUESTS & REQUIREMENTS				There’s a lack of an overview regarding transfers, which is crucial for an MTH	Needed insights: Modalities, users, Infrastructure		The need for an overview of traveller needs. Construction projects discussed for the first time, but not as a direction yet		The need for a clear overview of quantities. Needs are not always predictable, the ‘Thoughts’ concept is emerging	

Table 13.2 Chronological overview based on conducted research, with new designs evolving at each stage.

Two interviews with BlipTrack employees about sensor usage at Plaza

Concept brainstorm and iteration rounds

Creative facilitation workshop with students on project content

Interview with Customer Insights

Research with experienced travellers on traveller types and journeys

Discussions with Board (post-Midterm)

Two interviews with Sharepoint

User observations on rail-bus transfers

Self experience research on rail-bus transfers

Questionnair among travellers about needs linked to their traveller type (N=16)

Questionnaire at S&AP regarding the distribution of traveller types

Usability research on the design concept (N=11)

Custo-mer Insights validati-on

C D E F G H I J K L N

Reconsider the concept of the guideline

Dropping the circle idea. Support system as a concept

Implementation of the Support System concept considered realistic

Newest version of ths support system. Many new improvements for the design (functionality + interface)

Focussing on the 5 biggest modalities at Schiphol

Focus on transfers between buses and trains & construction projects

Explenation of categories and confirmation that I shouldn't do it in the current Customer Insights way

Using axes instead of fixed aspects. Fixed aspects exclude insights

Data for in final design + 3 best axes out of 9 options

Confirmation of 3 axes + still considering fixed aspects

Splitting needs into 'Thoughts' and 'Adjustments

New insights into needs based on customer journeys

Insights into current way of data collection + translating needs into insights

New needs

New needs. After combining all the research, created the final categories

Confirmation ofno internal overview for MTH transition

Excluding the numerical direction from the scope

Many requirements for the implementation of the support system

Transfer specification is not in line with requirements from RSG. Converging and diverging solution

More requirements for implementation

Testing the possibility of obtaining data yields positive results

14

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14.1 REFERENCES

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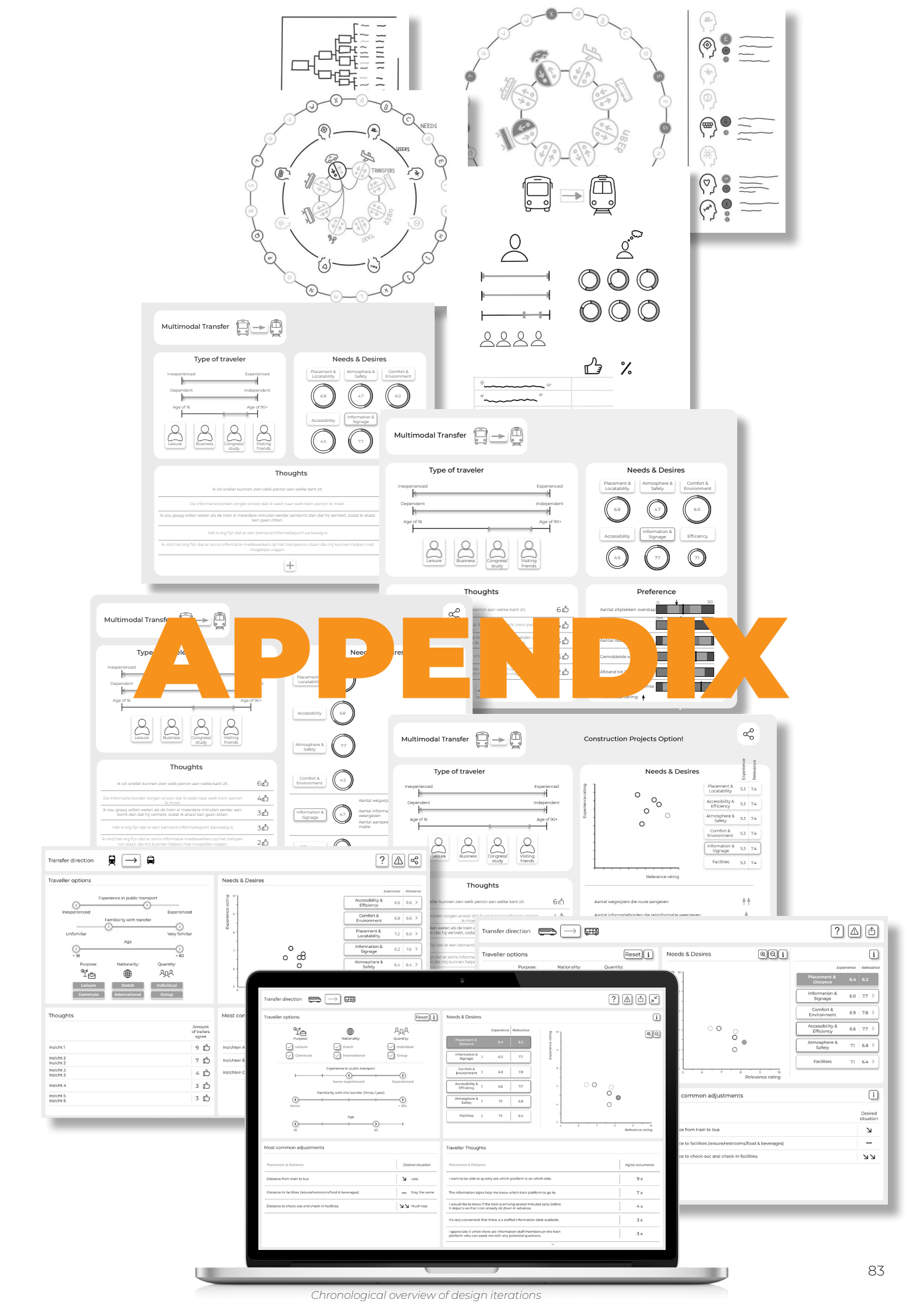

Chronological overview of design iterations

15

APPENDIX

APPENDIX 2.A MODALITIES AT SCHIPHOL

GENERAL

To integrate all forms of transportation in an MTH, the placement on the premises is crucial. However, people do not plan their journey with general types of transportation such as public, private, or shared transport, but with specific modalities. This placement is shown on the next page.

AIRPLANES AT SCHIPHOL

Schiphol is an airport that focuses on air travel, connecting the Netherlands with the world. In 2019, it facilitated nearly half a million flights and transported 71.7 million travellers (Schiphol Jaarcijfers, 2019). Schiphol has a strong focus on providing a seamless and efficient experience for air-passengers, ensuring smooth transitions throughout their journey. However, Schiphol also recognizes the environmental impact of aviation and is committed to making significant efforts towards more sustainable flying and exploring greener alternatives. After a few disappointing years, Schiphol has dropped to the 29th position in the word airport ranking (SKYTRAX, 2023). As a result, they are determined to regain their position and strive to move up the ranks again and enhance the transfer process in becoming a MTH.

CARS AT SCHIPHOL

Unlike in general, cars at Schiphol primarily serve as a modality that requires a transfer before or after their use. They only function as a door-to-door vehicle for the employees in the surrounding area, but serve as a transfer vehicle for all others. For car parking, there are numerous parking areas available, and for the more distant ones, shuttle buses operate to transport travellers to the Jan Dellaert Square in front of Schiphol Plaza. The presence of cars can be categorized into three types:

Long-term parking: Individuals park their own cars and transfer to another mode of transportation (often airplanes). This includes private vehicles, car-sharing options, and rental cars.

Short-term parking: People who are being dropped off, with their transporters accompanying them briefly into the hub (often the case for airplane transfers).

Non-parking: This includes services that provide transportation for dropping off or picking up people, such as taxis and Uber, as well as family or friends who drop off people at the Kiss&Ride.

TRAINS AT SCHIPHOL

The amount of trains passing through Schiphol is huge, with Schiphol being among the top 5 biggest train stations in the Netherlands. On an average working day in 2019, more than 115.000 travellers arrived at Schiphol by train, of which a small 19.000 had to transfer at Schiphol (NS Dashbord, n.d.). Unlike other 'cathedral' stations, Schiphol does not have a clear separation between of railway using OVCP gates. This is because a large number of travellers at Schiphol need to navigate the same area while using different modes of transportation. ProRail manages and maintains the railway infrastructure at Schiphol, while train services are operated by various companies, including the Dutch Railways (NS) and international operators like Thalys and Eurostar.

BUSES AT SCHIPHOL

At Schiphol, buses enable a smooth first and last mile connection, bridging the gap between the airport and nearby residential areas, offices, and hotels. There are two main types of buses that are operating at Schiphol.

Public transport buses:
- Shuttle buses within the airport premises, facilitating convenient transportation between parking areas, hotels, and other on-site facilities.
- Regional buses that transfer people to cities and villages in the area.

Tour buses:
- Shared transportation options, such as Flixbus, where individuals can purchase tickets for national and international routes.
- Private buses that have been chartered by larger groups to transport them to specific national or international destinations.

AIRPLANES

Airplanes connect people and goods across long distances. Airplanes offer unparalleled speed, allowing people to travel quickly between countries and even continents. The aviation industry is undergoing significant developments to address sustainability and environmental concerns. The adoption of cleaner fuels, improvements in aircraft efficiency, and the exploration of alternative propulsion systems are all contributing to a more sustainable future for air travel, but unfortunately is sustainable aviation still something for the future.

AIRPLANES AT SCHIPHOL

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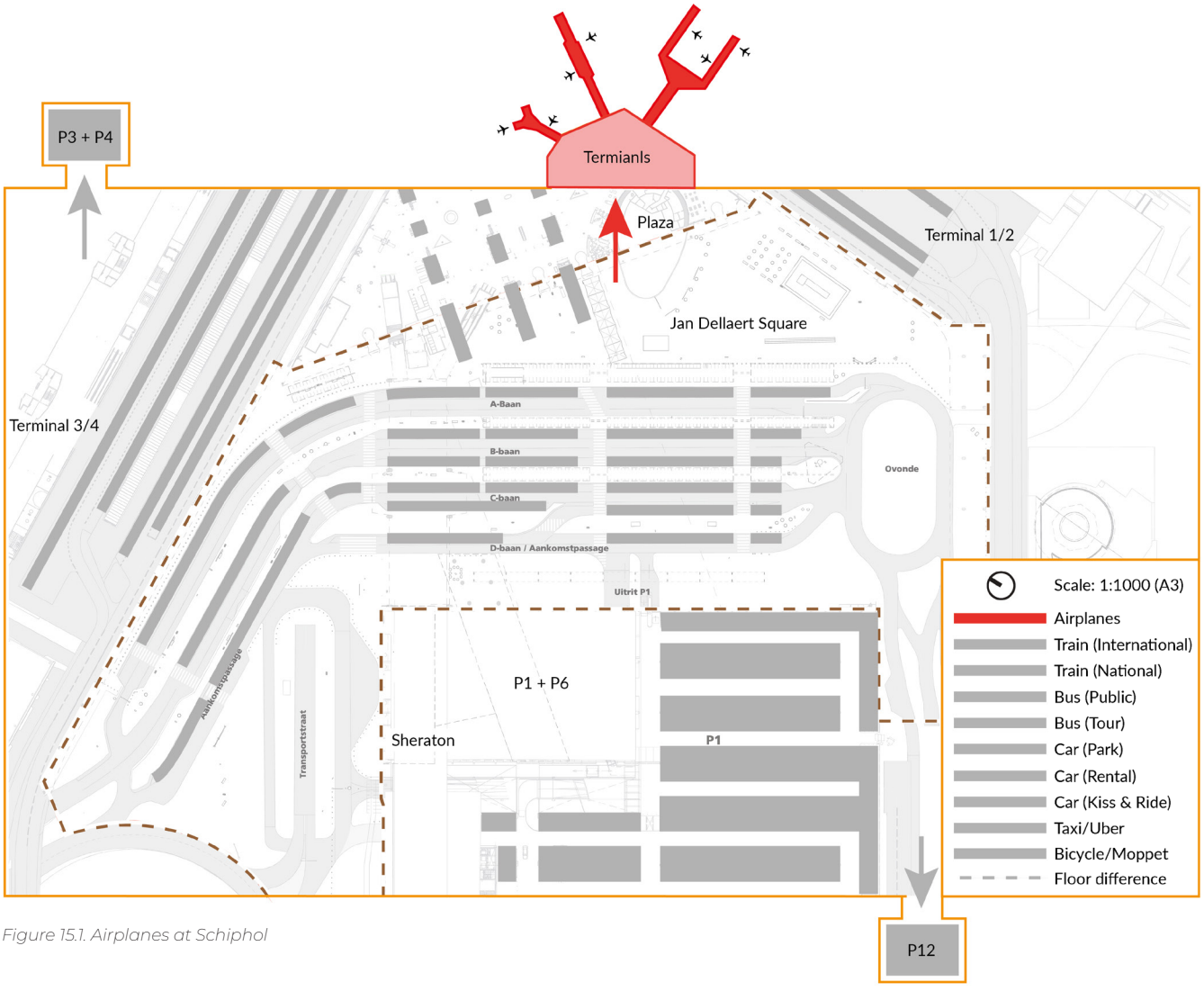

Figure 15.1. Airplanes at Schiphol

CARS

The integration of cars in MTHs presents new opportunities and challenges. Cars offer freedom and personalized door-to-door travel, serving as a crucial last-mile solution. Ride-sharing and car-sharing services contribute to the concept of mobility-as-a-service. However, increased car usage leads to congestion, environmental impact, and limited parking space. Sustainable solutions include promoting electric and shared vehicles. Collaborative efforts among stakeholders, transportation authorities, technology providers, and policymakers are essential to optimize the role of cars in a sustainable MTH network.

CARS AT SCHIPHOL

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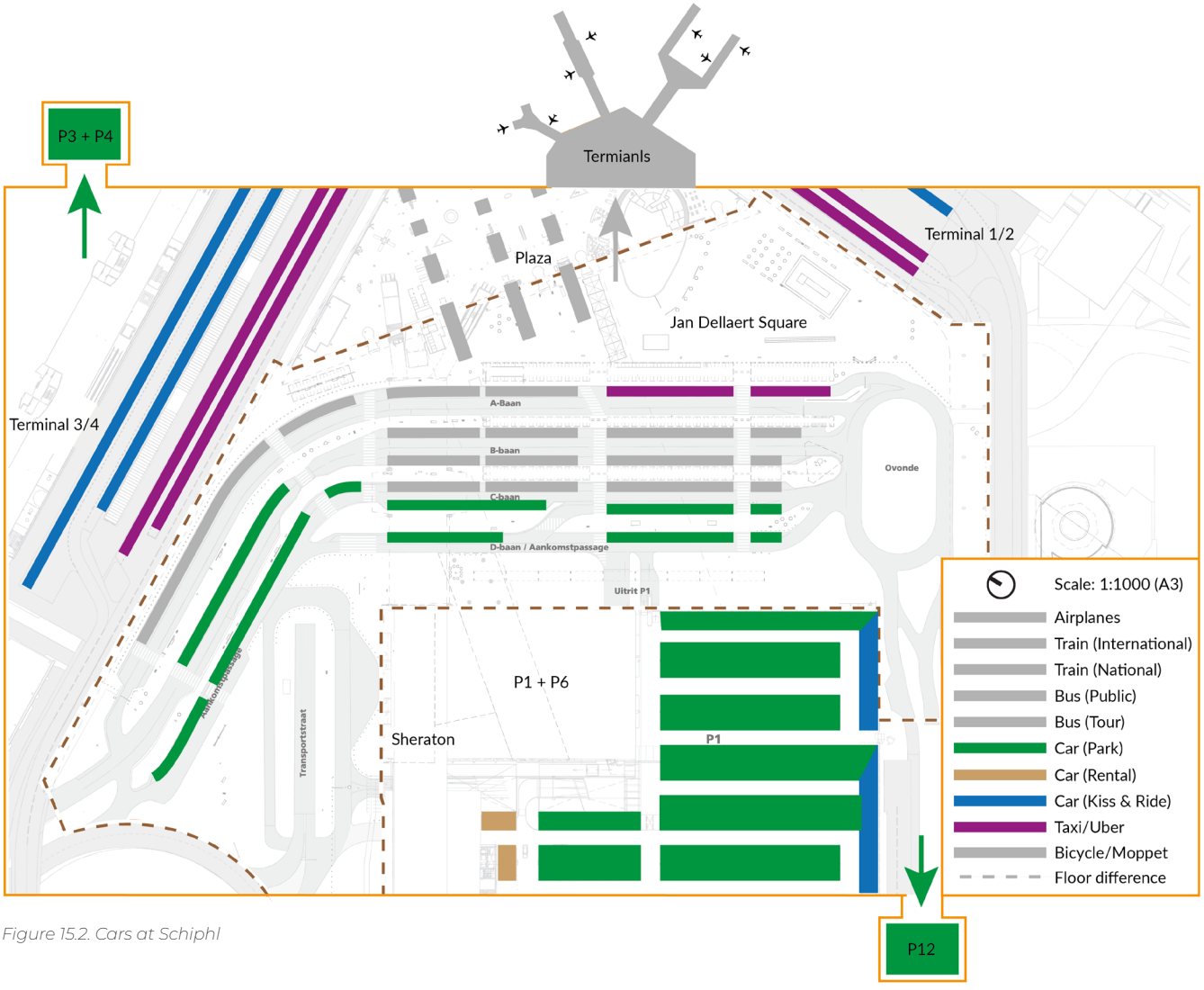

Figure 15.2. Cars at Schiphl

TRAINS

Trains are a vital mode of transportation within MTHs, offering efficient and sustainable options. With their speed, very high capacity, and ability to serve both short and long distances, trains shape the future of transportation, competing with short-haul flights since they can serve both national and international travel option. (Donners, 2018). They reduce congestion, save time, and contribute to urban sustainability. Advancements in high-speed trains, electrification, and international integration enhance efficiency, reduce emissions, and improve passenger experience. However, maximizing the potential of trains requires planning, infrastructure investment, and stakeholder collaboration. This includes optimizing schedules, expanding railway networks, ensuring convenient access including bagage, and integrating with other modes of transportation within MTHs.

TRAINS AT SCHIPHOL

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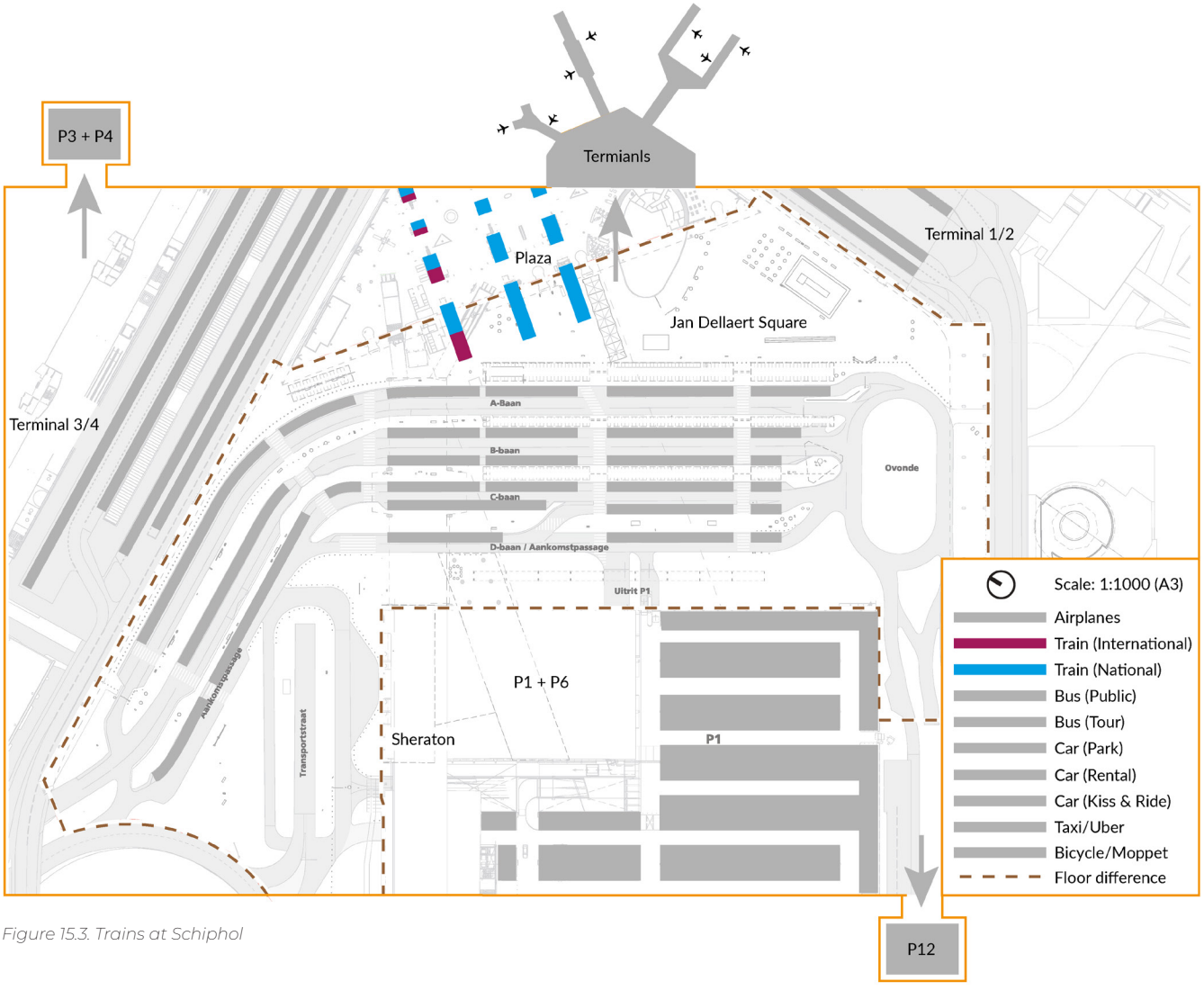

Figure 15.3. Trains at Schiphol

BUSES

Buses are crucial for connecting hubs and surrounding areas, enhancing accessibility and sustainability. The future impact of buses on MTHs is multifaceted. They have road flexibility, a high capacity, and offer reliable and affordable transportation, reducing reliance on private vehicles. They provide convenient and affordable options for commuters, tourists, and residents offering a viable alternative to driving within urban areas. But on the other hand, do most buses run on fossil fuels, contributing to air pollution. Advancements like electric buses and low-emission vehicles are paving the way for greener transportation. Additionally, the integration of smart technologies, such as real-time tracking, intelligent routing, and contactless payment systems, enhances the efficiency and user experience of bus services within an MTH. However, challenges like traffic congestion and limited infrastructure require proactive planning and collaboration with authorities to optimize bus services.

BUSES AT SCHIPHOL

At Schiphol, buses enable a smooth first and last mile connection, bridging the gap between the airport and nearby residential areas, offices, and hotels. There are two main types of buses that are operating at Schiphol.

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- Shared transportation options, such as Flixbus, where individuals can purchase tickets for national and international routes.
- Private buses that have been chartered by larger groups to transport them to specific national or international destinations.

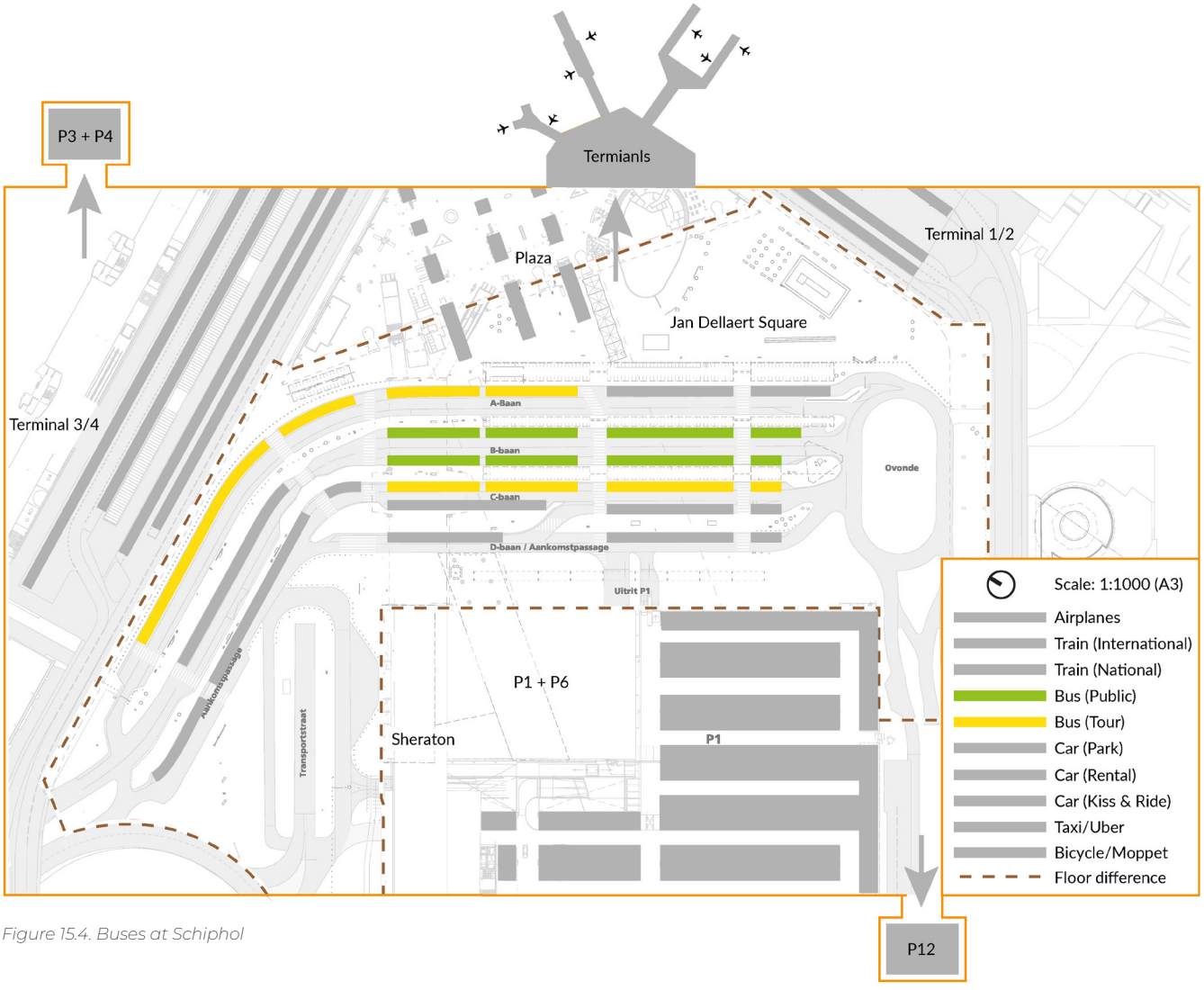


Figure 15.4. Buses at Schiphol

BICYCLES

Cycling is an eco-friendly and healthy mode of transportation that helps alleviate congestion in urban areas. Integrating bicycles into MTHs enables smooth connections with trains, buses, and metros, encouraging their use for efficient and sustainable first and last mile travel (Transportation Research Board, 2013).

BICYCLES AT SCHIPHOL

At Schiphol, bicycles are primarily used by employees in the surrounding area. While in most hubs, bicycles serve as a perfect first and last mile modality, at Schiphol, they predominantly function as a door-to-door transportation to go to work without a transit. When people take the bike to go to a hub, they choose the hub that is the closest to their home. Due to Schiphol's location and limited residential areas, people prefer other hubs when choosing the bike. Only for employees working around Schiphol and a very limited amount of people living around Schiphol, bikes can serve as a first and last mile option.

WALKING

Walking is an eco-friendly and efficient mode of transportation that offers numerous benefits, including improved health, no traffic congestion, and zero carbon emissions. In MTHs, walking plays a crucial role as the first and last mile connection between different modes of transport. Implementing clear wayfinding signage and digital tools is essential to assist pedestrians in navigating complex transportation networks. Pedestrian-friendly infrastructure, such as well-designed sidewalks, bridges, and crossings, is vital in the area of a MTH.

WALKING AT SCHIPHOL

Walking serves as a way to transition between different modes of transportation, but can also be considered as a mode of transportation itself. Many individuals who work at or near Schiphol rely on walking to commute between Schiphol Plaza or Jan Dellaert Square and their workplaces. Within Schiphol Airport, significant distances are covered on foot to transfer with an airplane. To facilitate this, long treadmills have been installed in various locations, reducing walking time and distance, including both at the gates and near parking facilities P1 and P6.

METROS

Metros, like trains and buses, efficiently transport large numbers of passengers, specifically within cities. Their high capacity and ability to operate above and below ground make them ideal for urban areas. Smart ticketing and real-time passenger information systems enhance their efficiency and convenience. As electric-powered systems, metros contribute to reducing carbon emissions and improving air quality.

METROS AT SCHIPHOL

Currently, Schiphol Airport does not have a metro system, but plans for its introduction in the future have been confirmed (Schiphol, 2023). The extension of the Noord-Zuid line to Schiphol will improve connectivity with Amsterdam and free up train tunnels beneath Schiphol Plaza for other connections such as international trains which is in line with Schiphol's goal to reduce short-haul flights (See Chapter 1.4). The role of the metro in this study receives less emphasis due to unconfirmed construction plans, making it challenging to gather perspectives on its implementation.

APPENDIX 2.B TRANSPORTATION

TYPES OF TRANSPORTATION

The Netherlands has a population density of about 508 people per square kilometre (World Bank, 2021). The three largest cities in the Netherlands, namely Amsterdam, Rotterdam, and The Hague, are all located within a proximity of 80 kilometers from each other. With more than 17 million inhabitants in a relatively small territory, there is a high demand for efficient transport.

Veeneman, Kuijk & Hiemstra (2020) describe three different types of transportation, namely Private, Public, and Shared transport (See Figure 15.5). Within an MTH, all three types of transportation are combined, and a seamless transfer experience needs to be facilitated. To gain further insights into how Schiphol can evolve into an MTH, it is essential to first explain these three types of transportation.

Transport service	Infrastructure	Vehicle	driver	Locations and times	Trips	Examples
Public	Dedicated	Service	Service	Scheduled lines	Combined	Train, metro, tram, some bus
	Shared	Service	Service	Scheduled lines	Combined	Bus, Ferry, Some train
Shared	Shared	Driver owned	Driver Traveller	Continuous	Combined	Ride sharing
	Shared	Driver owned	Service	Service hours	Dedicated	Ride hauling
	Shared	Service	Driver Traveller	Continuous	Dedicated	Free roaming bike or scooter sharing
	Shared	Service	Driver Traveller	Continuous	Dedicated	Car and bike rental and docked sharing
	Shared	Service	Service	Service hours	Combined	Jitney
	Shared	Service	Service	Continuous	Dedicated	Taxi
Private	Shared	Driver owned	Driver Traveller	Continuous	Dedicated	Car, Motorbike, Bicycle, Scooter

Figure 15.5: Public, shared and private transport services for personal mobility, Veeneman, Kuijk & Hiemstra (2020)

PRIVATE TRANSPORT

Car, Bicycle, Motor, Moppet, Boat

GENERAL

Private transportation provides individuals with the freedom and convenience of traveling according to their own schedules and preferences. Private transportation offers flexibility, privacy, and the ability to reach destinations that may not be easily accessible through public or shared transport options. The Netherlands is worldwide known for their bicycle use which is one of the most sustainable modes of transport.
Private vehicles serve as the primary mode for daily commuting and personal travel. In the start of 2023, The Netherlands has around 8.9 million registered passenger cars, accounting for over two-thirds of the country's total travel distance (CBS, 2023). As we strive to create more sustainable and livable cities, there is a growing recognition of the need to reduce reliance on private cars and promote alternative modes of transportation. As shown in Fugure 15.6, there is still a long way to go.

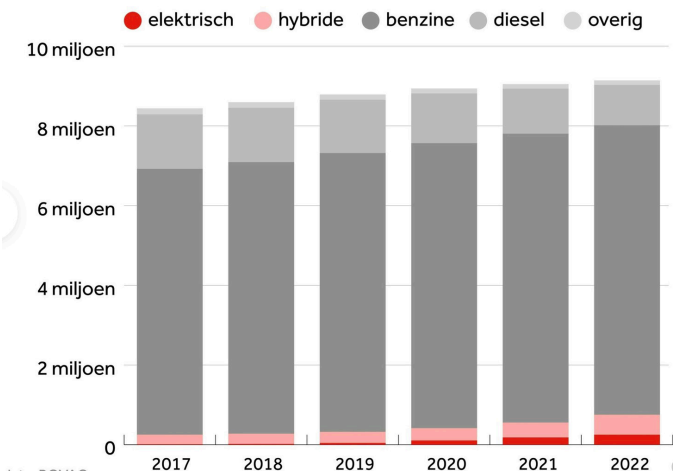


Figure 15.6: Number of cars by consumption (NOS, 2023)

PROS +

Convenience:	Personal mobility and direct travel to a destination without relying on schedules.
Flexibility:	Route choice, multiple stops, and adaptable travel plans.
Privacy and comfort:	Personal space, temperature control, and a customized environment.
Accessibility:	Reaches remote areas with limited public transport options.
Belongings:	Accommodate the transport of personal belongings securely.
Spontaneity:	Allows for unplanned trips and exploration.

CONS -

Congestion:	Contributes to road-congestion, leading to longer travel times and increased pollution.
Sustainability:	Greenhouse gases and air pollution negatively impacting the environment.
Cost:	High costs of purchasing, maintaining, and fueling a vehicle, along with parking fees and insurance.
Parking challenges:	Finding parking spaces can be difficult and time-consuming in crowded urban areas, leading to frustration and increased traffic.
Fossil Fuels:	Most private vehicles rely on fossil fuels, contributing to carbon emissions and contributing to climate change.

ELECTRICAL DRIVING IS UPCOMING

The Netherlands is actively encouraging the adoption of electric vehicles, whereas of the end of March 2023, a remarkable 6.4% of all cars were electric, and where there has been a growth with over five times as many electric cars added in the country in seven years, see Figure 15.7 (Netherlands Electric, 2023) (NOS, 2023). Although there is still a long way to go as the use of private transport continues to grow, more sustainable versions of private transportation offer hope.

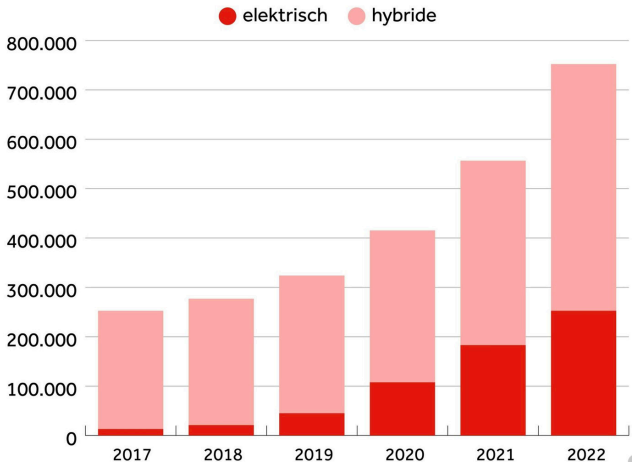


Figure 15.7: sales electric/hybrid cars (NOS, 2023)

PLACEMENT AT SCHIPHOL

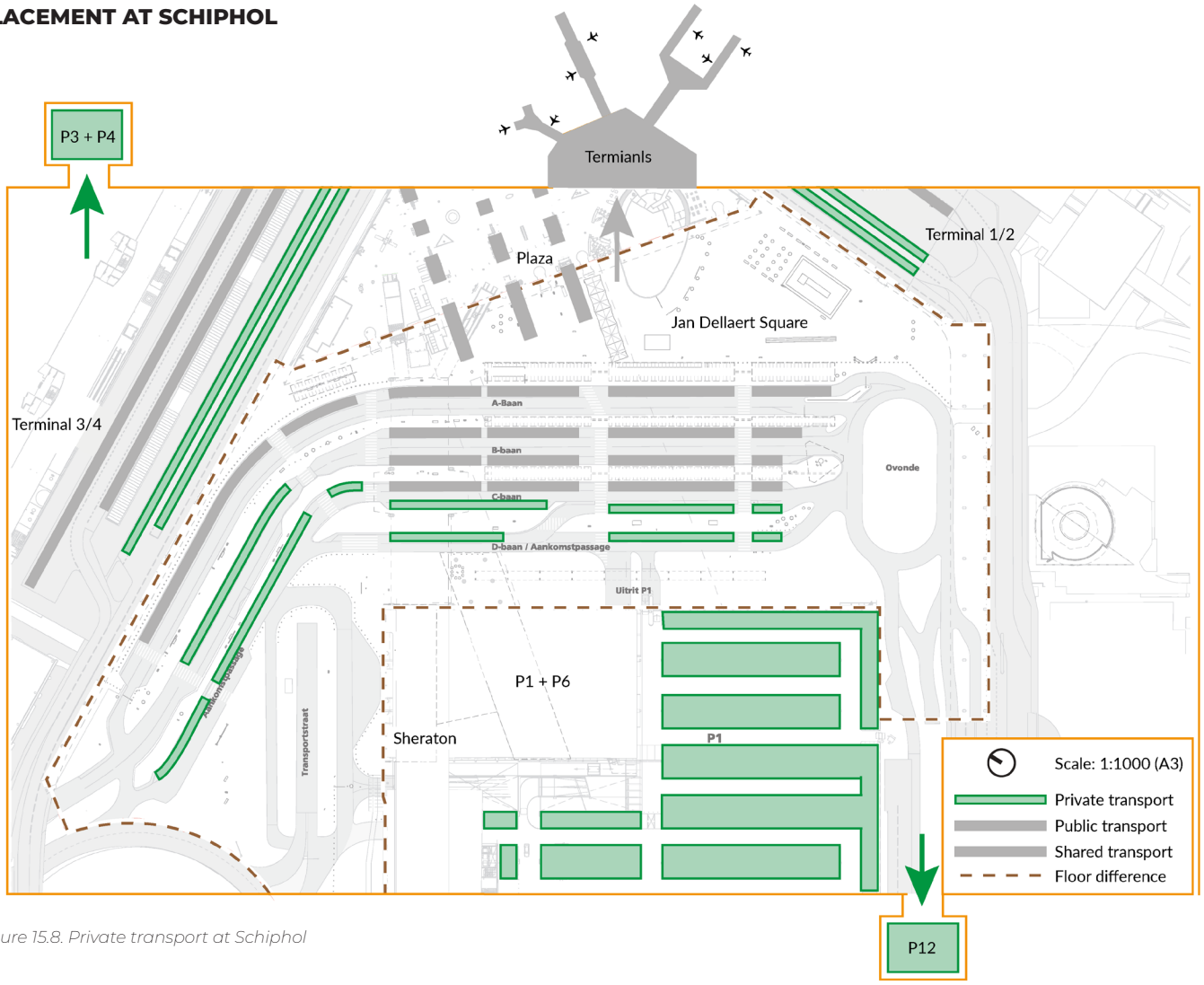


Figure 15.8. Private transport at Schiphol

PUBLIC TRANSPORT

Train, Airplane, Bus, Metro, Tram, Ferry

GENERAL

In the densely populated Netherlands, efficient and reliable public transport is crucial for connecting urban and rural areas. It facilitates access to work, education, recreation, and other activities. In 2019 a total of 25,1 billion kilometres were travelled using public transport (ACM Transport Monitor, 2021) showing its major role in the Netherlands. Despite its importance, public transport represents just over 8% of total transportation usage, as seen in Figure 15.9 (CBS, 2022).

DECENTRALIZED APPROACH

The regulation of public transport in the Netherlands follows a decentralized approach, meaning that it has no centralized authority or governing body. Instead, a committee comprising representatives from governments, transport providers, and consumer organizations oversees the functioning of the public transport system (Veeneman, Kuijk & Hiemstra, 2020).

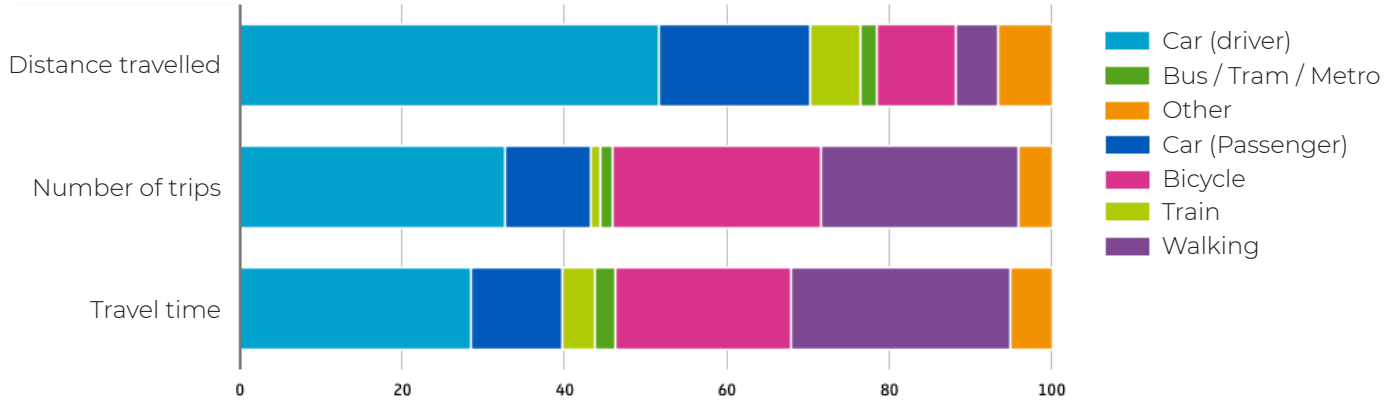


Figure 15.9 Modalities in numbers in 2021 (CBS, 2022)

PROS +

Space-effective:	Especially in densely populated urban areas (Holmgren, 2017).
Sustainable:	Reducing CO2 emissions aligns with Schiphol's 2050 sustainability goals (Holmgren, 2017; Schiphol Annual report, 2022).
Safety:	395% lower fatality rates in contrast to cars between 2010 and 2019 (SWOV, 2021; CBS, 2021).
Accessibility:	Improves mobility and provides easy access to various destinations.
Congestion reduction:	Helps reduce traffic congestion and enhances overall transportation efficiency.

CONS -

Limited Flexibility:	Fixed schedules and routes may not meet individual travel needs.
Lack of Personal Space:	Peak hours can lead to overcrowding and discomfort for travellers.
Dependence on Timetables:	Delays or cancellations can disrupt travel plans due to reliance on fixed schedules.
Limited Accessibility:	Public transport networks may be less accessible in rural regions.
Security Concerns:	Theft or harassment can undermine passenger well-being.
Lack of personal storage:	Insufficient storage space for personal belongings during travel

PUBLIC TRANSPORT GETS BIGGER

The future use of public transport in the Netherlands is expected to continue growing as it plays a vital role in sustainable and efficient transportation. According to the Dutch Ministry of Infrastructure and Water Management (2023), the number of public transport travellers has been steadily increasing over the years and will continue to rise in the coming years. In 2019, there were approximately 4.2 billion journeys made using public transportation in the Netherlands (CBS, 2020).

By 2040, it is estimated that the number of public transport journeys could reach 5.4 billion annually, according to the National Growth Fund (Nationaal Groeifonds, n.d.). This demonstrates the significance and popularity of public transport among the population. In terms of distance, mainly the train will play a greater role among various modes of transportation as can be seen in Figure 15.10.

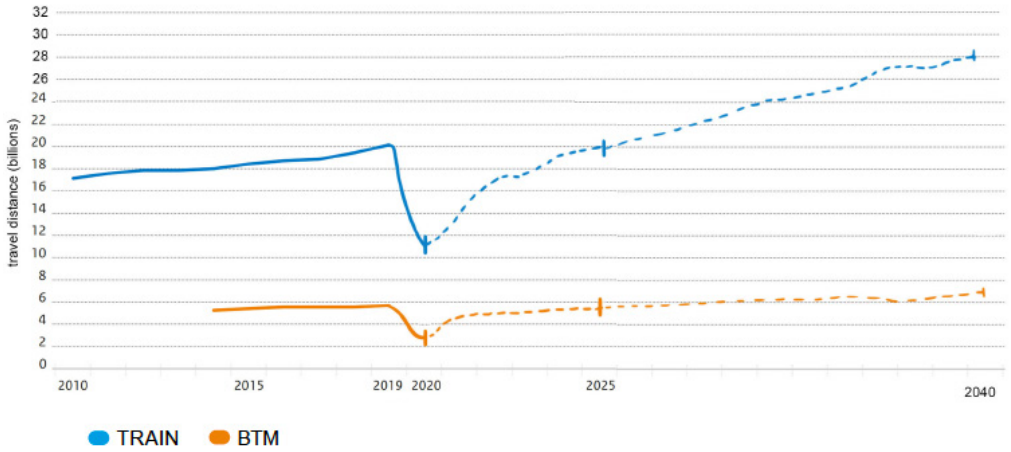


Figure 15.10. Travel distance of Train VS Bus-Tram-Metro in the years (KiM Kerncijfers Mobiliteit, 2020)

PLACEMENT AT SCHIPHOL

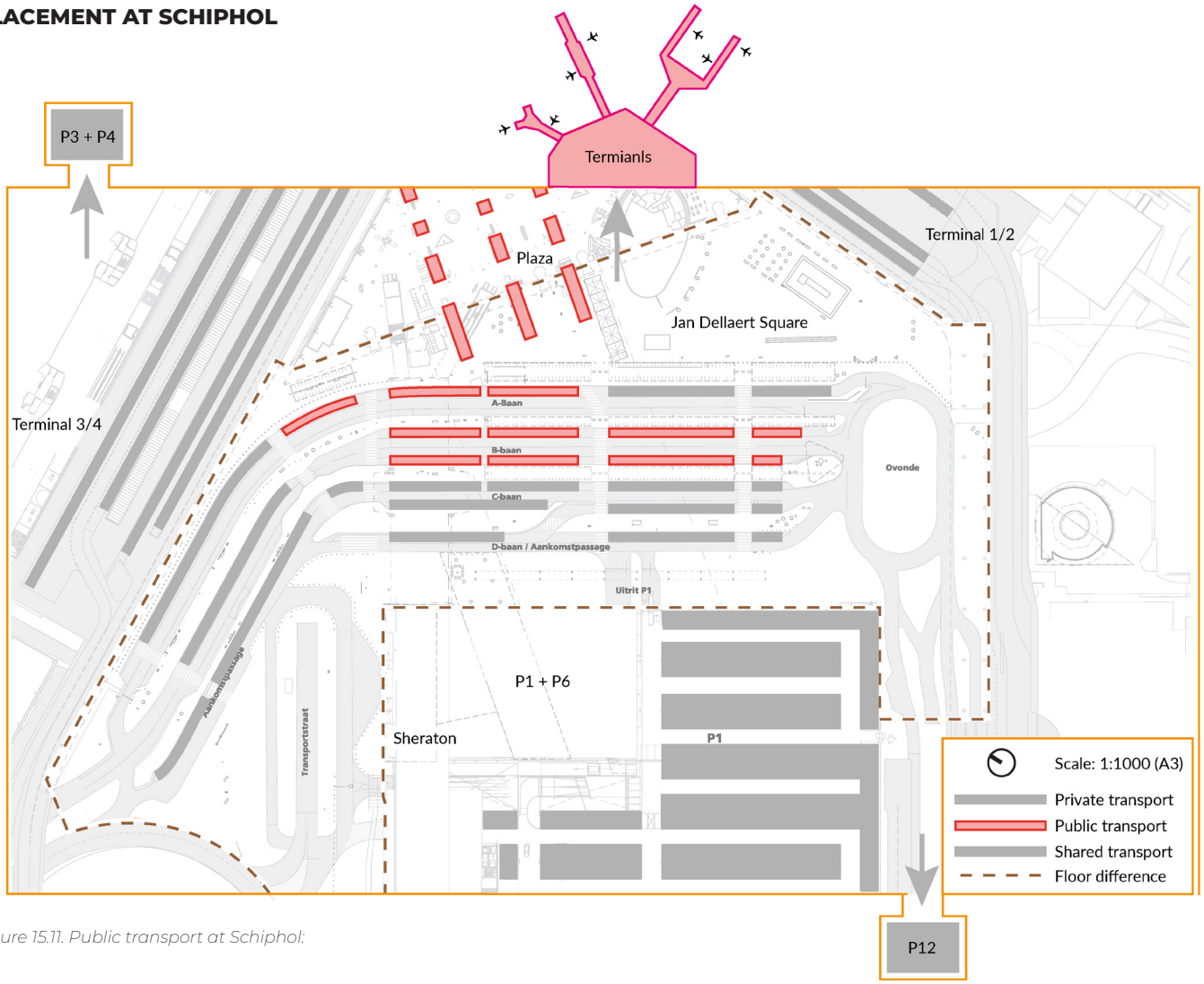


Figure 15.11. Public transport at Schiphol:

SHARED TRANSPORT

Taxi's, Tour buses, Ride-sharing, Car-sharing, Bike sharing

GENERAL

Besides private and public transport, there are mobility service providers that offer innovative solutions to enhance mobility.
Veeneman, Kuijk & Hiemstra (2020) describe it as a system where individuals can access and utilize vehicles for a specific duration, sharing them with others.
This shared mobility concept aims to enhance overall mobility by optimizing vehicle usage, reducing the need for individual vehicle ownership, and promoting sustainable transportation options.
Ride-sharing focuses on sharing rides with private vehicle owners for specific journeys (e.g. Uber), while other vehicle sharing services revolve around the rental of vehicles for short periods, providing flexibility and convenience for users who require occasional access to a vehicle (e.g. Snappcar/Felyx). Users can access shared transport for a specific moment by addressing drivers on the street, or making a reservation through platforms or apps. Shared transport complements public transport, providing convenient first and last-mile options. It reduces congestion, improves sustainability, and enhances overall accessibility.

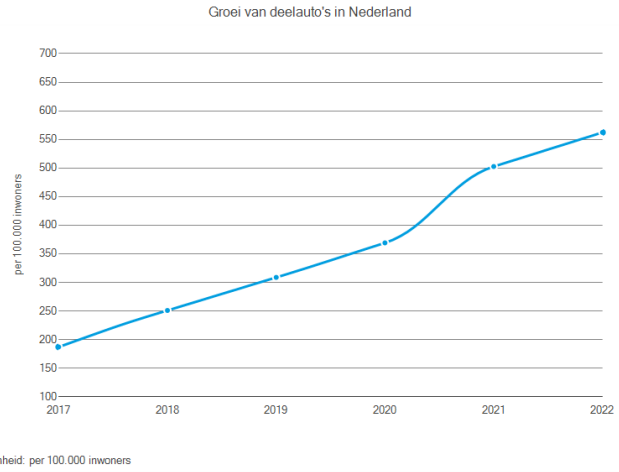


Figure 15.12. Increasing numbers of shared cars, Crow, 2022

PROS +

Sustainability:	Reduce greenhouse gas emissions and improve air quality, with car-sharing alone reducing CO2 emissions by 10-30% per user (Shaheen, Guzman, & Zhang, 2010).
Traffic congestion:	Replace up to 15 privately owned cars, reducing traffic congestion and freeing up urban space (Martin, Shaheen, & Lidicker, 2010).
Accessibility:	Flexibility, reduced travel time, and convenient options for short-distance and first/last-mile trips.
Social cohesion:	Social interactions and contributes to a more inclusive and cohesive society

CONS -

Limited availability:	Not accessible in all areas (rural/remote), limiting access for some individuals.
Reliability:	Not always be reliable, and disruptions or service outages can impact users' travel plans.
Scheduling constraints:	Fixed schedules may not always align with users' preferred travel times
Privacy and personal space:	Sacrificing privacy and personal space can potentially cause discomfort.
User behavior:	Involves varying cleanliness and behavior from other travellers, influencing user experiences.

SHARED TRANSPORT GETS BIGGER

Shared transport options like bikes, scooters, and cars are gaining popularity as you can see on from the large numbers of shared vehicles that have appeared on the sidewalks and streets in recent years. Figure 15.13 shows the amount of shared cars is rising very quick, with a growth of more than 300% between 2017 and 2022. Whilst in 2018 only 515,000 people used car-sharing, the numbers grew to 730,000 in 2021 (Crow, 2022). Figure 15.13 shows the distribution of modality options that are replaced by carsharing (Crow, 2022).

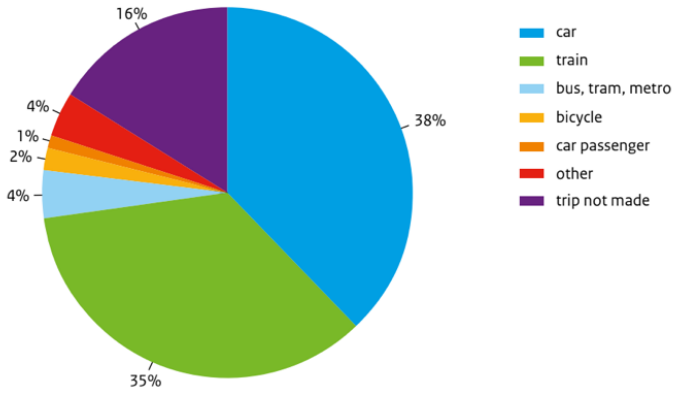


Figure 15.13 Shared car mileage replacing, Rijkswaterstaat Environment

PLACEMENT AT SCHIPHOL

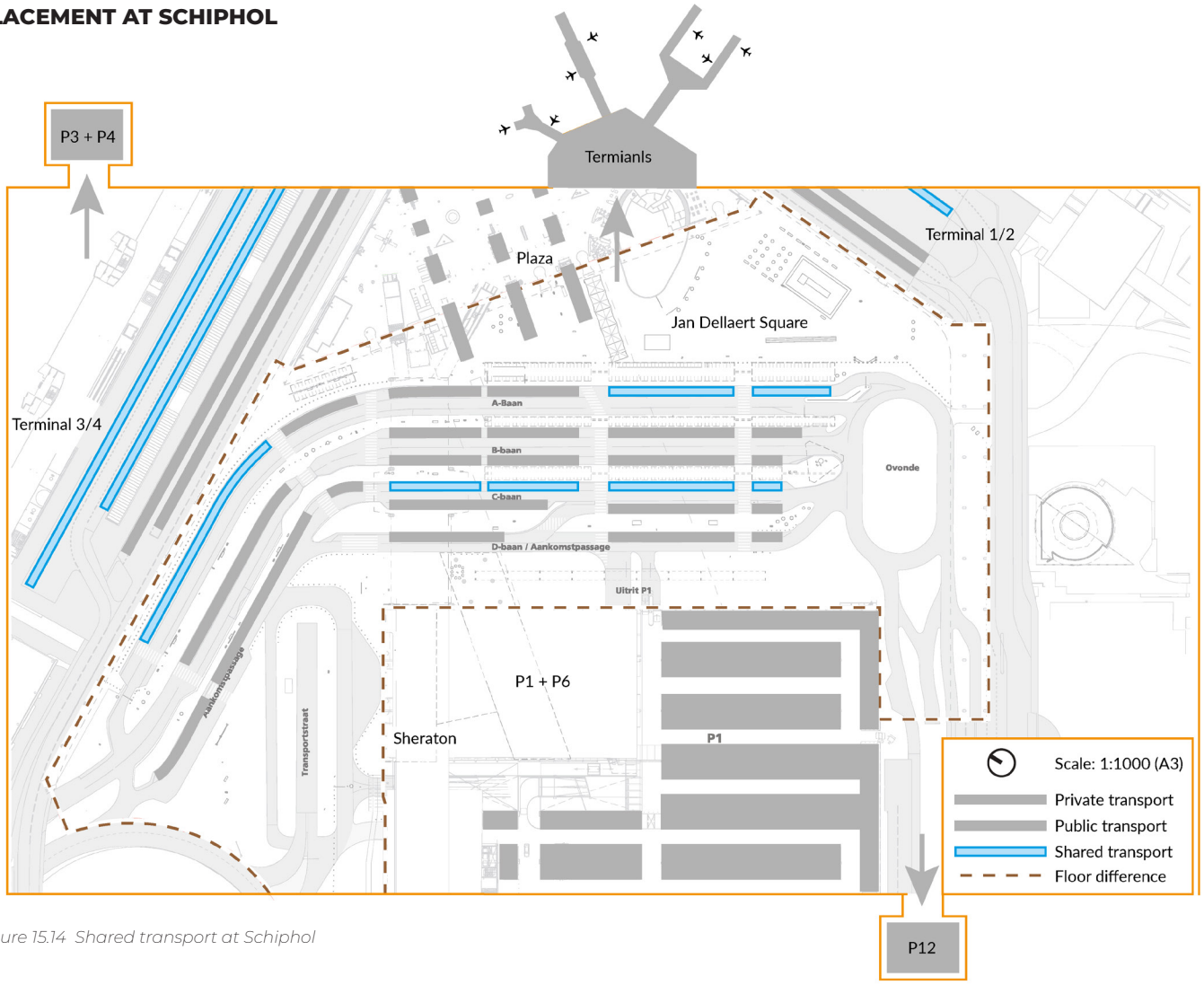


Figure 15.14 Shared transport at Schiphol

OVERVIEW OF ALL TYPES OF TRANSPORTATION

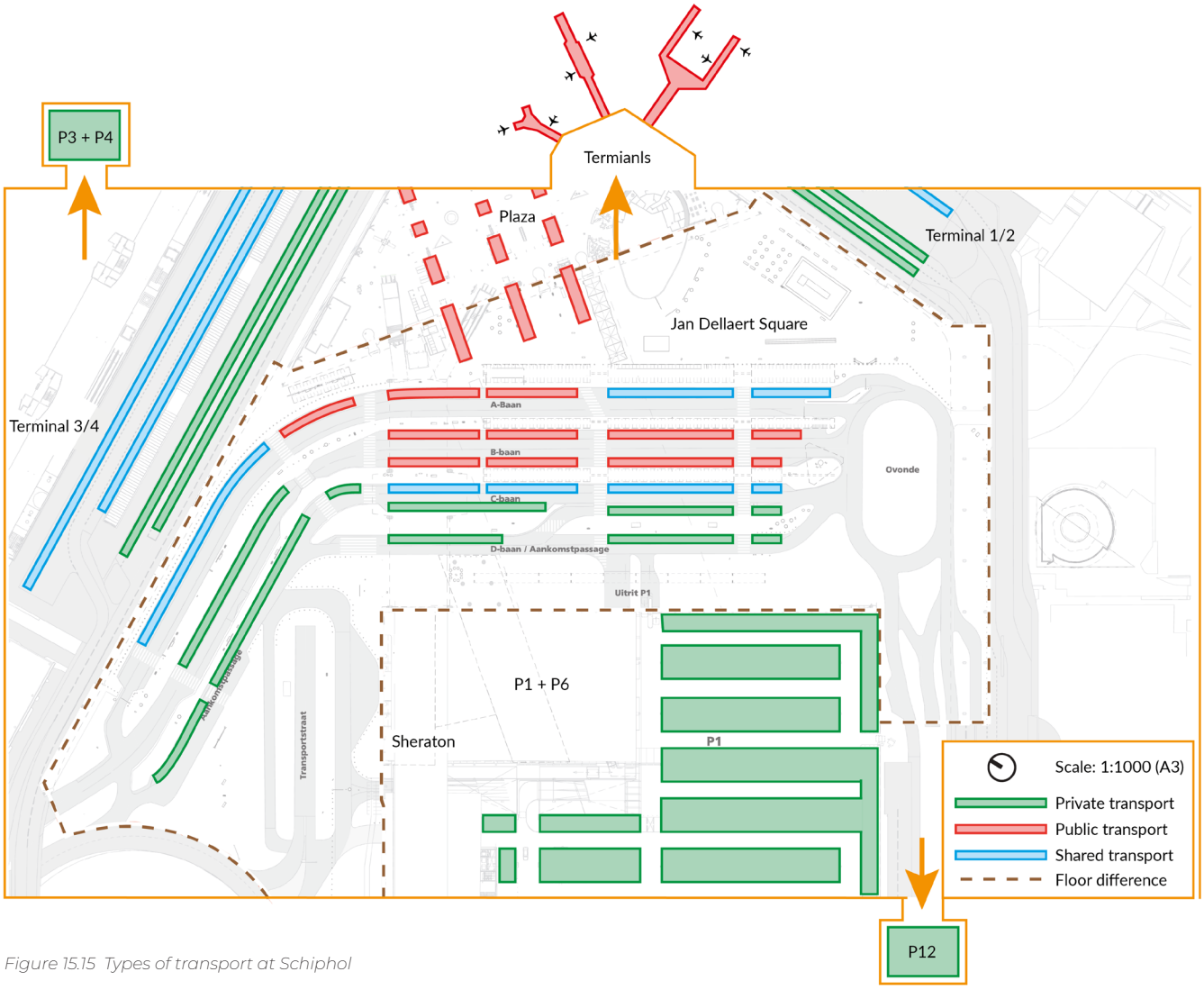


Figure 15.15 Types of transport at Schiphol

APPENDIX 2.C INSIGHTS IN PLAZA NUMBERS

DATA USAGE

To make this estimation, multiple sources are compared, with all Figures recalculated to the year 2019 for a fair comparison. 2019 is chosen as it represents travel behavior unaffected by the COVID-19 pandemic. Data from 2020 and 2021 were not used due to the distorted impact of the pandemic.

All calculations are presented as percentages rather than absolute numbers to provide insights into the relationship between different modalities and to minimize small margin errors. These errors can arise from inaccuracies in the recalculating ratios between years and from disparities in data from different sources.

The Pedestrian Flow Model (MIRT Trajecto, 2017) provides the total number of passengers who arrived or departed at Schiphol by Train and Bus, both Public Transport and Tour buses. NS data is used for trains, and data from ConneXXion (R-Net + Sternet), GVB, and Arriva (Q-Liner) were used for buses.

The ratios between passengers on international trains and domestic trains were obtained from the Modal Split Model (Qlikview, n.d.) and applied to the figures from the Pedestrian Flow Model.
Additionally, from both the Pedestrian Flow Model data and the Modal Split model data, the ratios of pre- and post-transport for air travellers were determined for Train, Bus (Public Transport), Bus (Tour), Car (Parking), Car (Rental), Car (Kiss&Ride), Taxi, Walking, and 'Other'. The total numbers werf compared to the figures published by RSG through the Schiphol Factsheet Transfer Passengers 2019 (RSG, 2020) and the Schiphol Traffic Review 2019 (RSG, 2020) to ensure accuracy.

The data used corresponds to March 2023. Since the dataset would overflow with using more data than one month, March is considered the most representative month in terms of passenger numbers according to the Pedestrian Flow Model (MIRT Trajecto, 2017

TERMINAL FLOW

The difference between arrivals and departures at the terminal is due to a different reason. This group consists of travellers who only arrive at the shopping/ pick-up area, as well as those who arrive through the baggage halls. In both cases, they pass through the terminals. Figure 15.16 specifies this distribution. Unfortunately, there is no data available regarding the distribution of departing travellers through the terminal.

An interesting insight is that out of all the travellers who arrive at Schiphol Plaza, 6.8%, are air-air transfers and pass through Schiphol Plaza. From the airport's perspective, this is not necessary, and individuals travelling on transfer flights do not need to first check out and then check in again (Nog bij Klaas bevestigen of dit zo is). Some of these travellers may deliberately check out to visit Schiphol Plaza, but there may also be a portion who are unaware that they don't need to check out.

	Jan Dellaert Squa	Train	Terminal	P1 + P6	Total
Terminal (Shopping / Pickir	6,6%	4,2%	6,6%	3,2%	20,7%
Terminal (Bagage hall)	32%	23%	15%	10%	79%
Total	38,2%	26,8%	21,7%	13,3%	100,0%

Figrue 15.16: Distribution of terminal transfers

PASSENGER FLOWS IN PLAZA

Figure 15.17 shows whether there has been an upward or downward trend in the number of transfers with airplanes between 2015 and 2019. It is notable that there has been a significant decrease in air transfers involving cars and noticeable increases in transfers involving trains. This aligns well with the ambition outlined by RSG in Chapter 2.1 for a more sustainable airport.
This data is obtained from the Pedestrian Flow Model (MIRT Trajecto, 2017) and Modal Split Model (Qlikview, n.d.) and compared to the figures published by RSG through the Schiphol Factsheet Transfer Passengers 2019 (RSG, 2020)

Modality	Increase/Decrease 2015-2019
Airplane	12,2%
Train (International)	17,9%
Train (National)	
Bus (Public)	-6,7%
Bus (Tour)	-3,0%
Car (Park)	-25,0%
Car (Rental)	7,1%
Car (kiss & ride)	-16,6%
Uber/Taxi	6,6%
Walking	20,5%
Other	-20,7%

Figure 15.17: Increase and decrease in modal split of air-transfers
** Bus (Tour) includes chartered buses and hotel buses.*

EMPLOYEES

A portion of the travellers from the terminal are employees working at Schiphol. No distinction has been made in Figure 15.17.
From the Pedestrian Flow Model (MIRT Trajecto, 2017), the distribution of all employees in the Schiphol area has been obtained. This can be seen in Figure 15.18.
It shows that 45% of the employees in the Schiphol region pass through the terminal. This accounts for 7% of all people passing through the terminals.
It is also noticeable that almost all employees that work around Schiphol use walking as their mode of transportation, except for employees of companies located on the surrounding offices.

	Terminals	Flying personel	Cargo Personel	Hotels	Offices	Other	Total
Employees	45,0%	32,0%	2,0%	2,0%	19,0%	0,0%	100,0%
% Walking	100%	100%	100%	100%	26%	100%	
Entry and exit point							
Terminals	100%						
Crew centre		100%	100%		8%		
Parking - Centre				100%	92%		

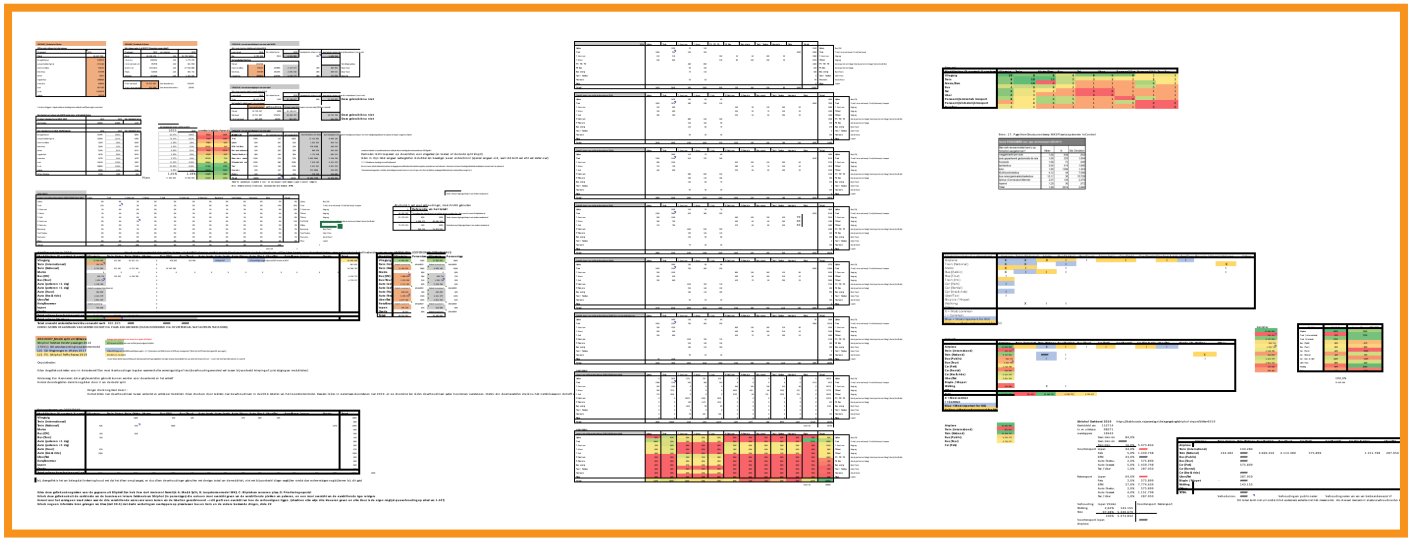
Figure 15.18: Distribution of employees transfering through Schiphol

CONCLUSION AND CONFIRMATION OF RSG'S ESTIMATE

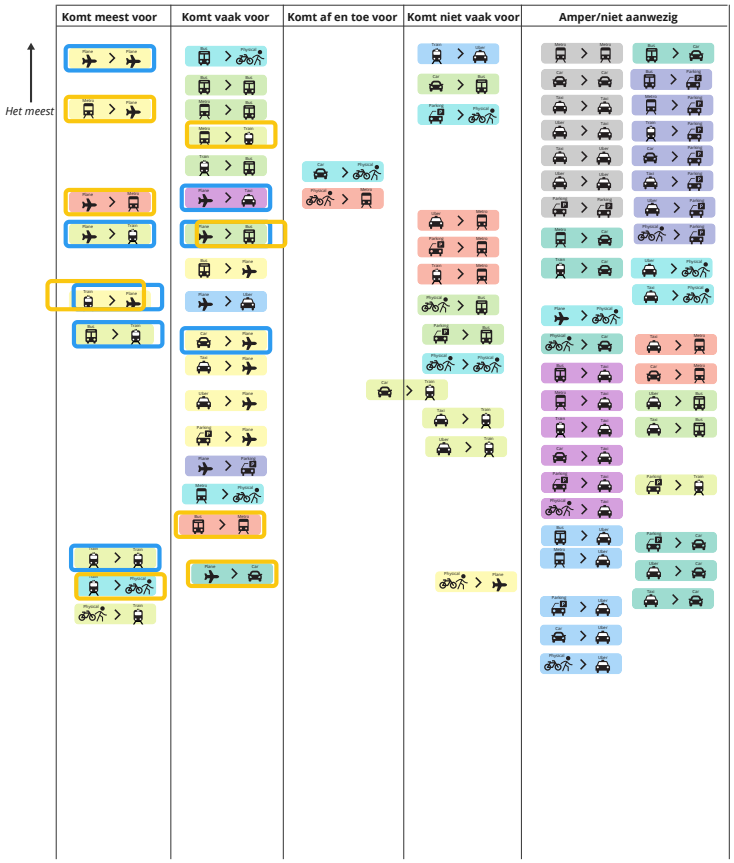
The ratios of incoming and outgoing modalities of passengers at Schiphol provide valuable insights into the prioritization of modalities and passenger preferences. Apparently there is difference in arrival or departure preference by modality. Additionally, it can be observed that the estimation made by RSG experts regarding the presence of modalities aligns with the actual numbers. In almost all transfers the estimate is correct, except for the transfer from public bus to the airplane, which appears to be less significant than estimated. The estimations regarding the major modalities such as Airplane and Train, and the big modalities as parked cars, kiss & ride cars, taxis, and tour buses, align with expectations.
One aspect that is less clear from the figures is the relevance of the number of pedestrians. During the brainstorming session, this group is considered as one of the major modalities, because there are significant distances that need to be covered between different modalities, especially with flying. This assumption is correct but just not reflected in the figures.

OVERVIEW OF CALCULATIONS

CLICK ON THE IMAGE BELOW TO OPEN THE EXCEL FILE



APPENDIX 2.D RESEARCH BOX A



1. Plaats de overstap in de juiste kolom.

2. Geef met deze 6 vakjes aan welke overstap voor Schiphol het belangrijkste is

Reserve:

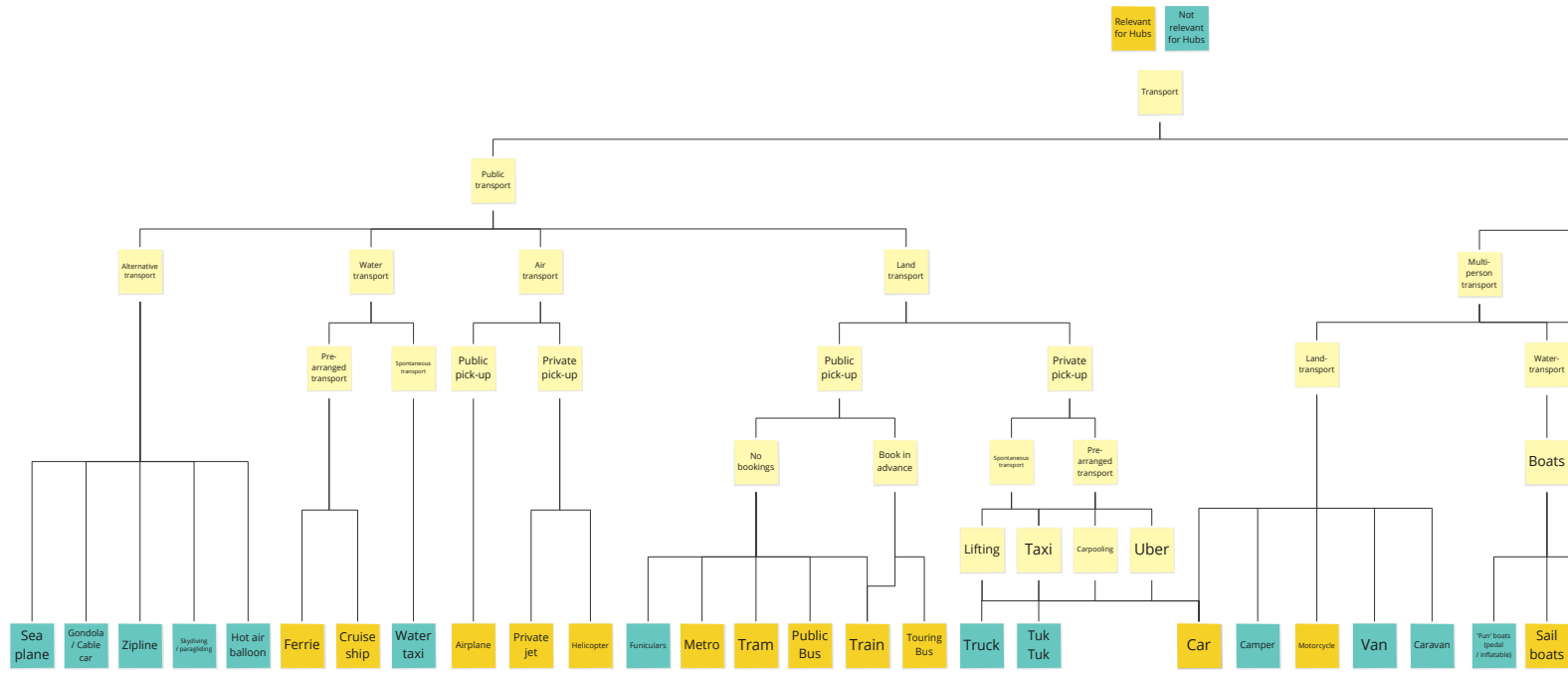
3. Geef met deze 6 vakjes aan welke overstap is onderbelicht

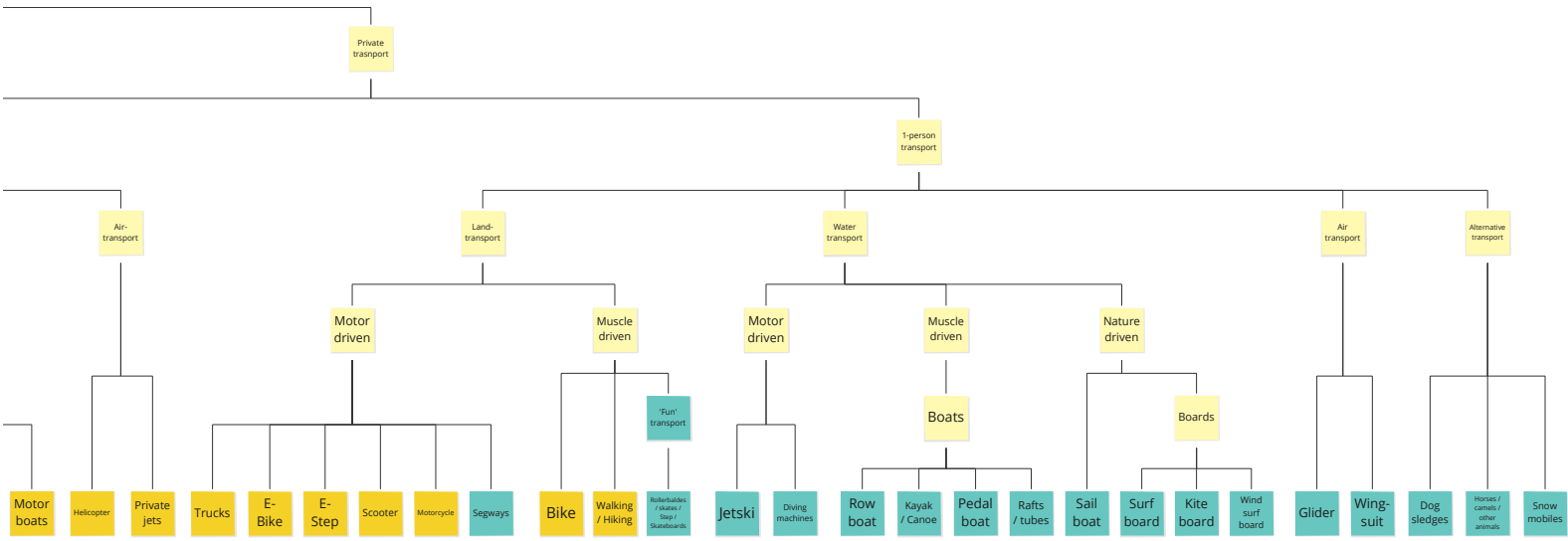
Reserve:

TYPES OF PROJECTS WHERE THE TOOL CAN BE HELPFUL:

- Development of the 'Centrum Plan'
- Prioritization of project initiatives
- Determining required infrastructure sizes (transfer/departure locations)
- Organizing the placement of services within the infrastructure
- Identifying capacities required for locations (connecting pedestrian flows)
- Brainstorming new features Schiphol wants to offer to passengers.

APPENDIX 2.E OVERVIEW OF ALL MODALITIES





APPENDIX 3.A DESIGN PRINCIPLES

THE PRINCIPLES

To provide guidance during the design phase, I have formulated design principles based on the many conversations I had during the preliminary research with employees from RSG, and the researches descibed in Research Box A and B. Design principles are guidelines that inform the overall approach and philosophy of the design. They guide the decision-making process and provide a framework for making choices that align with the intended goals and values of the project.

REFLECTION

Throughout the process, these guidelines served me as a reference point for making decisions and seeking inspiration, especially in the design phase.

Usability and Intuitiveness

Make the support system user-friendly and intuitive, enabling easy navigation and interaction for users.

Comprehensible

Present insights in a clear and concise manner that allows the users to easily understand the information.

Integration and Accessibility

Ensure that the support system seamlessly integrates with existing processes and technologies used by RSG and the S&AP department.

Data-Driven

Develop the support system to gather, analyze, and present relevant data and insights about traveller preferences, usage patterns, and pain points during their rail-bus transfer.

Data Accuracy

Ensure that the collected data is accurate, reliable, and representative of the actual traveller preferences and behaviors.

Targeted Insights

Design the support system to enable targeted specification showing different insights according to user input of preferences.

Flexibility

Design the support system that adapts to evolving traveller preferences and mobility-industry trends over time.

Collaboration

Create shareable features that encourage collaboration among different users within the S&AP department.

Ethical Considerations

Handle traveller data with respect for privacy and ethical guidelines, ensuring that the data collection and usage are in line with the legal regulations.

WORKSHOP - S&AP

Participants: N = 3
Prioritisation of modalities + Mapping of project purpose and requirements.

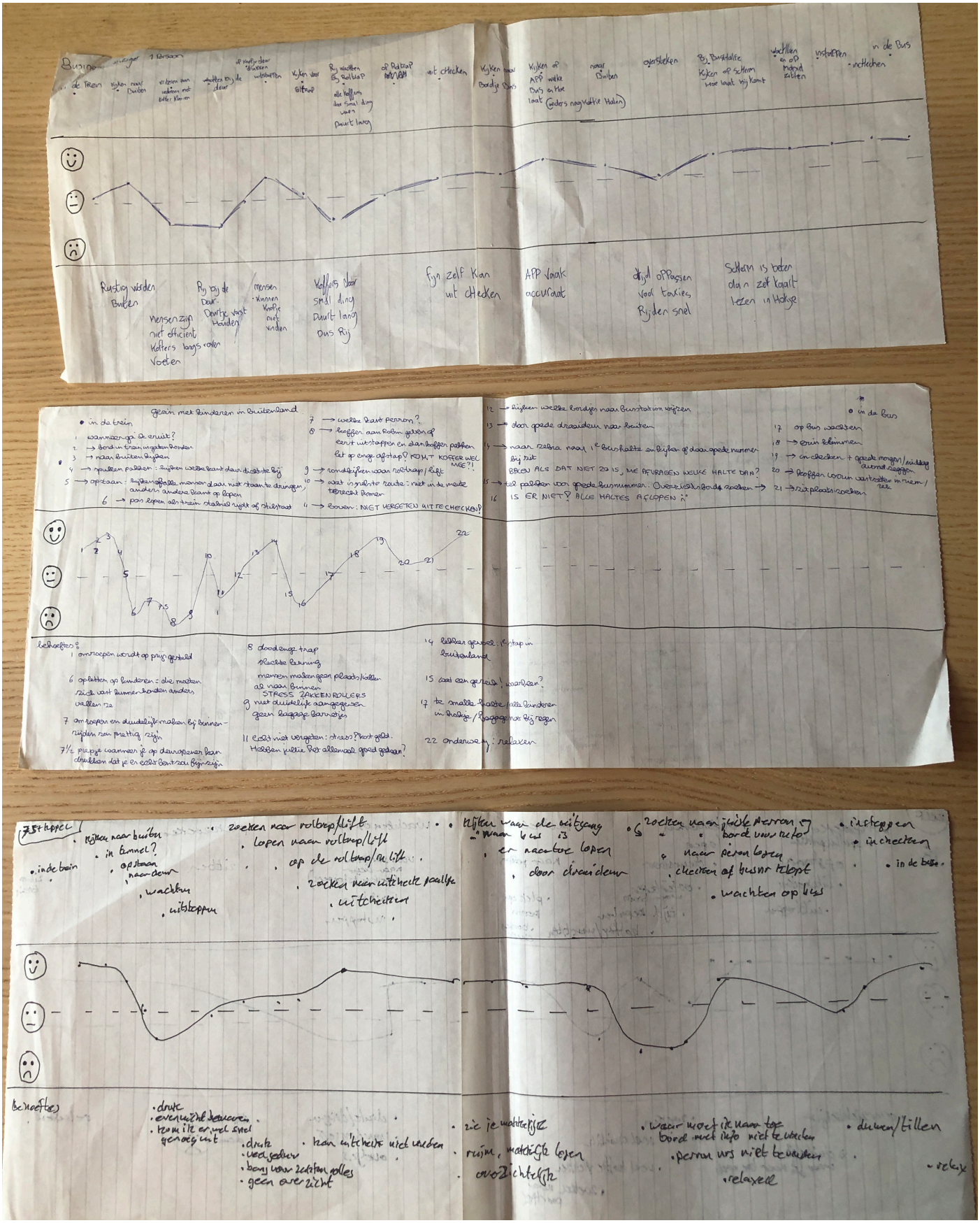
RESEARCH BOX - A

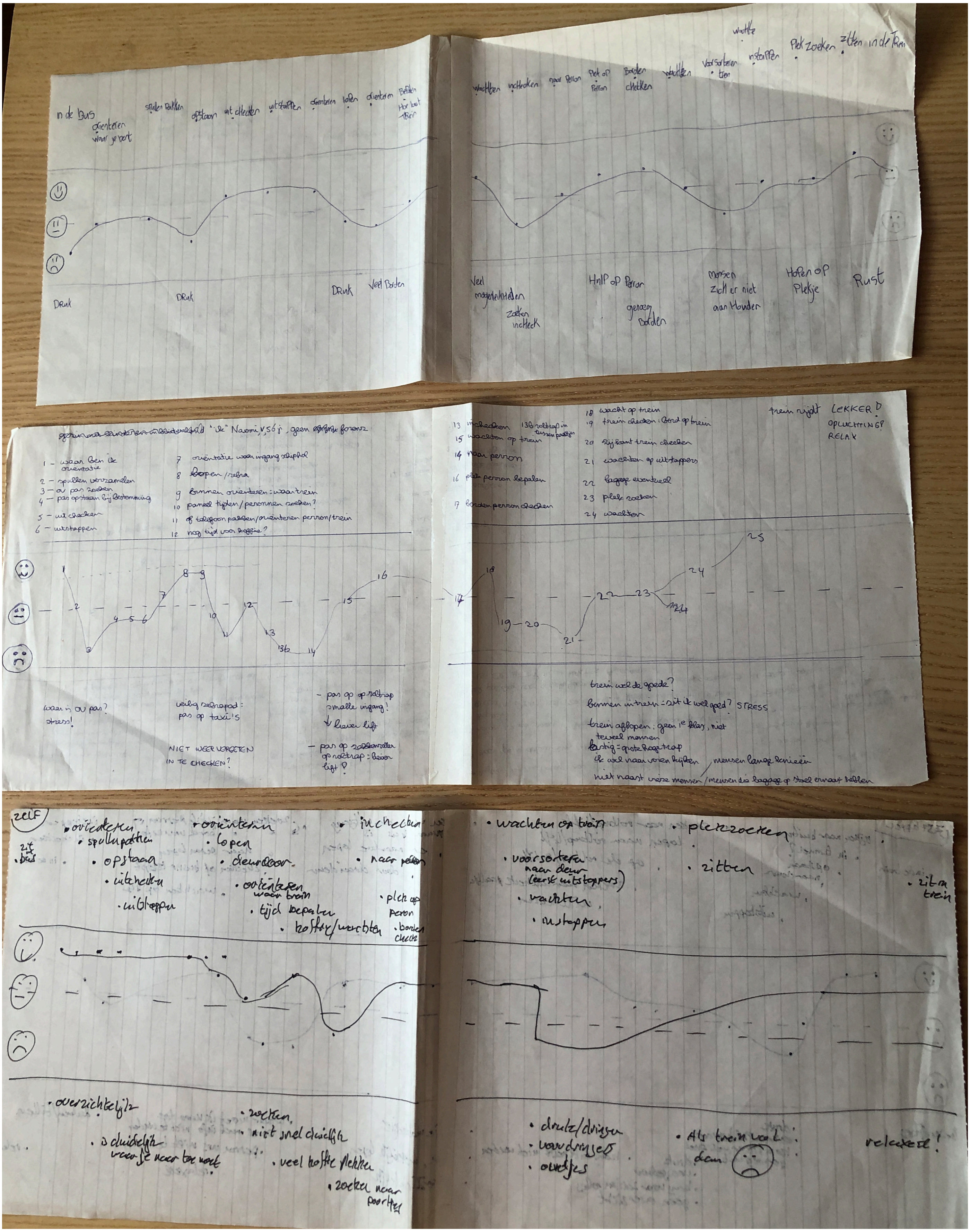
BRAINSTORM + WORKSHOP - DESIGN STUDENTS

Participants: N = 2
Unrestricted view of possible expression of insights. + Brainstorm on user experiences and usability. + Content restructuring.

RESEARCH BOX - D

APPENDIX 6.A CUSTOMER JOURNEYS



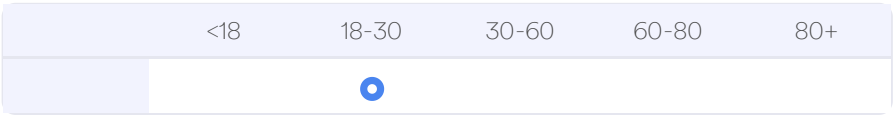


in de Bus
oriënteren waar je bent
spullen pakken
opstaan
uit checken
uitstappen
wachten
inchecken
naar perron
Plek op Perron
Borden checken
voorsorteren
instappen
Plek zoeken
zitten in de trein
Druk
Veel Borden
Veel mogelijkheden
Help op Perron
genoeg Borden
Mensen zich er niet aan houden
Hopen op Plekje
Rust
trein rijdt
LEKKER! OPLUCHTING! RELAX
NIET WEER VERGETEN IN TE CHECKEN?
pas op taxi's
stress!
zelf
overzichtelijk
zoeken, niet snel duidelijk
veel koffie plekken
druk/dringen
voordringers
oudjes
relaxed!

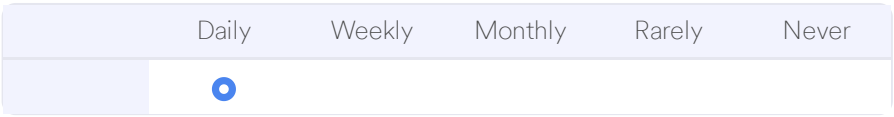
APPENDIX 6.B RESEARCH BOX K

QUESTIONNAIRE - MASTER PLANNING

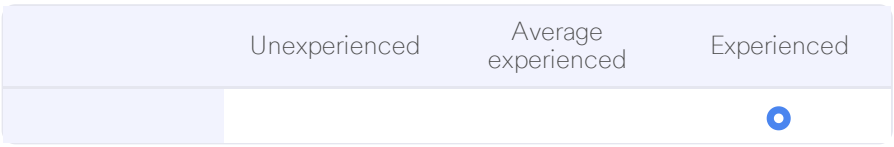
What is your age?



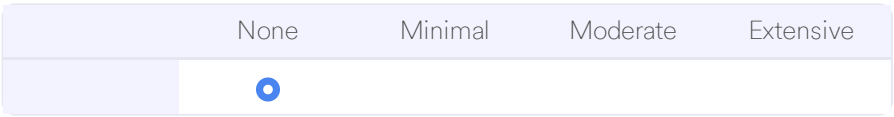
How often do you use public transportation?



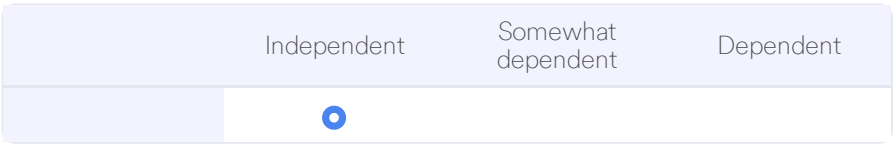
How experienced do you feel as a traveller?



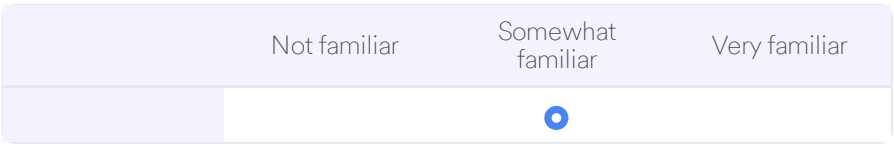
How much personal assistance do you require during a transfer?



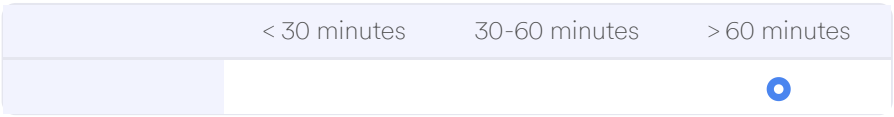
How dependent on help from others are you during a transfer?



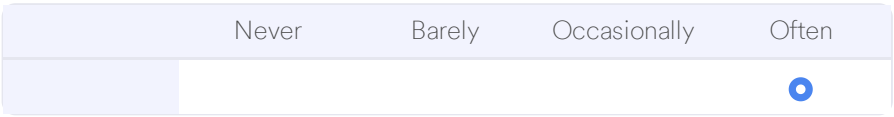
How familiar are you with the public transportation system?



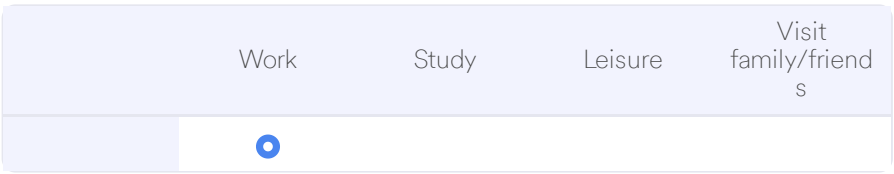
What is the average duration of your journey?



Do you use travel-related apps or technological aids during your transfer?



What is the most common reason for you to use public transportation?



Hoeveelheid ervaring met het type overstap (Eerste keer - Dagelijks)

Ervarenheid als reiziger (Onervaren - Ervaren)

Leeftijd (1-99)

Ervaring met het Nederlandse OV (Eerste keer - Dagelijks)

Hoeveelheid gebruik van reisgerelateerde applicaties (Nooit - Meerdere keren per reis)

Afhankelijkheid van anderen (Totaal onafhankelijk - Erg afhankelijk)

Behoefte aan persoonlijke assistentie (Geen - Veel)

Tijdsduur van reis (<30 min - >180 min)

APPENDIX 6.C ELABORATION ON ARCHETYPES

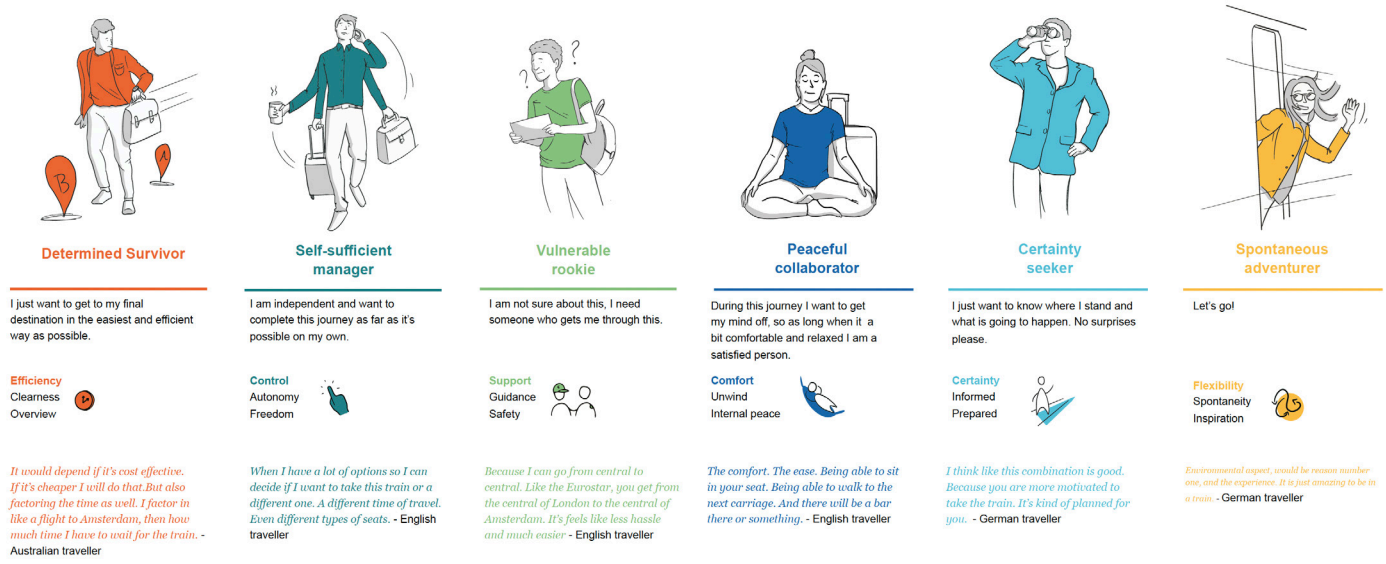
OVERVIEW OF THE TYPE DISTRIBUTION FROM THE RESEARCH OF R. HENDRIXK

CULTURAL SEEKER	• Trip purpose – private; predominant age group: 15–64; income level: (INC) medium/high • Trips per capita per year: 0.5–1.5; travel party size: 1–2 • Hand luggage only/check-in; access mode choice – public transport, taxi, car sharing
FAMILY AND HOLIDAY TRAVELLER	• Trip purpose – private; predominant age group: 30–50 + children; INC: medium/high • Trips per capita per year 0.5–1.5; travel party size: 2–3 • Check-in luggage; access mode choice – public transport, private car (park&travel)
SINGLE TRAVELLER	• Trip purpose – private; predominant age group: 44+; INC: low/medium • Trips per capita per year: 0.25–0.5; travel party size: 1 • Hand luggage only or check-in luggage; access mode choice – public transport, kiss&fly
BEST AGERS	• Trip purpose – private; predominant age group: 65+; INC: medium • Trips per capita per year: 0.5; travel party size: 1–2 • Check-in luggage; access mode choice – private car (park&travel), kiss&fly
ENVIRONMENTAL TRAVELLER	• Trip purpose – leisure; predominant age group: 30–44; INC: medium • Trips per capita per year: 0.5; travel party size: 1–2 • Hand luggage only; access mode choice – public transport, car sharing, cycling
DIGITAL NATIVE BUSINESS TRAVELLER	• Trip purpose – business; predominant age group: 25–64; INC: medium/high • Trips per capita per year 1.5–2; travel party size: 1–2 • Hand luggage only/check-in; access mode choice – public transport, taxi, car sharing

Future passenger profiles identified in DATASET 2050. (Babić et al., 2022)

APPENDIX 6.D TYPE DISTRIBUTION

OVERVIEW OF THE TYPE DISTRIBUTION FROM THE RESEARCH OF R. HENDRIXK



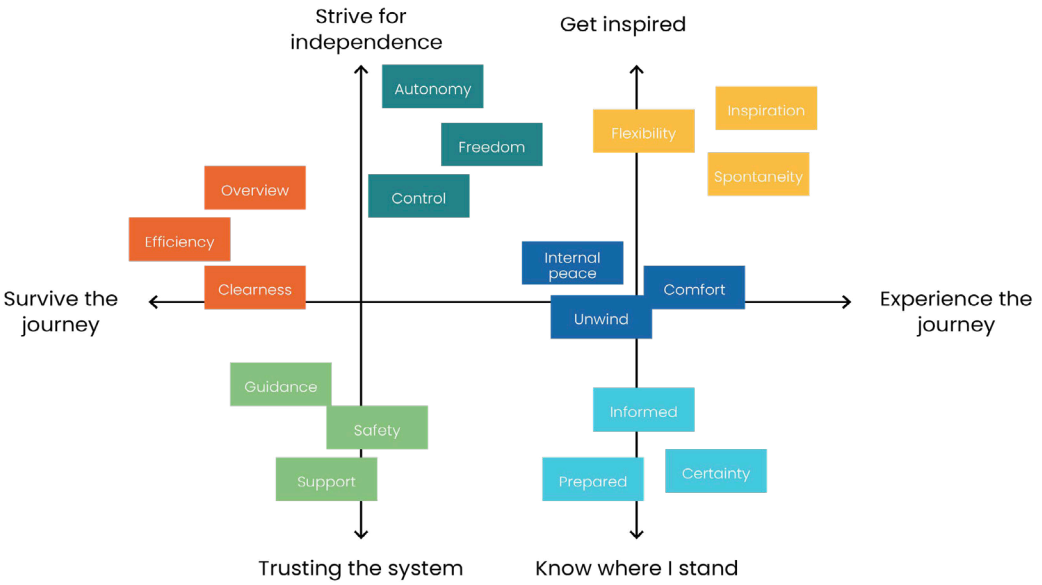


Figure 5.4. The tension model consisting of six key drivers and the identified needs of air-rail travellers

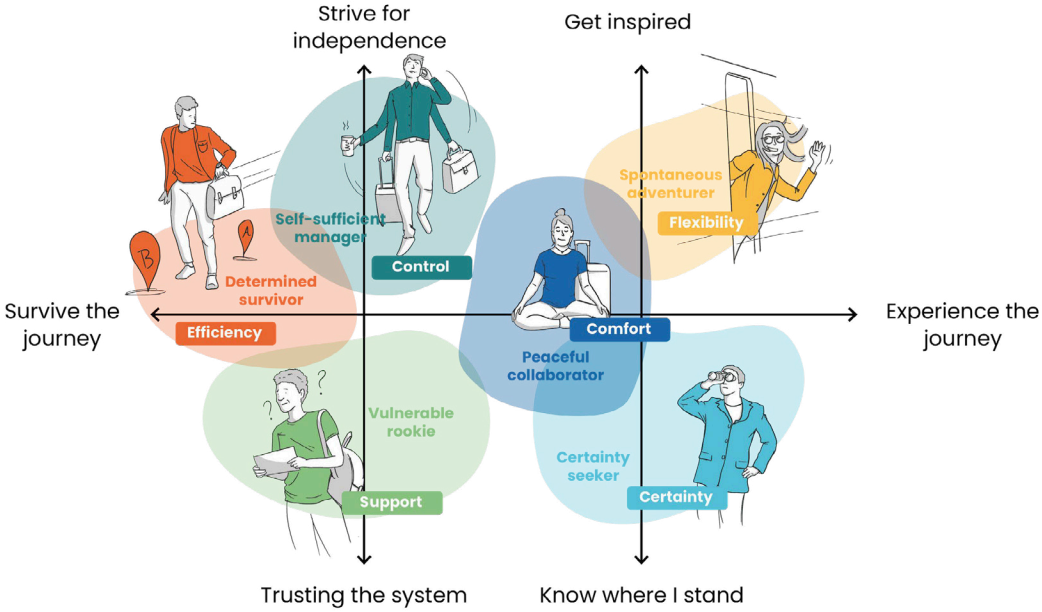


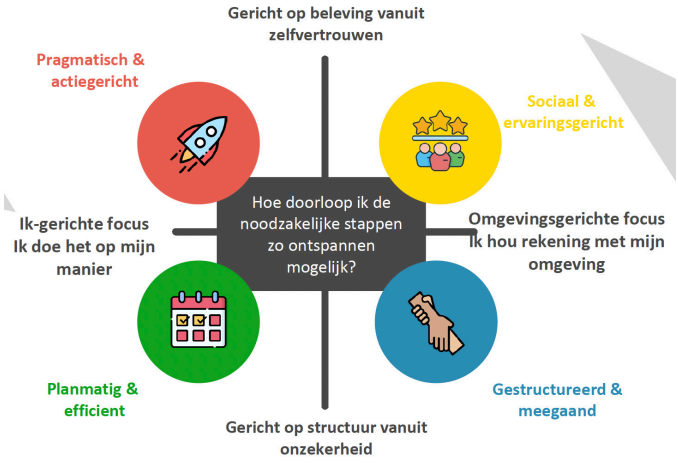
Figure 5.5. The need based personas plotted on the tension model

APPENDIX 6.E MOTIVATIONAL STRATEGIES

MOTIVATION STRATEGIES IN THE RESEARCH OF BEAUTIFUL LIVES CONCERNING TRAVELLER TYPES

The right side of this axis focuses on travellers' needs with a more environment-oriented perspective. They take into consideration their surroundings and other people.
The left side of this axis highlights the needs of travellers with a more self-oriented focus. They prioritize their own desires and behaviors, assuming that Schiphol will accommodate them.

At the bottom of this axis, we find travellers who tend to feel uncertain and thus have a strong need for structure and control.
At the top of this axis, we find travellers who act from a fundamental sense of self-confidence: 'it will be fine.'



Gedrag - vertrek
- Op tijd op Schiphol aanwezig omdat het moet
- Snel overal doorheen, netjes voordringen mag
- Geïrriteerd als het niet snel genoeg gaat
- Gericht op zoek naar actie om verveling te voorkomen
- Impulsieve shopper
- Liefst kort wachten bij gate: als eerste of als laatste het vliegtuig in

Gedrag - aankomst
- Snel overal doorheen, netjes voordringen mag
- Geïrriteerd als het niet snel genoeg gaat: "kunnen ze niet een beetje opschieten"
- Al weer bezig met activiteiten die ze straks thuis gaan doen

Gedrag - transfer
- Snel overal doorheen, netjes voordringen mag
- Geïrriteerd als het niet snel genoeg gaat
- Gericht op zoek naar actie om verveling te voorkomen
- Impulsieve shopper
- Liefst kort wacht bij boarden: als eerste of als laatste het vliegtuig in

Gedrag - vertrek
- Op tijd op Schiphol aanwezig zodat je op je gemak overal doorheen kan
- Rustig, relaxed doorstromen, zolang je maar op tijd bent
- Begrip voor als het even niet goed gaat/langer duurt
- Gericht op comfort en gezelligheid; de trip is immers al begonnen
- In voor leuke, gezellige items die de trip leuker/comfortabeler kunnen maken
- Op tijd bij de gate aanwezig om rustig te kunnen boarden

Gedrag - aankomst
- Rustig, maar wel doelgericht overal doorheen
- Begrip voor als het even niet goed gaat/langer duurt: "het komt heus wel goed"
- Nog even genieten van de laatste momenten, voordat thuis alles weer 'naar normaal' gaat

Gedrag - transfer
- Rustig, relaxed doorstromen, zolang je maar op tijd bent
- Begrip voor als het even niet goed gaat/langer duurt
- Gericht op comfort en gezelligheid; de trip is immers al begonnen
- In voor leuke, gezellige items die de trip leuker/comfortabeler kunnen maken
- Op tijd bij de gate aanwezig om rustig te kunnen boarden

Gedrag - vertrek
- Gecalculeerd op tijd; balans tussen efficiënt en rekening houdend met hick-ups
- Doelgericht en strategisch door de verplichtingen heen
- Assertief en oplossingsgericht als het even niet goed gaat/langer duurt
- Gericht op zo min mogelijk tijd 'verdoen' op de luchthaven
- Effectief en nuttig tijdens verblijf
- Op tijd bij de gate voor goede plek in boardingrij en plek voor handbagage

Gedrag - aankomst
- Gefocust en direct op weg naar de bagagehal / exit
- Doelgericht en strategisch door de verplichtingen heen
- Ongeduldig als het even niet goed gaat/langer duurt: "zonde van mijn tijd"'
- Gericht op alle activiteiten die vanaf vertrek luchthaven gepland staan

Gedrag - transfer
- Doelgericht en strategisch door de verplichtingen heen
- Assertief en oplossingsgericht als het even niet goed gaat/langer duurt
- Gericht op zo min mogelijk tijd 'verdoen' op de luchthaven
- Effectief en nuttig tijdens verblijf
- Op tijd bij de gate voor goede plek in boardingrij en plek voor handbagage

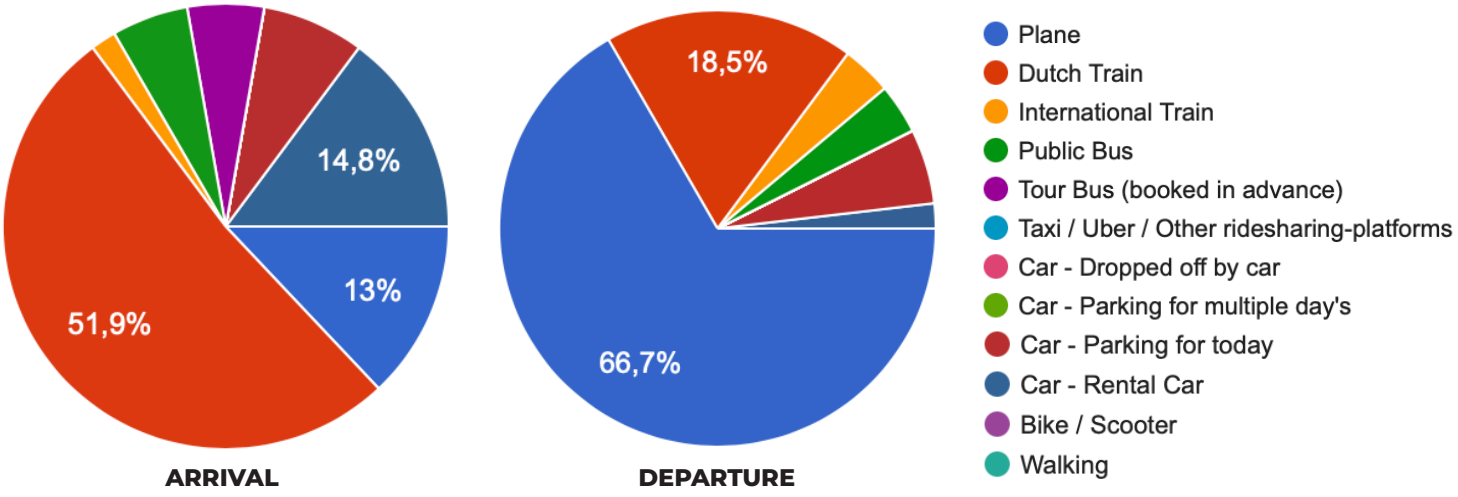
Gedrag - vertrek
- Ruim op tijd op Schiphol aanwezig en voorbereid om problemen te voorkomen
- Tikje onzeker en opgelucht als 'je er door bent'
- Nerveus en onzeker als het even niet goed gaat/langer duurt
- Gericht op voorkomen van problemen en daarom ruim op tijd bij de gate
- Rustig & voorspelbaar verblijf

Gedrag - aankomst
- Opgelucht dat je er weer 'bijna bent'
- Voortvarend overal doorheen (bekend terrein, 'ik ben weer thuis')
- Tikje ongeduldig als het even niet goed gaat/langer duurt: "zo hoort het niet te gaan'
- Gericht op alles wat er zo meteen thuis weer moet gebeuren

Gedrag - transfer
- Tikje onzeker en opgelucht als 'je er door bent'
- Nerveus en onzeker als het even niet goed gaat/langer duurt
- Gericht op voorkomen van problemen en ruim op tijd zijn bij de gate
- Rustig & voorspelbaar verblijf

(Beautiful Lives, 2023)

APPENDIX 7.B SURVEY INSIGHTS



Modality distribution of participants

The main objective of this survey is to gain initial insights into the experiences of travellers making transfers at Schiphol Airport. Participants were asked about their overall transfer experience, the key elements important to them during a transfer, and how Schiphol could further enhance their transfer experience. The obtained results have been clustered and presented in the the graph below. Specific preferences and wishes have been documented in an overview. Several aspects were frequently mentioned, such as a shortage of seating or confusion in choosing the correct public transportation tickets. Many participants expressed satisfaction with the clear wayfinding at the airport.

Participants were also asked to rate their transfer experience on a scale of 1 to 10. These results are depicted in the graph above. The graphs below shows the types of transfers reported by participants. It is worth mentioning that a significant portion of travellers arrived or departed by either airplane or train. Obtaining more results regarding other modalities is important to find more significant differences among various transfer options.

NUMBER OF PARTICIPANTS OF EACH TRANSFER

Number of awnsers each transfer	Plane	Dutch Train	Internationa	Car - Parking	Car - Rental	Public Bus	Tour Bus
Plane	3	20		1	8		3
Dutch Train	1	6	1			2	
International Train	1	1					
Car - Parking for today				3			
Car - Rental Car	1						
Public Bus		1				1	
Tour Bus							

AVERAGE SCORE OF EACH TRANSFER

Average grade each transfer	Plane	Dutch Train	Internationa	Car - Parking	Car - Rental	Public Bus	Tour Bus
Plane	9,0	8,2		8,0	6,6		8,3
Dutch Train	8,0	7,0	1,0			7,5	
International Train	10,0	7,0					
Car - Parking for today				6,0			
Car - Rental Car	8,0						
Public Bus		8,0				1,0	
Tour Bus							

Distribution of participants per transfer, including the average of their scores

It can be observed that “Atmosphere and personal experience,” “Clarity,” “Seamless pass-through/ Hub function,” and “Accessibility” received more positive experiences than negative ones. The themes “Duration and efficiency” and “Facilities (Physical)” had more divided opinions among the participants, suggesting areas for improvement at Schiphol. Once more results are obtained, the themes will be linked to the transfers, allowing for an examination of whether specific themes are more prominent in certain transfers.

The average rating given by the participants is a 7.4. To measure clear differences between different modalities, a larger number of participants would be required. There are no specific transfers or modalities that stand out as consistently positive or negative, as the instances of extreme ratings were based on evaluations from only one participant. The reasons behind these extreme ratings (three times a score of 1 and seven times a score of 10) have been incorporated into the above analysis. These outliers were distributed across different modalities. To gain further insights, additional research will be conducted to obtain more significant results.

APPENDIX 11A: USABILITY STUDY TASKS & DESIGN

THE STORYLINE WITH THE QUESTIONS

1. You are researching the transfer from Train to Bus. You are interested in how to assist people living around Schiphol. Some of these people do not use public transport frequently, but happen to use the train-to-bus transfer specifically. Which category do people with little to moderate public transport experience and moderate to high familiarity with the specific rail-bus transfer find the most important/relevant? *Age, purpose of the trip, nationality, and group size are not relevant in this context.*
   Accessibility & Efficiency + Comfort & Environment (Both 8.6 relevance)

2. In which category does this target group give the lowest rating?
   (Information and Signage, 6.2)

3. You're curious if this is the case in the opposite direction as well. What rating do the same group of passengers, but those making the transfer from Bus to Train, give?
   (5.6)

4. You see that these passengers find Placement & Locatebility very important, and you're curious about how Schiphol can assist these passengers with it. What is the most common thought these passengers have about this transfer?
   (Floor change for a transfer)

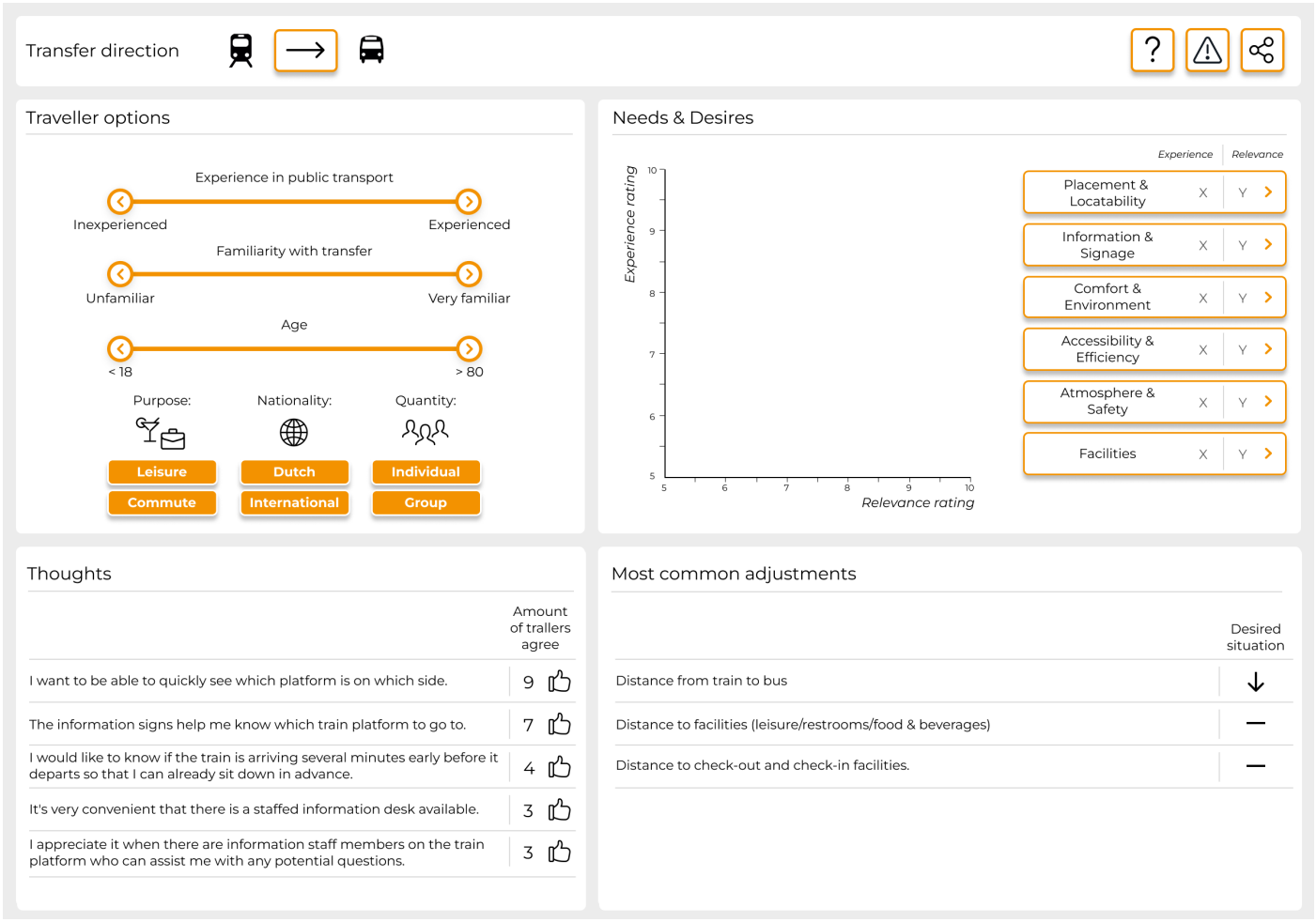
5. If a new location were to be established for the bus station, what do passengers prefer regarding the distance of this transfer?
   Becomes shorter

6. Someone comes with questions about the comfort and seating environment of waiting areas. You want to know what all passengers think about this. What is the overall rating given by all different passengers making the transfer from the bus to the train regarding their experience with Comfort & Environment?
   6.5 (not 7.7, that's relevance)

7. You want to see if this differs with only leisure travellers, and you want to exclude all commuters. What rating do they give for Comfort & Environment?
   1. 7.0

8. You want to print your insights. How can you do this?
9. You notice an error/issue in the system. How do you want to report it?
10. You want to review the explanation again. How can you do this?

THE DASHBOARD THAT IS USED DURING THE RESEARCH



APPENDIX PROJECT BRIEF

DESIGN FOR our future

6474

TU Delft

IDE Master Graduation

Project team, Procedural checks and personal Project brief

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

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

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

STUDENT DATA & MASTER PROGRAMME

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

family name: Bronkhorst
initials: S.I. given name: Samuel
student number: 4554574
street & no.:
zipcode & city:
country: The Netherlands
phone:
email:

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

SUPERVISORY TEAM **

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

** chair: Sicco Santema dept. / section: DOS
** mentor: Aniek Toet dept. / section: DOS
2nd mentor: Klaas Boersma
organisation: Royal Schiphol Group
city: Amsterdam country: The Netherlands

comments (optional)

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

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

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

Procedural Checks - IDE Master Graduation

TU Delft

APPROVAL PROJECT BRIEF

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

chair Sicco Santema date 24 - 04 - 2023 signature sicco santema Digitaal ondertekend door sicco santema Datum: 2023.04.24 18:15:39 +02'00'

CHECK STUDY PROGRESS

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

Master electives no. of EC accumulated in total: 30 EC

Of which, taking the conditional requirements into account, can be part of the exam programme 30 EC

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

★ YES all 1st year master courses passed

NO missing 1st year master courses are:

name Robin den Braber date 25 - 04 - 2023 signature RdB

FORMAL APPROVAL GRADUATION PROJECT

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

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

Content: V APPROVED NOT APPROVED

Procedure: V APPROVED NOT APPROVED

- with added planning approved

comments

name Monique von Morgen date - KE 2/5/2023 signature MvM

Initials & Name S.I. Bronkhorst Student number 4554574

Title of Project A Touchpoint that matters for successful seamless Multimodal transfers

Personal Project Brief - IDE Master Graduation

TU Delft

A Touchpoint that matters for successful seamless Multimodal transfers — project title

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

start date 05 - 04 - 2023 — 09 - 11 - 2023 end date

INTRODUCTION **

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

The mobility sector is rapidly evolving, with many different subsystems based on various transportation modes like trains, buses, and bicycles. When using these transportation systems, travellers switch between modes of transportation at transit hubs. The purpose of these hubs is to make it easy for people to make these transitions and complete their journeys smoothly through well-organized transfers. (Toet, 2022). With these developments taking place, airports are not just a place for air travel, but also serve as a hub for different modes of transportation. As one of the largest airports in Europe, Schiphol has the potential to develop as a Multimodal Transfer Hub (MTH) to provide seamless connectivity between air, rail, and road transport modes.

By doing so, Royal Schiphol Group (RSG) aims to reduce travel time, congestion, and environmental impact, while enhancing the overall travel experience for passengers. They have the ambition to create the world's most sustainable, high-quality airports and their top priority is to re-establish their reputation as a leading international airport (Schiphol Group's Annual Report, 2022). The creation of passenger-oriented MTHs is encouraged by the EU Commission, which stated that "…airports, ports, railway, metro and bus stations, should increasingly be linked and transformed into multimodal connection platforms for passengers" (European Commission, 2011)

This graduation project is part of the PhD research of Aniek Toet, that investigates the transformation of Airport Hubs into Multimodal Transport Hubs with Amsterdam Airport Schiphol as the research case.

An essential component of creating a seamless passenger flow, is to understand how to make the transfer between different modalities smooth. While there have been several studies on understanding and optimising transfers between specific modalities, such as air-rail or air-air, there is no overall overview of how to do this between all different modalities. The experience of transferring between different modalities can differ significantly between different types of travellers. For instance, international business travellers have different priorities and desires than international leisure travellers or regional commuters. When considering the main function of an MTH, which is to switch seamlessly between different modes of transport, it is essential to consider not only the different modalities, but also the different types of travellers, both internationally and regionally.

The objective of this research is to identify the needs and preferences of travellers during their transfer between modalities. This will result in a comprehensive guideline that outlines the different touchpoints in the transfer process, such as checking in and out, wayfinding, and ticket sales, and then form an overview of design principles and interventions. For RSG, several touchpoints will emerge that can be used as leads for improvements in seamless transfers.

For creating the guideline, the travellers are the main customers concerned since their perspectives and needs are essential in the process of coming up with the design principles and interventions.

For the implementation, the main stakeholder will be RSG as they are responsible for managing and operating the airport and play a critical role in determining the infrastructure and services needed to create a successful MTH. Within Schiphol, there are retail and service providers that are relevant for the services they deliver. Other important stakeholders are alle the operators of the different modalities. The airline companies with KLM being the biggest one; NS and Prorail as the main rail stakeholders; VRA (transport authority of Amsterdam Region) as the main Bus-cooperation involving Connexxion; the different taxi services; and also residents that use the Kiss&Ride and parking spots. Since there are plans to extend the Noord-Zuid lijn Metro the GVB also will be part of the modality stakeholders. The Ministry of Infrastructure and Water management is involved for the regulations and approval of future construction plans.

The parties mentioned above can provide input and the opportunity for user research during the analysis phase, as well as feedback on the concepts and designs developed.

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Initials & Name S.I. Bronkhorst Student number 4554574

Title of Project A Touchpoint that matters for successful seamless Multimodal transfers

introduction (continued): space for images

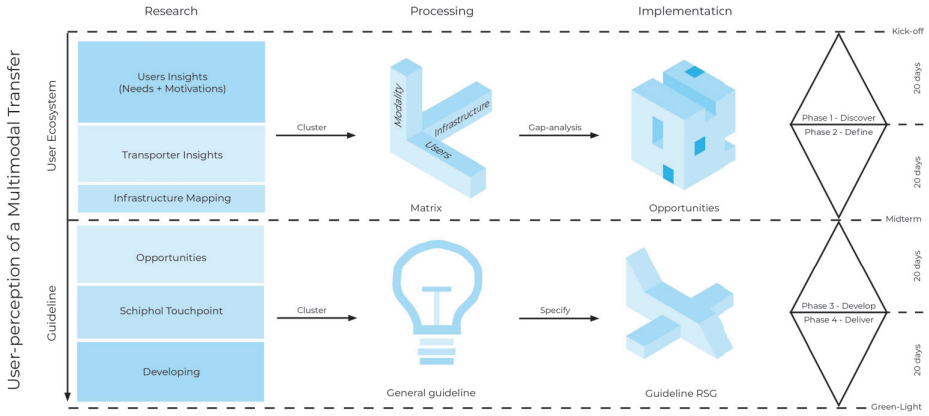

image / figure 1: Process Approach Overview

image / figure 2:

PROBLEM DEFINITION **

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

Schiphol airport aims to provide a seamless travel experience for travellers with the focus on air-travel, but what does that mean for the transfers between different other modalities? It needs to be clear what people want and how they will experience this 'seamless' transfer. If Schiphol wants to operate as an MTH, non-air modality transfers are now underexposed. The problem that needs to be dealt with is the lack of an overall guideline or understanding of how to create a seamless passenger flow between different modalities at Schiphol. While there have been studies on optimizing transfers for air-modalities, there is a need to have an overview of understand how to do this between other modes of transportation, for all different types of people that pass Schiphol. This guideline should be based on the findings from the research and should consider the traveller's perspective. It should provide a clear understanding of the different touchpoints in the transfer process and how they can be optimized to create a more efficient and enjoyable experience for travellers.

ASSIGNMENT **

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

Design a guideline consisting of design principles and interventions, that facilitates a seamless travel experience for transfers at a Multimodal Transfer Hub.

Th project involves researching the user experiences of different types of travellers to create user groups, each with their own unique needs and wishes. These user groups will then be assessed against the different transfers between modalities that occurs at Schiphol to identify touchpoints and areas for improvement. The goal is to create a guideline that shows the ideal transfers within a Multimodal Transfer Hub.

Initials & Name S.I. Bronkhorst Student number 4554574

Title of Project A Touchpoint that matters for successful seamless Multimodal transfers

PLANNING AND APPROACH **

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

start date 5 - 4 - 2023 — 9 - 11 - 2023 end date

Work	Study
No Uni	Special day

April

	Mon	Tue	Wed	Thu	Fri	Sat	Sun
13						1	2
14	3	4	5	6	7	8	9
15	10	11	12	13	14	15	16
16	17	18	19	20	21	22	23
17	24	25	26	27	28	29	30

Notes:
5 Apr: Formal Kickoff Meeting
7 Apr: Good Friday (National holiday)
10 Apr: Second day of easter (National holiday)
24 Apr: Team Meeting
27 Apr: Kingsday (National holiday)

May

	Mon	Tue	Wed	Thu	Fri	Sat	Sun
18	1	2	3	4	5	6	7
19	8	9	10	11	12	13	14
20	15	16	17	18	19	20	21
21	22	23	24	25	26	27	28
22	29	30	31				

Notes:
1-6 May: Military training in Germany
5 May: National memorial day (National holiday)
18-19 May: Ascension day (National holiday)
22 May: Team Meeting
29 May: Second day of Whitsun (National holiday)
30 May-2 jun: Military training

June

	Mon	Tue	Wed	Thu	Fri	Sat	Sun
22				1	2	3	4
23	5	6	7	8	9	10	11
24	12	13	14	15	16	17	18
25	19	20	21	22	23	24	25
26	26	27	28	29	30		

Notes:
28 Jun: Midterm Meeting
30 jun: Militairy Training Schotland

July

	Mon	Tue	Wed	Thu	Fri	Sat	Sun
26						1	2
27	3	4	5	6	7	8	9
28	10	11	12	13	14	15	16
29	17	18	19	20	21	22	23
30	24	25	26	27	28	29	30
31	31						

Notes:
1-14 Jul: Militairy Training Schotland
17-21 Jul: Nijmeegse 4-daagse

August

	Mon	Tue	Wed	Thu	Fri	Sat	Sun
31		1	2	3	4	5	6
32	7	8	9	10	11	12	13
33	14	15	16	17	18	19	20
34	21	22	23	24	25	26	27
35	28	29	30	31			

Notes:
14 Aug: Team Meeting
30 Aug: Team Meeting

September

	Mon	Tue	Wed	Thu	Fri	Sat	Sun
35					1	2	3
36	4	5	6	7	8	9	10
37	11	12	13	14	15	16	17
38	18	19	20	21	22	23	24
39	25	26	27	28	29	30	

Notes:

October

	Mon	Tue	Wed	Thu	Fri	Sat	Sun
40	2	3	4	5	6	7	8
41	9	10	11	12	13	14	15
42	16	17	18	19	20	21	22
43	23	24	25	26	27	28	29
44	30	31					

Notes:
4 Okt: Green-light Meeting
9-13 Oct: Vacation

November

	Mon	Tue	Wed	Thu	Fri	Sat	Sun
44			1	2	3	4	5
45	6	7	8	9	10	11	12
46	13	14	15	16	17	18	29
47	20	21	22	23	24	25	26
48	27	28	29	30			

Notes:
9 Nov: Graduation

Kick-off: 05-40-2023 - Mid-term: 28-06-2023 - Green-light: 04-10-2023 - Graduation: 09-11-2023
During the process, I will be working for my student job one day per week. The other four days of the week will be dedicated to my graduation project. This is in accordance with Schiphol and my board."

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MOTIVATION AND PERSONAL AMBITIONS

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

As a young boy, I found the entire process at Schiphol airport to be incredibly fascinating. I would often discuss with my father the various aspects of the check-in process that could be improved upon. Questions like "Why don't people take off their jackets while waiting in line?" and "Why don't people weigh their luggage at home?" would constantly cross my mind. I am someone who has a keen eye for things that can be done better, easier, and more efficiently. This is one of the reasons why I chose to study industrial design engineering. Improving and streamlining user experiences is something that I am truly passionate about, and it's something that I sought out for my thesis project.
To explore potential future job opportunities, I wanted to take a first-hand look at a major company that has a significant impact on its users. Schiphol seemed like the perfect match for me. It's an organization that I find incredibly interesting, and there are countless opportunities to enhance the user experience.

Throughout my MSc programme, I have developed an interest in the field of product-service design in the combination of user experience and strategy. This project offers an excellent opportunity to combine the strategy and user experience combination in a practical setting, working with various stakeholders to develop a comprehensive guideline that can inform the development of a concept that contributes to Schiphol's ambition to become an MTH.

Something that I have occasionally missed during my education is that the assignments did not have any real significance or usefulness. I was looking for a project where I could make a difference for a company, not just for the sake of graduating, but also to offer them something that will be used. That's how we together came up with the current project.

Competencies that I have developed during my studies are mostly related to creativity and practicality. I tend to perform better when a project has some clarity and when we can focus on moving forward. Ideation and conceptualization are the phases where I excel.
My greatest learning ambitions mainly focus on the ambiguous "research" phase of a project, where it is not always clear which direction the project will take. I would like to apply this to the extensive preliminary research that needs to be done, where I must strategically gather the necessary information and organize it into a coherent whole.

To challenge myself in this regard and in contrast to many projects at our faculty, I do not want to focus on solving a specific problem. This often provides a clearer framework for an approach. Instead, I want to try a more open-ended project where I am specifically looking for future changes, rather than solving past issues.

I have listed my biggest learning goals:
- Gaining experience with performing user research
- Bundling large amounts of diverse knowledge into a coherent whole.
- Expressing my insights both textually and visually, without it becoming chaotic.
- Managing multiple stakeholders, especially dealing with different views and being confident and convincing in making decisions.
- Develop myself in the field of mobility, become acquainted with the field and the ins and outs of running a mobility related project.

FINAL COMMENTS

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