REPORT

Booking and Payment Integration of Air- and Public Transport for First/Last Mile Airport Trips

A Conceptual Framework and Business Model Canvas

University: Technical University of Delft

Name: Jerry Schuiling

Student Number: 4296087

Date: 20 August 2020

Master's Programme: Transport, Infrastructure and Logistics

Thesis Committee

Chairman TU Delft:	Prof.dr.ir. Bart van Arem
Supervisors TU Delft:	Dr.ir Niels van Oort
	Dr. Wijnand Veeneman
Supervisor RHDHV:	Ing. Arjan Honingh

HASKONINGDHV NEDERLAND B.V.

Laan 1914 no.35
3818 EX AMERSFOORT
Transport & Planning
Trade register number: 56515154

+31 88 348 20 00 **T**
+31 33 463 36 52 **F**
info@rhdhv.com **E**
royalhaskoningdhv.com **W**

Table of Contents

Appendices

Executive Summary

Trends such as privatization and deregulation giving a continuous growth in air travel, have increased volumes of landside traffic travelling to/from airports (Vespermann & Wald, 2011). This results into an investigation in the total door to door trip of a traveller, which does not start or finish at an airport. Thereby, it is given that ticket platforms offer extensions besides selling airplane tickets. Extensions may vary from serving accommodations such as hotels, airport taxis and car rental. With the finding that landside airport traffic has increased, it is notable that public transport has not yet been seen as an extension on these ticket platforms. This can be seen in figures 1 and 2, where car rental and airport taxis are indicated on the Booking.com website and the KLM website having even less.

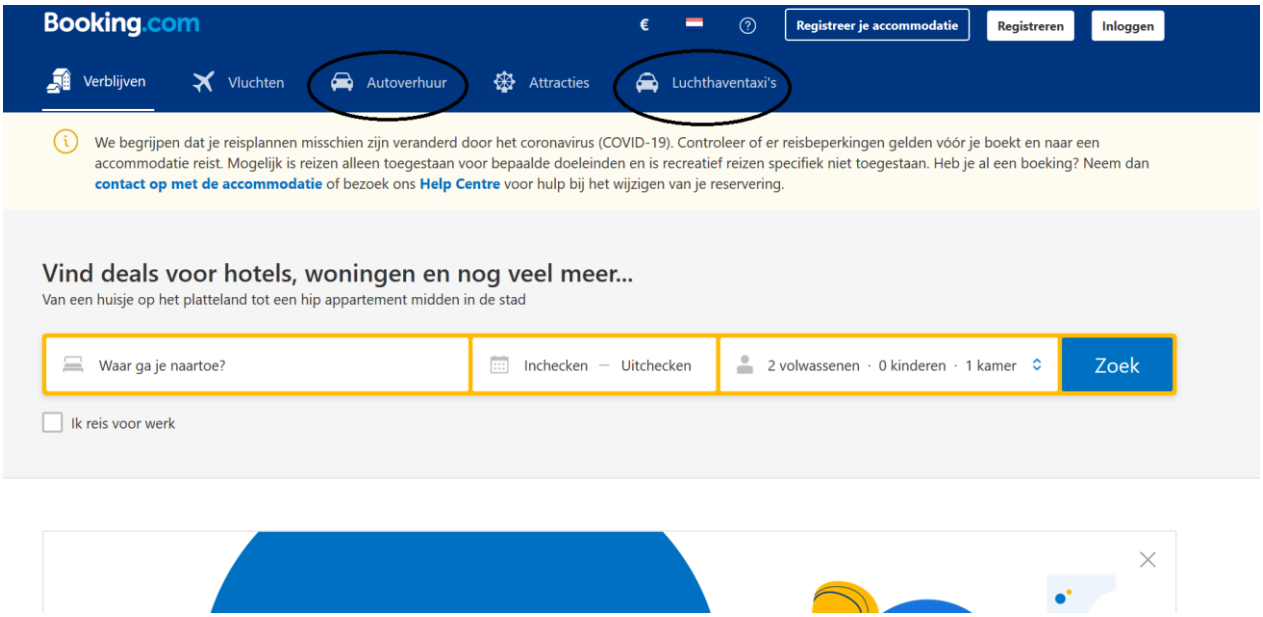


Figure 1 Extensions Booking.com

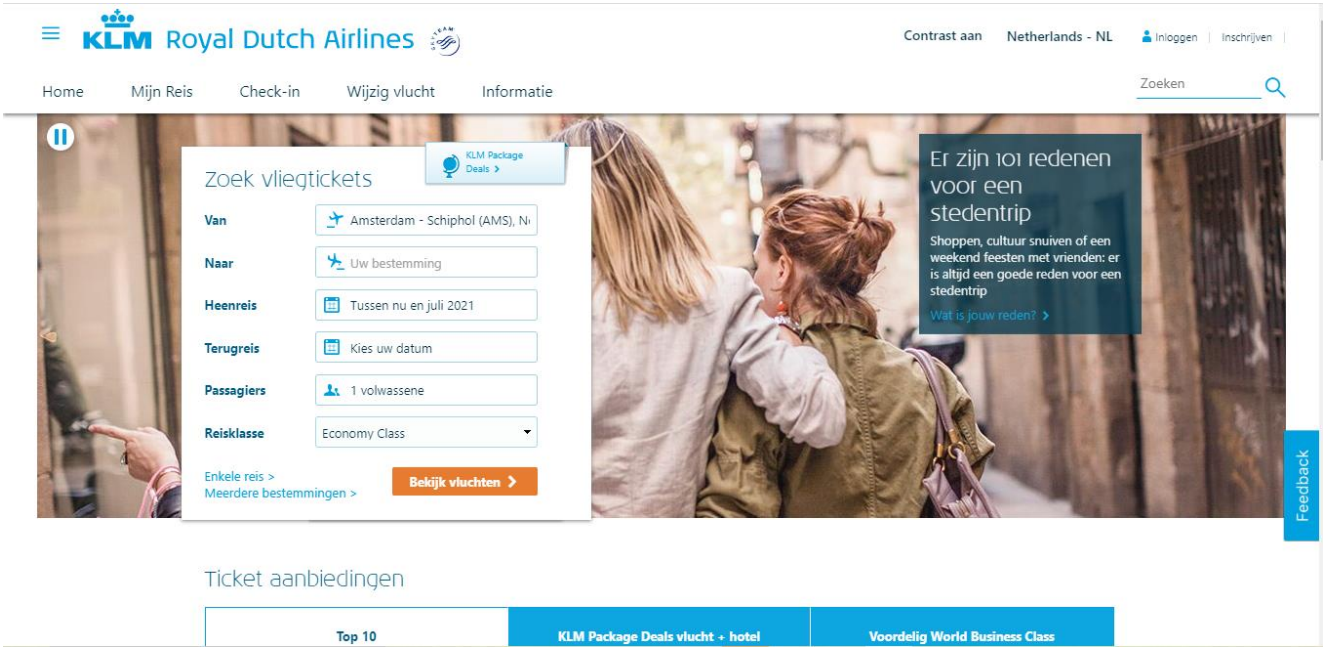


Figure 2 KLM.com

Current available literature on multimodal trips does not include a relevant study that shows if travellers would be interested in a combination ticket of air- and public transport. In this way, a barrier of putting an effort in to buy a public transport ticket in an unknown, foreign country may be solved. Passengers might therefore dodge the problem of finding the right ticket machines, lack of knowledge of public transport at their destination, probably paying a high amount of money for a taxi, unclear language on ticket machines for buying tickets and so on. Since airports are seen as a gateway and a strategic engine of economic development (Vanoutrive, 2019), the question arises why this has not yet been implemented.

The integration of booking and payment of these tickets have to be judged on feasibility, which corresponds to the demand of the system. Are there specific flows and numbers of passengers and/or type of traveller (leisure or business) to makes the integration feasible? On the other hand, literature has yet discovered desirability of a certain integration. This would correspond more towards stakeholder interests and power, markets and governance. Could integrating booking and payment of air- and public transport differ across different countries. Figure below shows an overview of the trip in this case, where the emphasis will be made to the public transport trip at the 'foreign' destination. It has namely been assumed that public transport trips in the traveller's resident area is known by the end user.

Figure 3 Overview Trip Consideration in Research Gap

Eventually, the proposition idea of Royal HaskoningDHV would be to create an integration platform that serves a mediator to integrate booking and payment of air- and public transport tickets. As a result, travellers normally booking an airline ticket for airport-to-airport travel, would then be able to buy an integrated ticket involving air- and public transport for travelling from origin to end destination. This research should further explain how to make this platform feasible and desirable to operate on for example which parties are involved and which governmental aspects need to be considered. In the evolving digital era, an application to assist the integration platform for relevant trip information provided towards the end-user will be discussed as well.

The research questions that are used to solve the research gap introduced in this thesis are divided into a main question and sub questions. Main question: *'To what extent is it feasible and desirable to integrate booking and payment for air transport and public transport tickets for first/last mile destination orientated airport trips?'*

Sub questions:

1. How are door-to-door trips involving air transport for travellers provided? How does the supply chain look like?
2. Which stakeholders are of importance in integrating booking and payment of air- and public transport tickets? What are requirements/wishes of these stakeholders?
3. What are preferences for travellers in deciding their first/last mile airport trips? Would integrating booking and payment be feasible and desirable for them? How large is the demand?
4. To what extent do legislative matters for various countries influence the feasibility and desirability of this integration? How does competition between mutual public transport providers, and public transport and other transport modes play a role?
5. Which factors can be identified from used case studies, a stakeholder analysis, literature review and a survey that lead to a general conceptual framework for integrating booking and payment for air- and public transport tickets?

6. In what way/which ways can an integration of booking and payment be economically beneficial and attractive for end users and other stakeholders? What might be perceived barriers?

Regarding the scope of this research, ideally would be to research if the booking and payment integration is feasible and desirable on a worldwide scale. Due to the high complexity and high amounts of involvements, this is assumed to be impossible. Though to attempt to come up with a general framework with important factors with this integration for worldwide usage, during this thesis the use of case studies will be conducted. In this research the case studies will relate to countries in Europe and thereby a selection of the biggest airports in the continent. The four biggest airports in Europe (2019) are London Heathrow, Paris Charles du Gaulle, Amsterdam Schiphol Airport and Frankfurt am Main Airport (List of busiest airports in Europe, 2020). For this research, only the link between air transport and local public transport will be examined. Another argument might identify that international rail may have similarities with aviation being the most prominent part of the total journey, but this falls out of the scope of this research.

The following scheme shows the methodology that is used to solve the sub questions in this thesis. The numbers shown in the scheme correspond with the number of the sub question in this research, which therefore link towards the method that is going to be used for solving the sub questions. Abbreviations of the airports taken into account in this research are stated above the methods in the scheme to indicate that the case studies are used for a specific sub question. Furthermore, text on the arrows indicate which input is generated for the two last follow up questions. A literature review, interviews, a travellers survey and other methods are used in this thesis. Eventually, a conceptual framework that captures the important factors that play a role in the feasibility and desirability of integrating booking and payment of air- and public transport tickets is made, and a business model canvas is set up to see how the integration platform can be success economically.

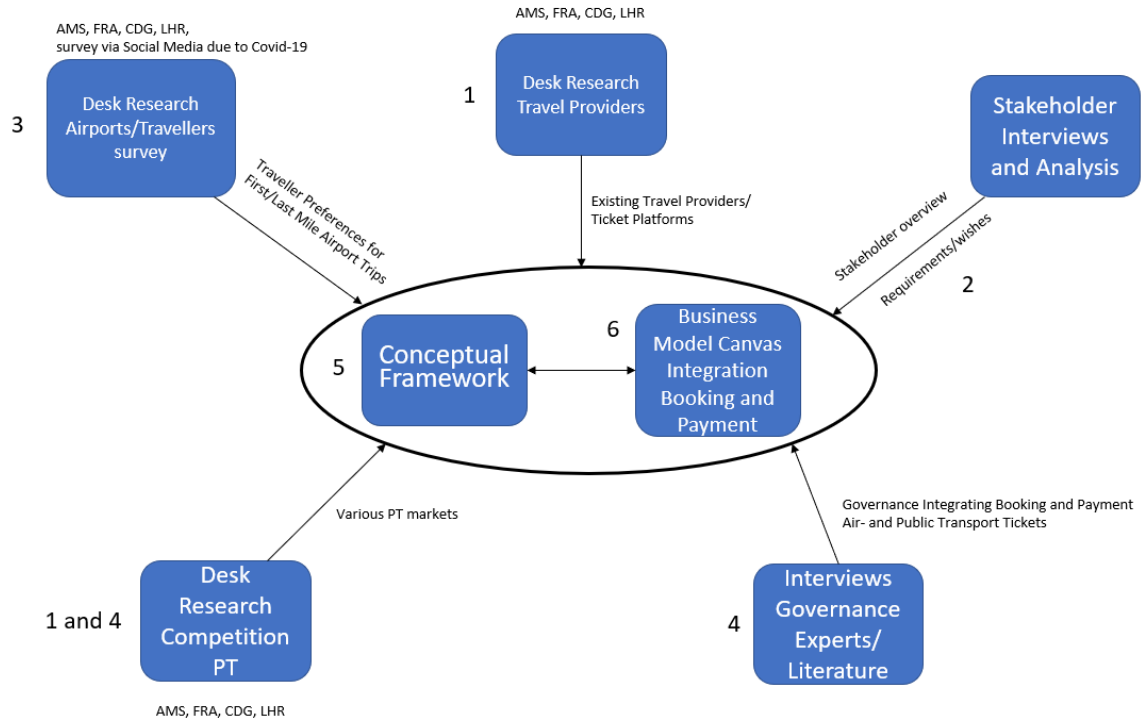


Figure 4 Methodology

Sub question 1: 'How are door-to-door trips involving air transport for travellers provided? How does the supply chain look like?'

Beginning chapters in this thesis were dedicated to give an overview of landside transport profiles and access and egress modes at the four major European airports that were taken into account, and the interface between ticket platforms and travellers. At first, it was identified that for the four airports having similar functions as a hub, modal

splits per airport differed from each other. Differences for each airport in general can be a result of various factors that play a role in the modal choice of travellers that are accessing and egressing an airport. These factors can vary from cultural transport habits to the availability of certain facilities such as a train station at the airport for example, or the public transport network's size.

Furthermore, for each of the airports considered in this research an analysis was conducted on the available public transport options and relevant ticketing, and the presence and popularity of other transport modes. Concluded would be that at the four airports, public transportation options are highly available. The conclusion can be made that popularity of transport modes for the first/last mile trips to/from an airport highly depend on how the airports are facilitated in their transport options. Examples are available ticketing throughout the airports and the magnitude of parking costs, which had an influence on the modal splits at the four airports in the scope. Therefore, emphasizing on public transport facilities leads to more usage of public transport, indicated from the modal split analysis in this research.

Other travel providers, such as travel agencies and ticket platforms play a role in the travel provision for travellers as well. Various business models were identified, which has an influence on how tickets are sold and how revenues are obtained by these ticket platforms. For the potential implementation of an integration platform for integrating booking and payment of air- and public transport tickets, these business models should be considered as these determine how these integrated tickets would be sold, either in batches, directly or via a commission.

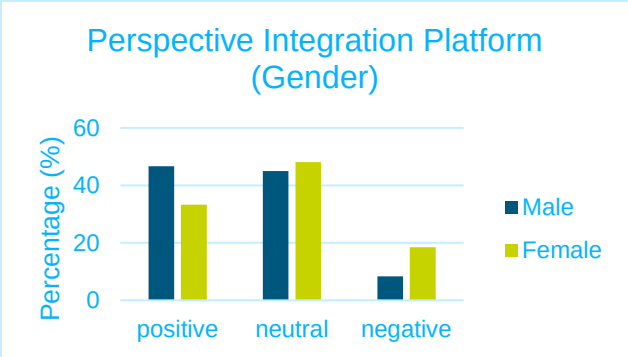
Sub question 2: 'Which stakeholders are of importance in integrating booking and payment of air- and public transport tickets? What are requirements/wishes of these stakeholders?'
In this complex topic, there are stakeholders that play a role for the feasibility and desirability of the integration platform of air- and public transport tickets. These are:

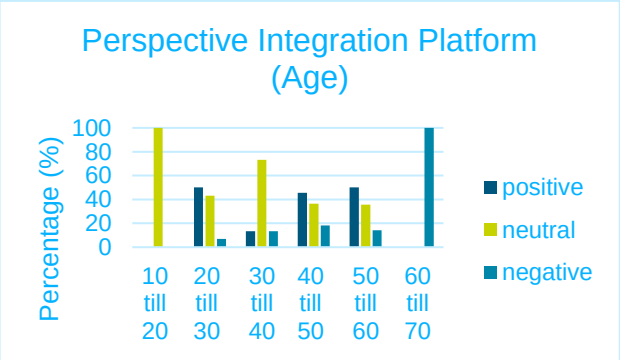
- Airliners
- Public transport companies
- Governmental bodies
- Travellers
- Travel agencies/ticket platforms
- Mobility companies
- Airport authorities
- Taxi companies
- Car rental companies

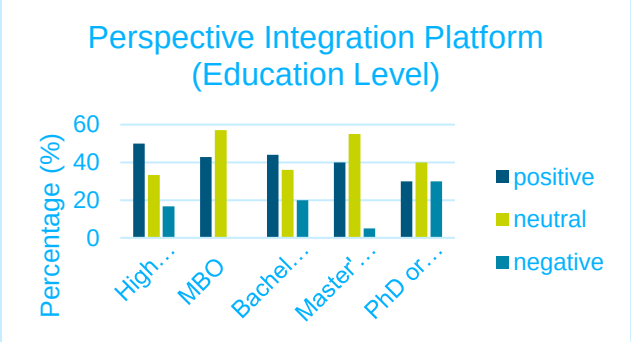
Each of these stakeholders were analysed in detail and requirements/wishes of each were identified. These varied from economic benefits to customer satisfaction, which all lead to a list of factors that are of importance, which were later on implemented in the conceptual framework. The stakeholders were also analysed on importance with the use of a power-interest and a problem-frame diagram. Concluded was that the direct parties, which are the airliners and public transport operators, and the airport authorities need to be considered the most for the success of the integration platform.

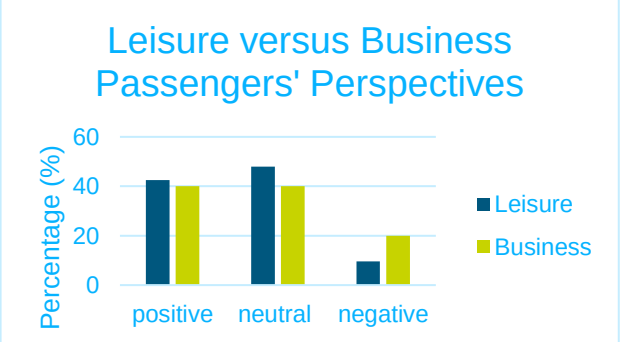
Sub question 3: 'What are preferences for travellers in deciding their first/last mile airport trips? Would integrating booking and payment be feasible and desirable for them? How large is the demand?'
For this specific research, a survey was handed out to identify preferences and the potential demand for integrating booking and payment of air- and public transport tickets. The main expectation for this survey was that the integration platform would significantly increase the potential usage of public transport to/from airports and therefore a significant interest to use the integration platform. The survey contained questions about this modal choice, experiences with public transport, the potential integration platform and general characteristic questions of the respondent. Due to the Covid-19 pandemic, the survey was handed out via social media platform, which led to not being able to control the respondent types and therefore no weight out groups. This was taken into account throughout the analysis.

The analysis on the survey responses consisted a few main findings. At first, a positive difference was indicated with the overall likeliness of respondents to make use of public transport with an integration platform. However, a statistical t-test showed that the difference was not statistically significant, meaning that the difference with integration platform was not convincing enough to guarantee success of a integration platform. However an in-depth analysis was aimed to find groups that might have potential for the platform, which was based on the survey sample. This led to the observations that it seems that male travellers prefer the platform slightly more than women, leisure travellers are more keen on using the integration platform than business travellers, young travellers (20-30 years old) show the most potential, and that high educated people give the most positive feedback on the platform. These results are shown in the following graphs.









Preferences in travelling can highly differ between individuals, which was also indicated through the peer review interviews that were taken after the survey. Another observation was that the integration platform might be interpreted differently by individuals as well. All of the findings of the survey give a small overview of what the demand of and/or the volume the platform could be, but cannot be fully confirmed due to the lack of fully convincing feedback.

Sub question 4: '*To what extent do legislative matters for various countries influence the feasibility and desirability of this integration? How does competition between mutual public transport providers, and public transport and other transport modes play a role?'*

Governance does play an important role in the feasibility and desirability of integrating booking and payment of air- and public transport tickets. For this topic, governance for public transport and aviation were considered. Most important from the public transport side would be the ticketing and fare setting regime. This namely determines to what extent third parties can be involved in selling the integrating tickets. The assumption is that a competitive tendering with governmental provision character of the public transport governance in a country would be most promising for the integration platform, as through tendering governmental bodies can control the ticketing regime. An open access regime in a country often leads to monopolies on public transport networks and therefore on ticketing as well, with Deutsche Bahn as an example.

Aviation governance has been characterised by deregulation and privatization over the last years, which have led to a continuous growth in air travel. The hypothesis thereby is that more national orientated airports would pay more attention to its surroundings than hub airports, and so an emphasis on public transport links with the airport would be made more important. From the airliner side, ownership perspectives and the willingness to improve their service on landside accessibility play a role on the successfulness of the integration platform. Links between air- and public transport already exist, but more on long distance however. Linking air transport with local public transport is assumed to be more complex and give more resistances with respect to contracting and attractive involvement of the essential parties, airliners and public transport operators.

Sub question 5: '*Which factors can be identified from used case studies, a stakeholder analysis, literature review and a survey that lead to a general conceptual framework for integrating booking and payment for air- and public transport tickets?'*

The research methods that were used led to results from which important factors were identified to judge the feasibility and desirability of integrating booking and payment of air- and public transport tickets. Factors were divided from being retrieved from the stakeholders, and the survey, literature study and interviews combined. From the stakeholder analysis, the following factors were obtained:

- Economic benefits
- Customer satisfaction
- Transport culture
- Service economy
- Environmental goals
- Collaboration contracting
- Airport conditions

Between the factors that were found from the stakeholders analysis and the other research methods, overlap between both was ascertained, although some were not present in one of the two. The framework from the literature study, survey and interviews was displayed as followed:

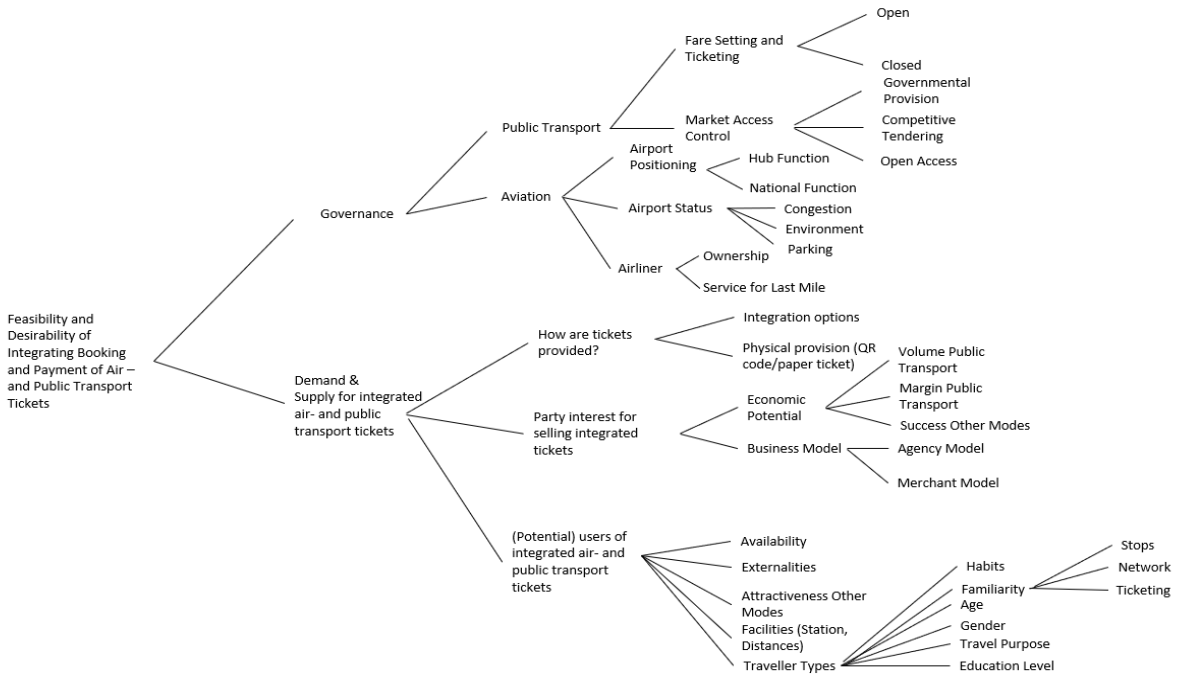


Figure 5 Conceptual Framework

As can be seen, factors were divided into two main groups of factors being related to either governance or demand and supply for integrated air- and public transport tickets. This framework thereby shows an overview of aspects that need to be taken into account when developing the integration platform. It can therefore be used as a

starting point for initiatives willing to invest in a platform and based on the framework decide if the overall situation where the integration platform can be feasible and desirable. Judgement can then be made by following the important factors, which thereby partly functions as a checklist to incorporate all relevant elements. The number of present factors that play a role is extensive, meaning that the feasibility and desirability of the integration depend on a high amount of conditions. Moreover, these conditions mostly need to fall into place all at once, possibly explaining why parties have not yet implemented public transport ticketing in their airline ticket sales.

Sub question 6: 'In what way/which ways can an integration of booking and payment be economically beneficial and attractive for end users and other stakeholders? What might be perceived barriers?'
In order to understand the implications regarding economic feasibility and attractiveness of the integration platform, a business model canvas was designed. This canvas showed nine building blocks that described which elements the platform should consist to eventually fulfil the overall value proposition. The left side represented the key partners that are needed, such as the airliners, public transport operators, ticket platforms and IT companies. Key activities were described on how these key partners need to be convinced on collaborating and key resources described the physical and human resources that are needed for making the integration platform feasible. On the right side of the canvas, customer relationships were described on how customers are going to be helped with the value proposition and the channels that are used to reach the customer segment. These named building blocks are supported by the cost structure, which consists of sales costs, contracting costs, development costs and tailoring costs, and the revenue streams that it would generate via commission fees, service fees and application revenues. (The canvas can be seen in appendix E)

The business model canvas displayed a number of steps that need to be taken to get the integration platform to operate. Most exhaustive measure that needs to be taken is collaborating and contracting with relevant key partners for this matter. Hereby, each party has its own factors that play a role in deciding to collaborate or not, where hesitations on the overall feasibility can be questioned by these parties.

To show a market potential, an estimation on revenues per year was made based on the landside O&D passenger volumes on the four airports and the assumptions on the share of passengers that would potentially use the integration platform. Eventually the range of revenues that can be made lie between approximately €700.000 and a little over €2.000.000 (calculations in section 12.10). The presence of potential revenues that could be made on the four airports is substantial, although the specific costs have not been accounted for yet, making it difficult to give a definitive answer on the economic feasibility. On the other side, accounted should be that this scope only handled the four largest airports in Europe, which implies that the potential volume over the whole world is larger. The total volume of air passengers in 2019 was namely 4.5 billion passengers and was growing each year before Covid-19. Advice would be to start with pilots to see if the integration platform can be beneficial, since hereby costs will be determined. The evaluation of the pilot should determine if the costs are outweighed by the revenues obtained.

Technological developments for the future (in 10 years for example) regarding this topic, like payment for public transport trips, need to be highly considered. As has been mentioned, developments on easing payments for example might affect the interest in buying tickets beforehand, as a public transport ride can be simply paid by a credit card. On the other hand, providing the service with an application for wayfinding, timetables etc. can still have an additional value for easing payments by collaborated with these credit card companies.

Main question: 'To what extent is it feasible and desirable to integrate booking and payment for air transport and public transport tickets for first/last mile destination orientated airport trips?'
The overall conclusion is formed by answering the main question of this thesis. It can be said that integrating booking and payment of air- and public transport tickets can be feasible and that certain (shares of) parties think it is or find it desirable.

However when looking at the feasibility of this integration platform, the number of requirements that will be needed to make this integration platform a success is very high and therefore makes it impossible to give a definitive answer.

Furthermore, these requirements/factors that were identified in the conceptual framework and business model canvas mostly need to fall into place all at the same time, which probably would lead to lots of time that still needs to be spend to arrange the full operation of this platform. Another point of attention are the governance regimes of public transport and aviation that need to be taken into account. It was namely identified that these regimes can highly differ for each country and each form, either open or a more governmental provision orientated governance, which eventually has its effect on the feasibility of tickets being sold by third parties. Aviation governance also has its effect on the emphasis of airports and airliners take on landside accessibility via public transportation and therefore improving their services via this route. It can therefore be said that feasibility with respect to governance highly depends on the specific situation where the integration platform should function. A specific scenario therefore needs to be considered explicitly and as a result it can be concluded that a generic integration platform applicable for all is not feasible.

The other main aspect of this research was if this ticket integration would be desirable. A big part in determining this has been the execution of the survey. The survey has been thoroughly analysed and the main conclusions were that over the whole survey panel, the positive likeliness difference in public transport usage with integration platform was not statistically convincing enough. However, the more in depth analysis definitely indicated interest from specific groups, such as young leisure travellers. Eventually, the question would be if this would generate enough volume to reach economic success. This mainly lies in the fact that margins in selling public transport tickets come with low margins. Furthermore, how the public transport market evolves need to be highly considered. Specific technological developments such as the contactless payment at public transport gates, might jeopardise this air- and public transport ticket integration initiative. On the positive side, the survey discovered that the most promising group for this integration platform are young leisure travellers. With the thought of the digital era developing even further, upcoming young leisure travellers might give extra volume to the usage of the integration in for example 10 years, where the current young leisure travellers are already being part of and stick with the concept.

All in all, it would take a sufficient amount of factors falling into place regarding feasibility and desirability to make the booking and payment integration of air- and public transport tickets a success. The research indicates that this is theoretically possible, but the question would be if initiating third parties are willing to take the risk to invest in this integration with all the uncertainties that come with it. Making this integration platform a success will require a lot of time and effort, where possible miscalculations regarding its potential and success are not excluded.

Recommendations for further research

This thesis has led to certain results that could answer the main question of this research. However, there are possibilities for further research regarding this topic. At first, the airports that were taken into account are all part of the largest airports around the world with many facilities and large volumes of passengers per year. It has been described that the four airports have paid significant attention towards public transport connections. It can therefore be said that public transport to/from these airports are already well known among travellers that make use of these airports. Therefore, for another research it would be interesting how the effect of this integration platform concept would be on smaller airports with less facilities regarding public transportation and of which travellers are less familiar with. Factors like these might lead to more positive outcomes on feasibility and desirability of the integration platform and might induce third parties to initiate the integration.

Another element for further research is the traveller survey that was held during this research. Especially due to the appearance of the Covid-19 pandemic, tools to get a representative panel to fill out the survey was lacking. This made drawing conclusions more difficult as the ratio between types of respondents and the number of respondents was not ideal. Therefore for further research, another survey could be held that would be handed out to a larger panel, which is also more weighted out (for example the same amount of women and men, and/or similar age group sizes within the responses). A larger sample size would lead to more reliable conclusions and a chance for more statistical significant differences that are observed within the results. The outcomes of the survey in this research namely already showed high shares for positive/neutral responses towards the integration platform. Additionally, a latent cluster analysis can be used as a more detailed method to identify subgroups within the survey sample that

could really point out the most important groups to achieve success of the integration platform for air- and public transport tickets.

Furthermore, practical recommendations for the industry are present as well. This research was done in collaboration with Royal HaskoningDHV for a potential proposition. Results of this research can be used for illustrating the possibilities with this integration platform and specifically Royal HaskoningDHV can use these results to look for potential collaborations with other mobility parties, public transport operators and airliners. By discussing the results, the relevant parties can be convinced in the potential of the integration platform, with the result of the integration platform becoming operational. The research recommendations that are mentioned in this section can also be a tool to build upon the reasoning and decision-making in that later stadium. Lastly, as this thesis has not identified costs to set up the integration platform, a specific costs study should also be dedicated for this.

Preface

My name is Jerry Schuiling and I am the author of this master thesis about booking and payment integration of air- and public transport tickets. As my study programme is Transport, Infrastructure and Logistics at the TU Delft, this complex topic is very suitable for a thesis with this master's programme. Before I started with TIL, I finished my bachelor's degree in Civil Engineering, also at the TU Delft.

In my search for a master thesis subject, I reached out to my old internship supervisor at Royal HaskoningDHV, which eventually led me to get in contact with Arjan Honingh. He had an idea for a proposition that involves a platform that combines airplane and public transport tickets to ease the trip of travellers. His curiosity had led to the question why this concept has not been implemented at big ticket platforms yet, such as Booking.com and/or Expedia where taxis or hotels contrarily could be booked easily. To research this, Arjan wanted to ask a graduate intern to dive into this topic and therefore the link between Arjan and I was made.

The subject might seem as a simple addition on a website. However, many parties are involved and many subtopics are of importance for this topic, which made this thesis extensive and complex. Thereby, unfortunately the Covid-19 pandamic took place during the process of this thesis, which made some elements more difficult and less accurate. Despite this fact, I managed to answer the research questions and contributed to partly solve a gap in literature and a possible business case. My supervisors Arjan Honingh (Royal HaskoningDHV), Wijnand Veeneman and Niels van Oort (both TU Delft) were there for answering questions from my side and to supervise me on improvement points within the research. Furthermore as chairman, Bart van Arem ensured that the thesis process ran smoothly.

In this way, I would like to thank all my supervisors and chairman for their time and effort in supervising towards this master thesis. I have found the supervision of all my supervisors very helpful and due to them, I was able to get my thesis to a higher level. Furthermore, I would also like to thank the respondents that participated in the travellers' survey. Without them I would have missed an essential part in my research. Also, I want to thank the department of Data & Digital Consultancy at Royal HaskoningDHV for being very welcome to me and letting me make use of their facilities at the office. From this department, I would like to thank Maria Oskina and Shubham Bhusari in particular for their advices they gave me, as they have been a Transport student from the TU Delft as well.

Lastly, I would like to give my thanks towards my friends and family for their supervision and support where needed. My parents were able to give me the right knowledge and especially my father was always there to read through my thesis and to discuss about the content within the report. All the people that have contributed in their way, have led to a complete research.

I wish you lots of pleasure in reading this thesis!

Jerry Schuiling

Amersfoort, 22 June 2020

1 Introduction

1.1 Multimodal Transport Integration involving Aviation

Because of digital transformation being prominent in the mobility sector, new opportunities and challenges arose and new challenges are still arising. An example of an innovation concerns Mobility as a Service, which can be defined as a concept that combines services from various transport modes towards a customised mobility service only using one interface (Alliance, 2017). This customised mobility service can be provided because many stakeholders provide transport services, being public or private.

Studies that have been published in Research in Transportation Business & Management 27 (2018) concerned complications with MaaS relating to the integration of transport services, focus on individual transport needs and interaction via a single interface. Integration of MaaS has been divided into four levels (and with an additional level 0, which stands for no integration) (Sochor, Arby, Karlsson, & Sarasini, 2018).

- Level 1: Integration of information (multimodal travel planners)
- Level 2: Integration of booking and payment (combining multimodal trips towards a single ticket)
- Level 3: Integration of offering the service (bundle subscription based on multimodal mobility services)
- Level 4: Integration of societal goals (having an influence on user behaviour through incentives coming from dynamic data sharing between MaaS operators and transport planning)

In this research, examined will be to what extent multimodal transport is integrated towards a level 2 MaaS integration and so to what extent different transport modes are integrated with respect to booking and payment towards a single ticket. To be more specific, the link between air travel and the first/last mile trip with public transportation will be researched, as Royal HaskoningDHV has identified that in practice, ticket platforms (such as Booking.com or Expedia) do not yet provide this integrated air- and public transport service. These sites already provide services to rent a car or book an airport taxi, but a button to book a public transport ticket is not available. Trends, such as privatization and deregulation giving a continuous growth in air travel, increase volumes of landside traffic travelling to/from airports (Vespermann & Wald, 2011), and so Royal HaskoningDHV sees potential in a business case towards the integration of air- and public transport tickets.

1.2 First/Last Mile and Airport Trips

Several studies have concerned the first/last mile problem within transport. Apparently, the role of first/last mile transit access has not been largely researched within recent literature (Boarnet, Giuliano, Hou, & Shin, 2017). Access and egress of transit services play an important role. Krygsman, Dijst, & Arentze (2004) mention that access/egress time has a high share in the total transit time of a traveller. Martens (2007) on the other hand mentions that better access/egress modes increase the use of transit services. This implies the importance of improving access towards stations/stops.

A study by De Witte, Hollevoet, Dobrudzkes, Hubert, & Macharis (2013) aimed to identify important factors that play a role in modal choice. Eventually, the researches were able to develop a framework that shows the interaction between modal choice and the determinants. Three categories were hereby distinguished, namely socio-demographic indicators, journey characteristic indicators and spatial indicators. In the framework, these indicators are linked with arrows that show interactions and dependecies between them, which thereby contribute to the modal choice. Additional to these three categories, socio-psychological indicators influence how travellers stand towards possible trip options. Examples of these indicators are familiarity, habits, lifestyle and more. The framework is shown in figure 6.

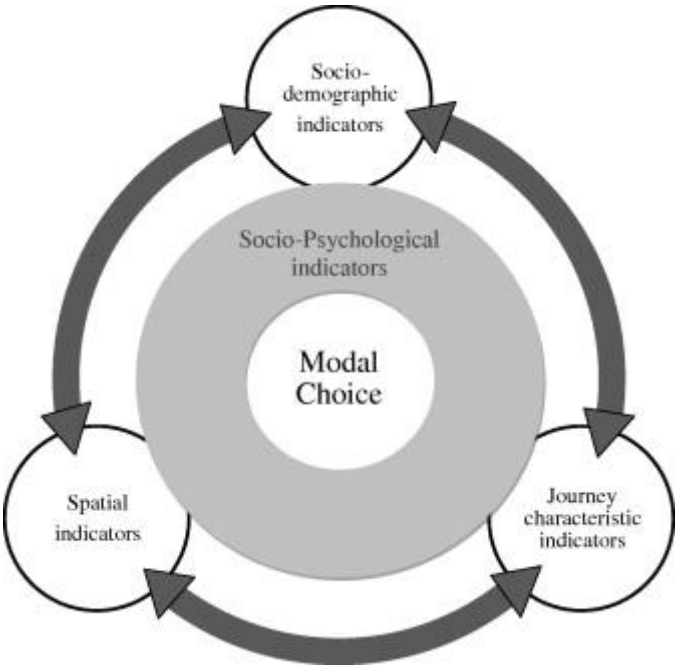


Figure 6 Interaction Modal Choice and Determinants (De Witte, Hollevoet, Dobrudzkes, Hubert, & Macharis, 2013)

Multimodal trips consist of different stages, which implies that various modal choices need to be made. Hereby, the first/last mile trip can be considered as a stage. According to Arentze & Molin (2013), and Yap, Correia, & van Arem (2016), different factors might play a role for each different stage in the multimodal trip. The research of Stam (2019) consisted of a literature review on factors that influence the mode choice for access/egress parts of a multimodal trip. Identified was that factors can be assigned to one of six categories, namely characteristics of the traveller (e.g gender, age, driver's license), psychological factors (e.g. attitude, perception), characteristics of the access/egress trip (e.g. distance, trip purpose), characteristics of the access/egress modes (travel time, costs, level of service), characteristics of the built environment (diversity, density) and main stage factors (e.g. travel time main mode). Stam (2019) thereby came up with a framework that displays modal choice for access/egress.

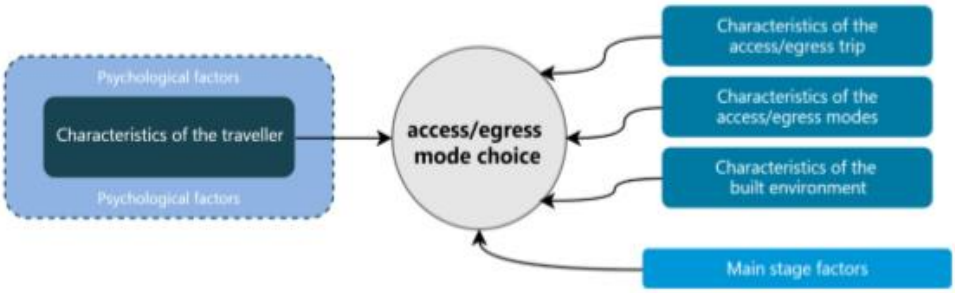


Figure 7 Access/egress mode choice framework (Stam, 2019)

With respect to the supply of transport for first/last mile trips, Franckx & Mayeres (2015) identified that three major game changers influences the supply side of mobility in the near future. One of them is the rise of shared economy. Carsharing, bikesharing, scooter sharing, individual on-demand ride services, collective on-demand ride services and ridesharing are part of this concept. The two other trend that Franckx & Mayeres (2015) mention are the additional technologies towards automated mobility and improvements of electric mobility. Noticeable is that Francx & Mayeres (2015) do not mention integrated mobility.

A paper by (Matheys, et al., 2008) described the last mile airport problem with Brussels Airport. The airport is surrounded with a ring road and so private vehicles having the highest share for the last mile airport trips. With the

back then prospected growth of Brussels Airport in the future and the lack of capacity of public transport to/from the airport, the main recommendation was the improve public transport lines. Further literature in chapter 4 show other emphasis of certain airports on improving landside transportation with public transport. This shows that airports are willing to invest in public transport solutions.

1.3 Research Gap

The total door to door trip of a traveller does not start or finish at the airport, which implies that the speed of air transport is seen as the most important part of the journey. This then is being reduced by the landside part of the whole trip. It influences competitiveness of an airport and air transport, with a higher share of influence to short haul trips (Badanik, Stefanik, & Matas, 2011). The authors mention that the total travel time of a door to door trip is one of the most important factors in choosing a transport mode for accessing and egressing an airport. Badanik, Stefanik & Matas (2011) however also mention that airport competitiveness is not the only factor that impacts links for accessing and egressing an airport. According to them, the size of the airport's catchment area, its finances, operations and capacity of the terminals and the environment are also important factors. Although the fact that this is given, landside access towards an airport is often still underestimated.

Most of today's airports, especially in Europe, US and Canada, have terminals that are designed in a way to be able to accommodate passenger arrivals or departures with taxi, shuttle bus or private car (Vespermann & Wald, 2011). So hereby with increasing urban expansion and the trend of growth in air travel, connectivity of airports with other modes of transport has become more important in order to disburden the road networks. Especially European and major Asian airports adopted intermodality in order to tackle this problem. Smaller Asian and North American airports however, do not adopt intermodal integration often.

Advanced Traveller Information Services (ATIS) can be used to get pre-trip public transport information for deciding the mode of transport to take, often between public transport or private car (Farag & Lyons, 2012). Air passengers also make use of these services in a sense that this group decides on which transport mode to take to/from an airport. The group of air passengers can be distinguished into four different groups: resident and non-resident business, and resident and non-resident leisure (Schabas, 2013). These passenger types give insights on their origin/destination, willingness to pay and quality of service. A study on regional air services compared the willingness to pay in the value of travel time savings between leisure and business travellers (Merkert & Beck, 2017). Apparently, with regional air services the willingness to pay is higher for business travel compared to leisure travel. In this study, regional air services were compared to private car. These results therefore does not represent larger distance trips.

According to Sharaby & Shiftan (2012), high quality, integrated and accessible transit services are of high importances to convert travelers from private towards public transport modes. Sharaby & Shiftan (2012) proved the positive effect of fare integration of public transport in their case study of the city of Haifa. The integration namely led to an increase up to 25 % over the first year. Furthermore, IT tools are seen as essential for integrating public transport services (Lubieniecka-Kocón, Kos, Kosobucki, & Urbanek, 2013). Air and high speed rail integration has been compared with air – air connections. Hereby in the study of Román & Martín (2014), it was found that fare integration is highly valued as well in the case of integrating air and high speed rail.

With these findings, a small desk research has been executed to what extent integrations have been applied into ticket platform websites. Two examples have been given being Booking.com and KLM.com.

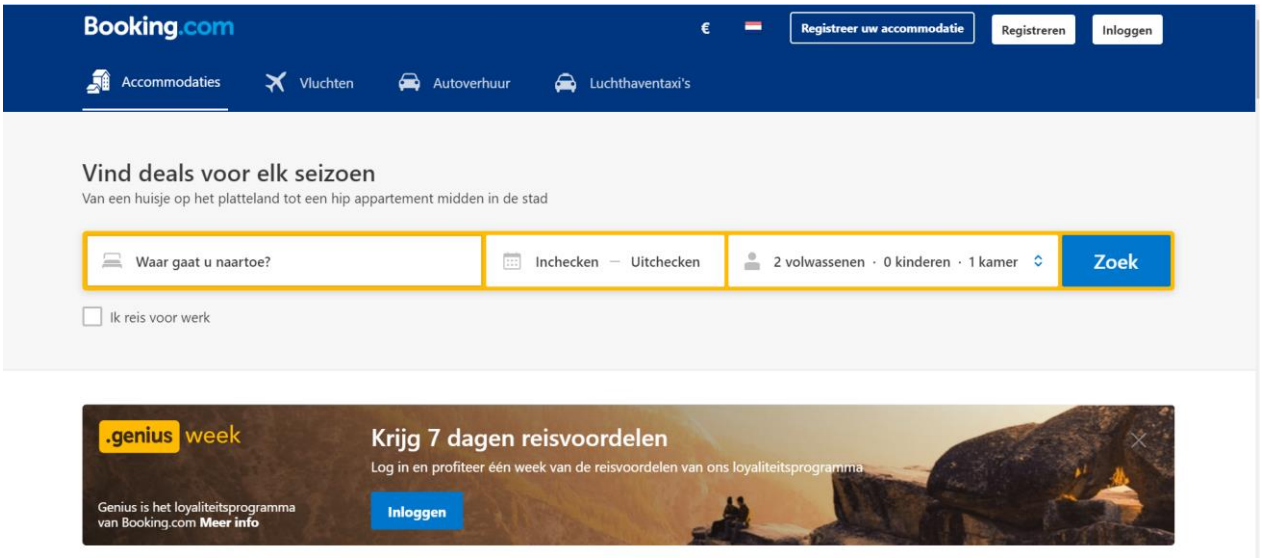


Figure 8 Booking.com

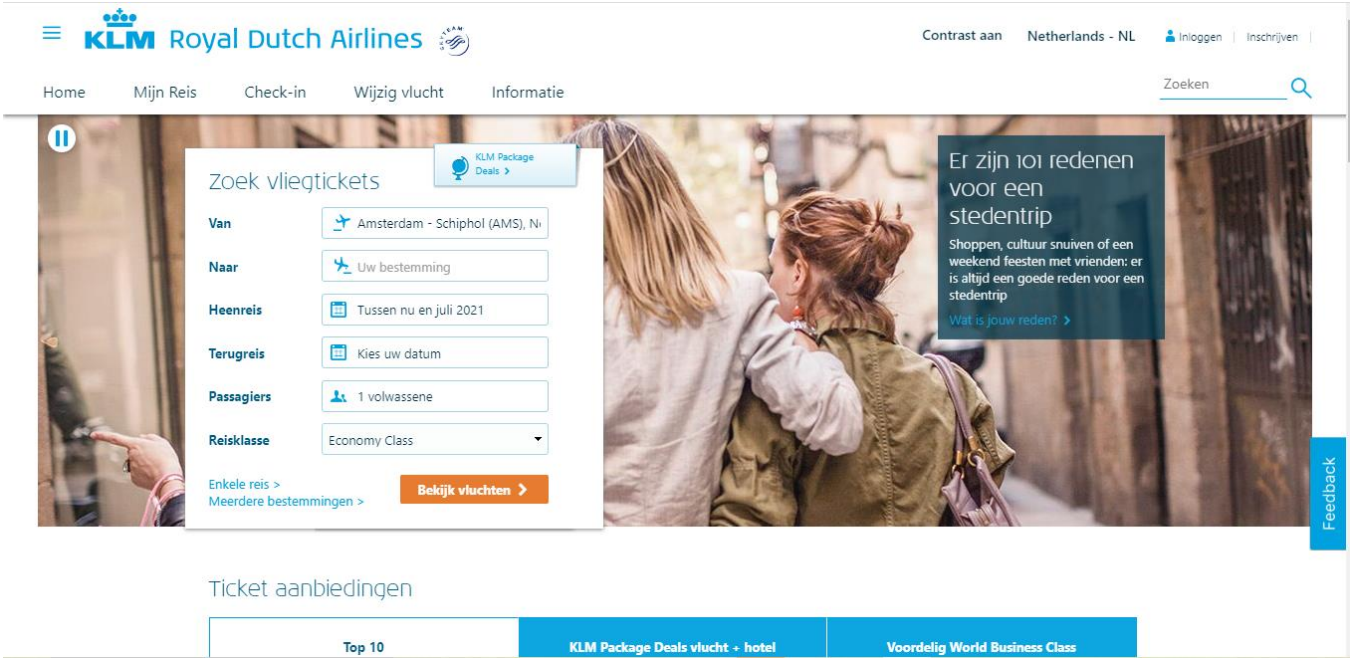


Figure 9 KLM.com

As can be seen in figure 8 and 9, ticket platforms offer extensions besides selling airplane tickets. Extensions may vary from serving accommodations such as hotels, airport taxis and car rental. With beforementioned discussions about public transport, it is notable that public transport has not yet been seen as an extension on these ticket platforms. Some projects have explored the multimodal trip involving air- and public transport, such as DORA (Baumgartner, Kätker, & Tura, 2016) with the aim to integrate air- and public transport. A pilot was held between Berlin and Palma de Mallorca and is described in Appendix B.

Given these findings from literature, it can be concluded that fare integration is valued by travellers. Furthermore, it has been found that DORA provided a solution for the information gap towards travellers willing to use public transport for first/last mile airport trips. However, the integration of booking and payment for air- and public transport tickets is lacking. Researches have yet tried to identify if travellers would be interested in a combination ticket of air-

and public transport. In this way, a barrier of putting an effort in to buy a public transport ticket in an unknown, foreign country may be solved. Passengers might therefore dodge the problem of finding the right ticket machines, lack of knowledge of public transport at their destination, probably paying a high amount of money for a taxi, unclear language on ticket machines for buying tickets and so on. All of these examples have the potential to improve the overall customer journey of travellers by creating the option to book a public transport ticket from home. Since airports are seen as a gateway and a strategic engine of economic development (Vanoutrive, 2019), the question arises why this has not yet been implemented.

The integration of booking and payment of these tickets have to be judged on desirability, which corresponds to the demand of the system. Are there specific flows and numbers of passengers and/or types of traveller (leisure or business) which makes this integration desirable? On the other hand, literature has yet discovered feasibility of a certain integration. This would correspond more towards stakeholder interests and power, markets and governance. Could integrating booking and payment of air- and public transport differ across different countries? Figure 10 shows an overview of the total multimodal trip that is taken into account, where the emphasis will be made to the public transport trip at the 'foreign' destination. It has namely been assumed that public transport trips in the traveller's resident area is known by the end user.

Figure 10 Overview Trip Consideration in Research Gap

Eventually, the proposition idea of Royal HaskoningDHV would be to create an integration platform that serves as a mediator to integrate booking and payment of air- and public transport tickets. As a result, travellers normally booking an airline ticket for airport-to-airport travel, would then be able to buy an integrated ticket involving air- and public transport for travelling from origin to end destination. This research should further explain how to make this platform feasible and desirable to operate on for example which parties are involved and which governmental aspects need to be considered. In the evolving digital era, an application to assist the integration platform for relevant trip information provided towards the end-user will be discussed as well. The platform can be illustrated as followed.

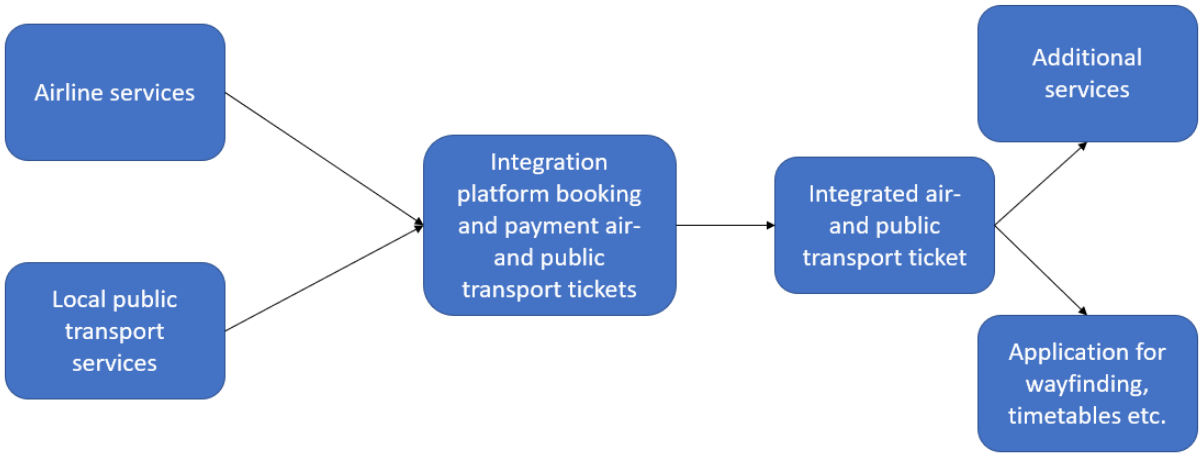


Figure 11 Integration platform booking and payment air- and public transport tickets

The main goal with this platform is to ease the trip of (unknown/unfamiliar) travellers by giving them the opportunity to book their last mile public transport trip from home. An integrated ticket will therefore be provided that gives permission to use the specific public transportation mode from the airport to the specific end-destination. Additionally, as has been said an application will be provided and further services linked towards this platform, such as facilities within the airport hall or public transport stop/station, can hereby be provided. With this platform, not only travellers might benefit, but also the public transport operator by possibly generating more interest from the available platform for these modes of transport. This thesis therefore contributes to the gap in literature to identify the feasibility and desirability of this integration platform, the demand that travellers would have for this integration and furthermore this research will be used by Royal HaskoningDHV to decide whether to invest in developing this integration platform for booking and payment of air- and public transport tickets and judge if a legit business case is present.

1.4 Reading Guide

This report starts with the explanation of the research questions for solving the research gap and the methodologies that are going to be used. Chapter 2 and 3 are dedicated to these matters. Followed by those two chapters, a literature review on what has already been researched regarding integrating air- and public transport tickets and the relevant sub questions is given in chapter 4. Chapter 5 gives insights in revealed data on traveller profiles for four major European airports. A survey analysis on traveller preferences regarding integrating air- and public transport tickets is described in chapter 6. Chapter 7 is dedicated to the ticket platforms and how these interfere with travellers and other parties. Business models are explained in this chapter as well. In the following chapter, an overview of the relevant stakeholders is given with an assessment on how these stakeholders play a role. Chapter 9 gives an overview of relevant governmental findings related to this research. Resulting from the research that has been done, a conceptual framework is created, which displays the most important factors that play a role in the feasibility and desirability of the integration platform for air- and public transport tickets. This framework is shown in chapter 10. Another method that is applied to this research is the business model canvas that especially describes the economic feasibility of the integration platform, which is stated in chapter 11. Chapters 12 and 13 are dedicated to the conclusions of this research and the discussion of the results and conclusions.

2 Research questions

In order to find answers to the research gap, research questions have been derived. The main aim of this thesis is to examine the feasibility and desirability of this booking and payment integration between public transport and air transport. This research may thereby be an input for the start of building a platform towards the booking and payment integration of a single ticket of air transport and public transport for the first/last mile. The main question for this research is therefore:

'To what extent is it feasible and desirable to integrate booking and payment for air transport and public transport tickets for first/last mile destination orientated airport trips?'

2.1 Sub questions

In order to support the final answer towards the main research question, sub questions have been designed to do so.

1. How are door-to-door trips involving air transport for travellers provided? How does the supply chain look like?
2. Which stakeholders are of importance in integrating booking and payment of air- and public transport tickets? What are requirements/wishes of these stakeholders?
3. What are preferences for travellers in deciding their first/last mile airport trips? Would integrating booking and payment be feasible and desirable for them? How large is the demand?
4. To what extent do legislative matters for various countries influence the feasibility and desirability of this integration? How does competition between mutual public transport providers, and public transport and other transport modes play a role?
5. Which factors can be identified from used case studies, a stakeholder analysis, literature review and a survey that lead to a general conceptual framework for integrating booking and payment for air- and public transport tickets?
6. In what way/which ways can an integration of booking and payment be economically beneficial and attractive for end users and other stakeholders? What might be perceived barriers?

2.2 Research scope

Regarding the scope of this research, ideally would be to research if the booking and payment integration is feasible and desirable on a worldwide scale. Due to the high complexity and high amounts of involvements, this is assumed to be impossible. Though to attempt to come up with a general framework with important factors with this integration for worldwide usage, during this thesis the use of case studies will be conducted. In this research the case studies will relate to countries in Europe and thereby a selection of the biggest airports in the continent. The four biggest airports in Europe (2019) are London Heathrow, Paris Charles du Gaulle, Amsterdam Schiphol Airport and Frankfurt am Main Airport (List of busiest airports in Europe, 2020). For this research, only the link between air transport and local public transport will be examined. Another argument might identify that international rail may have similarities with aviation being the most prominent part of the total journey, but this falls out of the scope of this research.

3 Methodology

The methodology provides guidelines for answering the research questions. Therefore, choosing the right methodology for every sub question is essential. It might be the case that more than one method is needed to fully cover a subject within the main question.

With the main question of this thesis implying that a research will be conducted to identify the feasibility and desirability for a booking and payment integration of air- and public transport tickets, the end goal will be to come up with a conceptual framework that describes the most important factors that play a role with such an integration and a Business Model Canvas on how the integration can be economically beneficial. The approach to lead to a conceptual framework and suitable Business Model Canvas for the integration will be described. Figure 12 displays stakeholder interactions in this case.

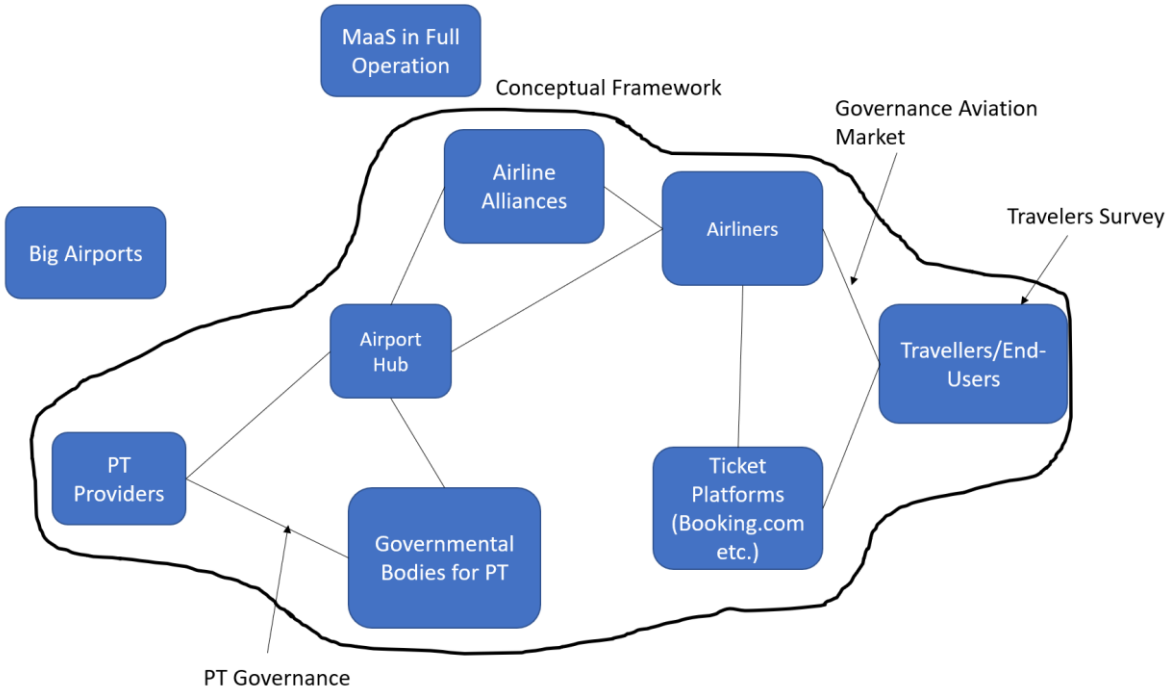


Figure 12 Stakeholder Interactions Booking and Payment Integration

Figure 12 shows various interactions between different role players within the framework. The diagram shows links between the role players, beginning on the right side with the traveller. These travellers have the choice to either book their ticket via a booking platform, such as Booking.com or Skyscanner, or directly via an airliner. Thereby the tickets provided by the ticket platforms have been purchased at the airliners as well, which also presents an interaction. Thereafter, airliners often also link towards an airline alliance, which is assumed to have a low influence on integrating tickets. The interaction between airliners and the airport hub is seen as the connection from air – and public transport tickets. Public transport providers and governmental bodies influencing public transport, interact within a triangular way.

As an input for the traveller preferences a desk research/survey will be held. Interactions between travellers and airliners, and Public transport Providers and Governmental bodies will be described by conducting a literature study. Both methods will be explained in more detail further on in this section. The conceptual framework firstly will provide factors for implementing the integration for the four mentioned airports mentioned in section 2.2. This explains that the box with big airports does not fall within the conceptual framework, because this box represents big airports over the world. Eventually, with obtained knowledge from the case studies, a general conceptual framework with

aspects and factors will be designed for general application. An assumption that Mobility as a Service will be in full operation in the future is kept outside the framework and scope as well, as this would imply that a general MaaS platform would provide a full solution already. This is not the case in the present situation.

The following scheme shows the methodology that is used to solve the sub questions in this thesis. The numbers shown in the scheme correspond with the number of the sub question in this research, which therefore link towards the method that is going to be used for solving the sub questions. Abbreviations of the airports taken into account in this research are stated above the methods in the scheme to indicate that the case studies are used for a specific sub question. Furthermore, text on the arrows indicate which input is generated for the two last follow up questions. A literature review, interviews, a travellers survey and other methods are used in this thesis. Eventually, a conceptual framework that captures the important factors that play a role in the feasibility and desirability of integrating booking and payment of air- and public transport tickets is made, and a business model canvas is set up to see how the integration platform can be success economically.

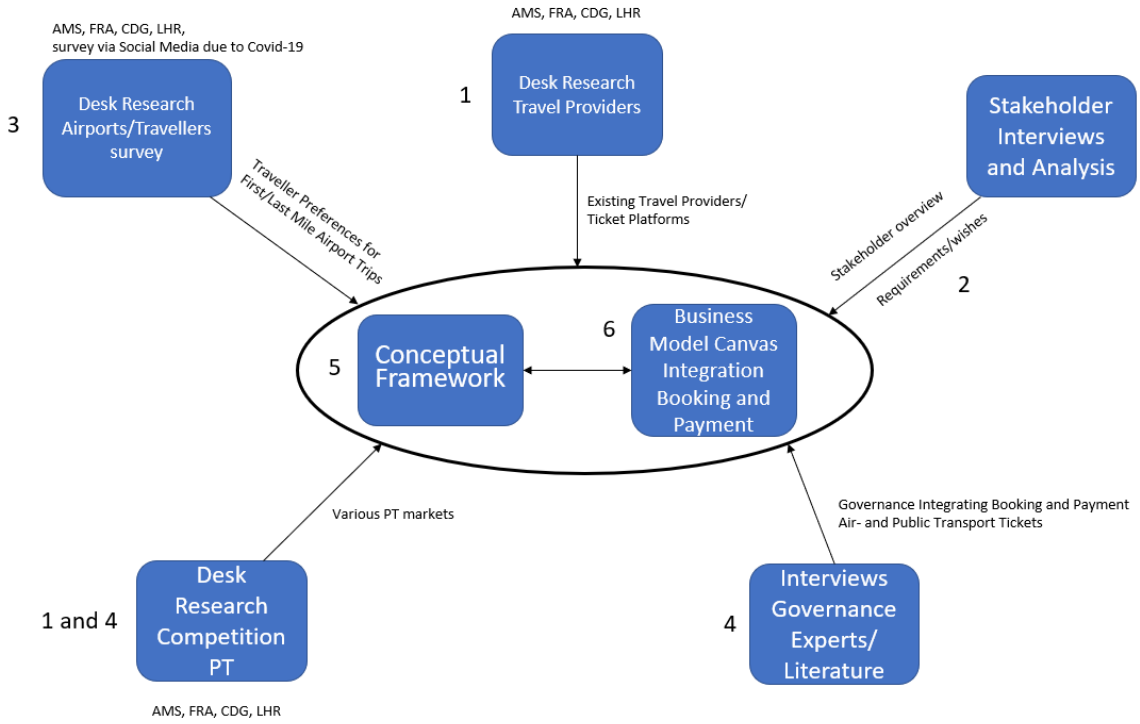


Figure 13 Methodology

The first essential step is a desk research on travel providers, which should identify the way these provide door-to-door trips to travellers. Essential for this desk research is to find out how existing trip providers set up their ticketing services and thereby in which way they provide their customers. To get more insights on this, besides the desk research also interviews with specific companies will be held. An example of a company is Tranzer, which is a MaaS developer in The Netherlands. Getting insights on how their working approach looks like, will be used as an input for the conceptual framework. These providers and trip information providers will therefore be compared with each other and the framework will thereby need to identify how to cope with the differences.

Identifying the stakeholders for this booking and payment is essential. A stakeholder analysis should hereby be conducted to identify important parties and clarifying their viewpoints, wishes and requirements with this potential integration. Attempted will be to interview these stakeholders. Furthermore, stakeholders will be placed in a power-interest diagram to point out the importance of stakeholders. It will thereby distinguish which stakeholders need to be monitored only, keep these informed or satisfied, or manage them closely. To find out supporters and opposites

for the integration, a problem-frame stakeholder map will be used. All four airports will be evaluated on these diagrams.

A part of this research is finding out what preferences are from travellers for first/last mile airport trips and as a result identifying how this corresponds with the various types of travellers is essential. In this manner, a part of the feasibility of the booking and payment integration is examined. Sub question 3, which relates to preferences of travellers for first/last mile, will be examined through a survey via social media platforms, specifically being LinkedIn pages of the researcher and supervisors. Facebook will also be used as a medium, especially for capturing leisure travellers. A desk research on all airports will reveal passenger number and statistics on travelling to/from the airport. Annual reports will be used in this case, where airports present their yearly results on revenues etc. The online survey will consist of questions on what kind of trip the traveller is making, how they would normally plan their first/last mile airport trips and what their opinions are on integrating air- and public transport tickets. Results will be retrieved via Survey Monkey, which is used via a subscription of Royal HaskoningDHV. The application gathers responses, which after that can be put in Excel sheets for further analysis.

Imaginable is that legislation/governance has an impact on integrating booking and payment for air- and public transport tickets. Since public transport is often subsidised by the governments of a country, complications regarding these legislative matters might be present (Radiuz, 2019). To find relevant information corresponding with the governance of public transport and aviation, experts on these fields will be interviewed. Firstly, current practices will be asked in this interview and how these are applicable in the case of integrating air- and public transport tickets. Last questions would relate towards the integration itself. All findings could be complemented by additional literature review on policy implications, MaaS Journal articles and journal articles on governance of public transport and air transport from Scopus and Google Scholar. Besides the interview, literature review can be used to further identify the importance of competition between public transport providers or public transport as a whole with other transport modes and the corresponding governance.

In order to set up the integration of booking and payment of air transport and public transport tickets, as has been mentioned in the beginning of this section, a conceptual framework should be created in order to provide specific steps for setting the system up. Conceptual frameworks support a study in the relevant knowledge bases that serve as a foundation for the importance of the problem states and research questions (Rocco & Plakhotnik, 2009). The conceptual framework should consist various factors that are of importance in setting up the integration of booking and payment of tickets for the mentioned airports in the first place. The result will be a general framework scheme, which will function as a guideline to implement a ticket integration of air – and public transport tickets.

As a tool to check feasibility and desirability of a booking and payment integration air transport and public transport tickets, the Business Model Canvas will be used as well. This model was designed by Alexander Osterwalder and Yves Pigneur (Mulder, 2015). The Business Model Canvas is a graphical representation of variables that are valuable for organizations with the variables being 9 building blocks that are important for the organization. It can be applied for developing a new organization, though it is also applicable to analyse the (business) situation of an existing company/organization. The Business Model Canvas will therefore be used for how a real implementation of this ticket integration can be a success. A specific prototype for business models for Mobility as a Service has been developed (Polydoropoulou et al., 2019). This prototype will be used for this case as inspiration, since a level 2 integration of MaaS is being examined.

4 Literature Review Booking and Payment Integration Air- and Public Transport Tickets

Before proceeding towards approaching the sub questions in this research, relevant literature for each sub question will be consulted. These references will be taken as a building block towards final answers in this research.

4.1 Traveller Preferences

Demand for Travel

Imaginable would be that traveller preferences influences the feasibility of integrating air- and public transport tickets. Studies have been done with respect to travelling. One of them concerned preferences of leisure travellers (Weaver, McCleary, Han, & Blosser, 2009). The study identified that novelty is a motivating factor when choosing and planning a vacation and corresponding activities. Given this statement, assumed can be that these leisure travellers face the novelty of finding a last mile transport solution. People planning these kinds of trips have been divided into three groups by Taylor (1998). He stated that travellers can be divided into planned travellers (who buy travel packages), independent travellers (who plan their trip themselves) and reluctant travellers (who prefer not to travel).

Increasing mobility of goods and people will lead to people demanding transportation services with a higher level of security, speed, safety, smoothness and comfort (Raga, 2004). Khaerat et al. (2015) identified in a study that a minimum requirement for switching from private to public transport is that the public transport mode should be at least as cheap and fast as the private transport mode.

Public Transport Ticketing

Some literature has been dedicated to research the importance of public transport ticketing. According to Zalar, Uspalyte-Vitkuniene, Rebolj, & Lep (2018), transport ticketing is one of the methods for improving attractiveness of public transport by reducing resistance for passengers. One of the transport ticketing methods is the use of smart cards, where the Oyster Card was a solution for Transport of London at around 2004 (Blythe, 2004). Noticable however is the fact that it is often necessary to stand in queues for charging your smart cards, not solving the same potential problem as the exposure of a queue to buy paper tickets for public transport. Therefore, Chandra, Prakash, & Lamdharia (2013) proposed another ticketing system involving cell phones of a commuter that pays a prepaid or postpaid subscription. Entrance can thereby be granted through phone number recognisation or the use of QR codes or barcodes.

Landside Transport to/from Airports

From a case study of people moving to and from Shanghai Pudong International Airport (Fu, Lin, Niu, & He, 2017), a comparison was made between modal shares of 2005 and 2014. A general observation in China was made that China was at a turning point of a rapid car increase and researchers aimed to identify want the implications would be for landside transportation to/from airports and in this case Shanghai Pudong International Airport in particular. Concluded was that the modal share for car at this airport had increased and the total modal share for public transportation stayed roughly the same. Last observation could, according to the researchers, be explained by the increasing use of a metro service and a decreasing trend of Maglev and bus usage. Again, according to the researchers, public transport services have not yet reached a satisfied level for users, which therefore explained the stable/constant trend related to the positive trend in air traffic of China.

An evaluation on public transport services has been executed on less dense areas have been executed as well. Bergantino, Capurso, & Hess (2020) researched the willingness to use public services to/from main airports in the region of Apulia, Italy. Airports in more densely areas in the region, Bari and Brindisi, were identified to have sufficient accessibility via bus and in the case of the airport of Bari with rail as well. Other popular and dense areas in the region are less accessible via public transport request to re-open more local airports. Therefore the research

tried to identified if improving accessibility via public transportation to these other regions to/from the airports of Bari and Brindisi would appear as a attractive alternative. Researchers of this case study concluded that this can be an attractive alternative in contrast to re-opening inefficient local airports, but that nevetheless the modal share for cars will still be the highest in each scenario that was taken into account.

Main Attributes for Modal Choice to/from Airports

Yazdanpanah & Hosseinlou (2016) executed a literature review on airport access modes and relevant attributes that influence choices made by travellers.

Table 1 Main attributes influencing mode choice to/from airports (Yazdanpanah & Hosseinlou, 2016)

Researchers	Main Attributes
(Pels, Nijkamp, & Rietveld, 2003)	- Fare - Frequency - Access time - Access cost
(Tam, Lam, & Lo, 2010)	- Satisfaction level (latent) - Cost - Time - Party Size - Number of Transfers - Baggage
(Jou, Hensher, & Hsu, 2011)	- Out of vehicle travel time - In vehicle travel time - Overall time-savings - User-friendliness of the mode
(Alhussein, 2011)	- Income - Luggage storage capacity - Travel access time - Nationality
(Koster, Kroes, & Verhoef, 2011)	- Travel time - Trip duration - Flight frequency
(Tsamboulas, Evmorfopoulos, & Moraiti, 2012)	- Total trip cost - Total trip duration - Income - Perception
(Chang Y.-C. , 2013)	- Safety - User-friendliness of the mode - Convenience of storing luggage
(Akar, 2013)	- Reliability - Travel time to airport - Flexibility of departure time - Frequency of service - Lower cost relative to driving - Luggage storage capacity

Table 1 shows a variety of important attributes for travellers making modal choices, where the studies sometimes focussed on specific groups. These were for example employees (Tsamboulas, Evmorfopoulos, & Moraiti, 2012) or elderly air travellers (Chang Y.-C. , 2013). Studies varied in opinion on the importance of cost/price. Pels, Nijkamp & Rietveld (2003) mentioned that access time with accessing airports is more important than access costs, and Jou, Hensher & Hsu (2011) stated that access modes attributes such as luggage storage are of more importance than price. On the other hand, the study of access modes to/from airports in Hong Kong showed that travel cost is the most important attribute. Despite the large variety of factors, booking and/or payment of tickets is not mentioned in this literature.

Conclusion

Concluded from this paragraph can be that traveller preferences are complex, since each individual can highly differ in various aspects. When looking at the specific case of airport access and egress, it is not much different. The usage of cars within this spectrum is assumed to play a significant role, since literature shows that the car is often still favoured over public transportation due to for example their quality levels. Ticketing of public transportation however is aimed to become more digital to avoid obstacles such as travellers standing in a queue for their tickets/smart cards. Table 1 shows the variety of important attributes that influence mode choices to/from airports. Studies from (Fu, Lin, Niu, & He, 2017) and (Bergantino, Capurso, & Hess, 2020) also indicated that geographical aspects play a role for preferences. For this research, the survey and interviews can give an overview of the preferences in this specific case for the four mentioned airports in section 2.2. Related to the integration of booking and payment of air- and public transport tickets, no literature was found that pointed out the importance of these attributes. Concluded therefore can be that this has not been studied yet.

4.2 Door-to-Door Trips involving Air Transport

Landside Transport Policies to/from Airports

With the research question implying a door-to-door trip for travellers, relevant literature around door-to-door trips is being examined. Section 1.2 already mentioned the airport of Brussels were researchers already tried to identify alternatives to disburden the ring road, surrounding the airport (Matheys, et al., 2008). The researchers made use of different scenarios that relate to the passenger growth of the airport. Important to mention is that for door-to-door trips, the only relevant number is the number of O&D passengers that make use of Brussels Airport. These passengers need to access and egress the airport, while transfer passengers only transfer at the airside part of the airport terminal. According to the researchers, scenarios also fluctuated in the share of O&D passengers, which therefore influences the total numbers access/egress passengers.

Within the context of air transport growing over the years, the United Kingdom has adopted a policy to emphasize public transport as the main ground access mode for going to/from airports (Humphreys & Ison, 2005). Researchers therefore have tried to identify differences in ground accesses to/from airports in the UK and Australia (Ison, Merkert, & Mulley, 2014). The researchers identified in their literature review that with ground access of airports, a few problems are central. These problems are the environmental footprint affected by traffic to/from the airport, the fact that both passengers and employees make use of ground access to/from airports, car parking provisions, commercialisation and privatisation of airports that have taken place in the recent periods and what its influence is on ground access to/from airports, and the airport's range of option to deal with the ground access.

For each of the abovementioned problems some notifications can be made. Firstly, it has been mentioned that the environmental footprint of airports is under pressure from the continuous growth in air transport (Ison, Merkert, & Mulley, 2014). Kazda & Caves (2008) thereby however state that one of the reasons is that the impact of ground access is higher than of aircraft movements. 91 % of the total emissions of airports in the UK in 2005 came from road-based journeys ((DIT), 2009), which therefore led to the promotion of public transport. Airport parking as well is complex as these are often non-aeronautical incomes for the airport authority that is not outsourced towards third parties (Ison, Merkert, & Mulley, 2014). Given this, airport authorities might still value parking high, for income and provision of parking spots for passengers and for employees. Privatisation and commercialisation of airports have

led to the popular trend of low cost carriers, which gave people a price incentive to travel a larger distance often to an airport with poor public transport (Budd, Ison, & Ryley, 2011).

Business Models Travel Agencies

Business models in the online travel agency world plays a role in how these agencies create revenue. Various business models can be used, such as the merchant and agency model (Liao, Ye, & Wu, 2017). The researchers mention that online travel agents, such as Expedia.com, Ctrip.com and many more, have developed as online alternatives for traditional channels that hotels used to sell their rooms. Thereby, the main difference between the merchant and agency model is that the merchant model handles buying rooms in this case at a wholesale price and resale these, where the agency model is that a online travel agent asks a commission from hotels for selling their rooms. Liao, Ye & Wu (2017) found that hotel and online travel agencies had four main interactions. Firstly, a hotel contracting with an online travel agent is only profitable if the capacity is large enough in comparison with offline sales channels and the magnitude of online customers being price sensitive towards online platforms. Secondly, hotels under the merchant model will control the wholesale price for optimising their revenue. Also, with the agency model commission rates highly depend on demand and price sensitivities of online travellers. Lastly, hotels with smaller capacities will prefer the agency model, since thereby revenues can be maximised more than handling wholesale prices. Business models of online travel agencies for selling hotel rooms can be assumed comparable with selling airline tickets. Thereby, airliners will consider to mainly sell their tickets directly or via online platforms.

New Developments in Mobility

Tuchen (2019) examined the role of aviation in end-to-end mobility, where she mentions that with the development of new aviation markets and the relevant missions with it, it is important to integrate new entrants, such as MaaS. These need to be integrated into the traditional and evolving transportation networks. The author furthermore mentions that tools such as frameworks are needed to evaluate these integrations and that it requires collaborations between multiple institutions, such as academia, governments and industry.

Conclusion

This paragraph showed that various countries, such as the UK and Australia, implemented policies that support the use of public transportation as access and egress mode to/from airports. This had various reasons, such as parking problems at the airports and the airport's environmental footprint. It was found that the largest part of the airport's emissions in the UK consist of landside transport emissions. The government implemented policies to avoid further deterioration of its airport's environmental footprint. Integrating booking and payment for air- and public transport tickets might contribute to these policies in the future and therefore this could mean that the integration platform can be a success. Furthermore, business models have been introduced which might be applicable for the platform. The merchant and agency model differ in business approach and might therefore influence the willingness of selling integrated tickets for certain parties. Lastly, it has been found that new entrants, such as MaaS are needed in end-to-end mobility. This new integration platform can therefore serve as a new entrant that would contribute to the role of aviation in end-to-end mobility.

4.3 Stakeholders for Integration

Importance Public Transport for Stakeholders

According to Carnell (2003), sustainable development of urban mobility cannot do without a transport system that meets the needs of citizens and businesses, remain socially and economically efficient and make a positive impact on the environment. Hereby, public transport plays an important role. Even with an increasing number in private cars, public transport can play a role as it is crucial for the rapid economical growth and people's welfare (Susniene & Jurkauskas, 2008):

- Citizens' lifes are improved by good functioning of the transport system
- It generates conditions for reaching educational institutions and work in different places
- Creates a highly developed society and allows freedom and opportinuties to travel for everyone
- It generates added value to economic, industrial and service processes

To survive and operate successfully, public transport companies need to consider new management models for their system (Susniene & Jurkauskas, 2008). To gain a strong position in the market, public transport companies need to take external factors into account (Vinck, 2000):

- Political, economical, legal, demographic, technological and social factors that are hard to influence
- Speciffic characteristics of services (privatization, cooperation among companies, self-service (electronic ticketing e.g.))
- Competitive factors of certain transport companies
- Suppliers and passengers that influence relevant factors

Public Transport Value for Stakeholders

For this thesis research, multiple stakeholders will play a role, which can be seen as the influence of multiple stakeholder within a supply chain. All stakeholder often have different objectives, leading to compromised solutions (Cachon & Netessine, 2004). Gao & You (2019) researched behaviour from multiple stakeholders in a supply chain in uncertainty within a decentralized environment, meaning that decision-making goes through various levels. An example of a case study that was chosen considered stakeholders booking flight tickets under uncertain flight delays. Results show that in uncertain conditions, stakeholders tend to choose conservative options. This finding is related to judging feasibility and desirability of the booking and payment integration of air- and public transport tickets, since travellers reaching unfamiliar airports reflects possible uncertain conditions.

Stakeholder Interactions

Issues and needs of multi stakeholder collaboration appear in passenger transport (Bulkeley, et al., 2011), freight transport (Lindholm & Browne, 2013) and in urban planning, where collaboration among stakeholders influences the transport sector as well (Hall, 2014). These researchers distinguish stakeholders into private and public actors, where private actors mainly base their decisions on personal interest and public actors on collective utility to business. Gonzalez-Feliu, Pronello, & Salanova Grau (2018) created an overview of the main stakeholders related to urban transport and their interactions, where the stakeholders categorize themselves as space users.

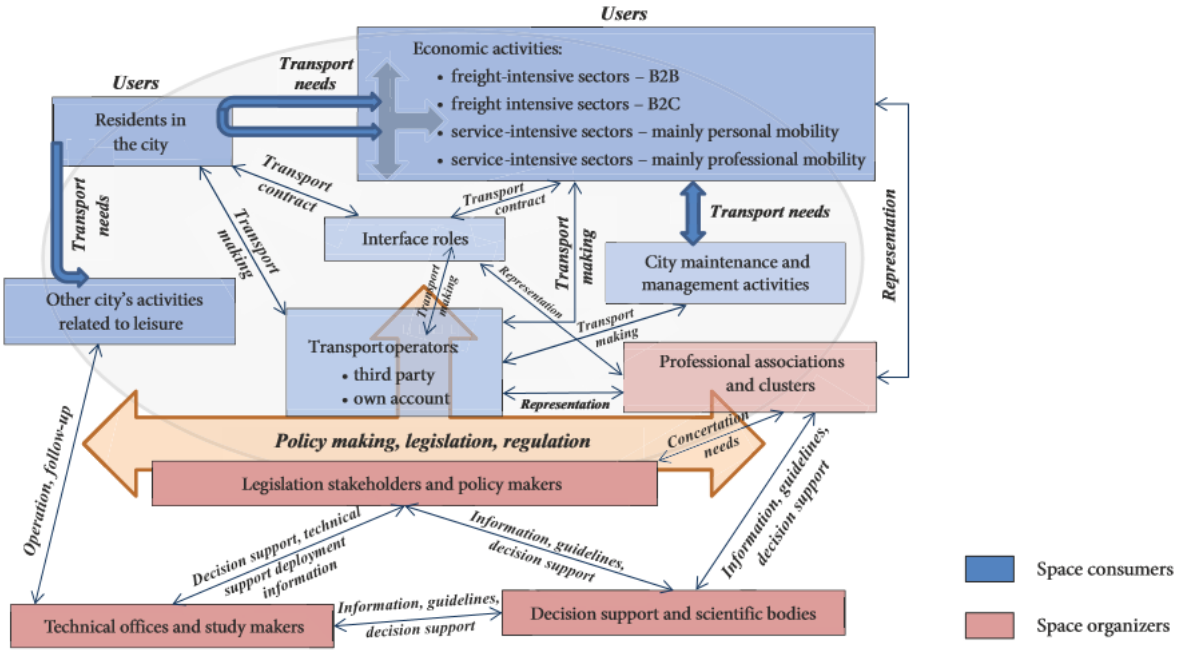


Figure 14 Overview main stakeholders in urban transport and interactions (Gonzalez-Feliu, Pronello & Salanova Grau, 2018)

Trends in tourism have moved towards developing interactive online services, social sharing of visiting information and personalisation of tourism experiences (McCabe, Sharples, & Foster, 2012). The researchers used Scenario-based design to engage diverse tourism stakeholders in collaboration based on product innovation and development. This is done for solving the knowledge gap surrounding new digital solutions in tourism to generate further interest (McCabe, Sharples, & Foster, 2012).

Conclusion

Public transportation can be very important to various stakeholders. It was found that it can have various values for different stakeholders, being for example economic benefits, freedom of travel and improvement of citizens' lifes. The way how stakeholders interact with respect to public transport is complex however. This is mainly due to the high number of stakeholders and the variety of wishes and requirements. For integrating booking and payment of air- and public transport tickets, it is of high importance to get an overview on which stakeholders are relevant and how these interact.

4.4 Governance Public Transport and Aviation

This paragraph describes findings from literature regarding public transport governance and aviation governance. Both parts are split up, where public transportation governance consists of a tendering part and a performance indication part, and aviation governance consists of airline and airport governance.

4.4.1 Public Transport

Open Access versus Competitive Tendering

Within Europe, countries handle various regimes for governing public transport in their country. Hereby, a distinction can be made between market initiatives and competitive tendering (Van de Velde, 1999). Hereby, market initiatives can be illustrated by bus services supply lies in the market, meaning that free entrepreneurs can create new transport services and can do so from requests or specific actions by (transport) authorities. On the other hand, competitive tendering represents a much more regulated path to competition. The transport authority in this case is a monopolistic entrepreneur that takes the initiative to arrange provision of passenger transport services and contracting the independent operators that are chosen via this competitive tendering (Van de Velde, 2014). Van de Velde & Preston (2013) gave policy recommendations on functioning of the various regimes in European countries. It included paying more attention and devising the 'rules of the game', which implies evaluating the network benefits and market failures. Another recommendation was to devise incentivising regulations. Furthermore, making smarter entry rules and evaluating new technologies for approaches makes certain procedures, such as the facilitation of the distinction between ticket integration and fare integration, easier. Lastly, it was observed that there is a bell-shaped relationship between the extent of regulatory prescriptions on market behaviour and the outcome of welfare and other measures.

Van de Velde (2014) mentions two trends that might increase the relevance of deregulated markets in public transport. Firstly, the introduction of new shared mobility types and other transport developments, such as automatic cars, requires rethinking of the general regulatory structure of the transport sector. The other trend is that the credit crisis and budget cuts in the past required public transport systems to become more efficient.

Public Transport Performance

Hischhorn, Veeneman & Van de Velde (2019) assumed before comparing organisations and performance of public transport between metropolitan areas in Europe, Australia and Canada that elements of the organisation of public transport might influence the achievement of before set performance goals. Hischhorn, Veeneman, & Van de Velde (2018) identified six elements of public transport organisations via the use of a worldwide Delphi survey that influence performance indicators modal split and cost-recovery:

- Integration of planning responsibilities within an authority at the metropolitan level
- Policy integration between land-use and transport

- Development of long-term public transport plans
- Availability and stability of public transport funding
- Ticket and fare integration
- Risk allocation strategies

Results of the study of Hischhorn, Veeneman & Van de Velde (2019) advance on the statement that public transport is a complex multifarious system, where technical elements and multiple actors with conflicting and diverse values play a role. Eventually, it was found that model split and cost-recovery depend on an interplay of several conditions, where different conditions might lead to the same result. It was furthermore found that enabling higher modal split highly relates to integration between land use and transport, and integrated planning authority. Higher cost-recovery related more to risk allocation strategies and the method of funding.

4.4.2 Aviation

Airline Governance

Governance in aviation has other dynamics between role players in comparison with governance of public transport. Aviation governance can be split into a division for airline governance and airport governance, where ownership and control are distinguished. In the beginning of this milennium, most countries required substantial ownership of designated national airlines, though the ongoing trend was there where changes in international markets have changed the way to control rights with equity in the airline business (Carney & Dostaler, 2006). A couple reasons were given for the fact for retaining foreign ownership of national airlines. Firstly, officials believed that domestic ownership would promote aspects, such as econmic development, trade and tourism and job preservation (Chang, Williams, & Hsu, 2004). Secondly, national security played an important role for ownership restrictions (Warden, 2003). Lastly, nationalism would imply that national ownership would be more likely to pay attention to national interest and consider local stakeholders (Reich, 1991).
Deregulation, privatization, airline bankrupcies, financial distress, the appearance of new financial investors and instruments, and restructering have influenced airline ownership patterns however (Carney & Dostaler, 2006). Airline ownership thereby according to Carney & Dostaler (2006), carries certain control rights and the firm's governance displays the legal mechanisms and economic incentives through which owners can use their rights.

Airport Governance

On the other hand, ownership and control also play a role in airport governance. Corporatization, privatization and other approaches for commercialization influenced the reform of airport governance structures, which was intended to lead towards benefits to air transport system stakeholders (Carney & Mew, 2003). The researchers thereby concluded that different modes of governance often lead towards trade-offs between stakeholder outcomes. These different governance modes lead to different incentives and constraints that public agents from the aviation sector will bring to the operation of airports.

Airports getting more privatized influences the way of price regulation at airports. Since the UK introduced price cap regulation in 1986, airports in several other countries are being privatized and global airport players are making their presence clear (Gillen, 2011). The introduction of price cap regulation was seen as a method where the regulator could delegate pricing decisions to a firm, but providing it with incentives to increase profit from cost reductions and productivity improvements (Phang, 2016). Phang (2016) furthermore mentions that privatization and deregulation of airlines and airports have led to a massive increase in aviation. Despite these trends, coming up with a general framework for implementing price cap regulation is difficult, since airports are very diverse (size, location etc.). Another effect of deregulation and privatization in aviation, is the rise of low cost airlines, which challenge traditional airlines with a business model with a cost leadership strategy (Alderighi, Nicolini, & Piga, 2016). The researchers thereby researched the method of fare setting of a low cost airline, Ryanair. Their method, unsegmented pricing, characterizes itself as a method that puts tickets in single fare classes. Dynamics of fare setting depended on two components, namely on time (days before departure) and capacity (current available

number of seats. Fare setting needs to be taken into account in integrating public transport tickets, since fares of public transport tickets are often decided beforehand and do not fluctuate.

4.4.3 Conclusion

The overall conclusion can be drawn that an increase in competition in public transport and aviation has been the main trend in the last years. It had several benefits, such as higher public transport quality and a growth in air travel. An expert interview will be used to find out how these developments would have its impact on the feasibility and desirability of the integration platform.

4.5 Conceptual Frameworks

As part of this research, a conceptual framework will be made to identify important factors for the feasibility and desirability of integrating booking and payment of air- and public transport tickets. This paragraphs describes relevant literature regarding these frameworks and how these can be applied.

Integrated Intermodality

The main aim of this thesis is to come up with a conceptual framework that displays important factors for implementing the integration of booking and payment of air- and public transport tickets. Relevant literature is evaluated and will be discussed in this section. Starting with the integration of intermodality, where the European Commission (1997) states that intermodality is integrated in three levels:

1. Infrastructure and transport means
2. Operations and use of infrastructure
3. Service and regulation

Air and Rail Integration

From a study of air and rail integration in Germany, the conclusion was drawn that long distance trains can be successful replacements for short feeder flights, but that the integration can be complex and expensive (Grimme, 2007). Projects, according to Grimme (2007), would not have been realised without political support in Germany. Main difficulty in this integration was customer acceptance of baggage handling being a complex. Li, Jiang, Wang, & Ma (2018) identified low, medium and high levels of partnerships between rail and air transport.

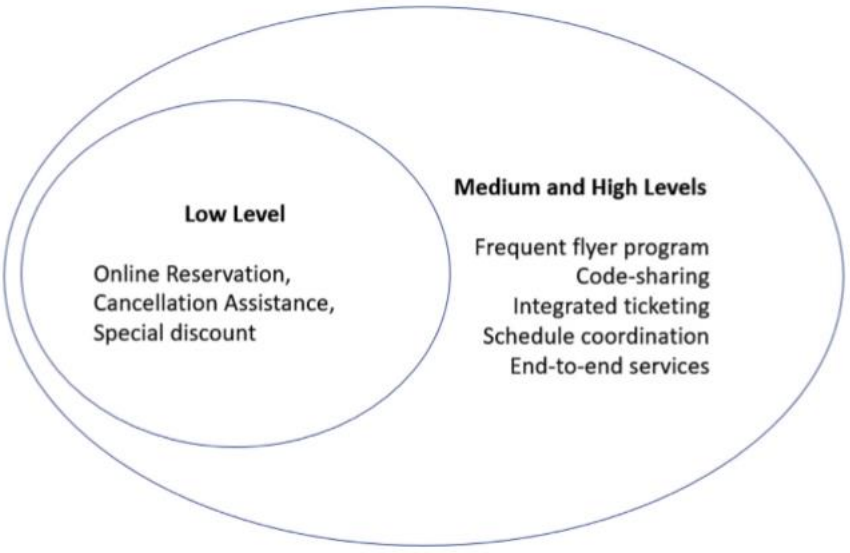


Figure 15 Levels of partnership between air and rail (Li et al., 2018)

In this case, air and rail operators do not have the incentive to cooperate when the integration costs are sufficiently too high (Xia & Zhang, 2017). Li, Jiang, Wang, & Ma (2018) have done a research towards determinants of partnership levels in air and rail, where the main conclusion was that the location of a train station related to an airport has the highest impact on the level of partnership. It was namely found that if a train station was located at the airport, the level of partnership between air and rail would be higher. Furthermore, partnerships in Europe are of a higher level than the partnerships of air and rail in Asia, according to the researchers.

With integrating air and rail transport, it is imaginable that passengers would have preferences. A study has been executed where these preferences were examined through a stated choice experiment (Román & Martin, 2014). A few observations were made, where at first a disutility is present with end users when switching transport modes. For this reason, a compensation should be realised in terms of in-vehicle, access and connecting time. Fare integration is hereby valued by end-users as well. The researchers also found differences in utilities for leisure and mandatory travels (Román & Martin, 2014). Leisure travellers value baggage integration more than business travellers. Disutility with travel is valued higher for business travels than leisure travels.

Recent Developments

Elaborating on a potential conceptual framework for integrating booking and payment of air- and public transport tickets in this thesis, Merkert & Beck (2020) have researched if integrated air-bus services create value for the proposition for the regional aviation market. According to Merkert & Beck (2020), when making this integration as a high priority, it can create business opportunities and competitive advantages for the air-bus transport value chain. Thereby, integrated planning and management, such as joint pricing and timetabling, are most likely to have an impact on demand, competitive advantage and therefore attractiveness and profitability of the air-bus service.

Further research has been done on an extension of Mobility as a Service. Part of this extension is proposed as Collaboration as a Service (CaaS), which incorporates operators more fully and utilises their commercial self-interest in order to create commercially viable and attractive integrated public transport options for consumers (Merkert, Bushell, & Beck, 2020). It furthermore facilitates more collaboration between private public transport operators for short or longer distance travel, possibly enabling opportunities for cross geographical transport providers to further integrate. CaaS hereby is seen as a tool for institutional integration, taking governances of various stakeholders into account.

Conclusion

Last sections have showed that integrating rail and air connections is possible. This was however done on larger rail distances. Furthermore, various frameworks have been shown that showed interactions within travel booking processes. These frameworks thereby showed factors that are of importance in those specific cases. The integration of this thesis research will be related to more local public transport and a conceptual framework should be created that display the relevant factors that play a role in the feasibility and desirability of this integration platform. New developments, such as CaaS, show that multimodal transport integration is becoming more important over the years.

4.6 Business Model Canvas

Business Model Canvas Definition

To evaluate how the integration platform of air- and public transport tickets can be economically beneficial, it has been decided to use the business model canvas method. Firstly, it is given that the definition of a business model is a model that describes the rationale of how an organization delivers, captures and creates value (Osterwalder & Pigneur, 2010). According to Osterwalder & Pigneur (2010), a business model can be best explained by nine building blocks:

1. Customer Segments: an organization often serves various segments
2. Value Propositions: with value proposition, an organization aims to solve customer problems and needs

3. Channels: propositions are delivered through channels, varying from communication, distribution and sales channels
4. Customer Relationships: customer segments are maintained through establishing sufficient relationships
5. Revenue Streams: result from successfully offering value propositions to customers
6. Key Resources: required assets to deliver services
7. Key Acitivities: activities that are of importance to deliver services
8. Key Partnerships: some activities need to be taken from other resources outside the organization
9. Cost Structure: all the elements named above result in the overall cost structure of the organization

These nine building blocks are displayed in a table leading to the Business Model Canvas.

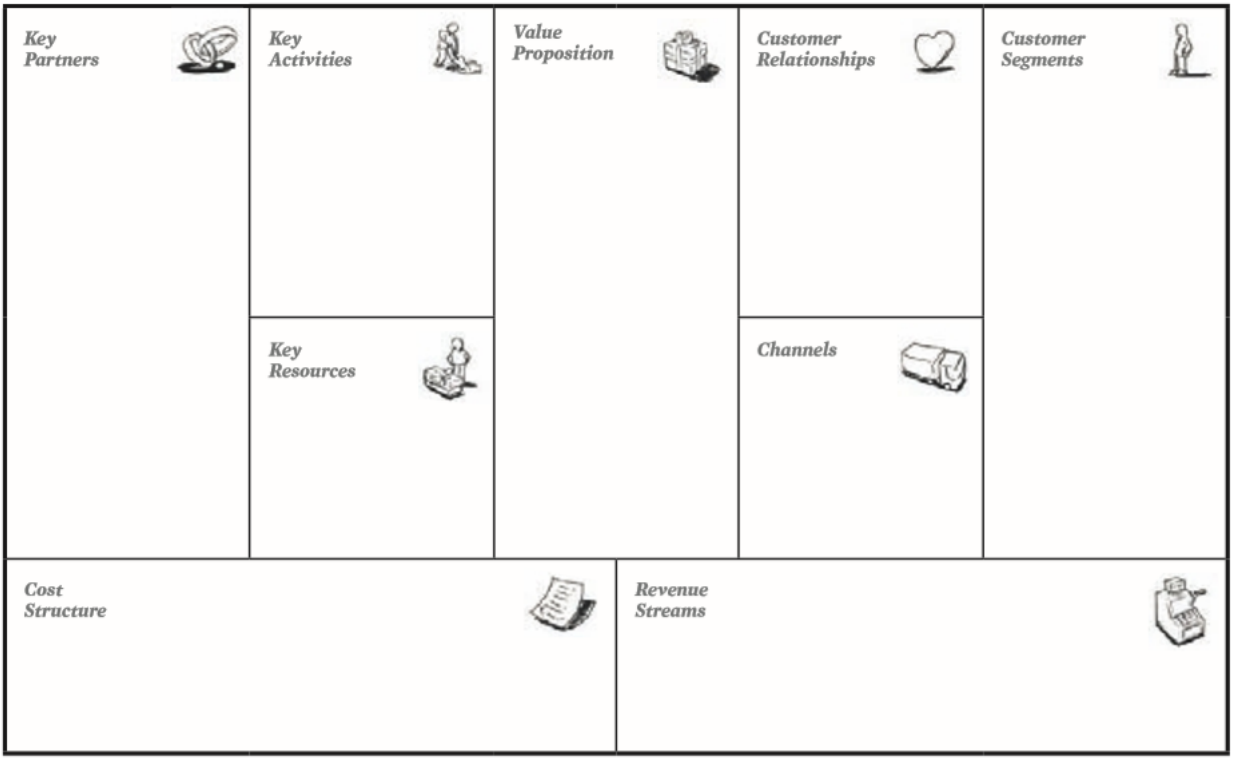


Figure 16 Business Model Canvas (Osterwalder & Pigneur, 2010)

Business Model Canvas for Prototype MaaS Applications

The business model canvas can also be used to evaluate new technology or can be used as a start-up tool. Polydoropoulou, et al. (2019) created a prototype business model canvas for applying MaaS in different cities. Hereby, all important aspects related to MaaS have been categorised in the nine building blocks. The study consisted of three case studies, namely in Budapest, Manchester and Luxembourg. Below the Business Model Canvas for Budapest is depicted. The marked parts in the canvas stand for relevancy to the city. As a whole it stands for the prototype business model canvas for MaaS applications. Elements in this prototype can be used for the business model canvas for this thesis case.

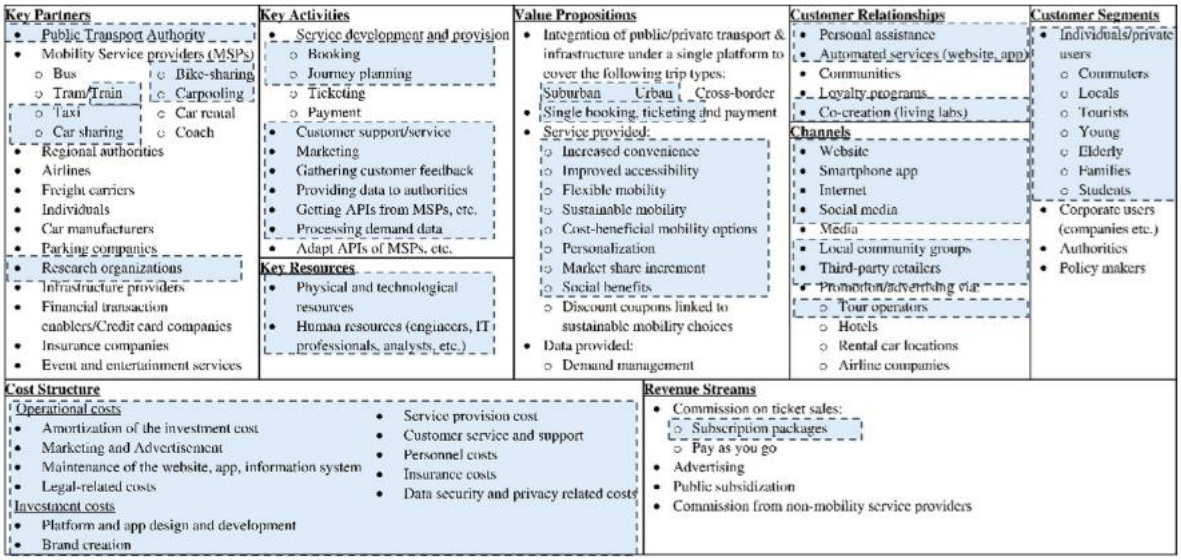


Figure 17 Business Model Canvas for MaaS in Budapest (Polydoropoulou et al., 2019)

Conclusion

This paragraph showed how the Business Model Canvas can be used for transport related businesses. It was shown how MaaS can be successfully implemented into a city. Findings of this paragraph will be used as inspiration for constructing the Business Model Canvas of integrating booking and payment of air- and public transport tickets. Especially on the elements which were implemented in the example cases and how these might relate to this specific case.

5 Landside Transport Data

This chapter aims to identify traveller flows from/to an airport and what preferences of travellers are. As has been mentioned in the methodology, the four largest airports of Europe will be taken into consideration. Modal splits will be identified for all four airports as these are within the scope of this research. The consideration should be made however if these results would reflect as the overall picture regarding landside transport at airports around the world, varying from the largest airports to the smallest airports, and their locations on the earth. These differences need to be taken into account in the conclusions later in this report, as various availabilities of for example public transport influences traveller landside transport profiles across the world.

Current Landside Modal Splits Airports

In discovering the landside modal splits of the airports, key facts and figures are needed that expose passenger numbers, number of transfer passengers and modal splits. The total number of passengers per airport in 2018 are given (List of the busiest airports in Europe, 2020).

Table 2 Total Number of Passengers

Airport	Number of Passengers (2018)
Amsterdam Schiphol Airport	71.1 million
London Heathrow Airport	80.1 million
Frankfurt am Main Airport	69.5 million
Paris Charles de Gaulle Airport	72.2 million

As can be seen in table 2, the busiest airport in Europe is London Heathrow. Frankfurt Airport is the least busy of the four. The mentioned airports being main hubs in Europe also means that the airports have a high share of transfer passengers. These transfer passengers are of importance in calculating total numbers regarding landside transport as these do not make use of landside transport at the airports. With the shares of transfer passengers being known, the number of transfer passenger and therefore the O&D passengers can be calculated.

Table 3 Transfer and O&D Passengers

Airport	Transfer Passengers (%)	Transfer Passengers	O&D Passengers
AMS	36.6	26.0 million	45.0 million
LHR	30	24.0 million	56.1 million
FRA	55	38.2 million	31.3 million
CDG	30.6	22.1 million	50.1 million

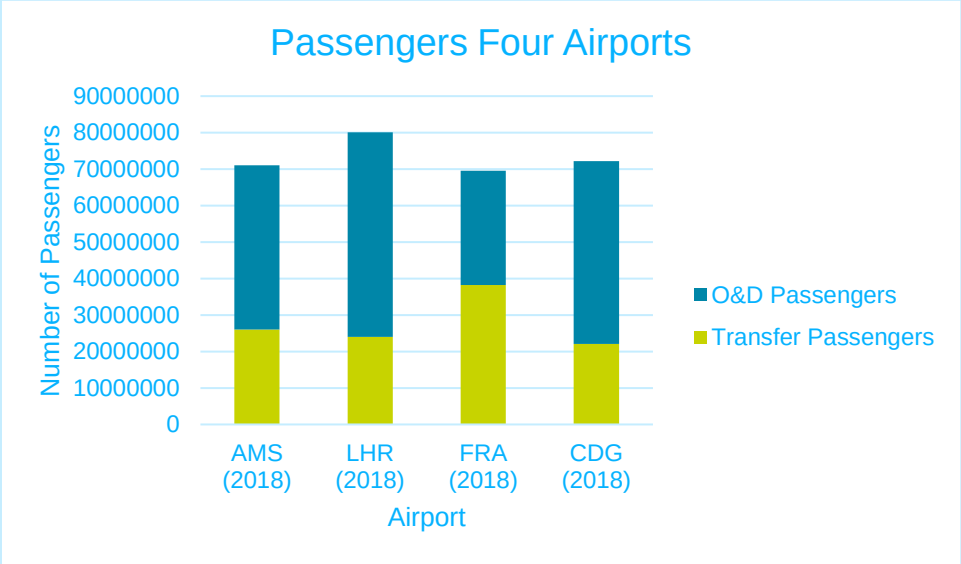


Figure 18 Graph Transfer and O&D Passengers

Figure 18 shows a visual of the differences of transfer and O&D passengers between airports. A notable aspect is the fact that London Heathrow as the busiest airport, relatively has the lowest share of transfer passengers. In contrast to that Frankfurt has the highest share of transfer, although the fact of having the lowest number of total passengers. An explanation of this difference can lie in the most popular destinations of both airports. The top 5 most popular destinations of London Heathrow are New York JFK, Dubai, Dublin, Amsterdam and Hong Kong (Facts and Figures, 2019). On the other hand, Germany is the second most popular country where passengers travel to from Frankfurt Airport (2018 Facts and Figures on Frankfurt Airport, 2019). This might explain the difference in shares of transfer passengers and thereby specifically that Frankfurt Airport serves as Germany's main airport for all other big cities in the country, which are spread around the country. Second largest airport in Germany is in Munich, which is a significantly distance away from Frankfurt Airport. In contrast to that, London Gatwick is the second largest airport in England, leading to the conclusion that the flight passengers in England mainly originate from London.

The various modal splits for landside transport from/to the airports are given below.

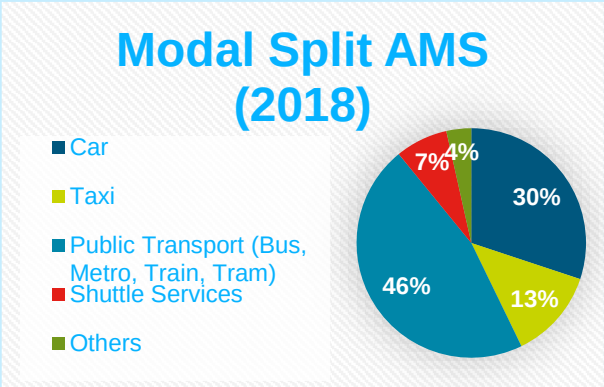


Figure 19 Modal Split Amsterdam Airport

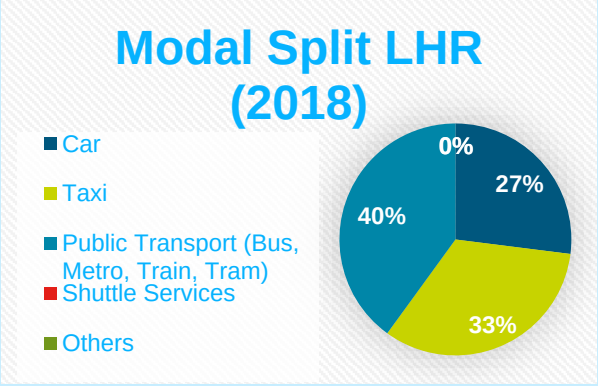


Figure 20 Modal Split London Heathrow

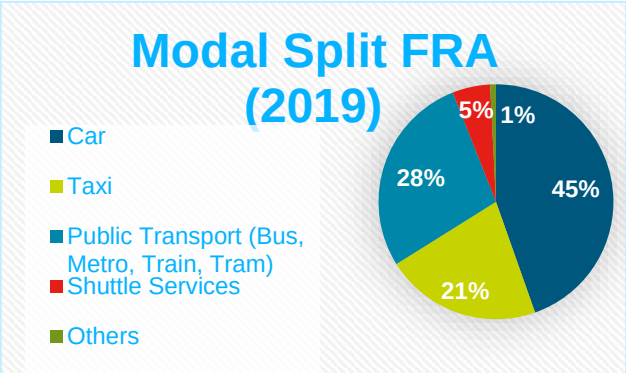


Figure 21 Modal Split Frankfurt Airport

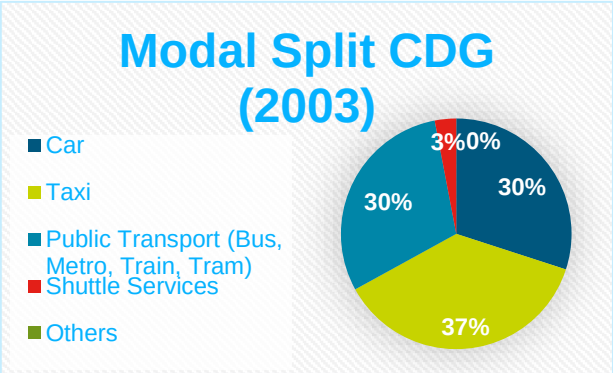


Figure 22 Modal Split Paris CDG Airport

All four airports have a relative high share of passengers that travel with public transport towards or from an airport, with Schiphol having the highest share of 46 % of its total O&D passengers and Frankfurt Airport having the lowest share with 28 %. These shares of public transport consist of bus, metro, train and tram. Therefore, the identity of public transport per airport can differ much and therefore may have its influence on the modal shares. To take train connections as an example, Frankfurt and Paris have a high share in high-speed long-distance trains because of the size of each country. Schiphol Airport is located in the Netherlands, which is a smaller country and therefore has a denser train network of which high speed trains play a less important role. Trains at Schiphol also serve almost the whole country of the Netherlands, which makes it more attractive to use the train at this airport. Rail connections at London Heathrow are mostly dedicated to London itself with the Heathrow Express for example. On the other hand, an underground/metro connection at Heathrow, being the Piccadilly line, is present in contrast to the other airports. The 0 percentage for shuttle service at London Heathrow is explained by the coach/shuttle being taken into account as a bus modality.

Further noticeable are the high modal shares for taxis at the airports of London and Paris. With percentages of 33 % and 37 %, taxis are substantially more popular than at the other two airports. When comparing car usage at the four airport, Amsterdam, Paris and London show similar modal shares. Frankfurt however shows a higher share for car usage towards and from the airport.

Main lessons that can be learned in this case are that modal splits very much rely on the transport options at the airport and the transport culture in each country. Related to the transport options might be the presence of a train station at the airport, making the option of using the train more attractive. This also reflects the findings in section 5.2. With transport culture it is meant that habits regarding mode choice can highly differ per country. The main example is the high modal share of taxis in England and France in contrast to lower shares in the Netherlands and Germany with respect to airport trips. These mode choices can however differ on various factors that thereby interact with habits of people when choosing modes, making the transport culture complex (table 1).

With the modal splits and the numbers for O&D passengers known, absolute figures per transport mode can be given for each airport.

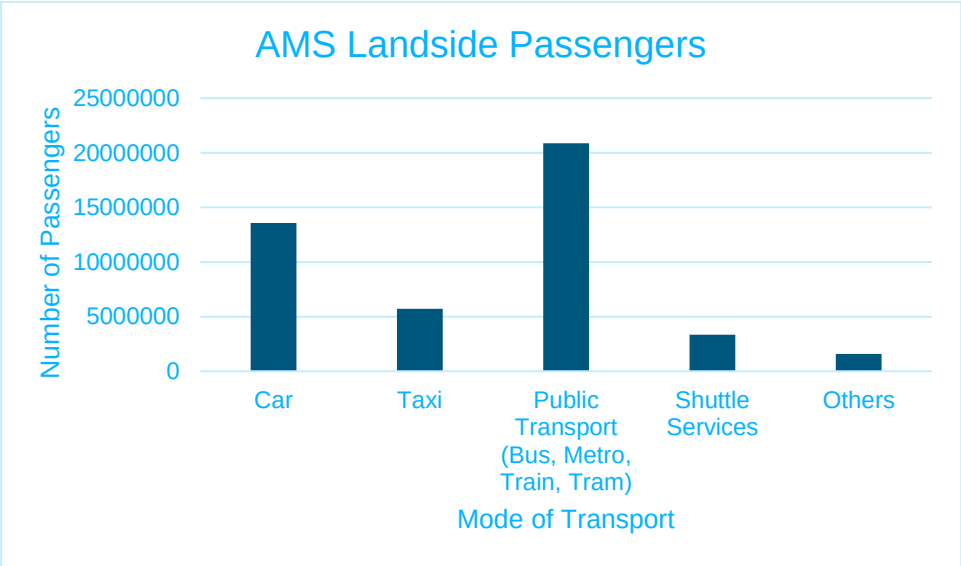


Figure 23 Landside passengers Amsterdam Schiphol Airport (2018)

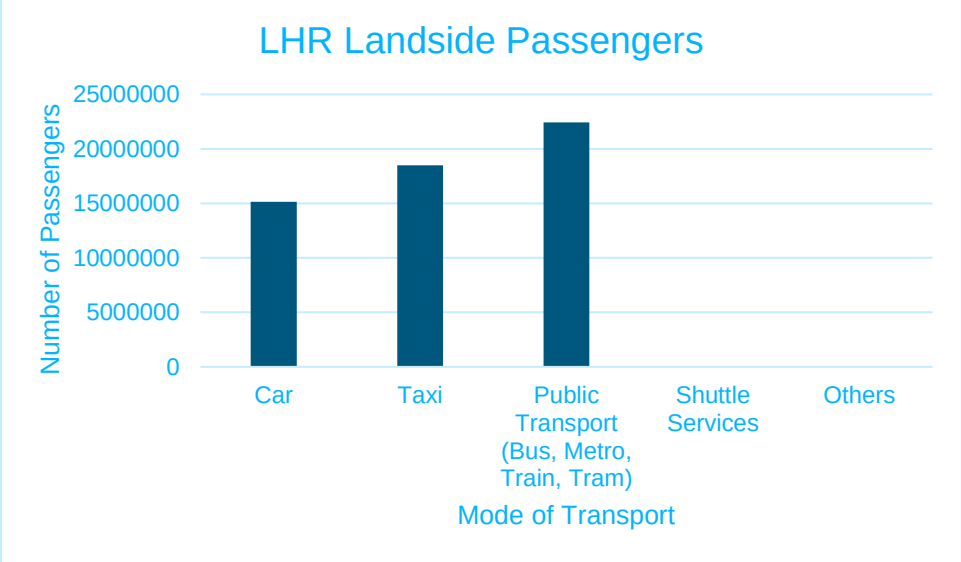


Figure 24 Landside passengers London Heathrow (2018)

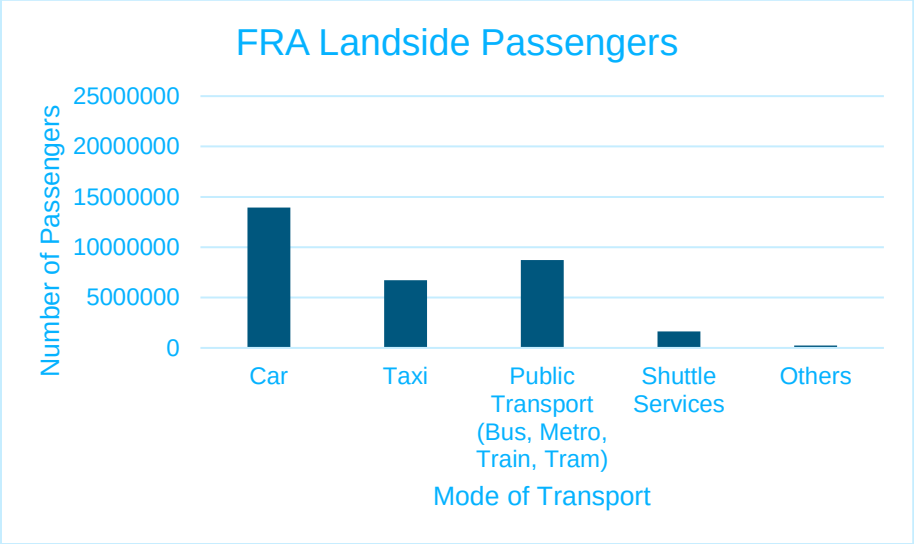


Figure 25 Landside passengers Frankfurt Airport (2018)

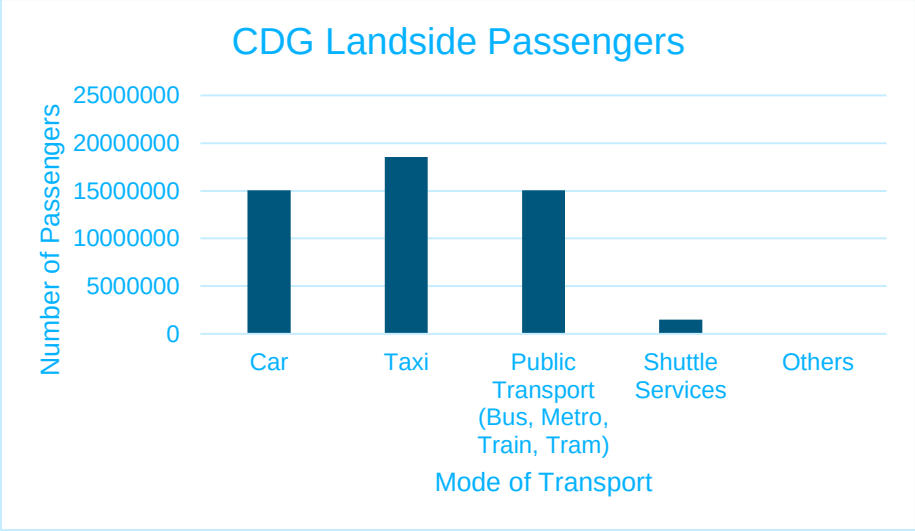


Figure 26 Landside passengers Paris Charles de Gaulle Airport (2018)

Looking at the absolute numbers, the differences in absolute shares of public transport between airports are noticeable. The absolute values for Amsterdam Airport and London Heathrow are the highest due to combination of shares and O&D passengers, both exceeding 20.000.000 public transport passengers per year. Notable to mention is that despite the significant differences in shares for car usage, all four airports show similar absolute numbers of car users throughout a year. Taxi shares showed similar results in the absolute values, both London Heathrow and Paris Charles de Gaulle reaching approximately 18.500.000 taxi passengers per year. Appendix C shows the public transport options and a comparison with the other modes at the four airports.

Conclusions

Concluding this section, data for modal splits and absolute transport flow numbers show revealed mode preferences of a pool of travellers moving to/from airports. It can be stated that the travellers' range of choices and thereby comfortable options are key in making a decision in which mode to choose. This range can vary in various factors such as available train station and the transport culture in the country. Differences in modal choices between the airports are indicated, where it is found that London and Amsterdam show the highest shares of public transport usage. The other two airports are often travelled to by taxi or car. Data of the four airports are later used for discovering market potential of the integration platform (chapter 11).

6 Survey Travel Preferences First/Last Mile Airport Trips

To extend the findings of chapter 5, a survey was held under air travellers. Questions that are asked relate to how they travel to and from the airport. Furthermore, questions about a proposed tool to integrate booking and payment of air- and public transport tickets will be asked to identify input on judging if the integration will have a demand. The survey is spread via social media, being LinkedIn and Facebook due to the restrictions with respect to the Corona Virus pandemic.

6.1 Questionnaire

To find out answers to the sub questions related to the main question of this thesis, different question sections have been created. The categories are as follows:

- Questions that are supposed to find out characteristics about the last trip the respondent made involving air travel.
- Questions about experiences with public transport in an unfamiliar/foreign country.
- Questions about the interest in integrating booking and payment for air- and public transport tickets and how this integration should be done.
- General questions that are supposed to find out the age, gender, level of education and travel history of 2019 of the respondent.

With the first category of questions, real events and choices of a respondent will be shown. The questions only cover the last trip of the respondent but shows their behaviour when making choices and which factors play a role in that case. Therefore, the question are build up by asking their end destination of their last trip first, where the respondent bought the airplane ticket and travel purpose, followed by if the respondent considered making use of public transport and if the respondent indeed made use of public transport, and finally which factors are important for their modal choice at that final destination airport.

After identifying a real scenario that the respondent was facing, the overall judgement of respondents towards their experiences about public transport at foreign/unfamiliar airports will be asked. These questions therefore function to find out standpoints of the respondent towards public transport. This category consists of questions about if the respondents have ever bought a public transport ticket at a foreign/unfamiliar airport, what the main obstacles of buying such a ticket are and how likely the respondents in general are to use public transport to/from unfamiliar airports.

A next step in the survey would be to identify the interest of respondents for an integration platform that integrates booking and payment of air- and public transport tickets. Eventually, the main goal of the survey is to identify if there is a demand for this integration platform and therefore if it is feasible for this platform to be implemented. Hereby, a comparison would be made how likely the respondent will be making use of public transport if they have the ability to book a public transport trip beforehand compared to if they do not have this ability. Furthermore, questions on how the platform should look like and how it should function will be asked in follow up questions.

The last batch of questions will be general questions about age, gender, education level and trip history of 2019. The first three questions will be asked for possible relations towards the responses to other questions that the respondent answered. A possible example could be that younger people might want to have their public transport ticket on their phone, where older people might want a paper ticket. Trip history would be used to identify what kind of traveller the respondent usually is.

6.2 Expectations and Hypotheses

Before handing out the survey some expectations and hypotheses can be stated about how respondents will fill out the survey. This is mainly based on information that has been obtained from literature review and thoughts that are based on logic and developments of the past years.

Type of Respondents

Because of the Corona Crisis, the survey has been handed out via social media platforms. To be specific the survey was spread on the researcher's personal Facebook page, within the Data & Digital Consultancy of Royal HaskoningDHV, within the department of Transport & Planning at the TU Delft and on the LinkedIn pages of the researcher and his supervisors. Both platforms have implications, firstly being that the respondents from Facebook will be family and friends that on average will probably have the same age as the researcher, which will narrow down the variety of types of respondents. Secondly, the survey being handed out via LinkedIn will be mostly attracted by transport experts. This is a result of the supervisors of this thesis being a transport expert themselves and their network mainly being in this sector as well. This argument also holds for the departments of Royal HaskoningDHV and the TU Delft, where many respondents will be within the same transport world and higher educated people. This potential lead to a bias in the results should therefore be considered.

As the literature review of chapter 4 indicated that air travel grew over the last years, it is imaginable that almost all respondents will have flied somewhere in the last five years. Therefore, questions asked in the survey about the link towards their transport from the airport are relevant for this research.

Furthermore, the assumption can be made that the majority of the respondents are Dutch citizens despite the fact of the international network that the supervisors of this thesis have. This may have led towards a bias in the findings about public transport in general. The Netherlands is considered to have high quality public transportation and is highly used. A reflection was also made within the modal splits in the previous paragraph indicating the high modal share of public transport to/from Schiphol. With the majority of the respondents being Dutch, this may have favoured the answers for interest in integrating air- and public transport tickets, because of the public transport preference.

Factors for Travel Preferences

The survey contains a question that identified the most important factors for the respondents in choosing the transport mode to travel to/from an unfamiliar/foreign airport. From section table 1 in section 4.1.6, factors are shown. A table can be made on how much factors appeared to be important according to the relevant literature. For simplicity, the factors that were mentioned more than twice are shown.

Table 4 Modal choice factors to/from airports

Factor	Appearance
Time (total travel time)	7
Baggage	5
Costs	4
Frequency (flight and public transport service)	4
Satisfaction	2
User-Friendliness	2
Income	2

Based on these findings and own interpretation of important factors, the following factors where stated in the question about the most important factors for respondents in choosing a transport mode to/from an airport.

- Travel Time

- Access and Egress Distance (Distance to a Public Transport Stop or Parking Lot e.g.)
- Availability (Frequency, Waiting Time)
- Costs
- Comfort (Space, User-Friendly)
- Reliability (On-time travel, Capacity, Number of Transfers)
- Safety
- Environmental performance
- And the option for respondents to name a factor if one of the options do not cover their important factor

Some factors that are asked in the survey overlap with the factors named in table 1. An example is that baggage is assumed to have an overlap with comfort, as well as user-friendliness of the mode. In this way based on literature, it was expected that respondents would have travel time, availability, costs and comfort as their most important factors.

Expectations Response on Integration Platform

The most important questions in the survey are related towards the feasibility and desirability of the integration platform for booking and payment of air- and public transport tickets. These questions are indicative in the sense that mainly the potential interests will be asked for without showing trade-offs, being for example price indications of the service. At first, a question will be asked how likely the respondent will be using public transport to/from an unfamiliar/foreign airport in general. After that, the likeliness will be asked if the integration platform will be an option for the respondent to use. Since the likeliness scales are indicative without trade-offs given yet, a significant difference between the responses of the two questions is expected. Due to the integration platform and therefore making travelling with public transport easier, will motivate public transport users in general even more and might attract switchers that would normally go for another transport mode, such as taxi or car rental. On the other hand, since no additional information on for example the costs is given, question marks can come up with the respondent, resulting in doubting the platform.

Further questions will be asked on what the main obstacles are for the respondents for using public transport from/to a foreign/unfamiliar airport. Since there is no relevant literature yet on this topic, the obstacles that are introduced are based on experiences and logical thoughts. With the unfamiliar character of public transport in foreign countries, it is imaginable that respondents would indicate that lack of knowledge about which public transport mode to use, which ticket to buy and finding the correct public transport stop are the most important obstacles.

Since the assumption has been made on that the majority of the respondents will be in the age group of 20-30, it is expected that the respondents would prefer more digital solutions for the integration platform. Therefore, most respondents are expected to answer that the public transport ticket as an addition and provided it on smartphone and/or tablet will be mostly preferred.

6.3 Survey Analysis

As has been mentioned, the survey has been spread on online social media platforms and within departments of Royal HaskoningDHV and the TU Delft. The total amount of responses reached a number of 121, of which 90 were filled out completely. Firstly, the survey analysis will be done on the scope of the whole group of respondents. Appendix G shows the composition of the survey respondents.

Integrating Booking and Payment of Public Transport and Airline Tickets

In this survey, the most important question was to find out how likely respondents would make use of public transport when the integration platform is available versus how likely the respondents would make use of public transport from an unfamiliar airport in general. The responses were given on a scale from 0 to 100. Averages of both questions were as follows.

Table 5 Scores likeliness respondents to use public transport

Usage Public Transport from an Unfamiliar Airport	Score
Likeliness using PT in general	76.5 out of 100
Likeliness using PT with integration platform	80.8 out of 100

First notable element of the table above is the relatively high score of 76.5 of using public transport from a foreign airport in general. Concluded can thereby be that public transport without an integration platform is already considered as an attractive alternative to travel from airport to end destination. As has been mentioned in the expectations, the likeliness with the introduction of the integration platform is expected to be significantly positively different. Observed can be that the score for the likeliness with an integration platform is higher but is yet to be tested statistically. Testing the statistical significance of the difference, the t-test was used. Appendix H shows the full t-test. The main t-test results are shown in the next table.

Table 6 T-test assuming equal variances

Statistic	Value
Hypothesis (difference means)	0
Degrees of freedom	183
T Statistic	-1.294
T Critical one tail	1.653
T Critical two tail	1.973

As has been mentioned in appendix H, the hypothesis in this t-test is that the means of both datasets are equal. This hypothesis can be rejected if t-statistic < - t-critical two tail and t-statistic > t-critical two tail. T-critical two tail is used because in this t-test inequality is tested. Since in this case - t-critical two tail < t-statistic < t-critical two tail (-1.973 < -1.294 < 1.973), this hypothesis cannot be rejected. This means that the difference found between the two questions is not significantly convincing enough. In practice this means that the introduction of an integration platform, statistically seen and according to this survey panel, would not have a significant influence on the usage of public transport from airports to an end destination.

Despite the overall conclusion that the difference created by the integration platform is not statistically significant, questions in the survey also already concerned how respondents would like the public transport tickets to be integrated. Respondents were asked to indicate how the public transport should be purchased and in which form the ticket should be provided.

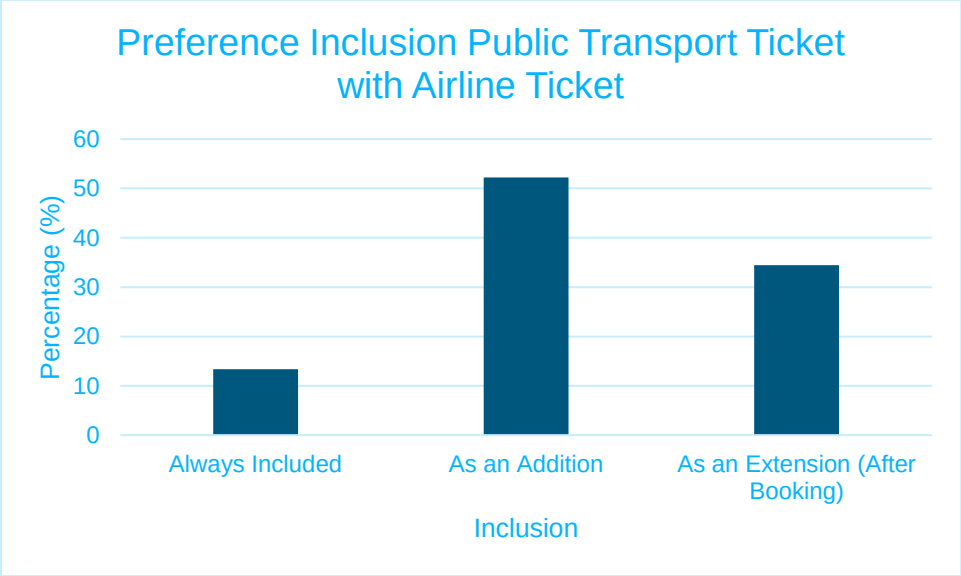


Figure 27 Public transport ticket inclusion

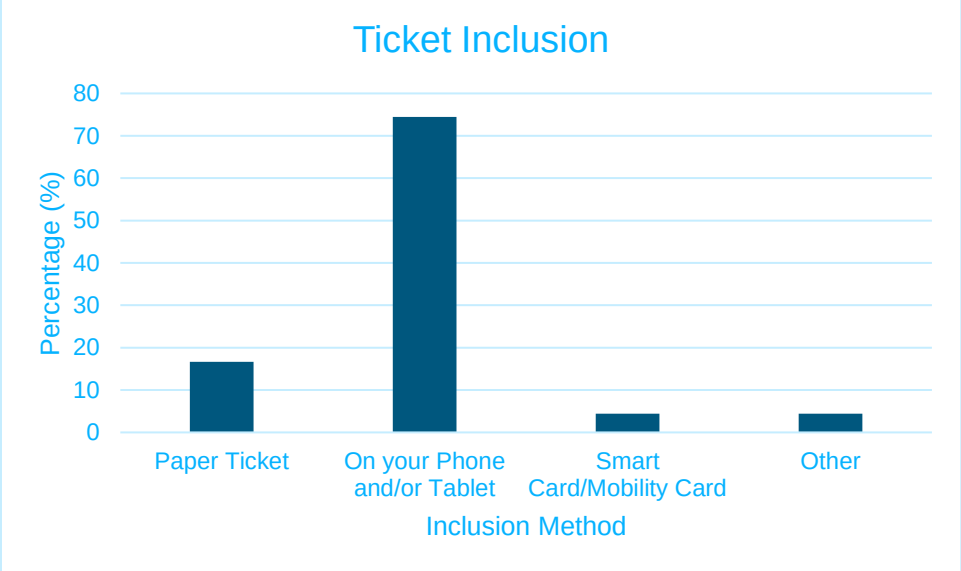


Figure 28 Inclusion methods

Respondents were given the option for public transport tickets to be always included with an airline ticket, as an addition during the booking process or as an extension after the airline ticket booking process. The results show that the majority of the respondents would want to purchase a public transport ticket as an option. Approximately 10 % of the respondents would want the public transport ticket always included. Furthermore, most respondents would still want to see a public transport ticket purchase as an option within the booking process of an airline ticket.

As expected, the large majority of respondents would want the ticket to be displayed on their smartphone and/or tablet. This was expected because the trend of digital solutions becoming more popular and the high amount of responses of younger groups. Noticeable is the fact that a low amount of respondents would see a mobility card as an optimal solution for the inclusion. The fact that the mobility card should be picked up at the airport would be the most logical reason. Some respondents filled in other, where everyone answered something similar towards having backups, receiving the ticket on their smartphone and the ability to print out the ticket as well.

6.4 In-Depth Analysis

A more in-depth analysis will be done on the comparison between the questions on how likely a respondent will be making use of public transport without and with public transport tickets integrated with airline tickets. For this comparison the responses on both questions will be compared and respondents will be categorized as having a positive, negative or neutral perspective towards the integration platform. In both questions, the respondents were asked to fill out how likely they will be using public transport from an unfamiliar airport on a scale from 0 – 100, for both in general and with an integration platform. In this case, the respondents' perspectives were categorised as follows:

- Positive: A positive difference of more than or equal to 10 points on the scale, when an integration platform is introduced. (Example: 80 before, 95 after)
- Neutral: A difference range when an integration platform is used of -10 till +10 points on the scale. (Example: 80 before, 75 after)
- Negative: A negative difference of more than or equal to 10 points on the scale, when an integration platform is introduced. (Example: 80 before, 65 after)

Judging the respondents' perspectives on the introduction of integrating booking and payment of public transport and airline tickets is firstly done on the whole sample.

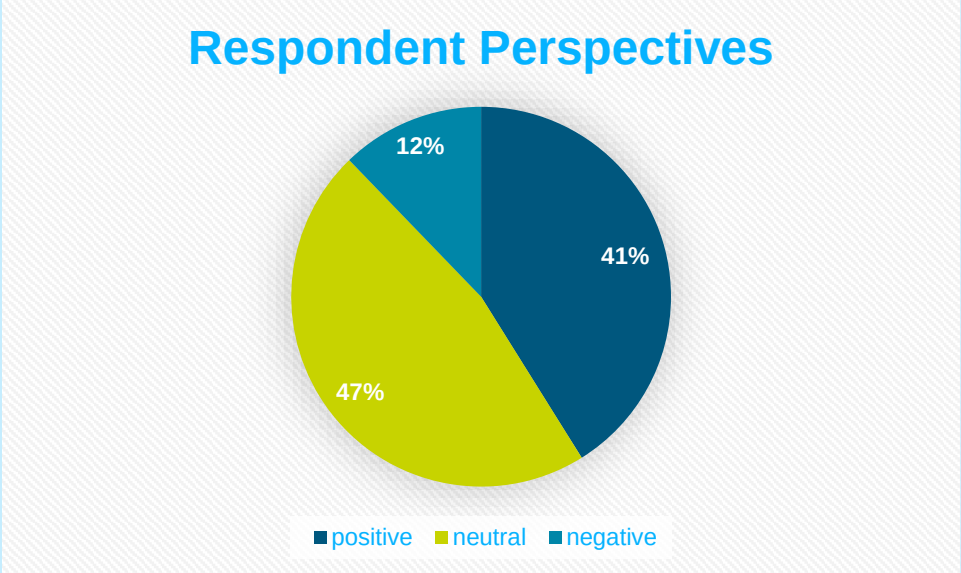


Figure 29 Perspectives of respondents towards the integration platform

The pie chart confirms that most of the respondents have a neutral perspective towards the platform. The other big group in this case are the respondents that have a positive attitude towards integrating public transport tickets with airline tickets. With 12 %, the group that has a negative attitude is the smallest group.

Next step in the in-depth analysis is to research if specific groups (age, gender, education level etc.) have a relation with the responses that were given in the survey. The main question thereby is if the positive, neutral or negative perception of the integration platform is coming from a specific group within the panel.

Gender

At first, responses from the survey are divided into the genders (male and female). Earlier it was found that the largest group of respondents were male.

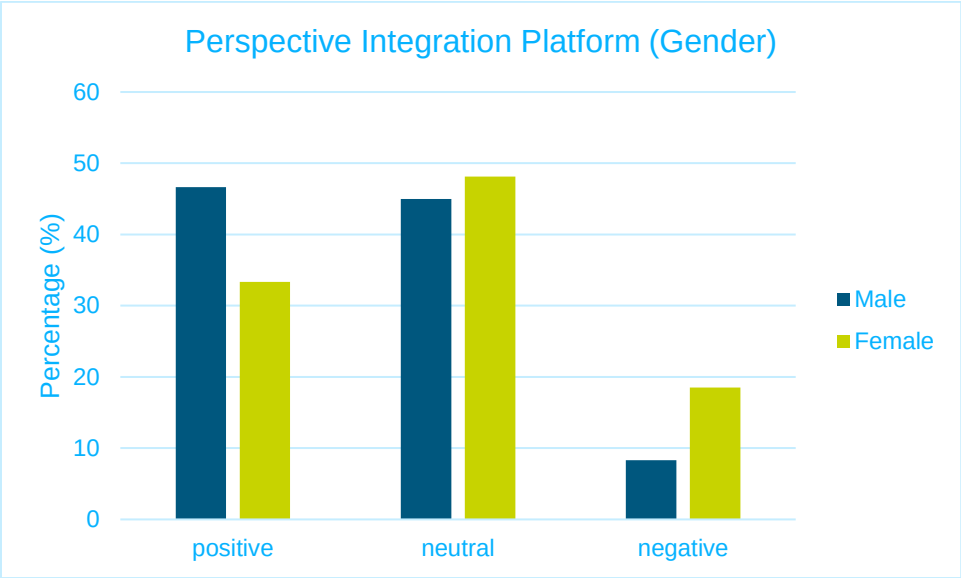


Figure 30 Perspective of genders towards the integration platform

Male respondents mostly had a positive or neutral perspective towards the integration platform. The number of females in the panel was smaller and it can be found that the slight majority has a neutral opinion. Despite the fact that the number of male respondents is larger, responses on having a negative opinion is relatively higher for females. The outcome might indicate that men would tend to make use of the ability to book a public transport ticket beforehand earlier than women. This is also based on the fact that the largest group of male respondents filled out a positive or neutral attitude, where female respondents were mostly neutral.

Age

Another aspect to look at are differences in age between the panel. The age groups are divided in the same groups as given in the descriptive section of this chapter.

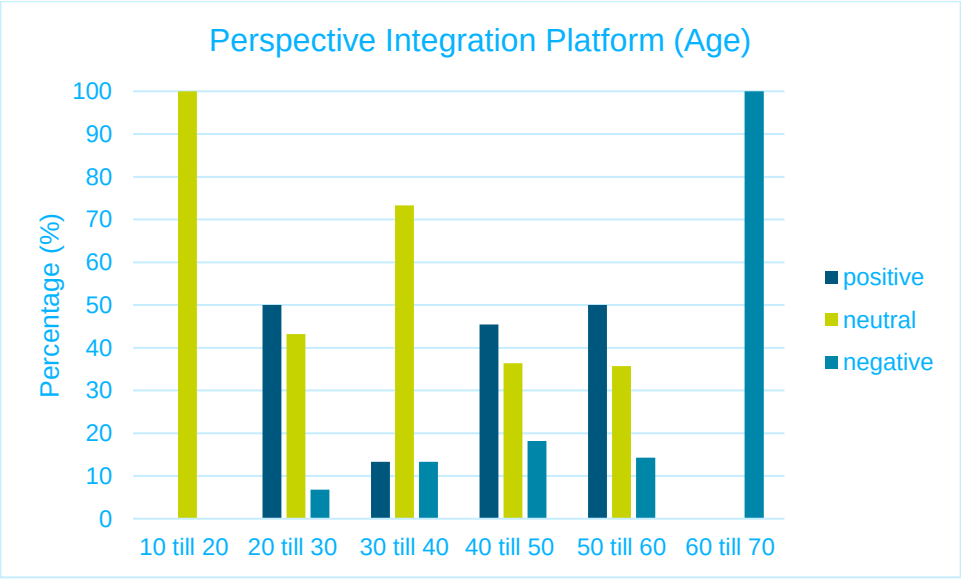


Figure 31 Perspectives of respondents divided in age groups

A noticeable aspect of the graph is the high positive and neutral attitude within the age group of 20 till 30 in comparison with the respondents having a negative attitude within that age groups. This difference is relatively

larger compared to other age groups, where with the age groups of 40 – 50 and 50 – 60 years differences between attitudes lie closer to each other. Furthermore, it can be observed that within the age group 30 – 40 years, the majority has a neutral opinion on integrating air- and public transport tickets. From this graph, the assumption could be made that younger age groups (20-30 years) might be a suitable fit for the integration platform. Conclusions on the age groups 10 – 20 years and 60 – 70 years old cannot be drawn, since both groups only consisted of one respondent.

Education Level

Another characteristic of the respondents that was asked in the survey was what their highest level of education has been.

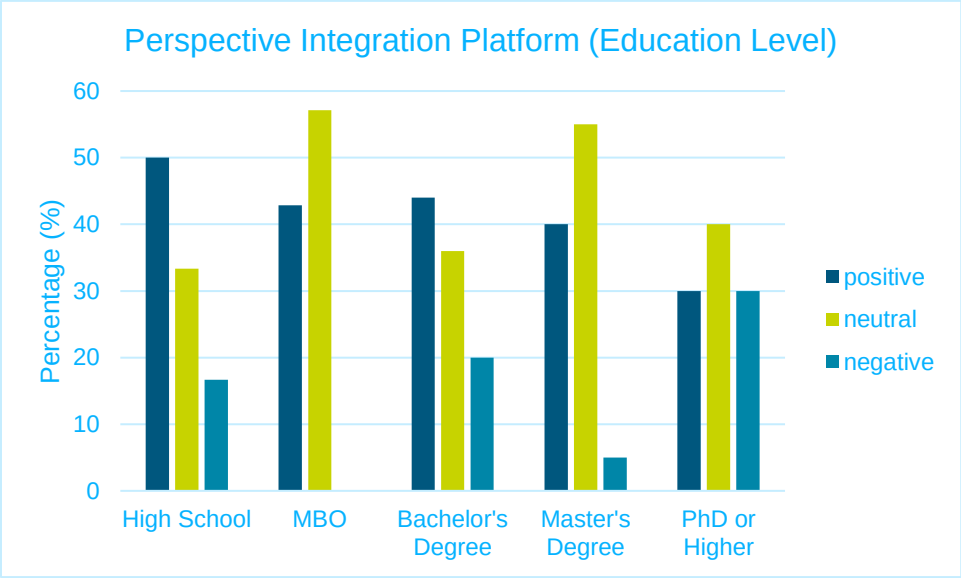


Figure 32 Perspectives between education levels

The most noticeable differences in positive, neutral and negative perspectives can be discovered within the group with a master's degree. In comparison with negative perspectives within that group, respondents with a master's degree tend to have a positive or neutral standpoint more. A less clear observable is the difference between the standpoints between respondents with a bachelor's degree. A slight majority is present for a positive standpoint against being neutral or negative. Respondents with high school, MBO or PhD or higher are smaller groups. It seems however that opinions of respondents with a PhD or higher or more spread out. Respondents with an MBO show no negative responses, but were a minority in the sample. Overall the results might indicate that highly educated people, especially with a master's degree, might be interested in the ability to purchase a public transport ticket from home.

Leisure versus Business Travellers

Within the survey, respondents were asked to indicate the number of trips (involving air travel) made in 2019 either being for leisure or business purposes. Business travellers were categorized as a respondent having made more business than leisure trips in 2019, and for leisure travellers it was the other way around.

Table 7 Type of Travellers

Type of Traveller	Number
Leisure	73
Business	10

Identified can be that most respondents in the survey sample are leisure travellers. In an ideal scenario the samples for both leisure and business travellers should have been the same to be able to possibly draw conclusions. However, standpoints of both traveller types are shown below.

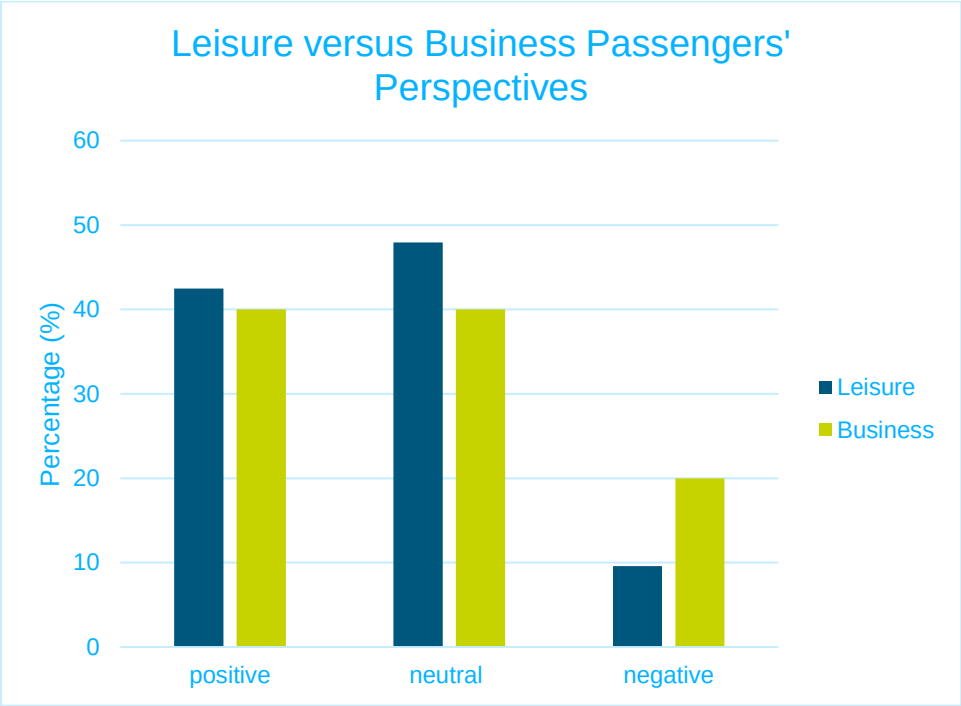


Figure 33 Leisure versus Business Travellers' Perspectives

Between business travellers, the differences between standpoints are small especially with the knowledge of the sample being small. Differences in opinions towards the integration platform between leisure travellers however are more noticeable. The largest group of leisure travellers have stand neutral towards integrating public transport tickets with airline tickets, followed closely by a positive group. Leisure travellers having a negative standpoint in this matter form a minority. Hereby, overall the hypothesis can be stated that the integration platform could be more suitable for leisure purposes, as ratio of positive-to-negative for approximately 4.5-to-1. The ratio for business travellers is 2-to-1.

Scores given between Public Transport Usage in General and with an Integration Platform

In the previous sections, the emphasis was made on which standpoints could be discovered between different groups within the sample. Standpoints were however based on the difference in points given between the two options of public transport usage from an unfamiliar airport in general or with an integration platform. This section is used to link the negative, neutral and positive respondents to the specific scores they gave to each of the scales.

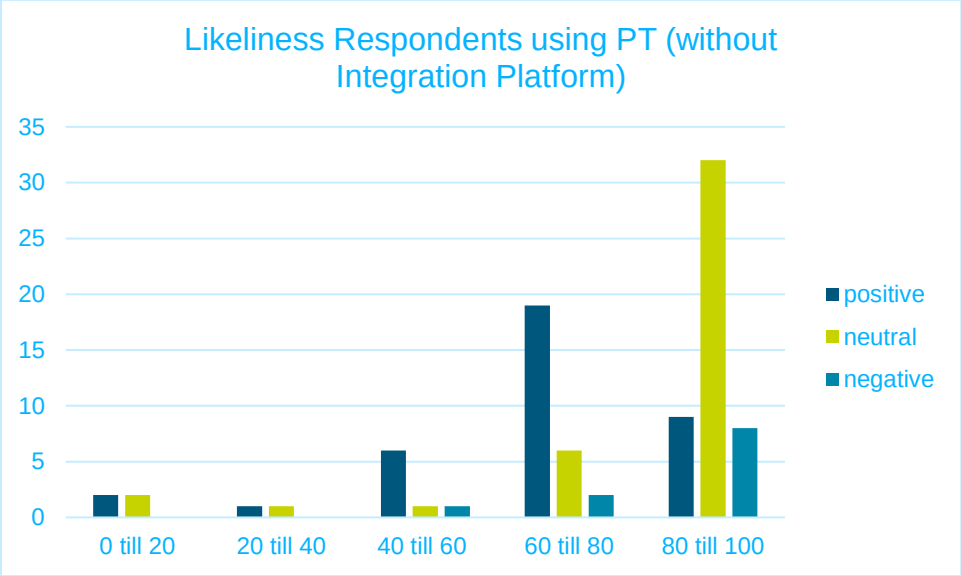


Figure 34 Scores for usage of public transport in general

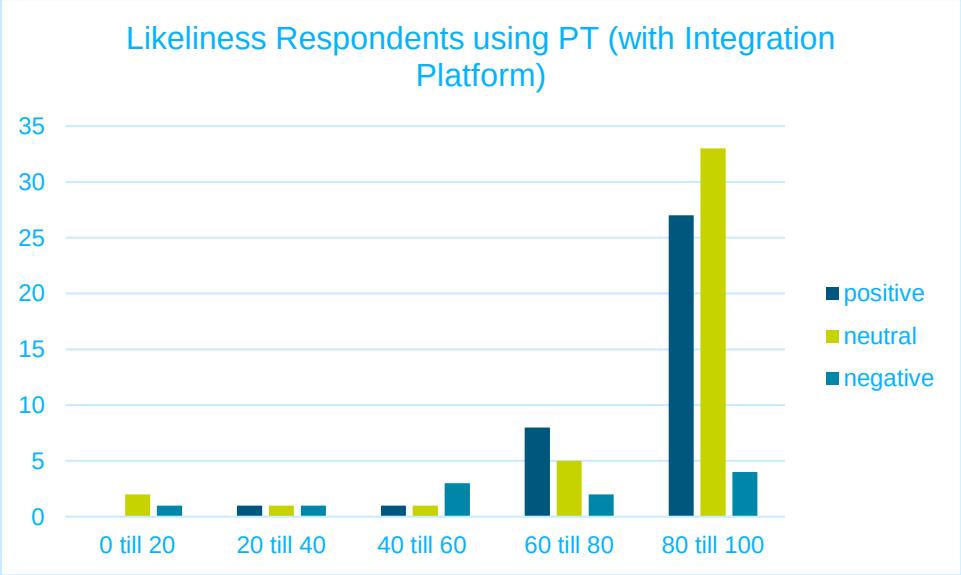


Figure 35 Scores for usage public transport with an integration platform

Both graphs reflect the beforementioned averages of scores that were given (77 for in general and 81 for with an integration platform). Groups that gave scores between 0 – 60 are relatively small in comparison with scores given within the 60 – 100 range, indicating that the spread of scores is not large. Noticeable is the increase of positive attitudes towards the integration platform, indicating that many respondents in the survey made a jump from giving a score between 60 – 80, towards 80 – 100. For the scores between 80 – 100 the neutral perspectives stayed roughly the same and the negative perspectives slightly decreases, indicating the jump from a 80 – 100 score to lower than 80.

The statistical t-test indicated that the difference between the two means was not statistically significant. However, given figure 34 and 35 a nuance can be made that the platform might induce people that are neutral or likely to make use of public transport from an unfamiliar airport to switch to be very likely to use public transport.

Promising Groups

From the in-depth analysis some results were found:

- When looking at gender, it seems that men are more likely to use the integration platform instead of women.
- The age group of 20-30 years old show the most potential with respect to the platform.
- Higher educated people, especially with a master's degree, tend to make use of the integration platform earlier.
- Leisure travellers seem keener to make use of the ability to book a public transport ticket beforehand than business travellers.

Given these findings, some combinations can be made to find out if there is a specific type of traveller that can be defined as a specific objective. Combinations that are researched are:

- Males of 20-30 years old
- Males with a master's degree or bachelor's degree in general and specifically between 20-30 years old
- Male leisure travellers in general and specifically between 20-30 years old

Firstly, male respondents of 20 – 30 years old are discussed.

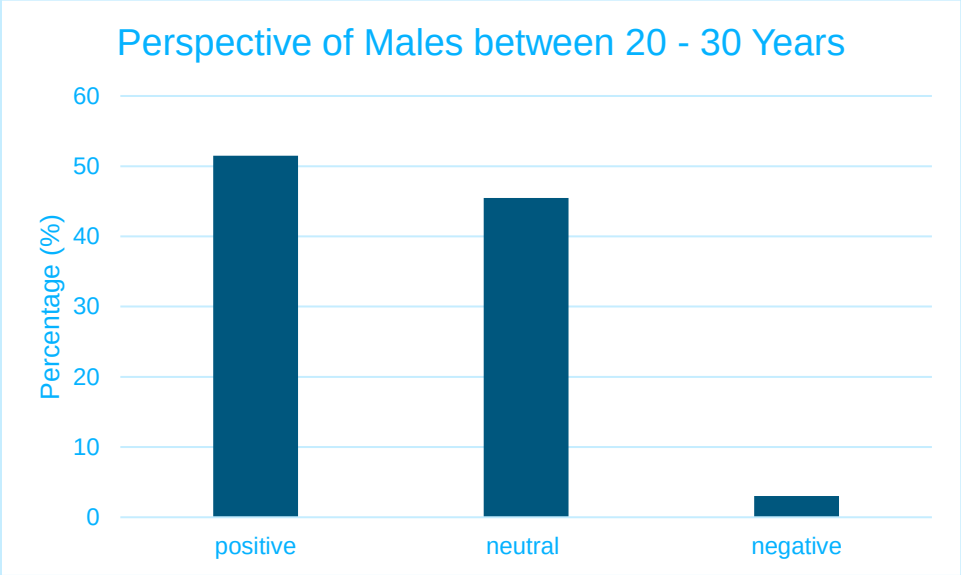


Figure 36 Perspectives of 20 - 30-year-old males

A clear difference is shown in the graph, where the share of positive and neutral reactions are significantly larger than negative responses. Hereby, the amount of positive and neutral reactions are similar. Taking the research to an even deeper level of detail, the influence of education level is displayed.

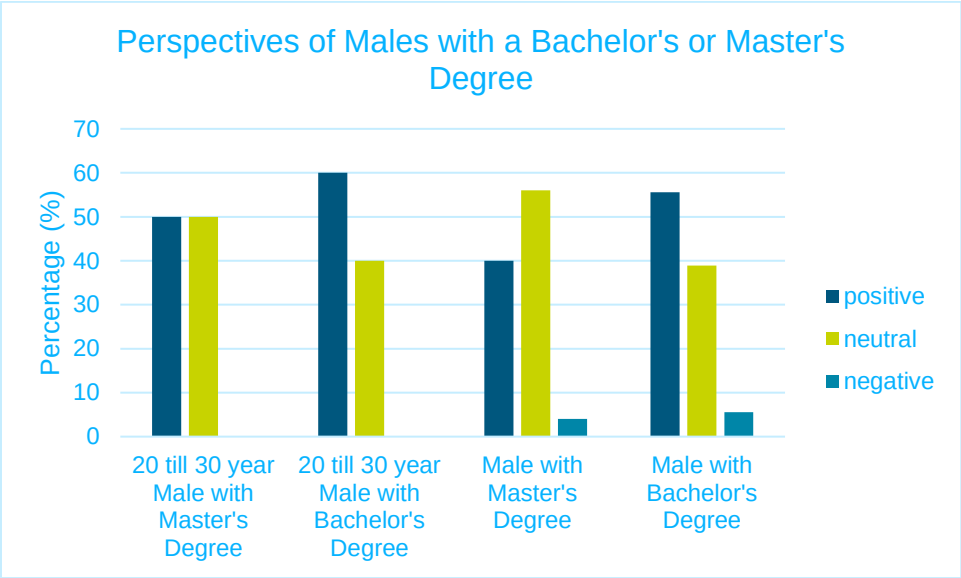


Figure 37 Perspectives of Males with a Master's or Bachelor's Degree

As can be seen, in general male respondents with a master's or bachelor's reacted positively or neutral. To a bit more detail, males of 20-30 years old with a certain degree showed no negative reactions towards the integration platform. It seems however that males with a master's or bachelor's degree in general, regardless of their age, have a neutral or positive attitude with the respondents with a Bachelor's Degree having the highest relative number of positive responses. Also, because of the high majority of 20-30 year old males in the sample. Next step is to look at the influence of age in combination with leisure travel purposes.

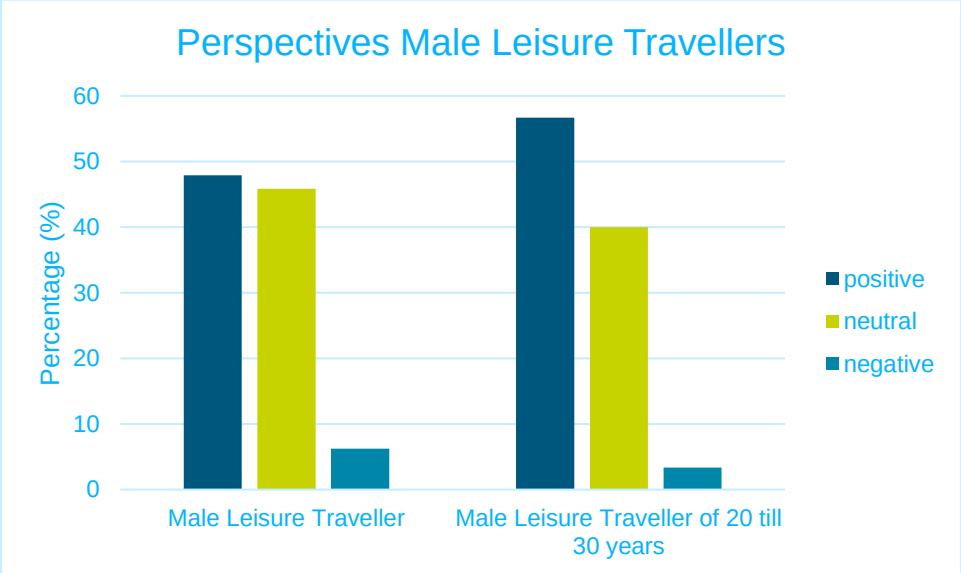


Figure 38 Perspective Male Leisure Travellers

The ratios of responses of male leisure travellers are roughly the same as males in general (or specifically 20 – 30 years old). This indicates that in general these types of respondents have a positive or neutral attitude towards the integration platform. Caution however is asked, since the largest group of the sample are leisure travellers.

6.5 Peer Review Interviews

After handing out the survey, four respondents of the survey were asked some detailed questions. The survey was filled out anonymously, but these respondents were known people, since these actively indicated that they filled out the survey. Ideally, specific people should have been asked for participation, such as one male and female from each age group. But due to the mentioned anonymous character of the survey, this was not possible. All participants were asked for permission before asking the questions.

The questions were as follows:

- Was the survey clear for you?
- The survey consisted a new concept, where booking and payment of public transport ticket would be integrated with airline tickets. Was the explanation of this concept clear?
- In the survey you were asked to fill out how likely you are to be using public transport from an unfamiliar airport in general and if you have the ability to buy a public transport ticket from home. What was your response and why?
- What are according to you pros and cons of the integration platform?
- When would you make use of the ability to buy a public transport beforehand? Would you do that for travelling to familiar places already?
- The idea is that the service provided by integrating air- and public transport tickets will come with a service fee. Could you give an indication on how much you would spend for this service? (A monetary value or in a percentage of the public transport ticket for example)

The participants were all male, where three of them were between the age of 20-30 and one was in the group of 30-40 years old respondents. All respondents had a bachelor's or master's degree.

Scores given by Participants

Interesting aspect of the answers from participants, that two of the participants filled out a positive standpoint towards the integration platform, and one each for a neutral or negative perspective. The participants with a positive attitude mentioned that ease and stress relief were the most important factors for filling out a positive response. Interesting aspect was that one participant was an overall public transport user and the other only would use public transport when there is no other option. Respondent with a neutral perspective on the topic mentioned that there is no restriction to use the platform and is capable in finding out how public transport at the unfamiliar place works by himself. The participant that filled out a negative standpoint towards the platform indicated that there is a certain amount of hesitation in the system and would therefore research by himself first. According to last named participant, him using the platform would highly depend on ratings given by experienced users.

Pros and Cons of the Integration Platform

Participants of the interviews mentioned a variety of pros and cons for the integration platform.

Pros:

- Avoidance of language barrier
- Assurance/stress relief
- Cheaper
- Experience/adventurous
- Ease and speed

Cons:

- Possible lack for options such unlimited public transport usage
- Lack of flexibility, you are stuck with the option of public transport (mentioned twice)
- Preference to search by himself

The pros that were named by the participants overlap with the factors that were given as an option of important factors for modal choice. Besides the confidence in searching the public transport ticket by themselves, it was indicated that the lack of flexibility bothered the participants, which was mentioned twice.

When to use the Integration Platform

The answers on when to use the integration platform varied between the participants. The neutral participant mentioned that he would not use the platform within Europe, since public transport in Europe is often well-known on how to make use of it. It would become interesting when language would become a problem, for example in a country such as China. Positive participants varied in using it only when the airport is unfamiliar and the other already when the destination is familiar, if the service would not get too expensive. The participant with a negative standpoint would only use it when the destination is familiar.

Willingness to Pay

All participants were lastly asked to indicate how much they would pay for the service provided. It was found that the participants had similar opinions, which was a range of 10 – 20 % of the price of the public transport ticket. Between these participants therefore, their standpoint was not important in determining the willingness to pay. Given the small sample, this is however stated with very high uncertainty.

Conclusion

The main conclusion that can be drawn from these interviews is that individuals highly differ from each other. Each of them indicating various important factors and therefore various tastes for integrating booking and payment of air- and public transport tickets.

6.6 Discussion

The discussion section in this chapter will concern elements that might have an impact on outcomes from the survey. These are discussed below.

This chapter contains a high amount of statements that were made based on the survey that was handed out under 121 respondents, of which 90 filled out the survey completely. Due to the current situation of the Corona Crisis, it was not possible to control the responses on the survey. It was handed out via social media instead resulting in majorities and minorities in groups. Given this, and the character of respondents being Dutch for the most, transport experts and a younger audience, would have probably created a certain amount of bias in the survey. Despite the fact that the wanted number of respondents (around 100), drawing conclusions with the relative low response and inequality in responses from different groups (for example more 20 – 30 year old respondents than 50 – 60), should be done very carefully. Every hypothesis or conclusion that is drawn from this survey should therefore be cautiously made with the knowledge of present biases in the responses.

A noticeable aspect of the composition of the group of respondents, was the high majority of leisure travellers in the survey. According to KiM (2020) the motives of people travelling from Schiphol in 2018 was as followed.

Table 8 Travel motives from Schiphol Airport 2018

Motive	Percentage (%)
Business	33
Holiday	46
Visiting friends/family	20
Other	1

During the survey of this research, the only options that were given were leisure and business, where leisure was assumed to be a combination of vacations and family/friendly visit. The panel consisted of 73 leisure travellers and 10 business travellers, which corresponds with a ratio of 7-to-1. Revealed data for travel motives from Schiphol show a lower ratio however, being 2-to-1. This concludes that the panel in this research does not reflect the real travel motive composition, which need to be taken into account in the conclusions.

The lack of business travellers in the sample probably relates to the fact that the highest share of business travellers are males from 35 – 44 years old (28 % of the males of 35 – 44 years old versus 18 % in general) (van der Lelij & Oomen, 2019). Panel in this research were mostly between 20 and 30 years old, which are therefore mostly not assumed to be a business traveller.

Results from the survey might indicate that male travellers are more likely to use the integration platform. However, the number of responses from male and female were not even. The ideal situation would have been to get a 50/50 ratio, which makes the conclusion or observation more legit.

A further discussion can be made on the composition of respondents travelling alone or in groups. The survey did not consist of a question that would identify how respondents travelled in their last trip, either individual or in a group. This is an important aspect in the modal choice for their last mile trip, as costs can be split up especially if the group consists of young travellers/students. Dividing the cost for a taxi for example probably in some cases made that alternative more attractive, affecting public transport usage.

Furthermore, as the peer review interviews also indicate, travel taste preferences highly depend on individual tastes. Individuals have habits in modal choices in other fields of transport, which might apply to the scenario of choosing a transport mode to/from an airport.

Lastly, the assumption was made that the integration should have the purpose to provide travellers with a service to overcome unfamiliar situations in choosing public transport from an airport. However, a statement was made in the peer review interviews that an argument against the platform were the unfamiliar characteristics of public transport at an unfamiliar airport. Despite the fact that this is only one qualitative statement, it should be taken into account that the use of the integration might not only be based on unfamiliar situations, which could even discourage people to use it. This might explain some negative responses, or lower scoring in general (neutral responses), since this could be a reason.

6.7 Conclusions/hypotheses

The survey was used to get an overview on what preferences are for travellers are when choosing a transport mode to/from an airport and what their opinions are on the possibility of purchasing a public transport ticket before reaching the unfamiliar airport. It was expected that there would be a significant difference in scores for people using public transport in that case in general and if there is an integration platform available. First main observation was that the general usage of public transport in that case is 77 out of 100, which can be assumed as a high score. A t-test however showed that the introduction of an integration platform would not lead to a statistically significant difference in public transport usage from an unfamiliar/foreign airport. However, further in-depth analysis was made were standpoints towards the platform were plotted against characteristics of the respondents in order to find potential promising groups. According to the small sample, it was found that it seems that the platform could be successful for male travellers of 20 – 30 years old. Another observation might indicate that the platform would be more suitable for leisure travellers instead of business travellers. Lastly, the sample showed that people with a master's or bachelor's degree have the relatively least amount of negative responses. Further interviews with respondents of the survey showed that travel taste preference of travellers highly vary in general, making drawing overall conclusions difficult.

As has been mentioned in the discussion part of this chapter, conclusions and hypotheses should be made very cautiously given the panel in this research. However, outcomes of the survey are interesting and therefore a more detailed and sophisticated approach of another survey, especially with choosing your panel to create an equal number of male and female respondents, could be a next step with this topic. Hereby, promising groups for the integration platform could be sought for in more detail with the use of a latent class cluster analysis. With this research method, constructs are created from unobserved subgroups that are based on individual responses (Solutions, 2020). Eventually, groups found with the latent class cluster analysis could be compared with the groups that were found in this thesis.

7 Travel Providers (Ticket Platforms, Travel Agencies and Transport Operators)

Following the overview of revealed landside transport data and the transport options for every airport, this chapter describes the current situation regarding travel providers of aviation and public transport. Booking an airline ticket can be done in various manners, which can be explained with an interface structure consisting out of the traveller, airliners and travel agents. On the other hand, service provided via public transport towards travellers differ per country. These interactions will be elaborated on in the coming sections.

7.1 Interface Traveller – Airliners – Travel Agents/Ticket Platform

As has been mentioned in chapter 3, where the stakeholder interface in this case is depicted, travellers can book their flight ticket directly via the website of the airliner or via a ticket platform, such as Booking.com or Skyscanner. The development of the internet had a major influence on the history, technological progressions of these travel agencies, creating a new definition of the Online Travel Agent (Sánchez, Gutiérrez-Artacho, & Bernardino, 2017). This concept forced companies to adapt to new methods of communication and connection between customers and third companies using web services, which exchanges data between various platforms and applications via the internet. As a result, online travel agents can provide programming interfaces to third parties. This leads to an access towards information regarding airfares which enables optimizing flight searches and automated management processes (Sánchez, Gutiérrez-Artacho, & Bernardino, 2017). Foris et al. (2019) mention that reseller booking sites invest high amounts of money in the development of their web platforms as a part of a global marketing strategy. Despite the high amount of investments, not enough attention has yet been paid on the usefulness and effectiveness of the websites.

This phenomenom already led to the decline of the role of traditional travel agencies providing complete travel packages towards customers. Consumers apparently increasingly prefer planning their trips individually instead of approaching a traditional travel agent for a full package service (Yoon, Yoon, & Yang, 2006). The study of Castillo-Manzano & López-Valpuesta (2010) gave insights on other causes. These were airline companies getting more familiar with the internet and thereby extending their own services into an own full travel agency and the deregulation of the airline market resulting in the rise of low cost carriers, such as Ryanair and EasyJet. These airlines make use of their own website, making traditional travel agencies more unnecessary.

According to Hatton (2003), despite the fact that travel agencies becoming less popular at the period around 2003, travel agencies would always have a role in the booking market. Furthermore, Hatton (2003) states that commissions are paid towards travel agents for selling tickets from airliners. Good agencies apparently still provide key advantages for consumers in contrast to directly book at a host of competing suppliers. A metasearch engine, such as Skyscanner also earns from commissions from partners, but besides that formed their business model around advertisements as well (Geven en ondernemen, 2018). Another business model that can be applied is buying and reselling airline tickets. These mentioned business models for online travel agencies are divided into different types, which are given in the table below (Uenlue, 2017).

Table 9 Online Travel agency business models and direct airline sales model

Business Model	Revenue	Company example(s)
Agency Model	Revenue is obtained by commissions in percentages of the sale paid by airliners towards online travel agencies. Agencies with this business model serve as a middleman to offer these airline tickets.	Booking.com
Merchant Model	Revenue is obtained by firstly buying a batch of airline tickets at a discount and reselling the tickets for a higher price but often still under the market price, making their service attractive for consumers. Agencies than can be compared with a salesman.	Expedia
Advertising Model	Revenue obtained in various ways: - Click-based: commissions paid towards agency via costs per click, independently if a booking will be made. - Transaction-based: Commissions paid towards the agency through direct bookings via the agency's website. - Display-based: Commissions paid for having banner ads on the agency's website. Commissions are defined in costs per impression. - Subscription-based: Commissions paid towards the online travel agency via a contract for a period of time.	TripAdvisor, Skyscanner
Direct Sales Model	Airline company directly receives revenue by selling their tickets via their own booking website.	Airliners (e.g. KLM or Transavia)

Concluding, the interface between the three relevant parties can be displayed visually. The process starts at the traveller, which can make the decision between booking an airline ticket, directly from the airline's website or from a travel agency/ticket platform. Furthermore, the interaction between airliners and the ticket platforms than might differ according to the handled business model explained in table 9. Therefore, ticket platforms/travel agencies would either buy a batch of tickets from the airliners, serve as a middleman to sell tickets or serve as a advertisement tool for the airliners. These interactions should be part of the conceptual framework of integrating booking and

payment for air- and public transport tickets, since the business models of the ticket platform might be complied to for implementing public transport tickets as well.

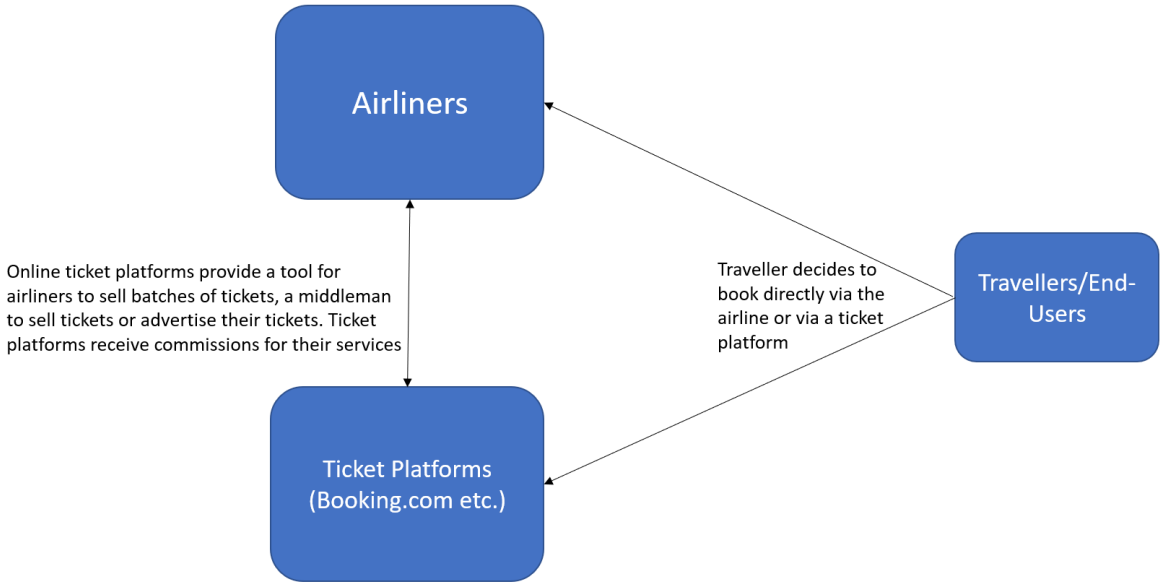


Figure 39 Interface airliners - Ticket Platforms – Traveller

7.2 Interface Ticket Platforms/Travel Agencies and Trip Providers

As has been mentioned in the introduction, travel agencies and ticket platforms have yet implemented an extension for booking public transport. From sites like Skyscanner and Booking.com, extensions on car rental and/or airport taxis can be noticed.

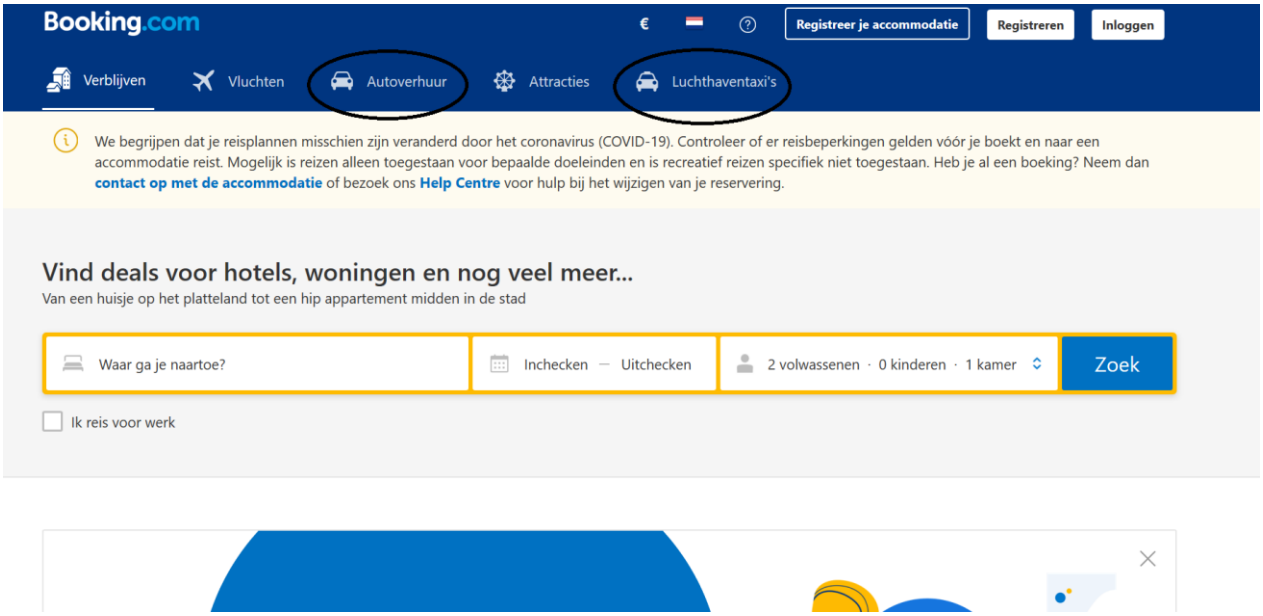


Figure 40 Extensions Booking.com

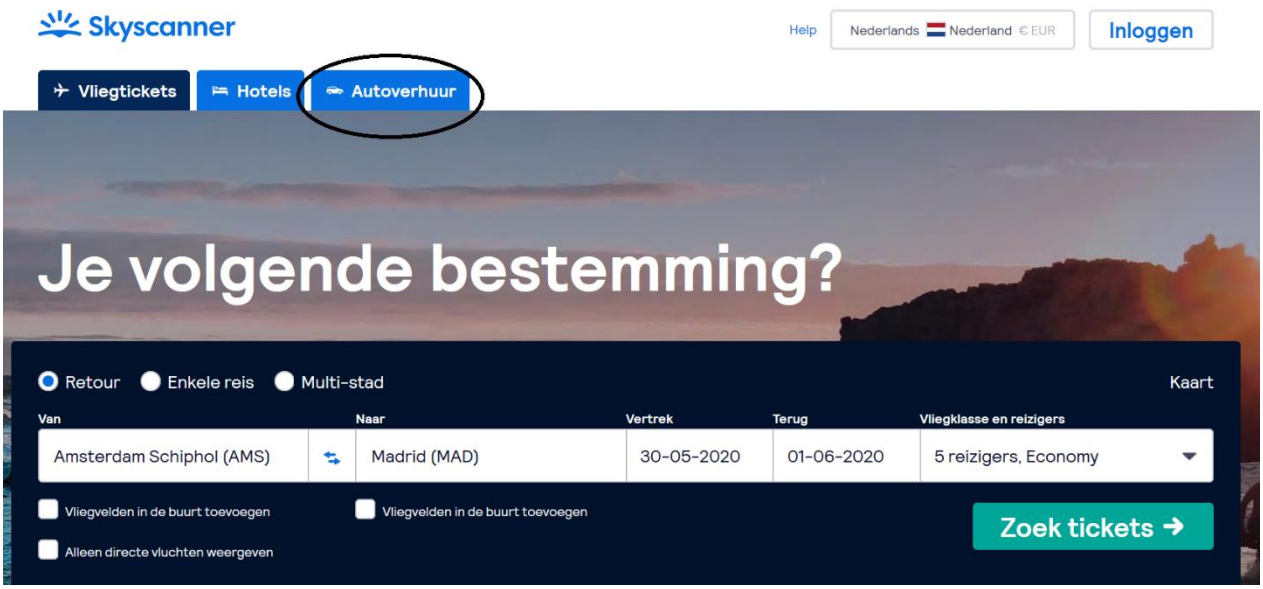


Figure 41 Skyscanner Extensions

Table 9 showed the different business models of travel agencies. Imaginable hereby is the importance of margins that extensions offer towards these agencies. Hereby, according to Radiuz (2019) public transport has not been taken into account because of their low margins and legislations. Therefore, parties like Booking.com or Expedia have shown interest in taxis because of having higher margins and less legislative related matters.

8 Stakeholder Analysis

Next step in this thesis is to elaborate on the desirability and feasibility of the integration platform with respect to the stakeholders that play a role. Therefore, relevant stakeholders will be identified and analysed on their standpoints and requirements regarding the integration platform. A detailed description of all stakeholders are shown in Appendix D. Furthermore, interactions will be explained as well and stakeholders will be placed in a power-interest diagram and problem-frame diagram.

The stakeholders that are taken into account are:

- Airliners
- Public transport companies
- Governmental bodies
- Travellers
- Travel agencies/ticket platforms
- Mobility companies
- Airport authorities
- Taxi companies
- Car rental companies

8.1 Power-Interest Diagram

The stakeholders that are mentioned can be characterized by their power and interest in the integration platform. These power and interests of each stakeholder can be displayed in power-interest diagrams. Power and interests of the stakeholders are the two dimensions in this concept, which are displayed in a two by two matrix. Four types of stakeholders are hereby distinguished namely, players, subjects, crowd and context setters. In a specific case, players would have a high interest and power; subjects have little power, but a high interest; crowd have little interest and power; and lastly context setters have low interest, but high power for a specific topic (Stathopoulos, Valeri, & Marcucci, 2012). With this knowledge, how to cope with the stakeholders can be distinguished as well. Crowd should only be monitored, context setters should be kept informed, subjects need to be kept satisfied and players need to be managed closely. The diagrams give an overview in which stakeholders' interests and power need to be accounted for (Bryson, 2004). With this figure it can therefore be determined which players need to be highly taken into account versus which players should only be monitored. Eventually when implementing the integration platform, the diagram reflects on the important and less important stakeholders for the initiators of this platform.

Displaying the power-interest diagram will be as followed.

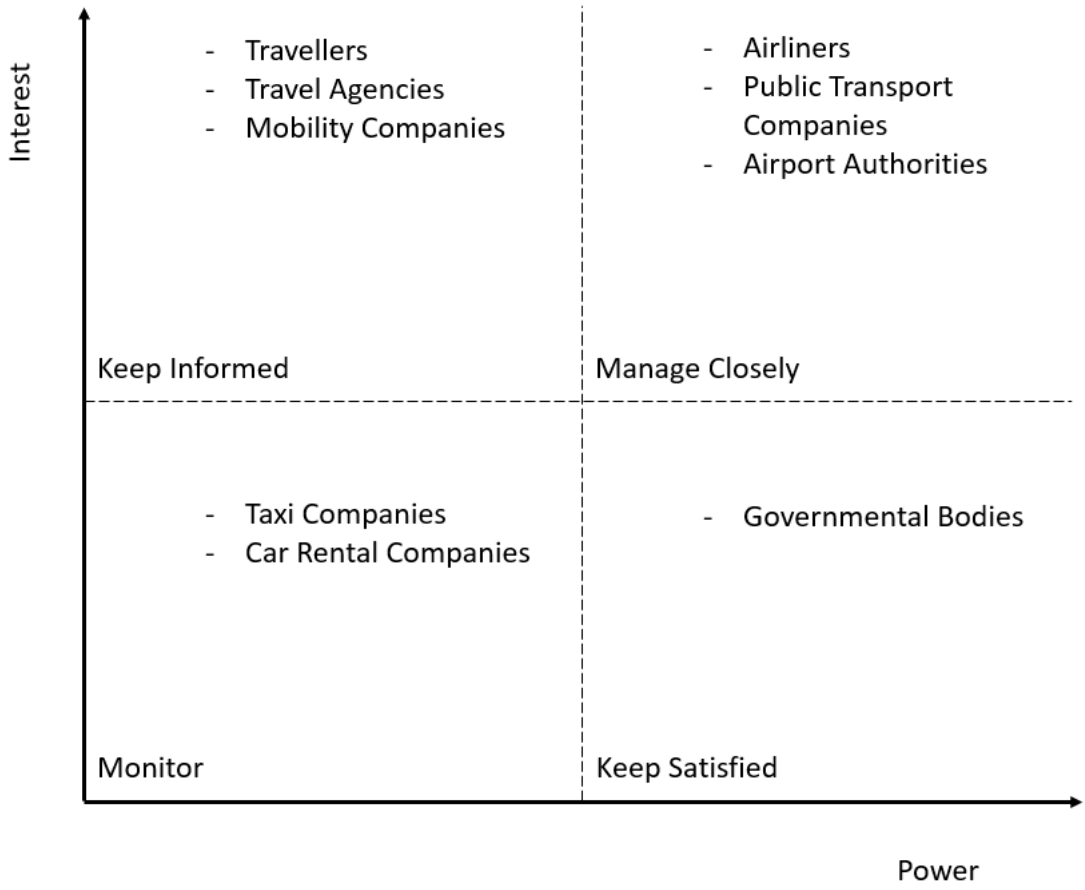


Figure 42 Power-Interest Diagram for the Integration Platform of Air- and Public Transport Tickets

Taxi companies and car rental companies are seen as crowd in this specific matter. Each party does not have high interest in this ticket integration between air- and public transport. Integrating booking and payment does not have a direct impact on airport operations. It might affect taxi and car rental operations, though these parties might not be afraid of many customers switching, since the concept has not been implemented yet. The two parties do not influence ticket sales decisions of air- and public transport.

The context setter in this topic would be the governmental bodies. These namely have a high stakeholder power in the sense that they control and set relevant legislations and governance. A big part of the desirability for the booking and payment integration of the tickets depends on this. Governmental bodies would have interest in this integration. However, it would not be seen as the most urgent point on their agenda. It can potentially promote public transport and therefore improve environmental footprints. The magnitude of this footprint depends on the demand towards the integration platform.

Subjects in this context are the travellers, travel agencies and travel mobility companies. These three parties would have high interest, but a less decisive factor in the overall judgement of feasibility and desirability of the integration platform. Travellers would have interest for their travel ease, where travel agencies and travel providers would have a more commercial interest perspective.

Main players for judging the feasibility and desirability of integrating booking and payment of air- and public transport tickets, are the airliners and public transport companies themselves, and the airport authorities. These should therefore be managed closely when potentially implementing the integration platform. The high interest and power

lays in the fact that direct sales come from the airliners and public transport companies and will therefore be the key players for enabling a third party to combine their tickets. The airport authority might oblige the airliners that are closely related to the airport to do so.

8.2 Problem-Frame Diagram

Besides wanting to know what specific power and interests are of stakeholders in this topic, standpoints for every stakeholder are of importance as well. The power-interest diagram does not feature if a stakeholder would oppose to the initiative or not. Hereby, a problem-frame diagram can be used. This diagram includes stakeholders who are characterized as an opposition or supporter to the initiative versus their stakeholder power. Given this structure, the diagram gives the ability to identify strong and weak opposition or supporters of the integration platform.

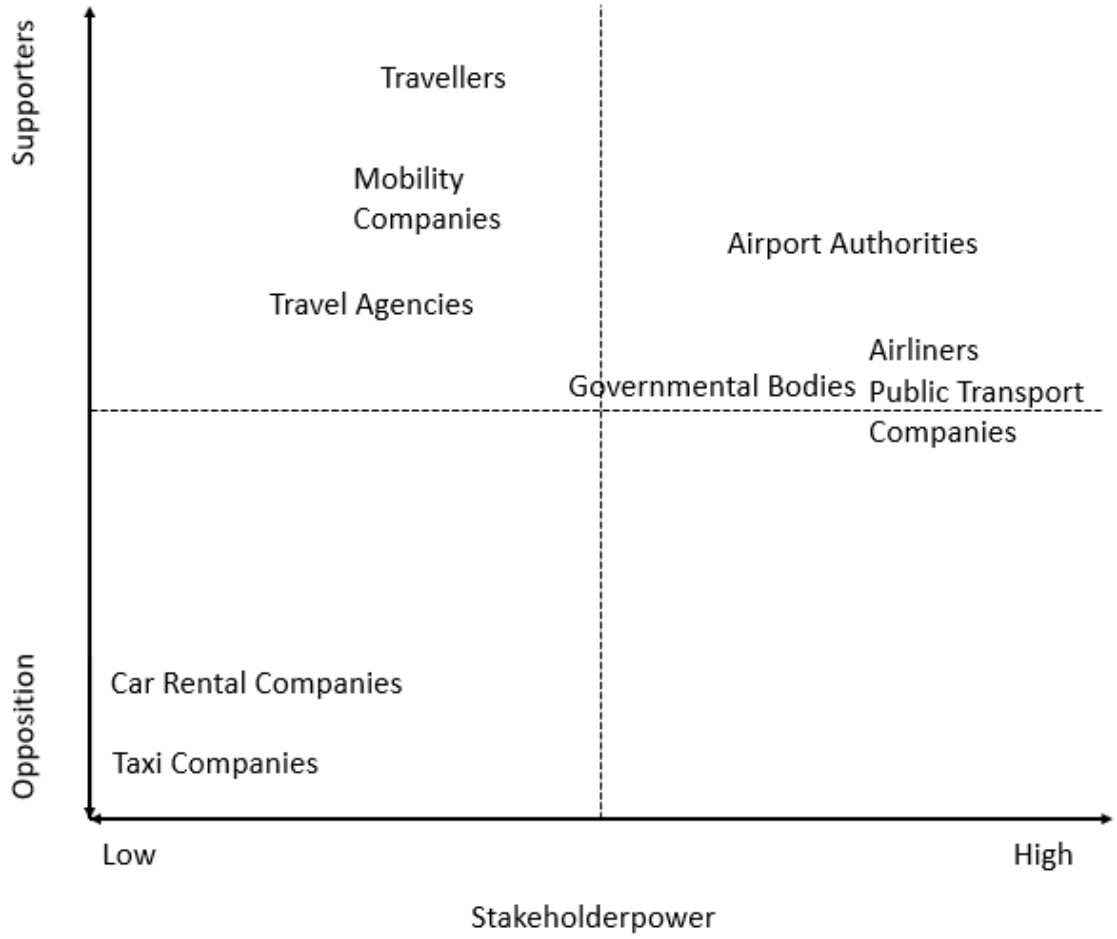


Figure 43 Problem-Frame Diagram for the Integration Platform of Air- and Public Transport Tickets

Figure 43 displays the supporters and opposition towards integrating booking and payment for air- and public transport tickets. Taxi and car rental companies are seen as the biggest opposition parties, despite their low stakeholder power in this case. Airport authorities would be slightly affected if the integration reduces their revenues at for example parking, but the integration might solve other landside transport related problems, such as congestion. This however might depend on the character of the airport being more national or hub orientated (more in chapter 9). Governmental bodies would be a supporter for this integration, but not the biggest. Travellers and public transport companies can be both supporters or opposition parties based on their approaches regarding landside transport (Appendix D), followed by travel providers, travel agencies and airliners. Travel providers and

travel agencies might see opportunities for ticket sales. Airliners might see the integration with local public transport as an additional service, what can lead to higher popularity through air travellers.

8.3 Conclusion

There are multiple stakeholders that play a role in the integration of booking and payment of air- and public transport tickets. The power-interest and problem-frame diagrams show the positions, interests and standpoints of each stakeholder. Each stakeholder was divided in a group being crowd, context setter, subject or player, and if the stakeholder is a weak or strong supporter or opposition. Concluded can be that the direct parties, airliners and public transport companies, and the airport authorities are of most importance because of their direct matter in this context. Eventually, standpoints of the stakeholder can highly depend on the demand that would be generated and the new legislations that might need to be introduced. Therefore, following this chapter relevant governance aspects regarding this topic are discussed, which can further illustrate how stakeholders would state their standpoints with respect to rules and regulations.

9 Governance and Legislations

Section 4.4 already described current governance methods and trends within the world of public transportation and aviation. This knowledge will be used in this chapter about governance and legislations that will be relevant for the integration of booking and payment of air- and public transport tickets. Identified will be which types of governances are most suitable, which forms can be used and which measures need to be taken additionally. For this an expert in the field of public transportation governance, Wijnand Veeneman of the Technical University of Delft, was interviewed (Veeneman, 2020).

9.1 Governance Trends in Public Transportation

From the literature review regarding this topic, it was identified that governance of public transportation is divided into two types of governance, namely competitive tendering and market initiatives/open access (Van de Velde, 2014). Furthermore, the trend has been discovered that the European Union has forced countries to involve more competition on public transportation lines in order to improve quality (EU competition policy in the transport sector, 2015). In the interview it was discussed if increasing competition would benefit the specific integration platform. This highly depend on how the public transport lines are being serviced and the card system that is handled. Imaginable is that when a country handles open access, often a monopoly is created by one public transport company. These sort of companies thereby would keep their ticket sale platform closed due to their dominance in the market. An example is Germany, where public transport governance is in principle open for access, though Deutsche Bahn has almost full control on the German rail network. Third parties in this case have almost no influence on ticketing. Increasing competition by governments allows for more tendering and control from governments, which leads to more open ticket systems. An open ticket system would thereby be more approachable for third parties to sell tickets via an integration platform for example and is therefore essential.

A comparison on ticketing systems between the Netherlands and England can be made. In the Netherlands the ticketing system is a single closed system, operated by TLS (Trans Link Systems). England on the other hand is more open, where public transportation consists of more ticketing systems across countries. Despite the fact that it consists of various ticketing systems, an organisation is present which implements all ticket systems to link public transport services. The Netherlands has integrated their ticketing systems further with respect to similarities in transaction for example. This has the benefit that the integration of booking and payment would be easier as the link towards all public transport modes can be made. On the other hand, the different ticketing systems in England might see the integration as an important addition, meaning that these might see it as a competitive addition maybe leading to a higher interest.

Section 4.4.1 also identified that new developments in public transport would require regulative structure rethinking by governments. This also implies on ticketing in public transport and air transport. Since this has not yet been implemented, current laws might be outdated. New technologies and developments in general lead to the need of new up to date regulations.

9.2 Governance Trends in Aviation

The interviewee is an expert in public transport governance. However, this subject also needs an aviation governance perspective. In section 4.4.2, it has been notified that within aviation similar developments have taken place with respect to privatization. Airports have namely become more private over the past years. Veeneman (2020) thereby takes the hypothesis that private airports are more willing to have a hub function, where airports more restricted by the government have a more national function. As a result of this, imagined can be that airports with governmental restrictions would pay more attention towards their surroundings. Therefore, these airports might put more energy in improving local public transport to/from the airport, than other bigger private hub airports.

9.3 Combination Aviation and Public Transportation

Eventually this research is about integrating booking and payment for air- and public transport tickets. There are already links between air transport and public transport, though literature showed that these public transport services were serviced on a larger scale. Veeneman (2020) mentions that this depends on what airliners see as destinations in their own network. To illustrate as an example, if an airline arrives at Frankfurt Airport, Berlin might still be an interesting destination. Berlin however is not part of their flight network and so therefore the airline would approach Deutsche Bahn to operate this line with a transfer. Why local public transport has not been implemented therefore seems a result of airliners not seeing more close by cities, villages and/or suburbs as an end destination of their customers.

Another mentionable aspect is the beforementioned importance of culture and habits in a country. This reflects in transport related choices that inhabitants of a country make. A biased judgement on a policy that this integration would not benefit public transportation beforehand, because of a country traditionally being more car orientated, can affect the potential of the integration platform of this research.

Last question of the interview was why the concept of integrating air- and local public transport tickets has not been done yet. Veeneman (2020) thereby sees complexity and resistance of linking the tickets and with additional disruptions such as delays as a main reason that this has not been implemented yet. For it to operate successfully, appropriate and sufficient coordination would be required. Thereby, the interviewee sees main roles between the airliner or ticket platform and public transport companies. Airports namely do not have an impact on ticket sales.

9.4 Conclusion

Concluded can be that the way public transport governance is organized can impact the successfulness of the integration platform and especially the open character of the ticketing system plays a very important role. Main interaction would be between airliner/ticket platform and public transport company. Characteristics of an airport can reflect in the emphasis an airport wants to make on local public transportation. Longer distance public transport integrated with air transport has its successes and the link with local public transport is assumed to have more complexity and resistance. These findings are used as input for the conceptual framework and business model canvas in the next two chapters.

10 Conceptual Framework Booking and Payment Integration

With all the input that has been obtained via revealed and stated travel preference data, a literature review, interviews and a stakeholder analysis, a conceptual framework for integrating booking and payment for air- and public transport tickets can be displayed. The conceptual framework consists of two parts, which corresponds with frameworks that are designed from the stakeholder analysis, and the survey combined with findings from literature and interviews. Both frameworks consist of important factors that are found during the course of this research.

10.1 Conceptual Framework from Stakeholder Analysis

From the stakeholder analysis, seven main factors were identified being:

- Economic benefits
    - Depended on:
        - Margin in ticket sales, especially in public transport tickets
        - Volume of travellers willing to use the integration platform
- Customer satisfaction
- Transport culture
    - Split up in:
        - National transport habits
        - National transport agenda
- Service Economy
- Environmental goals
- Collaboration contracting
    - Important parties to contract:
        - Public transport providers
        - Airliners
        - Travel agencies/mobility companies
- Airport conditions
    - Divided into:
        - Environmental footprint
        - Parking: does the airport own parking lots?
        - Congestion issues

The factors that were identified are explained in the coming sections.

Economic Benefits

The integration platform would be interesting for stakeholders when the platform would create economic benefits for these parties. Parties, such as the public transport operators, travel agencies, mobility companies and travellers would want to have an economic incentive to use the platform. Travellers would want to have evidence that with the use of the platform they are saving money. Providers, such as the public transport operators, travel agencies, mobility companies and airliners, would provide the service if there is potential for economic value. Important factors within this are the margin and volume that the integration platform would generate. Margins in public transport, as has been found during this research, are considered to be small because most of the time public transport is being subsidised by the government (Radiuz, 2019). With the margins being small, parties would need a high volume of travellers that are willing to use the integration platform. In this way the platform could be economically beneficial for the providers.

Customer Satisfaction

Another important factor would be the satisfaction that travellers would get from being able to buy a public transport ticket from home. Furthermore, the service would include an application which provides elements such as wayfinding, public transport timetables and delays. With these elements, the aim is to ease the trip of travellers in

unfamiliar situations. Hereby, the satisfaction level that the traveller gets is of high importance, since this effects the number of times that the travellers would use the platform.

Transport Culture

From the revealed modal splits to/from airports and the insights of countries visions on transport, it is imaginable that the transport culture of a country also has an impact on the feasibility/desirability of the integration platform. Each country has its own legislations/agenda corresponding with transport, which can highly differ between each other. Furthermore, each country having their own approach have led to habits that inhabitants of the country have. Many elements thereby pay a role that determine the affection of a population with public transport for example. This study has for example found that public transport is the most popular transport mode to/from Schiphol Airport, in contrast to Frankfurt Airport to name an example. The willingness of travellers to use public transport has an impact on the feasibility of the platform to become successful.

Service Economy

At airports, service economy is an aspect that must be taken into account. This phenomenon is characterized as the contracts that various parties would have with each other. An example is a contract that a travel agency has with a taxi company, where both parties benefit from with sales for the travel agency on one hand and more customers for the taxi company at the other. This can/may also involve the airport by itself, having contracts with certain transport operators. Service economy therefore, where parties benefit from each other, possibly has its impact on the feasibility and desirability to incorporate a platform that only promotes public transport. Stakeholders/parties might not be willing to leave or jeopardise their successful collaborations.

Environmental Goals

Within governmental bodies such as the European Union, goals and legislations are set up to achieve environmental goals with transport. Public transport is seen as a transport mode that has environmental benefits. Given this statement, governmental bodies might favour public transport usage and therefore promote the use of an integration platforms that thereby contributes to possible increases in public transport usage.

Collaboration Contracts

Making integration between air- and public transport tickets requires a certain level of collaboration between various parties. In some cases, according to Mulderink (2020), setting up contracts between a mobility company, such as Tranzer, and public transport companies is a tough task. These operators would namely be hestiant to fully cooperate because of the fear of benefitting the mobility companies too much. Mulderink (2020) also thereby mentioned that the process of setting up contract can be time exhaustive. Given that the number of parties that could be involved in this platform is very high, making creating collaborations in general very complex.

Airport Conditions

Airport authorities play a significant role in the feasibility of the integration platform. The role that it takes, depends on the conditions a certain airport is in, such as their environmental footprint, which parking lots the airport owns and the magnitude of congestion that the airport experiences. All these factors might influence the willingness of an airport to cooperate in promoting the usage of public transport and therefore possibly advising or obliging airliners and/or public transport operators to use the platform. And the other hand, parking lots are often owned by airport authorities. Discouraging car usage reduces parking revenues, which might oppose airport authorities to the air- and public transport integration platform.

10.2 Conceptual Framework from Literature, Interviews and the Survey

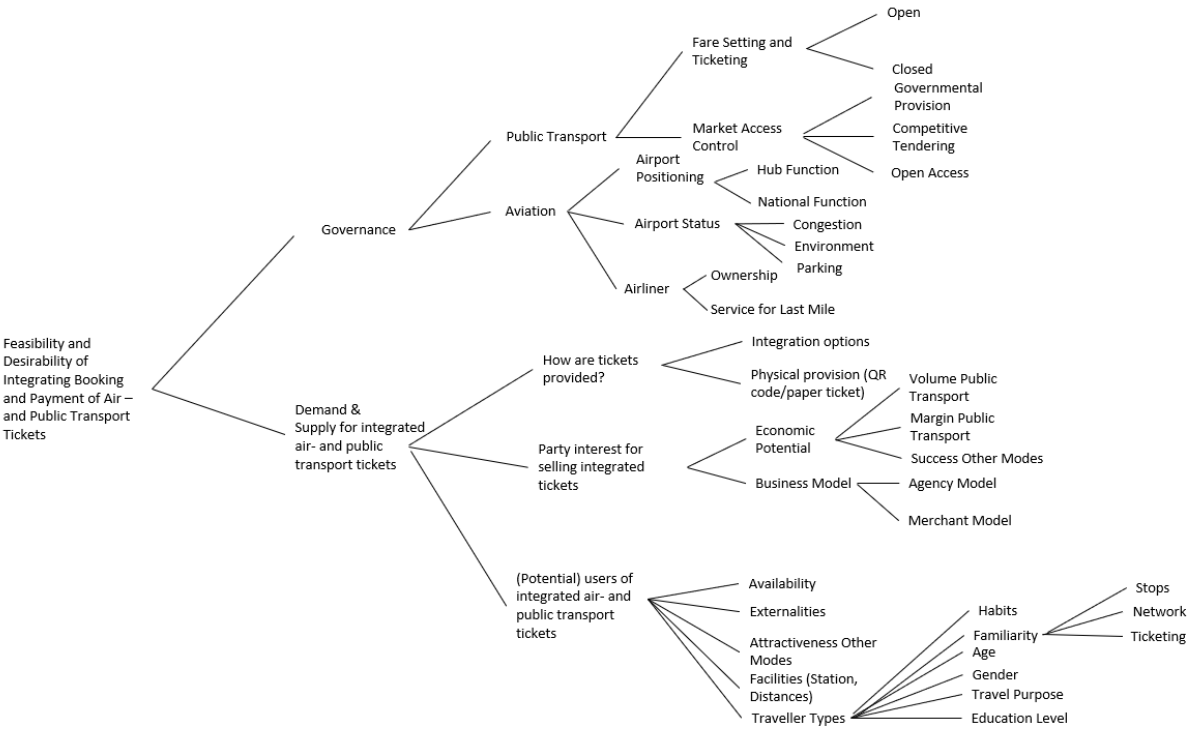


Figure 44 Conceptual framework from literature, interviews and the survey

Besides the factors that were found from the stakeholder analysis in this analysis, other factors (and overlapping factors) were found from the survey, literature review and interviews. From the study it was identified that the factors for the feasibility and desirability for integrating booking and payment of air- and public transport tickets can be divided into two main groups. These are a group of factors related to governance and the other group with the demand for the integration platform. As can be seen, the framework consists of lines, which correspond with splitting up the factors in subfactor and sub-subfactors further on. This has been done, since particular factors rely on other factors by itself.

10.2.1 Governance

First group of factors that influence the feasibility and desirability of the integration platform is the group that relate to governance. Within this group of factors, a distinction is made between governance that relate to public transport and aviation.

Public Transport

Within the governance of public transport, the most important aspects are on how public transport operators handle their ticketing and fare setting, and if the public transport operator in the area of an airport has to deal with open access, competitive tendering or governmental provision. Firstly, in an interview with Veeneman (2020) it was made clear that the character of ticketing would have a high influence on the feasibility of this integration platform, either being open or closed. Discussed was that an open character of the ticketing system would often lead to a public transport operator having a monopoly on the public transport tickets, making it difficult for third parties to sell tickets. A more closed system and thereby controlled by a regulatory/governmental body, leads to more competition and therefore chances for third parties to be involved in the ticketing system.

A similar view can be done on the overall character of tendering in a country, being open access, competitive tendering or governmental provision. Again, it is assumed that a regulatory body with competitive tendering would give higher chances for third parties to get involved in public transport services.

Aviation

Governance within aviation experienced changes over the last years mainly having something to do with privatization and deregulation in the airline and airport industry. These trends have led to more freedom in this business and overall increase in air transport usage. Privatization and deregulation have led to airports having the opportunities to fulfil hub function roles spreading their market wider than only on a national level. In the interview with Veeneman (2020), the hypothesis was stated that a more national orientated airport instead of a more hub orientated airport would value the connection with public transport more. This also has a link to an airport paying attention to their surroundings or status, which involves environment, congestion and parking. A hub airport might also have a high focus on transfer passengers, where national orientated airports would concern their near surroundings as an important factor.

On the other hand of the aviation spectrum, airliners could play a role as well. Airliner governance is thereby split up into ownership and service related to last mile trips. With privatization and deregulation, airline ownership has experienced similar trends as with in airport governance. Airliners' ownership has moved more towards shareholders nowadays, where shareholders can give their view on the integration platform. Furthermore, the attention that airliners in their governance give towards landside services is of importance as well. Thereby the question would be to what extent airliners are willing to think about linking public transport with their services and therefore potentially increasing the satisfaction level of their customers.

10.2.2 Demand and Supply

The other group of factors relate to the demand that can be generated or that there will be for the integration platform. It is inevitable that the demand for the service needs to be sufficient to let it operate successfully. Demand is split further into three sub categories being service provision, third party sellers and modal choice at the airports.

How are Tickets Provided?

Within the survey it was asked how respondents would like the integration being provided. This came with to what level the public transport ticket should be integrated and in which form the ticket should be provided. Respondents indicated that they value these aspects of the integration, where the biggest group prefers the integration to still be an option instead of a compulsory addition. Also, since many things are getting more digital, people would prefer ticket provision via smartphone and/or tablet.

Party interest for selling integrated tickets

In order to combine air- and public transport tickets, the need for a third party is often present being a mobility company (such as Tranzer) for example. Another option would be a travel agency such as Booking.com or Skyscanner that already offer airport taxi services for example. Again, the economic aspect is hereby of high importance, where third parties will judge if the combination of margin within the integration and volume/demand would be high enough. A more external aspect hereby is the attractiveness of other modes.

Furthermore, section 7.1 indicated the various business models that travel agencies have. The options were the merchant, agency, advertising and direct model. Assuming a third party would sell the integrated tickets, the merchant and agency model would suit best. Third parties vary in their business model and having a merchant or agency model does have an effect. As has been indicated, the difference between the two is that within a merchant model a batch of public transport would be bought beforehand for reselling to a higher price, where the agency model would involve commissions paid by the airliners and/or public transport operators. Views of both types of travel agencies towards this integration and the potential that these parties see would influence the overall feasibility and desirability of the integration platform.

(Potential) users of integrated air- and public transport tickets

Lastly, a very important factor is the modal choice that the travellers make at an (unfamiliar/foreign) airport, and therefore which travellers are going to make use of public transport. From the literature study, factors that can

influence the modal choice at airports were identified. This also holds for the most decisive factors identified from the survey that was held during this research. Modal choice at an airport is divided into:

- Availability: in order to make it feasible to book a public transport ticket with an airline ticket, the public transport to/from the unfamiliar/foreign airport needs to be sufficient. The public transport operator in this case also needs to have agreed to collaborate in selling their tickets.
- Externalities: external factors, such as safety, acquaintances of the traveller living at the end destination and satisfaction of public transport, can have an influence as well. An example was the example mentioned by Donners (2020) where public transport to/from Charles de Gaulle is not the most popular mode also because of safety and the route the train takes, being through the problem areas of Paris.
- Attractiveness of other modes: the attractiveness of other modes has an influence on the use of public transport to/from an airport in general. Factors, such as distance, travel time and costs lead to a consideration that the traveller makes during their modal choice.
- Facilities: the facilities that are present for providing public transport services is of importance as well. Aspects such as the presence of a train station and other public transport stops often promotes the use of public transport.
- Traveller types: from the survey it was identified that characteristics of a traveller influences modal choice. a group of respondents from the survey indicated that familiarity of the situations they are in when choosing a transport mode for their last mile trips influences their choices. Characteristics of public transport that operate to/from an airport plays a role and specifically the knowledge of travellers of the network, type of ticket needed and the location of stops relevant for their trip. modal choice also highly depends on habits that travellers have in transport related scenarios. A transport mode that is common for a specific traveller, would be a likely choice made at an unfamiliar airport/situation. Lastly, directly related to the integration platform, characteristics like age, education level, gender and leisure or business travel purposes influence modal choice and the usage of buying a public transport ticket before reaching the final airport.

10.3 Comparison Factors

Noticeable between both frameworks is the fact that there is overlap with factors in both, but also factors that are present in the overview from the stakeholder analysis but not within the conceptual framework based on the survey, literature and interviews. Among the reasons for this is that the survey was mainly based on responses from travellers and that there was no literature available corresponding with this integration and the involvement of stakeholders within it, as this concept that is being researched in this thesis has yet to be implemented somewhere. Two factors from the stakeholder analysis that are not present in any possible way in the other framework, are service economy and environmental goals. At first, service economy would be between the travel providers, such as taxis, and airport authorities. This factor was not judged within the survey or literature. Lastly, environmental goals would mostly relate to goals that governmental bodies set and which they see as important. More specifically, transport emissions for example as a whole would be considered, instead of only specifically this topic as this is part of the bigger picture.

10.4 Conclusion

This chapter has shown two parts of the overall conceptual framework, which indicates the most important factors in judging the feasibility and desirability of integrating booking and payment of air- and public transport tickets. Both schemes show a high amount of factors that have an influence. Therefore, it can be concluded that the complexity of this integration is probably the reason for the fact that this concept researched in this study, has yet to be implemented by a party such as Booking.com or Expedia. Successfulness of this integration platform depends on various and diverse conditions, making the implementation of the integration platform a challenge for involved parties. These should namely go through a significant amount of criteria in deciding if these are willing to be involved in creating the integration platform. Criteria/factors named in the overall conceptual framework mostly need to fall in place at the same time.

11 Business Model Canvas Ticket Integration

Another part in answering the main question of this research, is setting up a business model canvas. The business model canvas in this case is used to see how the integration platform can be economically beneficial. In the literature review, an overview of the building blocks was given. These will be explained for this specific scenario firstly, and will be put together in the overall canvas. Most elements are aimed to be related towards the findings from this research, with for example the results from the travellers survey, interviews with for example Tranzer, governance overview and stakeholder analysis. However, some practical elements outside of this study are needed as well. These are more related towards the development of the corresponding application that comes with the integration, cost structure of the platform and the revenue streams. Brainstorm sessions with Royal HaskoningDHV led to some elements related to the practical implications of the platform, which need to be implemented. The business model canvas also has been used by them already in the past. Most of these elements can be found in the key resources, key activities, channels and customer relationships, and costs and revenues. These elements were based on experiences with building applications.

11.1 Key Partners

The first building block of the business model canvas should consist of the key partners in this matter. At first, the operators of transport are seen as an important partner, being the airliners and public transport operators. These parties should give permission to integrate their tickets into one. Furthermore, the airport authority should be considered strongly as well. Important points that these authorities take into account for their operations, such as congestion and parking, are important for the implementation of the integration platform. Third parties such as mobility companies and ticket platforms should be (partly) assigned to offer the service to sell integrated tickets. Lastly, IT companies may be needed to provide specialists in order to build/develop the integration platform and application. These IT companies can either be contracted externally or within Royal HaskoningDHV itself.

11.2 Key Activities

The business model canvas also consists of key activities that are needed for a sufficient level of operation for the integration platform. One of the activities is notifying airport authorities to let them promote the integration platform to airliners and public transport operators, or even oblige these parties to use the integration platform. As airliners and public transport operators are making use of the airport, the authority might have a controlling function on these parties and the authorities would be able to add requirements. Next aspect is to get, buy, or make an API for enabling data processing and enabling the integration platform to operate. Moreover, marketing is needed to promote the integration platform to get ticket sellers to cooperate. According to what Mulderink (2020) (Tranzer) mentioned is that this activity can be difficult and time exhaustive as transport operators might be hesitant to let their tickets be sold by another party. Therefore, contracting is seen as a very important aspect in the process, which need to be done from two sides. This being airliners on one side for selling tickets via their website and public transport operators on the other hand to sell their tickets. Overall the integration platform would provide a service for the users, which therefore as a whole needs to be developed.

11.3 Key Resources

Resources are key as well for letting the integration to be successful. With brainstorm sessions, it was identified what is needed to develop the integration service. The presence of an API for the integration and overall data science knowledge would be needed. Since many parties and factors are involved for seamless operations, these sophisticated methods are essential. The API would function as the engine of the integration and additional data science would be required to get the API to a high/innovative level. Furthermore, in order to let this platform function specific knowledge on how to operate a certain integration platform is needed. For this knowledge and development of the application, data scientists, IT specialists, front-end and back-end developers, and/or UX designers will be contracted to develop it. Also, the platform would require sufficient payback time considered by involved parties to give the opportunity to let revenues outweigh the costs, and therefore the success of the integration platform.

11.4 Value Proposition

The value proposition of this business modal canvas is the service that can be provided by integrating booking and payment of air- and public transport tickets, which with this research is judged on feasibility and desirability. In addition, an application will be provided as well for wayfinding, timetables, delay considerations and other things to ease the traveller's trip.

11.5 Customer Relationships

Overall, travellers will be eased in their trip providing an integrated ticket from origin to end destination, instead of a ticket that brings the traveller from airport to airport. To let customers/travellers notice the possibility of booking a public transport ticket, the service should be promoted. Sites where the tickets can be bought should be provided with a public transport button, similar to an airport taxi button for example. Otherwise, during the booking process of an airline ticket the additional option of booking a public transport should be notified. Actively informing travellers would probably tend them to buy a public transport with the airline ticket. After that customers have booked the integrated ticket, they will be informed for further ease of their trip (wayfinding, timetables etc.), as well as information on which public transport operator will be need to made use of by the traveller.

11.6 Channels

There are some channels that the integration platform should need to operate successfully. At first, advertisement should be used to notify potential customers via the selling platform websites, being from the airliners or parties which for example can be Booking.com or Expedia (white labelling from Royal HaskoningDHV's perspective). Secondly as has been mentioned in last section, booking websites should be provided with links/buttons within the booking process to enable travellers to buy the additional public transport ticket. The application after that is an addition to inform the user on easing their trip. Lastly, another important aspect will be the presence of third party retailers that will be selling the integrated tickets.

11.7 Customer Segment

Eventually, the integration platform that provides integrated tickets will be available for every user that books an airline ticket online. In the survey analysis however, an attempt was made to identify the most interesting groups for the integration platform. It was identified that younger people, high educated, male and leisure travellers would have the most potential. However, since the survey sample was small and not weighted out across the various groups in the panel, only the most noticeable hypothetically promising types are given at first. These are eventually travellers of a younger age, between 20 and 30 years, and travellers that have a leisure purpose of travelling. Targeting this group, with the knowledge of this study, might lead to the highest efficiency.

11.8 Cost Structure

Costs that will come with the integration platform would be divided in fixed and variable costs, with firstly fixed being the investment in creating/building the platform and application with corresponding API and implemented data sciences. Variable costs might relate to tailoring the platform to specific airliners and/or public transport operators at various airports, as various scenarios need to be considered which leads to differences in implementation. Also, since contracting parties is very time exhaustive, contracting costs will be a substantial part of the cost picture as well. Besides contracting, sales costs will be present as well to promote the integration platform and therefore getting third party ticket sellers to cooperate.

11.9 Revenue Streams

Firstly, the peer review interviews gave a small preview of what might be the willingness to pay for the use of the service. The interviewees indicated that a percentage of between 10 – 20 % of the public transport ticket price would

be a fee that they would pay. This means that if a public transport ticket would cost 5 euros, approximately an additional euro would be added to the original price for the service of integrating the booking and payment of both tickets and the application for wayfinding etc. In essence, the provided service should help ticket sales of public transport tickets. Therefore, a small fee for this advertisement should be implemented as well. Lastly, other external third parties can be included in the application for wayfinding as well. An example are food and beverages companies, where a fee on their revenues can be asked as well.

In the next scheme, the business model canvas for integrating booking and payment of air- and public transport tickets is displayed. (For a bigger display, see appendix E)

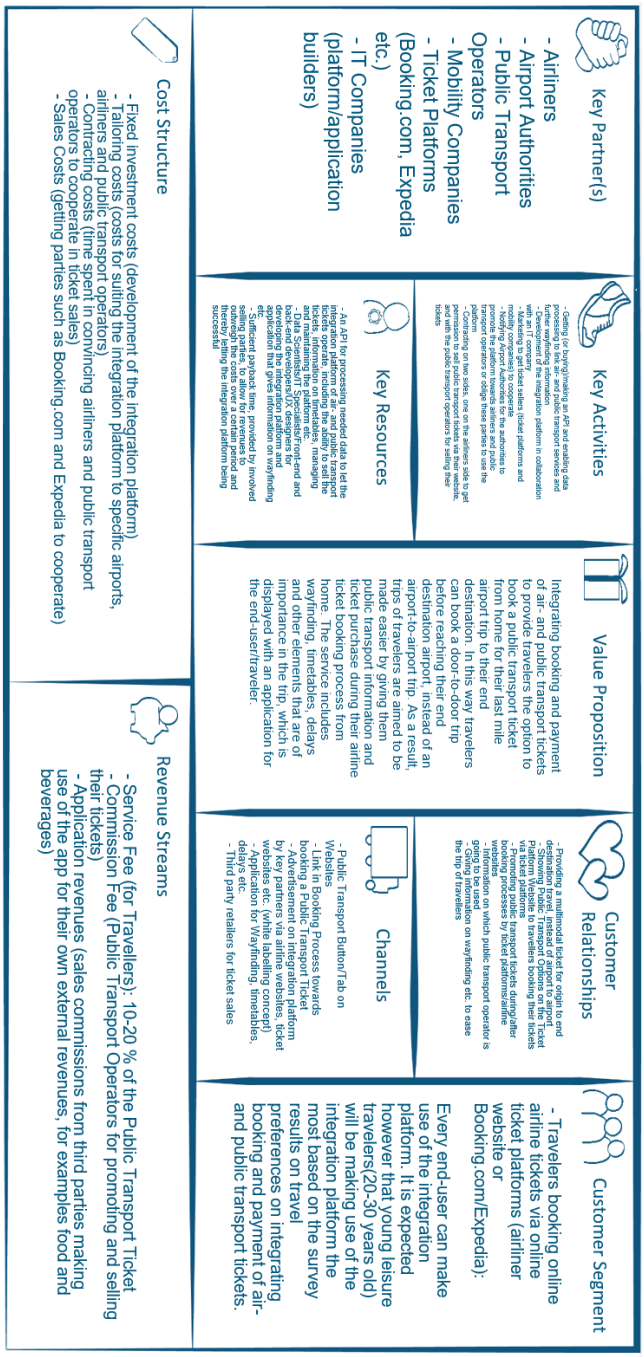


Figure 45 Business Model Canvas Integration Platform

The building blocks within the business model canvas link with each other. Overall, the main aim of the integration platform is described within the value proposition, as this is what is aimed for to reach as an end goal. At first on the left side, to involve key partners that are needed for the value proposition, key activities will be dedicated to provide tools to involve these key partners. Key resources depict the human and physical resources that are needed from these key partners to contribute to the value proposition. On the right sight of the canvas, the customer segment that is targeted with the value proposition is served via various channels to supply the value to them. With the customer relationships, the type of aid variations are described in order to achieve the value proposition for them. These blocks thereby stand on the cost structure, which explains the involved costs that need to be made to reach the value proposition, and the revenue streams that would come from implementing it.

11.10 Market Potential

In chapter 6, which was dedicated to the survey, specific target groups were specified. These target groups are displayed in the customer segment of the business model canvas that are described as to be young and travel for leisure purposes. Question with this would be if targeting these groups will create a sufficient demand for a good market potential. Overall as also was mentioned within the customer segment, the integration platform will be available for every traveller that books their ticket online. Eventually, for involved parties benefits should outweigh the costs that the integration platform would bring to get the integration of booking and payment of air- and public transport tickets running.

Chapter 5 showed the volumes of travellers to/from the four airports that were taken into account within the scope of this research. Within these volumes, the question is which share might use the integration platform for their total trip. From the survey results, it was seen that the overall response for the integration platform was mostly positive or neutral, indicating interest by potential users. These users could be characterised as people that would make use of public transport already, but also switchers from other modes. On the other hand, there is still an uncertainty in if travellers would really make use of the integration.

Inevitable is to look at costs and revenues that correspond with the implementation of this integration platform. As has been described, costs consist of initial development costs, contracting costs and tailoring costs. It is assumed that development and contracting costs are the highest, as tailoring costs are assumed to be characterized as small adjustments needed to specific situations. On the other hand, assumed revenues consists partly of a service fee from travellers per ticket sale of around 10 – 20 % and a commission fee for public transport operators as their tickets are promoted and sold (Tranzer handled 5% of the ticket prize (Mulderink, 2020)). To make the platform attractive for all parties, the demand/volume for these integrated tickets should be high enough. It is questionable if only targeting young leisure travellers of 20-30 years old would create a sufficient volume of customers for the integration platform. Reasons for this are at first the knowledge of that not every trip of young leisure travellers will consists of an integrated ticket due to specific scenarios given that public transport will not be used as a transport mode, or that the public transport ticket is bought on the airport itself as travellers already know how to buy these or that they are being adventurous to take care of themselves. Secondly, the share of young travellers should be examined. According to Reed (2016) the age group of 18-34 and 35-54 each are responsible for 35 % of the total in the case of US air passengers, with the age group of 18-34 flying 6 times per year on average. US aviation statistics might not be applicable for the whole world, but it gives an indication of what the distribution of air travellers in reality could be across continents. Given that a high share of travellers are young (20-30 years old) is certainly within the possibilities, is favourable for the potential of the integration platform. Besides this statement, the users of this platform would not be only young leisure travellers, as the platform would be available for every traveller that books an airline ticket online, which might also be interested and would actually use it.

As part of the market potential, the potential volume of users for these four airports is being calculated. With the arguments in mind, such as potential users/target groups and insecurity of the eventual use of the platform, the share of the total number of landside O&D passengers is estimated to be 1% (indicative). This means that of the total number of passengers that travels from and/or to an airport, 1% would consult the integration platform. This

results in a calculation on the volume of passengers for this integration from the four airports, also divided into one-way or return trips (table 2 in chapter 5 shows the volumes of O&D passengers).

With all the assumptions the number of passengers for the integration platform can be calculated. Therefore, 1 % of the total landside O&D passengers are determined for return trips for the platform. To find out how many passengers would only use it for a one-way trip, the previous number should be divided by 2:

0.01 * (45.0 million+56.1 million+31.3 million+50.1 million) = 1.825.000 passengers for a return ticket and therefore 912.500 passengers if only a one-way ticket would be bought.

These volumes are part of potential revenues that can be created, purely on ticket sales. For this, table 14 in Appendix C is consulted, which showed public transport ticket prices for all four airports. For simplicity sake, a representable price of €5 per public transport ticket is taken into account. The revenue than is assumed to consists out of a commission fee from the traveller of 10-20 % and 5 % for the public transport operators, resulting in a range of €0.75 - €1.25 that can be generated per ticket sale. This results in the following outcomes for one-way or return trips.

Table 10 Potential revenues from the four major European airports

Ticket type	Revenue per year (€)
One-way	680.000 – 1.150.000
Return	1.360.000 – 2.300.000

Table 10 shows a rough estimation on how large the revenue streams per year could be on the four considered airports. Costs have been identified in the cost structure of the business model canvas, but cannot be displayed in monetary values. This makes it difficult to give a definitive conclusion on the economic feasibility. Furthermore, the revenues that are shown in table 10 are only based on the four airports considered in this research, which implies that there is a larger volume across the world that has potential for this integration platform. With 4,5 billion passengers in 2019 (Number of scheduled passengers boarded by the global airline industry from 2004 to 2021 , 2020), it is imaginable that more volume for the integration platform could eventually be generated if the platform is judged to be feasible and desirable.

All in all, the market potential of integrating public transport and airplane tickets depends on multiple factors, making it difficult to give a clear answer. In this thesis, the hypothesis is made that the age group of 20-30 would be most interesting for these integrated tickets. Given that this is a large represented group within the total amount of travellers, this would favour the market potential. However, the question would be if a high percentage of these travellers will really make use of the integration platform, leading to high enough revenues to weigh out the costs. Furthermore, getting airliners and public transport operators to cooperate based on business perspectives will be a difficult task. Eventually to test the economic feasibility of the platform, pilots at specific airports should be started to see what costs and benefits would be. As not only young travellers might buy integrated tickets, the platform should be available for everyone. After the pilot period, an evaluation would point out the most popular groups and how the ratio of benefit to cost ratio is.

Lastly, developments over the coming years need to be taken into account as well. A spectrum of 10 years in the future might lead to developments that hinder the integration platform. Examples are the developments of possibilities that Mobility as a Service could bring. Specifically, methods of payment in public transport could involve towards more general ticket sales by scanning with credit cards, QR codes of bank accounts on smartphones etc. (van Weele, 2018). This can lead to jeopardising the initiative of integrating air- and public transport tickets, since paying for public transport tickets in foreign countries would be made easier. On the other hand, the integration can contribute to the idea of easing payment by still providing integrated information on wayfinding, timetables, delays and more.

Figure 46 Future of paying in public transport (van Weele, 2018)

11.11 Conclusion

This chapter showed the business model canvas for integrating booking and payment of air- and public transport tickets. With this being the main part of the value proposition, other building blocks are needed to make this value proposition possible and beneficial for all parties. These blocks have a number of elements that depend on various factors to be successful. It can therefore be said that at one time, various aspects need to come in the right place to make the integration feasible, with contracting the transport suppliers as the toughest task. Looking at the market potential, a definitive answer cannot yet be given. The high volume of young travellers is promising, but the constraint of weighing out the benefits to the costs on the other hand would still be questionable due to no revealed data on the use of the integration platform and low margins in public transport. Pilots at airports with involved parties can confirm or reject the promise of this integration platform. Hereby, it can also be tested how the business model canvas would apply to different airports, as the canvas may represent each individual airport differently. An example thereby could be the willingness of airport authorities to cooperate to let the integration platform be a success. Besides this, technological developments in the future relevant to this topic, such as methods of payment in public transport, should be highly considered.

12 Discussion

In the discussion section of this thesis, validity of this research is tested, results are interpreted, limitations of this research are discussed and possible implications of this study are named. Firstly, regarding the validity of this research the question should be asked if this study is repeatable and reliable. Literature that has been used are mostly from scientific sources, which implies that statements that are based on these sources in this study are of good quality and reliable. Furthermore, a large set of the conclusions that are made are based on the survey that was handed out. Results from the survey allowed to get insights on traveller preferences regarding the integration platform and also link this towards traveller types. However, observations made from these results might not be fully viable, as the panel of the survey was not weight out. Specific groups, such as young male respondents formed a majority within the sample, limiting to what extent comparisons could have been made. As has been mentioned, this can partly be blamed on the Covid-19 pandemic. Therefore, the situation where this study was held in should always be taken into account, which make the conclusions made not fully generalizable.

From the overall literature study that has been conducted in this thesis, literature was found on car travel and public transport to/from airports. Besides the fact that literature mentioned car travel to be popular still and highly used, governments had implemented policies to promote public transportation to/from their airports. Furthermore, it was mentioned that public transportation contains high value for stakeholders. Therefore results from the survey for example reflected literature, in the sense that public transport is extensively used. As the integration platform is aimed to ease the overall trip of travellers, it was expected that the interest for the platform would be significant. Based on the panel in this survey, the potential is shown, however not statistically convincing. The overall results however have shown that the integration platform could be a success when most requirements fall into place.

It has been mentioned shortly already, but mostly due to the Corona crisis this research consisted of some limitations. It mainly influenced the composition of the survey panel with the panel eventually not having the ideal ratio between response groups. This also holds for reaching out for interviews, as agendas of people became full. Furthermore, trade-offs between factors have not been tested in this research. This could have been done with a stated choice preference experiment, where this survey mostly gave an indication on the overall demand for the integration platform. The stated choice preference experiment could have identified the magnitude of the willingness to pay for the services of the integration. In combination with the latent cluster analysis, these willingnesses to pay could be assigned to the specific recognised sub groups.

Implications of this research relate to what might happen after this thesis. This study can be used as a report to decide for Royal HaskoningDHV if the company wants to develop this integration platform and the corresponding measures that need to be taken to make this platform successful. This thesis also can be a starting point for follow up researches where the link between air transport and local public transport is being examined. On the other hand, it may occur that the conclusions might not be convincing enough for further research or for further implementation by a company such as Royal HaskoningDHV. As a result, travellers who are willing to use public transport to/from an airport would eventually not be able to book a public transport ticket from home. However, technological developments are assumed to be continuously coming over the years, where this concept of easing the travellers multimodal trip will inevitably be addressed. And since multimodality is inevitable over the coming years, this research might contribute to the attention that it needs.

13 Conclusions

With all the research steps that have been executed, conclusions can be drawn by answering the sub questions in this chapter, followed by the overall conclusion on the main research question of this thesis and recommendations for further research.

13.1 Current Transport Provision

Sub question: '*How are door-to-door trips involving air transport for travellers provided?'*
Beginning chapters in this thesis were dedicated to give an overview of landside transport profiles and access and egress modes at the four major European airports that were taken into account, and the interface between ticket platforms and travellers. At first, it was identified that for the four airports having similar functions as a hub, modal splits per airport differed from each other. Differences for each airport in general can be a result of various factors that play a role in the modal choice of travellers that are accessing and egressing an airport. These factors can vary from cultural transport habits to the availability of certain facilities such as a train station at the airport for example, or the public transport network's size.

Furthermore, for each of the airports considered in this research an analysis was conducted on the available public transport options and relevant ticketing, and the presence and popularity of other transport modes. Concluded would be that at the four airports, public transportation options are highly available. The conclusion can be made that popularity of transport modes for the first/last mile trips to/from an airport highly depend on how the airports are facilitated in their transport options. Examples are available ticketing throughout the airports and the magnitude of parking costs, which had an influence on the modal splits at the four airports in the scope. Therefore, emphasizing on public transport facilities leads to more usage of public transport, indicated from the modal split analysis in this research.

Other travel providers, such as travel agencies and ticket platforms play a role in the travel provision for travellers as well. Various business models were identified, which has an influence on how tickets are sold and how revenues are obtained by these ticket platforms. For the potential implementation of an integration platform for integrating booking and payment of air- and public transport tickets, these business models should be considered as these determine how these integrated tickets would be sold, either in batches, directly or via a commission.

13.2 Stakeholder Analysis

Sub question: '*Which stakeholders are of importance in integrating booking and payment of air- and public transport tickets? What are requirements/wishes of these stakeholders?'*
In this complex topic, there are stakeholders that play a role for the feasibility and desirability of the integration platform of air- and public transport tickets. These are:

- Airliners
- Public transport companies
- Governmental bodies
- Travellers
- Travel agencies/ticket platforms
- Mobility companies
- Airport authorities
- Taxi companies
- Car rental companies

Each of these stakeholders were analysed in detail and requirements/wishes of each were identified. These varied from economic benefits to customer satisfaction, which all lead to a list of factors that are of importance, which were later on implemented in the conceptual framework. The stakeholders were also analysed on importance with the use of a power-interest and a problem-frame diagram. Concluded was that the direct parties, which are the airliners

and public transport operators, and the airport authorities need to be considered the most for the success of the integration platform.

13.3 Traveller Preferences

Sub question: 'What are preferences for travellers in deciding their first/last mile airport trips? Would integrating booking and payment be feasible and desirable for them? How large is the demand?'
For this specific research, a survey was handed out to identify preferences and the potential demand for integrating booking and payment of air- and public transport tickets. The main expectation for this survey was that the integration platform would significantly increase the potential usage of public transport to/from airports and therefore a significant interest to use the integration platform. The survey contained questions about this modal choice, experiences with public transport, the potential integration platform and general characteristic questions of the respondent. Due to the Covid-19 pandemic, the survey was handed out via social media platform, which led to not being able to control the respondent types and therefore no weight out groups. This was taken into account throughout the analysis.

The analysis on the survey responses consisted a few main findings. At first, a positive difference was indicated with the overall likeliness of respondents to make use of public transport with an integration platform. However, a statistical t-test showed that the difference was not statistically significant, meaning that the difference with integration platform was not convincing enough to guarantee success of a integration platform. However an in-depth analysis was aimed to find groups that might have potential for the platform, which was based on the survey sample. This led to the observations that it seems that male travellers prefer the platform slightly more than women, leisure travellers are more keen on using the integration platform than business travellers, young travellers (20-30 years old) show the most potential, and that high educated people give the most positive feedback on the platform.

Preferences in travelling can highly differ between individuals, which was also indicated through the peer review interviews that were taken after the survey. Another observation was that the integration platform might be interpreted differently by individuals as well. All of the findings of the survey give a small overview of what the demand of and/or the volume the platform could be, but cannot be fully confirmed due to the lack of fully convincing feedback.

13.4 Governance

Sub question: 'To what extent do legislative matters for various countries influence the feasibility and desirability of this integration? How does competition between mutual public transport providers, and public transport and other transport modes play a role?'
Governance does play an important role in the feasibility and desirability of integrating booking and payment of air- and public transport tickets. For this topic, governance for public transport and aviation were considered. Most important from the public transport side would be the ticketing and fare setting regime. This namely determines to what extent third parties can be involved in selling the integrating tickets. The assumption is that a competitive tendering with governmental provision character of the public transport governance in a country would be most promising for the integration platform, as through tendering governmental bodies can control the ticketing regime. An open access regime in a country often leads to monopolies on public transport networks and therefore on ticketing as well, with Deutsche Bahn as an example.

Aviation governance has been characterised by deregulation and privatization over the last years, which have led to a continuous growth in air travel. The hypothesis thereby is that more national orientated airports would pay more attention to its surroundings than hub airports, and so an emphasis on public transport links with the airport would be made more important. From the airliner side, ownership perspectives and the willingness to improve their service on landside accessibility play a role on the successfulness of the integration platform. Links between air- and public transport already exist, but more on long distance however. Linking air transport with local public transport is

assumed to be more complex and give more resistances with respect to contracting and attractive involvement of the essential parties, airliners and public transport operators.

13.5 Conceptual Framework Integration Platform

Sub question: 'Which factors can be identified from used case studies, a stakeholder analysis, literature review and a survey that lead to a general conceptual framework for integrating booking and payment for air- and public transport tickets?'

The research methods that were used led to results from which important factors were identified to judge the feasibility and desirability of integrating booking and payment of air- and public transport tickets. Factors were divided from being retrieved from the stakeholders, and the survey, literature study and interviews combined. From the stakeholder analysis, the following factors were obtained:

- Economic benefits
- Customer satisfaction
- Transport culture
- Service economy
- Environmental goals
- Collaboration contracting
- Airport conditions

Between the factors that were found from the stakeholders analysis and the other research methods, overlap between both was ascertained, although some were not present in one of the two. The framework from the literature study, survey and interviews was displayed as followed:

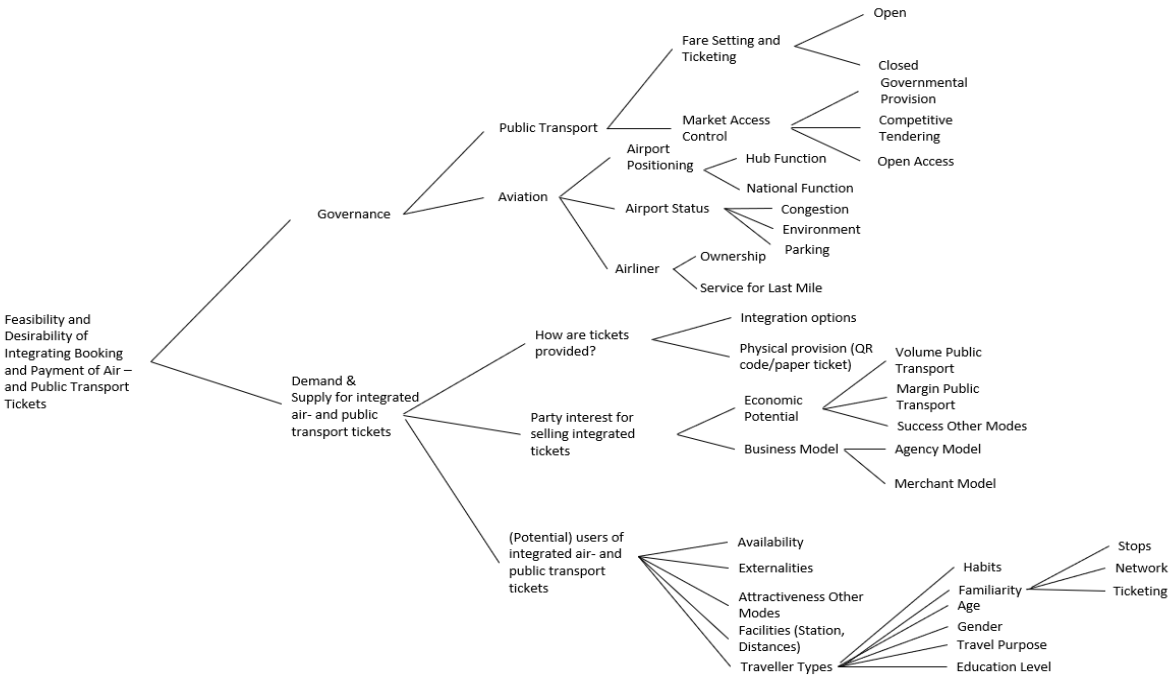


Figure 47 Conceptual Framework

As can be seen, factors were divided into two main groups of factors being related to either governance or demand and supply for integrated air- and public transport tickets. This framework thereby shows an overview of aspects that need to be taken into account when developing the integration platform. It can therefore be used as a starting point for initiatives willing to invest in a platform and based on the framework decide if the overall situation where the integration platform can be feasible and desirable. Judgement can then be made by following the important factors, which thereby partly functions as a checklist to incorporate all relevant elements. The number of present

factors that play a role is extensive, meaning that the feasibility and desirability of the integration depend on a high amount of conditions. Moreover, these conditions mostly need to fall into place all at once, possibly explaining why parties have not yet implemented public transport ticketing in their airline ticket sales.

13.6 Business Model Canvas Integration Platform

Sub question: '*In what way/which ways can an integration of booking and payment be economically beneficial and attractive for end users and other stakeholders? What might be perceived barriers?'*
In order to understand the implications regarding economic feasibility and attractiveness of the integration platform, a business model canvas was designed. This canvas showed nine building blocks that described which elements the platform should consist to eventually fulfil the overall value proposition. The left side represented the key partners that are needed, such as the airliners, public transport operators, ticket platforms and IT companies. Key activities were described on how these key partners need to be convinced on collaborating and key resources described the physical and human resources that are needed for making the integration platform feasible. On the right side of the canvas, customer relationships were described on how customers are going to be helped with the value proposition and the channels that are used to reach the customer segment. These named building blocks are supported by the cost structure, which consists of sales costs, contracting costs, development costs and tailoring costs, and the revenue streams that it would generate via commission fees, service fees and application revenues. (The canvas can be seen in appendix E)

The business model canvas displayed a number of steps that need to be taken to get the integration platform to operate. Most exhaustive measure that needs to be taken is collaborating and contracting with relevant key partners for this matter. Hereby, each party has its own factors that play a role in deciding to collaborate or not, where hesitations on the overall feasibility can be questioned by these parties.

To show a market potential, an estimation on revenues per year was made based on the landside O&D passenger volumes on the four airports and the assumptions on the share of passengers that would potentially use the integration platform. Eventually the range of revenues that can be made lie between approximately €700.000 and a little over €2.000.000 (calculations in section 12.10). The presence of potential revenues that could be made on the four airports is substantial, although the specific costs have not been accounted for yet, making it difficult to give a definitive answer on the economic feasibility. On the other side, accounted should be that this scope only handled the four largest airports in Europe, which implies that the potential volume over the whole world is larger. The total volume of air passengers in 2019 was namely 4.5 billion passengers and was growing each year before Covid-19. Advice would be to start with pilots to see if the integration platform can be beneficial, since hereby costs will be determined. The evaluation of the pilot should determine if the costs are outweighed by the revenues obtained.

Technological developments for the future (in 10 years for example) regarding this topic, like payment for public transport trips, need to be highly considered. As has been mentioned, developments on easing payments for example might affect the interest in buying tickets beforehand, as a public transport ride can be simply paid by a credit card. On the other hand, providing the service with an application for wayfinding, timetables etc. can still have an additional value for easing payments by collaborated with these credit card companies.

13.7 Overall Conclusion Feasibility and Desirability Integration Platform

Main question: 'To what extent is it feasible and desirable to integrate booking and payment for air transport and public transport tickets for first/last mile destination orientated airport trips?'
The overall conclusion is formed by answering the main question of this thesis. It can be said that integrating booking and payment of air- and public transport tickets can be feasible and that certain (shares of) parties think it is or find it desirable.

However when looking at the feasibility of this integration platform, the number of requirements that will be needed to make this integration platform a success is very high and therefore makes it impossible to give a definitive answer. Furthermore, these requirements/factors that were identified in the conceptual framework and business model canvas mostly need to fall into place all at the same time, which probably would lead to lots of time that still needs to be spend to arrange the full operation of this platform. Another point of attention are the governance regimes of public transport and aviation that need to be taken into account. It was namely identified that these regimes can highly differ for each country and each form, either open or a more governmental provision orientated governance, which eventually has its effect on the feasibility of tickets being sold by third parties. Aviation governance also has its effect on the emphasis of airports and airliners take on landside accessibility via public transportation and therefore improving their services via this route. It can therefore be said that feasibility with respect to governance highly depends on the specific situation where the integration platform should function. A specific scenario therefore needs to be considered explicitly and as a result it can be concluded that a generic integration platform applicable for all is not feasible.

The other main aspect of this research was if this ticket integration would be desirable. A big part in determining this has been the execution of the survey. The survey has been thoroughly analysed and the main conclusions were that over the whole survey panel, the positive likeliness difference in public transport usage with integration platform was not statistically convincing enough. However, the more in depth analysis definitely indicated interest from specific groups, such as young leisure travellers. Eventually, the question would be if this would generate enough volume to reach economic success. This mainly lies in the fact that margins in selling public transport tickets come with low margins. Furthermore, how the public transport market evolves need to be highly considered. Specific technological developments such as the contactless payment at public transport gates, might jeopardise this air- and public transport ticket integration initiative. On the positive side, the survey discovered that the most promising group for this integration platform are young leisure travellers. With the thought of the digital era developing even further, upcoming young leisure travellers might give extra volume to the usage of the integration in for example 10 years, where the current young leisure travellers are already being part of and stick with the concept.

All in all, it would take a sufficient amount of factors falling into place regarding feasibility and desirability to make the booking and payment integration of air- and public transport tickets a success. The research indicates that this is theoretically possible, but the question would be if initiating third parties are willing to take the risk to invest in this integration with all the uncertainties that come with it. Making this integration platform a success will require a lot of time and effort, where possible miscalculations regarding its potential and success are not excluded.

13.8 Recommendations for Further Research and Practical Implementations

This thesis has led to certain results that could answer the main question of this research. However, there are possibilities for further research regarding this topic. At first, the airports that were taken into account are all part of the largest airports around the world with many facilities and large volumes of passengers per year. It has been described that the four airports have paid significant attention towards public transport connections. It can therefore be said that public transport to/from these airports are already well known among travellers that make use of these airports. Therefore, for another research it would be interesting how the effect of this integration platform concept would be on smaller airports with less facilities regarding public transportation and of which travellers are less familiar with. Factors like these might lead to more positive outcomes on feasibility and desirability of the integration platform and might induce third parties to initiate the integration.

Another element for further research is the traveller survey that was held during this research. Especially due to the appearance of the Covid-19 pandemic, tools to get a representative panel to fill out the survey was lacking. This made drawing conclusions more difficult as the ratio between types of respondents and the number of respondents was not ideal. Therefore for further research, another survey could be held that would be handed out to a larger panel, which is also more weighted out (for example the same amount of women and men, and/or similar age group sizes within the responses). A larger sample size would lead to more reliable conclusions and a chance for more

statistical significant differences that are observed within the results. The outcomes of the survey in this research namely already showed high shares for positive/neutral responses towards the integration platform. Additionally, a latent cluster analysis can be used as a more detailed method to identify subgroups within the survey sample that could really point out the most important groups to achieve success of the integration platform for air- and public transport tickets.

Furthermore, practical recommendations for the industry are present as well. This research was done in collaboration with Royal HaskoningDHV for a potential proposition. Results of this research can be used for illustrating the possibilities with this integration platform and specifically Royal HaskoningDHV can use these results to look for potential collaborations with other mobility parties, public transport operators and airliners. By discussing the results, the relevant parties can be convinced in the potential of the integration platform, with the result of the integration platform becoming operational. The research recommendations that are mentioned in this section can also be a tool to build upon the reasoning and decision-making in that later stadium. Lastly, as this thesis has not identified costs to set up the integration platform, a specific costs study should also be dedicated for this.

14 Bibliography

(DIT), D. f. (2009). *UK air passenger demand and CO2 forecasts.* London.

(2019). *2018 Facts and Figures on Frankfurt Airport.* Frankfurt: Fraport.

Abdelaziz, T. M. (2011). Conceptual framework for formalizing multi-agent systems. *CCIS 181*, 644-658.

About Tranzer. (n.d.). Retrieved from Tranzer: https://tranzer.com/about

Akar, G. (2013). Ground access to airports, case study: Port Columbus International Airport . *Journal of Air Transportation Management 30*, 25-31.

Alandari, F., & Mason, K. (2006). The future of airline distribution. *Journal of air transport management vol.12* , 122-134.

Alderighi, M., Nicolini, M., & Piga, C. A. (2016). Targeting leisure and business passengers with unsegmented pricing. *Tourism Management 54*, 502-512.

Alhussein, S. (2011). Analysis of ground access modes choice King Khaled International Airport, Riyadh, Saudi Arabia. *Journal of Transportation Geography 19*, 1361-1367.

Alliance, M. (2017). *What is MaaS?* Retrieved from MaaS Alliance: https://maas-alliance.eu/homepage/what-is-maas/

Anable, J. (2005). 'Complacant Car Addicts' or 'Aspiring Environmentalists'? Identifying travel behaviour segments using the attitude theory. *Transport Policy 12*, 65-78.

Arentze, T. A., & Molin, E. J. (2013). Travelers' preferences in multimodal: Design and results of a comprehensive series of choice experiments. *Transportation Research Part A: Policy and Pracitce vol. 58*, 15-28.

Arriving by bus. (2020). Retrieved from Frankfurt Airport: https://www.frankfurt-airport.com/en/transport-and-directions/by-bus.html

Badanik, B., Stefanik, M., & Matas, M. (2011). Using fast-time simulations for designing and operating airport terminals as nodes of intermodal transport. *Communications 3*, 83-90.

Baumgartner, C., Kätker, J., & Tura, N. (2016). DORA - integration of air transport in overall urban and regional mobility information. *Transportation Research Procedia 14*, 3238-3246.

Belobaba, P., Odoni, A., & Barnhart, C. (2009). *The Global Airline Industry.* John Wiley & Sons Ltd.

Bergantino, A. S., Capurso, M., & Hess, S. (2020). Modelling regional accessibility to airports using discrete choice models: An application to a system of regional airports. *Transportation Research Part A 132*, 855-871.

Blythe, P. T. (2004). Improving public transport ticketing through smart cards. *Municipal Engineer 157*, 47-54.

Boarnet, M. G., Giuliano, G., Hou, Y., & Shin, E. J. (2017). First/last mile transit access as an equity planning issue. *Transportation Research Part A 103*, 296-310.

Boitani, A., Nicolini, M., & Scarpa, C. (2013). Do competition and ownership matter? Evidence from local public transport in Europe. *Applied Economics 45*, 1419-1434.

Borén, S., & Grauers, A. (2019). Stakeholder collaboration models for public transport procurement of electric bus systems. *The international journal of sustainability policy and practice*, 19-29.

Bryson, J. (2004). What to do when stakeholders matter: stakeholder identification and analysis . *Public Management Review 6 (1)*, 21-53.

Budd, T., Ison, S., & Ryley, T. (2011). Airport ground access: issues and policies. *Journal of Airport Management 6 (1)*, 80-97.

Bulkeley, H., Schroeder, H., Janda, K., Zhao, J., Armstrong, A., Chu, S., & Ghosh, S. (2011). The role of institutions, governance and urban planning for mitigation and adaption. In *Cities and Climate Change: Responding to an Urgent Agenda* (pp. 125-159).

Cachon, G., & Netessine, S. (2004). *Game theory in supply chain analysis.* Springer.

Carnell, D. (2003). *Performance excellence systen at public transport companies.*

Carney, M., & Dostaler, I. (2006). Airline ownership and control: A corporate governance perspective. *Journal of Air Transport Management 12*, 63-75.

Carney, M., & Mew, K. (2003). Airport governance reform: a strategic management review. *Journal of Air Transportation Management 9*, 221-232.

Castillo-Manzano, J. I., & López-Valpuesta, L. (2010). The decline of the traditional travel agent model. *Transportation Research Part E 46*, 639-649.

Chandra, D. G., Prakash, R., & Lamdharia, S. (2013). Mobile Ticketing System for Automatic Fare Collection Model for Public Transport. *5th International Conference on Computational Intelligence and Communication Networks.*

Chang, Y.-C. (2013). Factors affecting airport access mode choice for elderly air passengers. *Transportation Research Part E Logistic Transportation Review 57*, 105-112.

Chang, Y.-C., Williams, C., & Hsu, C.-J. (2004). The evolution of airline ownership and control provisions . *Journal of Air Transport Management 10*, 161-172.

Cole, M. (2018). Mobility as a Service putting Transit Front and Center of the Conversation. *Cubic Transportation Systems*.

Commission, E. (1997). *Communication from the Commission to the European Parliament and the Council: Intermodality and Intermodal Freight Transport in the European Union.* Brussels: EU.

Commuting: Public Transport. (2020). Retrieved from Heathrow: https://www.heathrow.com/company/team-heathrow/commuting-to-heathrow/public-transport

Costa, Á., & Fernandes, R. (2012). Urban public transport in Europe: Technology diffusion and market organisation. *Transportation Research Part A 46*, 269-284.

De Oyster Card - De OV Chipkaart van Londen. (n.d.). Retrieved from Alles over Londen: https://www.allesoverlonden.nl/oyster-card-londen/

De Witte, A., Hollevoet, J., Dobrudzkes, F., Hubert, M., & Macharis, C. (2013). Linking modal choice to motility: A comprehensive review. *Transportation Research Part A: Policy and Practice vol. 49*, 329-341.

den Ouden, G. (2020, January 24). Interview Transavia. (J. Schuiling, Interviewer)

Donners, B. (2020, February 18). Discussion Thesis MaaS Airports. (J. Schuiling, Interviewer)

Dudás, G., Boros, L., & Vida, G. (2017). Comparing the temporal changes of airfares on online travel agency websites and metasearch engines. *Tourism vol. 65 nr. 2*, 187-203.

Easy Access by Train. (2020). Retrieved from Frankfurt Airport: https://www.frankfurt-airport.com/en/transport-and-directions/by-train.html

Eckhardt, J., Nykänen, L., Aapaoja, a., & Niemi, P. (2018). MaaS in rural areas - Case Finland. *Research in Transportation Business and Management 27*, 75-83.

ECTRI. (2007). *The European Commission green paper on urban transport.*

EU. (2016). *Horizon 2020 - smart, green and integrated transport: Important notice on the second horizon 2020 work programme.* European Commision.

EU competition policy in the transport sector. (2015, December 18). Retrieved from European Comission: https://ec.europa.eu/competition/sectors/transport/overview.html

Facts and Figures. (2019). Retrieved from Heathrow Airport: https://www.heathrow.com/company/about-heathrow/company-information/facts-and-figures

Farag, S., & Lyons, G. (2012). To use or not to use? An empirical study of pre-trip public transport information for business and leisure trips and comparison with car travel. *Transport Policy 20*, 82-92.

Finger, M., Bert, N., & Kupfer, D. (2015). *Mobility-as-a-Service: from the Helsinki experiment to a European model?* FSR Transport, 1.

Foris, D., Tecau, A. S., Hartescu, M., & Foris, T. (2019). Relevance of the features regarding the performance of booking websites. *Tourism Economics*, 1-21.

Franckx, L., & Mayeres, I. (2015). *Future trends in mobility: challenges for transport planning tools and related decision-making on mobility product and service development.*

Fu, J., Lin, H., Niu, Y., & He, S. (2017). Share ratio change of public transport in airport landside under the background of car population rapid increase - A case of Shanghai Pudong International Airport. *Transportation Research Procedia 25*, 92-102.

Gao, J., & You, F. (2019). A stochastic game theoretic framework for decentralized optimization of multi-stakeholder supply chains under uncertainty. *Computers and Chemical Engineering 122*, 31-46.

Gatersleben, B., & Uzzell, D. (2003). The journey to work: exploring commuter mood among driver, cyclists, walkers and users of public transport. *Proceedings of the EPUK Conference.* Aberdeen.

Geven en ondernemen. (2018, July 1). Retrieved from Werner Liebregts: http://wernerliebregts.nl/een-succesvol-ondernemer-biedt-wat-aan-in-ruil-voor-klantgegevens/
Gillen, D. (2011). The evolution of airport ownership and governance. *Journal of Air Transport Management 17*, 3-13.
Global, M. (n.d.). *About Whim*. Retrieved from Whim: https://whimapp.com/about-us/
Go cross-country by bus. (2020). Retrieved from Schiphol: https://www.schiphol.nl/en/page/bus-from-schiphol/
Gonella, C. (1998). Visualising and measuring intellectual performance - the scandia approach. *Accountability quartely 6*, 7-20.
Gonzalez-Feliu, J., Pronello, C., & Salanova Grau, J. M. (2018). Multi-stakeholder collaboration in urban transport: state-of-the-art and research opportunities. *Special issue on collaboration and urban transport*, 1079-1094.
Grimme, W. (2007). *EXPERIENCES WITH ADVANCED AIR-RAIL PASSENGER INTERMODALITY – THE CASE OF GERMANY.* Cologne.
Hall, P. (2014). *Cities of Tomorrow: an Intellectual History Of Urban Planning and Design since 1880.* Wiley-Blackwell.
Hatton, M. (2003). Redefining the relationships - The future of travel agencies and the global agency contract in a changing distribution system. *Journal of Vacation Marketing vol. 10 no. 2*, 101-108.
Hesselgren, M., Sjöman, M., & Pernestal, A. (2018). Understanding user practices in mobility service systems: Results from studying large scale corporate MaaS in practice. *Travel Behaviour and Society*.
Hietanen, S. (2014). "Mobility as a Service" - the new transport model? *Eurotransport 12 (2)*, 2-4.
Hischhorn, F., Veeneman, W., & Van de Velde, D. (2018). Inventory and rating of performance indicators and organisational features in metropolitan public transport: a worldwide Delphi survey. *Research Transportation Economics 69*, 144-156.
Hischhorn, F., Veeneman, W., & Van de Velde, D. (2019). Organisation and performance of public transport: A systematic cross-case comparison of metropolitan areas in Europe, Australia and Canada. *Transportation Research Part A 124*, 419-432.
Hoadley, S. (2017). Mobility as a Service: Implications for urban and regional transport, discussion paper offering the perspective of Polis member cities and regions on Mobility as a Service (MaaS). *Polis*.
Holmberg, P.-E., Collado, M., Sarasini, S., & Williander, M. (2016). *Mobility as a service - MaaS: describing the framework.*
Hudson, M. (2020, June 30). Feasibility and desirability of integrating booking and payment for air- and public transport tickets. (J. Schuiling, Interviewer)
Humphreys, I., & Ison, S. (2005). Changing airport employee travel behaviour: the role of airport surface access strategies. *Transport Policy 12 (1)*, 1-9.
Humphreys, I., Ison, S., Francis, G., & Aldridge, K. (2005). UK airports surface access targets. *Air Transportation Management 11 (2)*, 117-124.
Ison, S., Merkert, R., & Mulley, C. (2014). Policy approaches to public transport at airports - Some diverging evidence from the UK and Australia. *Transport Policy 35*, 265-274.
Jittrapirom, P., Marchau, V., van der Heijden, R., & Meurs, H. (2018). Dynamic adaptive policymaking for implementing Mobility-as-a-Service (MaaS). *Research in Transportation Business & Management 27*, 46-55.
Jittrapirom, P., Marchau, V., van der Heijden, R., & Meurs, H. (2018). Future implementation of mobility as a service (MaaS): Results of an inernational Delphi Study. *Travel Behaviour and Society* .
Jou, R., Hensher, D., & Hsu, T. (2011). Airport ground access mode choice behaviour after the introduction of a new mode: a case study of Taoyuan International Airport in Taiwan. *Transportation Research Part E Logistic Transportation Review 47*, 371-381.
Joyce, A., & Paquin, R. L. (2016). The triple layered business model canvas: A tool to design more sustainable business models. *Journal of Cleaner Production*, 1-13.
Kazda, A., & Caves, R. (2008). *Airport Design and Operation .* Bradford: Emerald.
Kenton, W. (2020, March 22). *T-test*. Retrieved from Investopedia: https://www.investopedia.com/terms/t/t-test.asp

Khaerat, N., Samang, L., Ramli, I., & Hamid, S. (2015). Study of modes transformation preferences of private transport based travel cost and travel time. *Proceedings Konteks 9*, 181-187.
KiM. (2020). *Mobiliteitsbeeld 2019, Gebruiksmotieven Luchthaven*. Retrieved from Kennisinstituut voor Mobiliteitsbeleid: https://www.kimnet.nl/mobiliteitsbeeld/mobiliteitsbeeld-2019#/rapport/1.7.4
Koster, P., Kroes, E., & Verhoef, E. (2011). Travel time variability and airport accessibility. *Transportation Research Part B Methodology 45* , 1545-1559.
Krygsman, S., Dijst, M., & Arentze, T. (2004). Multimodal public transport: an analysis of travel time elements and the interconnectivity ratio. *Transportation Policy 11 (3)*, 265-275.
Le Dinh, T., & Pham Thi, T. T. (2010). A conceptual framework for service modelling in a network of service systems . *Business information processing*.
Li, X., Jiang, C., Wang, K., & Ma, J. (2018). Determinants of partnership levels in air-rail cooperation . *Journal of Air Transportation Management 71*, 88-96.
Li, Y., & Voege, T. (2017). Mobility as a Service (MaaS): Challenges of Implementation and Policy Required. *Journal of Transportation Technologies 7*, 95-106.
Liao, P., Ye, F., & Wu, X. (2017). A comparison of the merchant and agency models in the hotel industry. *International Transactions in Operational Research*, 1-22.
Lindholm, M., & Browne, M. (2013). Local authority cooperation with urban freight stakeholders: a comparison of partnership approaches. *European Journal of Transport and Infrastructure Research 13 (1)*, 20-38.
Link, C., Heinemann, A., Gerike, R., Jonuschat, H., & Maryschka, M. (2017). Who uses a Mobility Card? A case study on the WienMobil Card. *Urban Transport 2016*.
List of busiest airports in Europe. (2020, January 20). Retrieved from Wikipedia: https://en.wikipedia.org/wiki/List_of_the_busiest_airports_in_Europe
List of the busiest airports in Europe. (2020). Retrieved from Wikipedia: https://en.wikipedia.org/wiki/List_of_the_busiest_airports_in_Europe
Louw, C. (2019). Airport Wi-Fi Service Delivery and Monetisation Strategies - an International Perspective. *African Journal of Hospitality, Tourism and Leisure, volume 8*.
Lowson, M. V. (2011). Sustainable Personal Transportation. *IEEE Forum on Integrated and Sustainable Transportation Systems*.
Lubieniecka-Kocón, K., Kos, B., Kosobucki, L., & Urbanek, A. (2013). Modern tools of passenger public transport integration. *Communications in Computer and Information Science 395*, 81-88.
Ma, Z., Urbanek, M., Pardo, M. A., Chow, J. Y., & Lai, X. (2017). Spatial welfare effects of shared taxi operating policies for first mile airport access. *International Journal of Transportation Science and Technology 6*, 301-315.
Martens, K. (2007). Promoting bike-and-ride: the Dutch experience . *Transportation Research Part A: Policy Practice 41 (4)*, 326-338.
Matheys, J., Rogolle, C., Sergeant, N., Boureima, F.-S., Timmermans, J.-M., Rombaut, H., & Van Mierlo, J. (2008). Analysis and improvement of "The Last Mile" to and from the national airport as part of the mobility policy in the Brussels urban area. *WIT Transactions on The Built Environment, Vol 101*.
McCabe, S., Sharples, M., & Foster, C. (2012). Stakeholder engagement in the design of scenarios of technology-enhanced tourism services. *Toourism Management Perspectives (4)*, 36-44.
Merkert, R., & Beck, M. (2017). Value of travel time savings and willingness to pay for regional aviation. *Transportation Research Part A 96*, 29-42.
Merkert, R., & Beck, M. J. (2020). Can a strategy of integrated air-bus services create a value proposition for regional aviation management? . *Transportation Research Part A 132*, 527-539.
Merkert, R., Bushell, J., & Beck, M. J. (2020). Collaboration as a service (CaaS) to fully integrate public transportation – Lessons from long distance travel to reimagine mobility as a service . *Transportation Research Part A 131*, 267-282.
Mulder, P. (2015). *ToolsHero*. Retrieved from Business Model Canvas: https://www.toolshero.nl/strategie/business-model-canvas/
Mulderink, S. (2020, March 24). Meeting Tranzer and Royal HaskoningDHV. (J. Schuiling, Interviewer)

Number of scheduled passengers boarded by the global airline industry from 2004 to 2021 . (2020). Retrieved from Statista: https://www.statista.com/statistics/564717/airline-industry-passenger-traffic-globally/

Osterwalder, A., & Pigneur, Y. (2010). *Business Model Generation.* Hoboken: John Wiley & Sons, Inc. .

Paris-Charles de Gaulle by public transport. (2020). Retrieved from Paris Aéroport: https://www.parisaeroport.fr/en/passengers/access/paris-charles-de-gaulle/public-transport

Pels, E., Nijkamp, P., & Rietveld, P. (2003). Access to and competition between airports: a case study for the San Francisco Bay Area. *Transportation Research Part A Policy Practice 37*, 71-83.

Pereira, B. A., & Caetano, M. (2015). A conceptual business model framework applied to air transport . *Journal of Air Transport Management 44-45*, 70-76.

Phang, S.-Y. (2016). A general framework for price regulation of airports. *Journal of Air Transport Management 51*, 39-45.

Polydoropoulou, A., Pagoni, I., & Tsirimpa, A. (2018). Ready for Mobility as a Service? Insights from stakeholders and end-users. *Travel Behaviour and Society*.

Polydoropoulou, A., Pagoni, I., Tsirimpa, A., Roumboutsos, A., Kamargianni, M., & Tsouros, I. (2019). Protoype business models for Mobility-as-a-Service. *Transportation Research Part A*.

Présentation de Projet. (2020). Retrieved from CDG Express: https://cdgexpress.groupeadp.fr/presentation.html

Project Objectives. (2016). Retrieved from DORA Project: https://dora-project.eu/about-dora/project-objectives/

Radiuz. (2019, October 28). Mobility as a Service and Public Transport. (J. Schuiling, Interviewer)

Raga, P. (2004). *Assessment of Transportation Performance Services.* Jakarta: Warta Penelitan Perhubungan.

Reed, D. (2016, April 14). *Americans love to complain about flying, but probably less than you think*. Retrieved from Forbes: https://www.forbes.com/sites/danielreed/2016/04/14/americans-love-to-fly-they-also-complain-about-it-a-lot-but-probably-less-than-you-think/#292544f06423

Reich, R. (1991). *The work of nations.* New York: Vantage.

Rezaei, A., & Puckett, S. M. (2012). Accounting for systematic influences on preference heterogeneity in air travel: Application to a low-travel-propensity market. *Journal of the Transportation Research Board no.2300*, 147-154.

Rocco, T., & Plakhotnik, M. (2009). Literature Reviews, Conceptual Frameworks, and Theoretical Frameworks: Terms, Functions and Distinctions. *Human Resource Development Review Vol. 8 No.1*, 120-130.

Rochet, J., & Tirole, J. (2003). Platform competition in two-sided markets. *Journal European Economic Association 1 (4)* , 990-1029.

Román, C., & Martín, J. C. (2014). Integration of HSR and air transport: Understanding passengers' preferences. *Transportation Research Part E 71*, 129-141.

Román, C., & Martin, J. C. (2014). Integration of HSR and air transport: Understanding passengers' preferences. *Transportation Research part E 71*, 129-141.

Safe, sustainable and connected transport. (2018). Retrieved from European Union: https://europa.eu/european-union/topics/transport_en

Sánchez, M., Gutiérrez-Artacho, J., & Bernardino, J. (2017). A Web Integration Framework for Cheap Flight Fares. *Proceedings of the 13th International Conference on Web Information Systems and Technologies (WEBIST 2017)*, 260-267.

Schabas, M. (2013). Who rides airport railways? The case of London City Airport. *Transportation Research Record: Journal of the Transportation Research Board No.2350*, 80-90.

Scheltes, A., & Honem de Almeida Correia, G. (2017). Exploring the use of automated vehicles as last mile connection of train trips through an agent-based simulation model: An application to Delft, Netherlands. *International Journal of Transportation Science and Technology*.

Sharaby, N., & Shiftan, Y. (2012). The impact of fare integration on travel behavior and transit ridership. *Transport Policy 21*, 63-70.

Smith, G., Sochor, J., & Sarasini, S. (2018). Mobility as a Service: Comparing developments in Sweden and Finland. *Research in Transportation Business & Management 27*, 36-45.

Sochor, J., Arby, H., Karlsson, I. M., & Sarasini, S. (2018). A topological approach to Mobility as a Service: A proposed tool for understanding requirements and effects, and for aiding the integration of societal goals. *Research in Transportation Business & Management 27*, 3-14.

Sochor, J., Strömberg, H., & Karlsson, I. M. (2015). Implementing Mobility as a Service: Challenges in Integrating User, Commercial, and Societal Perspectives. *Transportation Research Record: Journal of the Transportation Research Board, No. 2536*, 1-9.

Solutions, S. (2020). *Latent Class Analysis*. Retrieved from Statistics Solutions: https://www.statisticssolutions.com/latent-class-analysis/

Stam, B. (2019). *Access/egress facilities at railway stations: An exploratory study on the future development of railway station areas.* Delft: TU Delft.

Stathopoulos, A., Valeri, E., & Marcucci, E. (2012). Stakeholder reactions to urban freight policy innovation. *Journal of Transport Geography 22*, 34-45.

Steg, L., Vlek, C., & Slotegraaf, G. (2001). Instrumental-reasoned and symbolic-affective motives for using a motor car. *Transport Research Part F 4*, 151-169.

Surakka, T., Härri, F., Haahtela, T., Horila, A., & Mirchl, T. (2018). Regulation and governance supporting systemic MaaS innovations. *Research in Transportation Business & Management 27*, 56-66.

Susniene, D., & Jurkauskas, A. (2008). Stakeholder approach in the management of public transport companies. *Transport 23 (3)*, 214-220.

Svendsen, A. (1998). *The stakeholder strategy: collaborative business relationships.* San Francisco: Berret-Koehler Publishers.

T test. (n.d.). Retrieved from UCONN, University of Connecticut: https://researchbasics.education.uconn.edu/t-test/#

Tam, M., Lam, W., & Lo, H. (2010). Incorporating passenger perceived service quality in airport ground access mode choice model. *Transportmetrica 6*, 3-17.

Taylor, G. (1998). *Style of travel.* Boston: Butterworth-Heinemann.

Teichert, T., Shehu, E., & Wartburg, I. (2008). Customer segmentation revisited: The case of the airline industry. *Transportation Research Part A vol.42*, 227-242.

Too, L., & Earl, G. (2010). Public transport service quality and sustainable development: a community stakeholder perspective. *Sustainable Development 18*, 51-61.

Train travel in the Netherlands. (2020). Retrieved from Schiphol: https://www.schiphol.nl/en/page/by-train-from-schiphol/

Transdev. (2019). *Moovizy Saint-Etienne, the first MaaS solution in France*. Retrieved from Transdev, the mobility company: https://www.transdev.com/fr/solutions/maas-saint-etienne/

Travel by bus or coach. (2020). Retrieved from Heathrow: https://www.heathrow.com/transport-and-directions/by-coach-or-bus

Travelling on public transport. (2020). Retrieved from Schiphol: https://www.schiphol.nl/en/page/public-transport-and-the-public-transport-card/

Tsamboulas, D., Evmorfopoulos, A., & Moraiti, P. (2012). Modelling airport employees commuting mode choice. *Journal of Air Transportation Management 18*, 74-77.

Tuchen, S. (2019). *Role of aviation in seamless end-to-end mobility.* Moffett Field.

UbiGo. (n.d.). *About UbiGo*. Retrieved from UbiGo: https://www.ubigo.me/en/about-ubigo

Uenlue, M. (2017, September 30). *Business models compared: Booking.com, Expedia, TripAdvisor*. Retrieved from Innovation Tactics: https://www.innovationtactics.com/business-models-tripadvisor-booking-com-expedia/

Urban, M., Klemm, M., Ploetner, K. O., & Hornung, M. (2018). Airline categorisation by applying the business model canvas and clustering algorithms. *Journal of Air Transport Management 71*, 175-192.

Van de Velde, D. (1999). Organisational forms and entrepeneurship in public transport (Part 1: classifying organisational forms). *Transport Policy 6*, 147-157.

Van de Velde, D. (2014). Market initiative regimes in public transport in Europe: Recent developments. *Research in Transportation Economics 48*, 33-40.

Van de Velde, D., & Preston, J. (2013). Workshop 3B: governance, ownership and competition issues in deregulated (free market) public transport: lessons that can be learnt from developed and developing economies. *Research in Transportation Economics 39*, 202-207.

van der Lelij, B., & Oomen, K. (2019). *Luchtvaart in Nederland: Draagvlakonderzoek onder het Nederlandse publiek, vervolgmeting 2019.* Amsterdam: Motivaction.
van Exel, N., de Graaf, G., & Rietveld, P. (2011). "I can do perfectly well without a car!" An exploration of stated preferences for middle-distance travel. *Transportation 38*, 383-407.
van Weele, B. (2018). De toekomst van de OV-chipkaart en betalen in het OV. *MaaS Congres.* Rotterdam.
Vanoutrive, T. (2019). Commuting, spatial mismatch, and Transport Demand Management: The Case of gateways. *Case studies on Transport Policy 7*, 489-496.
Variance. (2020, May 9). Retrieved from Wikipedia: https://simple.wikipedia.org/wiki/Variance
Veeneman, W. (2020, April 9). Interview Governance Integrating booking and payment of air- and public transport tickets. (J. Schuiling, Interviewer)
Vespermann, J., & Wald, A. (2011). Intermodal integration in air transportation: status quo, motives and future developments. *Journal of Transport Geography 19*, 1187-1197.
Vinck, S. (2000). *Quality and customer satisfaction in public transport.* Stuttgart.
Warburg, V., Bhat, C., & Adler, T. (2006). Modelling demographic and unobserved heterogeneity in air passengers' sensitivity to service attributes in itinerary choice. *Journal of the transportation research board no.1951*, 7-16.
Warden, J. (2003). Open skies at the crossroads: how the United States and European Union should use the ECJ transport cases to reconstruct the Transatlantic aviation regime . *Northwestern Journal of International Law and Business 24* , 227-255.
Weaver, P. A., McCleary, K. W., Han, J., & Blosser, P. E. (2009). Identifying leisure travel market segments based on preference for novelty. *Journal of Travel & Tourism Marketing 26*, 568-584.
Willing, J.-N., & Schilling, T. (2016). *Door to Door Information for Air Passengers: D3.4 Specification of DORA Applications.* Berlin: EU Horizon 2020.
Xia, W., & Zhang, A. (2017). Air and high-speed rail transport integration on profits and welfare: effects of air-rail connecting time. *Journal of Air Transport Management 65*, 181-190.
Yap, M. D., Correia, G., & van Arem, B. (2016). Preferences of travellers of using automated vehicles as last mile public transport of multimodal train trips. *Transportation Research Part A 94*, 1-16.
Yazdanpanah, M., & Hosseinlou, M. H. (2016). The influence of personality traits on airport public transport access mode choice: A hybrid latent class choice modelling approach. *Journal of Air Transport Management 55*, 147-163.
Yoon, M., Yoon, D., & Yang, T. (2006). Impact of e-business on air travel markets: distribution of airline tickets in Korea. *Journal of Air Transport Management 12 (5)*, 253-260.
Your guide to public transportation in Frankfurt. (2020). Retrieved from TimeOut: https://www.timeout.com/frankfurt/things-to-do/public-transportation-in-frankfurt
Zalar, D., Uspalyte-Vitkuniene, R., Rebolj, D., & Lep, M. (2018). A METHODOLOGICAL FRAMEWORK FOR MEASURING THE LEVEL OF CONVENIENCE OF TRANSPORT TICKETING SYSTEMS . *Transport volume 33 issue 4*, 1005-1016.

Table of Tables

Table of Figures

Royal HaskoningDHV

TU Delft

Appendix A Scientific Paper

Booking and Payment Integration of Air- and Public Transport Tickets for First/Last Mile Airport Trips

Jerry Schuiling

[1] Transport, Infrastructure and Logistics, Technical University of Delft, Delft, The Netherlands
[2] Data & Digital Consultancy, Royal HaskoningDHV, Amersfoort, The Netherlands

E-mail: J.H.N.Schuiling@student.tudelft.nl

Received 06-08-2020
Published 20-08-2020

Abstract

In this paper, the link between air travel and the first/last mile trip with public transportation will be researched, as in practice, ticket platforms (such as Booking.com or Expedia) do not yet provide this integrated air- and public transport service. Eventually, the idea would be to create an integration platform that serves as a mediator to integrate booking and payment of air- and public transport tickets. As a result, travellers normally booking an airline ticket for airport-to-airport travel, would then be able to buy an integrated ticket involving air- and public transport for travelling from origin to end destination. This research therefore has used methods to judge the feasibility and desirability for this idea, namely a literature review regarding this topic, desk researches, a survey for travel preferences regarding this integration, a stakeholder analysis, and interviews with potential linked parties and governance experts. Eventually the end goal is coming up with a conceptual framework that shows the most important factors regarding the feasibility and desirability of this integration platform, and a business model canvas. It can be said that integrating booking and payment of air- and public transport tickets can be feasible and that certain (shares of) parties think it is or find it desirable. However, the conceptual framework and business model canvas displayed a high amount of important factors, which mostly need to fall into place at the same time. Results of the survey indicated positive reactions, but the question will still be if in reality this interest from potential users will play out. Also, technological developments regarding payment in public transportation can jeopardise this initiative. All in all, risks of this integration platform for potential initiators are not excluded.

Keywords: Aviation, Public Transport, Multimodality, Ticket Integration, First/Last Mile Airport Trips

1.

Introduction

Because of digital transformation being prominent in the mobility sector, new opportunities and challenges arose and new challenges are still arising. An example of an innovation concerns Mobility as a Service, which can be defined as a concept that combines services from various transport modes towards a customised mobility service only using one interface (Alliance, 2017). This customised mobility service can be provided because many stakeholders provide transport services, being public or private.

Studies that have been published in Research in Transportation Business & Management 27 (2018) concerned complications with MaaS relating to the integration of transport services, focus on individual transport needs and interaction via a single interface. Integration of MaaS has been divided into four levels (and with an additional level 0, which stands for no integration) (Sochor, Arby, Karlsson, & Sarasini, 2018).

- Level 1: Integration of information (multimodal travel planners)
- Level 2: Integration of booking and payment (combining multimodal trips towards a single ticket)
- Level 3: Integration of offering the service (bundle subscription based on multimodal mobility services)
- Level 4: Integration of societal goals (having an influence on user behaviour through incentives coming from dynamic data sharing between MaaS operators and transport planning)

In this paper, examined will be to what extent multimodal transport is integrated towards a level 2 MaaS integration and so to what extent different transport modes are integrated with respect to booking and payment towards a single ticket. To be more specific, the link between air travel and the first/last mile trip with public transportation will be researched, as in practice, ticket platforms (such as Booking.com or Expedia) do not yet provide this integrated air- and public transport service. These sites already provide services to rent a car or book an airport taxi, but a button to book a public transport ticket is not available. Trends, such as privatization and deregulation giving a continuous growth in air travel, increase volumes of landside traffic travelling to/from airports (Vespermann & Wald, 2011), and so a potential might be there for a business case towards the integration of air- and public transport tickets.

1.1. Research Gap

The total door to door trip of a traveller does not start or finish at the airport, which implies that the speed of air transport is seen as the most important part of the journey. This then is being reduced by the landside part of the whole trip. It influences competitiveness of an airport and air transport, with a higher share of influence to short haul trips (Badanik, Stefanik, & Matas, 2011). The authors mention that the total travel time of a door to door trip is one of the most important factors in choosing a transport mode for accessing and egressing an airport. Badanik, Stefanik & Matas (2011) however also mention that airport competitiveness is not the only factor that impacts links for accessing and egressing an airport. According to them, the size of the airport's catchment area, its finances, operations and capacity of the terminals and the environment are also important factors. Although the fact that this is given, landside access towards an airport is often still underestimated.

Most of today's airports, especially in Europe, US and Canada, have terminals that are designed in a way to be able to accommodate passenger arrivals or departures with taxi, shuttle bus or private car (Vespermann & Wald, 2011). So hereby with increasing urban expansion and the trend of growth in air travel, connectivity of airports with other modes of transport has become more important in order to disburden the road networks. Especially European and major Asian airports adopted intermodality in order to tackle this problem. Smaller Asian and North American airports however, do not adopt intermodal integration often.

With these findings, a small desk research had been executed to what extent integrations have been applied into ticket platform websites. Two examples have been given being Booking.com and KLM.com.

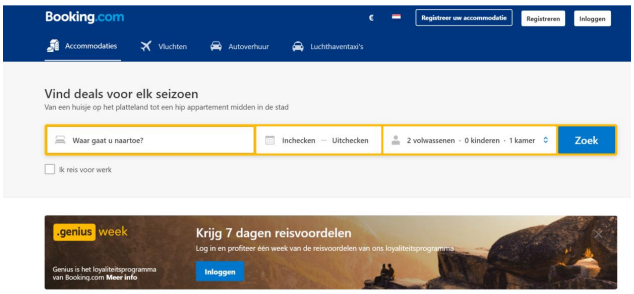


Figure 1 Booking.com

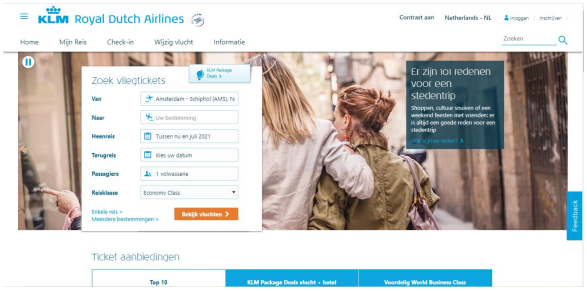


Figure 2 KLM.com

As can be seen in figure 1 and 2, ticket platforms offer extensions besides selling airplane tickets. Extensions may vary from serving accommodations such as hotels, airport taxis and car rental. With beforementioned discussions about public transport, it is notable that public transport has not yet been seen as an extension on these ticket platforms. Some projects have explored the multimodal trip involving air- and public transport, such as DORA (Baumgartner, Kätker, & Tura, 2016) with the aim to integrate air- and public transport. A pilot was held between Berlin and Palma de Mallorca.

Given these findings from literature, it can be concluded that fare integration is valued by travellers. Furthermore, it has been found that DORA provided a solution for the information gap towards travellers willing to use public transport for first/last mile airport trips. However, the integration of booking and payment for air- and public transport tickets is lacking. Researches have yet tried to identify if travellers would be interested in a combination ticket of air- and public transport. In this way, a barrier of putting an effort in to buy a public transport ticket in an unknown, foreign country may be solved. Passengers might therefore dodge the problem of finding the right ticket machines, lack of knowledge of public transport at their destination, probably paying a high amount of money for a taxi, unclear language on ticket machines for buying tickets and so on. All of these examples have the potential to improve the overall customer journey of travellers by creating the option to book a public transport ticket from home. Since airports are seen as a gateway and a strategic engine of economic development (Vanoutrive, 2019), the question arises why this has not yet been implemented.

The integration of booking and payment of these tickets have to be judged on desirability, which corresponds to the demand of the system. Are there specific flows and numbers of passengers and/or types of traveller (leisure or business) which makes this integration desirable? On the other hand, literature has yet discovered feasibility of a certain integration. This would correspond more towards stakeholder interests and power, markets and governance. Could integrating booking and payment of air- and public transport differ across different countries? Figure 3 shows an overview of the total multimodal trip that is taken into account, where the emphasis will be made to the public transport trip at the 'foreign' destination. It has namely been assumed that public transport trips in the traveller's resident area is known by the end user.

Figure 3 Overview Trip Consideration in Research Gap

Eventually, the idea would be to create an integration platform that serves as a mediator to integrate booking and payment of air- and public transport tickets. As a result, travellers normally booking an airline ticket for airport-to-airport travel, would then be able to buy an integrated ticket involving air- and public transport for travelling from origin to end destination. This research should further explain how to make this platform feasible and desirable to operate on for example which parties are involved and which governmental aspects need to be considered. In the evolving digital era, an application to assist the integration platform for relevant trip information provided towards the end-user will be discussed as well. The platform can be illustrated as followed.

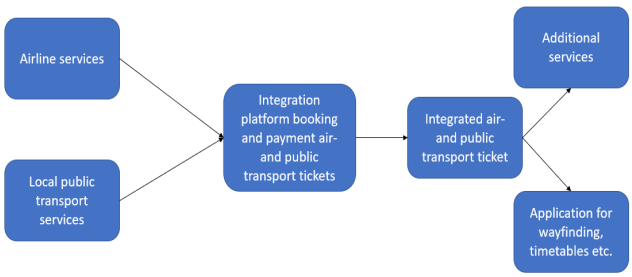


Figure 4 Integration Platform Booking and Payment of Air- and Public Transport Tickets

The main goal with this platform is to ease the trip of (unknown/unfamiliar) travellers by giving them the opportunity to book their last mile public transport trip from home. An integrated ticket will therefore be provided that gives permission to use the specific public transportation mode from the airport to the specific end-destination. Additionally, as has been said an application will be provided and further services linked towards this platform, such as facilities within the airport hall or public transport stop/station, can hereby be provided. With this platform, not only travellers might benefit, but also the public transport operator by possibly generating more interest from the available platform for these modes of transport. This thesis therefore contributes to the gap in literature to identify the feasibility and desirability of this integration platform, the demand that travellers would have for this integration and furthermore this research will be used by Royal HaskoningDHV to decide whether to invest in developing this integration platform for booking and payment of air- and public transport tickets and judge if a legit business case is present.

1.1.1. Research Questions

In order to find answers to the research gap, research questions have been derived. The main aim of this thesis is to examine the feasibility and desirability of this booking and payment integration between public transport and air transport. This research may thereby be an input for the start of building a platform towards the booking and payment integration of a single ticket of air transport and public transport for the first/last mile. The main question for this research is therefore:

'To what extent is it feasible and desirable to integrate booking and payment for air transport and public transport tickets for first/last mile destination orientated airport trips?'

In order to support the final answer towards the main research question, sub questions have been designed to do so.

1. How are door-to-door trips involving air transport for travellers provided? How does the supply chain look like?
2. Which stakeholders are of importance in integrating booking and payment of air- and public transport tickets? What are requirements/wishes of these stakeholders?
3. What are preferences for travellers in deciding their first/last mile airport trips? Would integrating booking and payment be feasible and desirable for them? How large is the demand?
4. To what extent do legislative matters for various countries influence the feasibility and desirability of this integration? How does competition between mutual public transport providers, and public transport and other transport modes play a role?
5. Which factors can be identified from used case studies, a stakeholder analysis, literature review and a survey that lead to a general conceptual framework for integrating booking and payment for air- and public transport tickets?
6. In what way/which ways can an integration of booking and payment be economically beneficial and attractive for end users and other stakeholders? What might be perceived barriers?

1.1.2. Research Scope

Regarding the scope of this research, ideally would be to research if the booking and payment integration is feasible and desirable on a worldwide scale. Due to the high complexity and high amounts of involvements, this is assumed to be impossible. Though to attempt to come up with a general framework with important factors with this integration for worldwide usage, during this thesis the use of case studies will be conducted. In this research the case studies will relate to countries in Europe and thereby a selection of the biggest airports in the continent. The four biggest airports in Europe (2019) are London Heathrow, Paris Charles du Gaulle, Amsterdam Schiphol Airport and Frankfurt am Main Airport (List of busiest airports in Europe, 2020). For this research, only the link between air transport and local public transport will be examined. Another argument might identify that international rail may have similarities with aviation being the most prominent part of the total journey, but this falls out of the scope of this research.

1.1.3. Methodology

The scheme in figure 5 shows the methodology that is used to solve the sub questions in this thesis. The numbers shown in the scheme correspond with the number of the sub question in this research, which therefore link towards the method that is going to be used for solving the sub questions. Abbreviations of the airports taken into account in this research are

stated above the methods in the scheme to indicate that the case studies are used for a specific sub question. Furthermore, text on the arrows indicate which input is generated for the two last follow up questions. A literature review, interviews, a travellers survey and other methods are used in this thesis. Eventually, a conceptual framework that captures the important factors that play a role in the feasibility and desirability of integrating booking and payment of air- and public transport tickets is made, and a business model canvas is set up to see how the integration platform can be success economically.

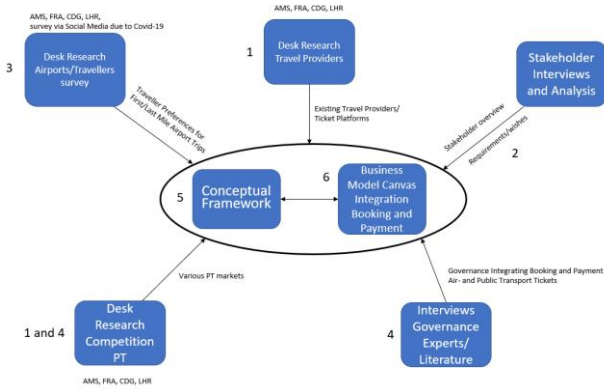


Figure 5 Methodology

1.2. Reading Guide

Firstly, the paper starts with a literature review that has been done regarding the integration of air- and public transport tickets. Section 3 will describe the results of this research, split up in landside transport data of the four airports, stated preference data retrieved from the handled survey, a stakeholder analysis, governance overview, the conceptual framework and the business model canvas with discussed market potential. After the results, a discussion will be made on these results. Last two sections explain the conclusions and recommendations made from this research.

2. Literature Review

Imaginable would be that traveller preferences influences the feasibility of integrating air- and public transport tickets. Studies have been done with respect to travelling. One of them concerned preferences of leisure travellers (Weaver, McCleary, Han, & Blosser, 2009). The study identified that novelty is a motivating factor when choosing and planning a vacation and corresponding activities. Given this statement, assumed can be that these leisure travellers face the novelty of finding a last mile transport solution. People planning these kinds of trips have been divided into three groups by Taylor (1998). He stated that travellers can be divided into planned travellers (who buy travel packages), independent travellers (who plan their trip themselves) and reluctant travellers (who prefer not to travel).

Some literature has been dedicated to research the importance of public transport ticketing. According to Zalar, Uspalyte-Vitkuniene, Rebolj, & Lep (2018), transport ticketing is one of the methods for improving attractiveness of public transport by reducing resistance for passengers. One of the transport ticketing methods is the use of smart cards, where the Oyster Card was a solution for Transport of London at around 2004 (Blythe, 2004). Noticable however is the fact that it is often necessary to stand in queues for charging your smart cards, not solving the same potential problem as the exposure of a queue to buy paper tickets for public transport. Therefore, Chandra, Prakash, & Lamdharia (2013) proposed another ticketing system involving cell phones of a commuter that pays a prepaid or postpaid subscription. Entrance can thereby be granted through phone number recognisation or the use of QR codes or barcodes.

Yazdanpanah & Hosseinlou (2016) executed a literature review on airport access modes and relevant attributes that influence choices made by travellers.

Table 1 Main Attributes influencing mode choice to/from airports (Yazdanpanah & Hosseinlou, 2016)

Researchers	Main Attributes
(Pels, Nijkamp, & Rietveld, 2003)	Fare Frequency Access time Access cost
(Tam, Lam, & Lo, 2010)	Satisfaction level (latent) Cost Time Party Size Number of Transfers Baggage
(Jou, Hensher, & Hsu, 2011)	Out of vehicle travel time In vehicle travel time Overall time-savings User-friendliness of the mode
(Alhussein, 2011)	Income Luggage storage capacity Travel access time Nationality

(Koster, Kroes, & Verhoef, 2011)	Travel time Trip duration Flight frequency
(Tsamboulas, Evmorfopoulos, & Moraiti, 2012)	Total trip cost Total trip duration Income Perception
(Chang Y.-C. , 2013)	Safety User-friendliness of the mode Convenience of storing luggage
(Akar, 2013)	Reliability Travel time to airport Flexibility of departure time Frequency of service Lower cost relative to driving Luggage storage capacity

Table 1 shows a variety of important attributes for travellers making modal choices, where the studies sometimes focussed on specific groups. These were for example employees (Tsamboulas, Evmorfopoulos, & Moraiti, 2012) or elderly air travellers (Chang Y.-C. , 2013). Studies varied in opinion on the importance of cost/price. Pels, Nijkamp & Rietveld (2003) mentioned that access time with accessing airports is more important than access costs, and Jou, Hensher & Hsu (2011) stated that access modes attributes such as luggage storage are of more importance than price. On the other hand, the study of access modes to/from airports in Hong Kong showed that travel cost is the most important attribute. Despite the large variety of factors, booking and/or payment of tickets is not mentioned in this literature.

Within the context of air transport growing over the years, the United Kingdom has adopted a policy to emphasize public transport as the main ground access mode for going to/from airports (Humphreys & Ison, 2005). Researchers therefore have tried to identify differences in ground accesses to/from airports in the UK and Australia (Ison, Merkert, & Mulley, 2014). The researchers identified in their literature review that with ground access of airports, a few problems are central. These problems are the environmental footprint affected by traffic to/from the airport, the fact that both passengers and employees make use of ground access to/from airports, car parking provisions, commercialisation and privatisation of airports that have taken place in the recent periods and what its influence is on ground access to/from airports, and the airport's range of option to deal with the ground access.

For each of the abovementioned problems some notifications can be made. Firstly, it has been mentioned that the environmental footprint of airports is under pressure from the continuous growth in air transport (Ison, Merkert, & Mulley, 2014). Kazda & Caves (2008) thereby however state that one of the reasons is that the impact of ground access is higher than of aircraft movements. 91 % of the total emissions of airports in the UK in 2005 came from road-based journeys ((DIT), 2009), which therefore led to the promotion of public transport. Airport parking as well is complex as these are often non-aeronautical incomes for the airport authority that is not outsourced towards third parties (Ison, Merkert, & Mulley, 2014). Given this, airport authorities might still value parking high, for income and provision of parking spots for passengers and for employees. Privatisation and commercialisation of airports have led to the popular trend of low cost carriers, which gave people a price incentive to travel a larger distance often to an airport with poor public transport (Budd, Ison, & Ryley, 2011).

Tuchen (2019) examined the role of aviation in end-to-end mobility, where she mentions that with the development of new aviation markets and the relevant missions with it, it is important to integrate new entrants, such as MaaS. These need to be integrated into the traditional and evolving transportation networks. The author furthermore mentions that tools such as frameworks are needed to evaluate these integrations and that it requires collaborations between multiple institutions, such as academia, governments and industry.

From a study of air and rail integration in Germany, the conclusion was drawn that long distance trains can be successful replacements for short feeder flights, but that the integration can be complex and expensive (Grimme, 2007). Projects, according to Grimme (2007), would not have been realised without political support in Germany. Main difficulty in this integration was customer acceptance of baggage handling being a complex. Li, Jiang, Wang, & Ma (2018) identified low, medium and high levels of partnerships between rail and air transport.

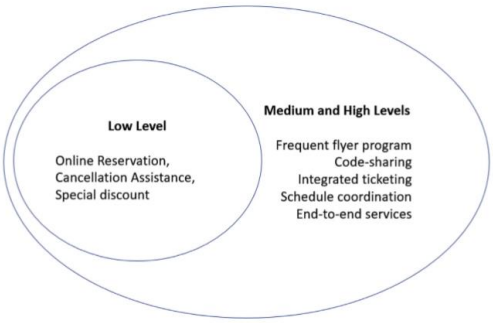


Figure 6 Levels of partnerships between air and rail (Li et al., 2018)

In this case, air and rail operators do not have the incentive to cooperate when the integration costs are sufficiently too high (Xia & Zhang, 2017). Li, Jiang, Wang, & Ma (2018) have done a research towards determinants of partnership levels in air and rail, where the main conclusion was that the location of a train station related to an airport has the highest impact on the level of partnership. It was namely found that if a train station was located at the airport, the level of partnership between air and rail would be higher. Furthermore, partnerships in Europe are of a higher level than the partnerships of air and rail in Asia, according to the researchers.

With integrating air and rail transport, it is imaginable that passengers would have preferences. A study has been executed where these preferences were examined through a stated choice experiment (Román & Martin, 2014). A few observations were made, where at first a disutility is present with end users when switching transport modes. For this reason, a compensation should be realised in terms of in-vehicle, access and connecting time. Fare integration is hereby valued by end-users as well. The researchers also found differences in utilities for leisure and mandatory travels (Román & Martin, 2014). Leisure travellers value baggage integration more than business travellers. Disutility with travel is valued higher for business travels than leisure travels.

Elaborating on a potential conceptual framework for integrating booking and payment of air- and public transport tickets in this thesis, Merkert & Beck (2020) have researched if integrated air-bus services create value for the proposition for the regional aviation market. According to Merkert & Beck (2020), when making this integration as a high priority, it can create business opportunities and competitive advantages for the air-bus transport value chain. Thereby, integrated planning and management, such as joint pricing and timetabling, are most likely to have an impact on demand, competitive advantage and therefore attractiveness and profitability of the air-bus service.

Further research has been done on an extension of Mobility as a Service. Part of this extension is proposed as Collaboration as a Service (CaaS), which incorporates operators more fully and utilises their commercial self-interest in order to create commercially viable and attractive integrated public transport options for consumers (Merkert, Bushell, & Beck, 2020). It furthermore facilitates more collaboration between private public transport operators for short or longer distance travel, possibly enabling opportunities for cross geographical transport providers to further integrate. CaaS hereby is seen as a tool for institutional integration, taking governances of various stakeholders into account.

3. Results

3.1. Landside Transport Data

Modal splits are identified for all four airports as these are within the scope of this research. The consideration should be made however if these results would reflect as the overall picture regarding landside transport at airports around the world, varying from the largest airports to the smallest airports, and their locations on the earth. These differences need to be taken into account in the conclusions later in this report, as various availabilities of for example public transport influences traveller landside transport profiles across the world.

In discovering the landside modal splits of the airports, key facts and figures are needed that expose passenger numbers, number of transfer passengers and modal splits. The total number of passengers per airport in 2018 are given (List of the busiest airports in Europe, 2020).

Table 2 Total Number of Passengers

Airport	Number of Passengers (2018)
Amsterdam Schiphol Airport	71.1 million
London Heathrow Airport	80.1 million
Frankfurt am Main Airport	69.5 million
Paris Charles de Gaulle Airport	72.2 million

As can be seen in table 2, the busiest airport in Europe is London Heathrow. Frankfurt Airport is the

least busy of the four. The mentioned airports being main hubs in Europe also means that the airports have a high share of transfer passengers. These transfer passengers are of importance in calculating total numbers regarding landside transport as these do not make use of landside transport at the airports. With the shares of transfer passengers being known, the number of transfer passenger and therefore the O&D passengers can be calculated.

Table 3 Transfer and O&D Passengers

Airport	Transfer Passengers (%)	Transfer Passengers	O&D Passengers
AMS	36.6	26.0 million	45.0 million
LHR	30	24.0 million	56.1 million
FRA	55	38.2 million	31.3 million
CDG	30.6	22.1 million	50.1 million

The various modal splits for landside transport from/to the airports are given below.

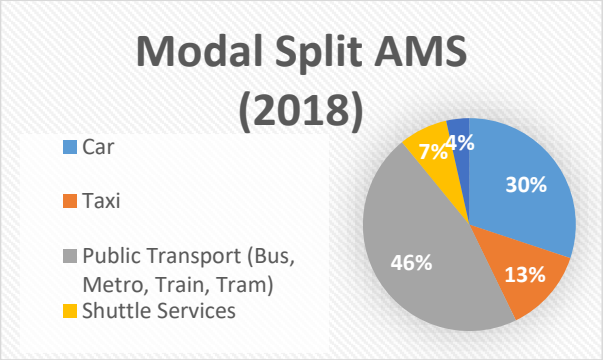


Figure 7 Modal Split Amsterdam Schiphol Airport

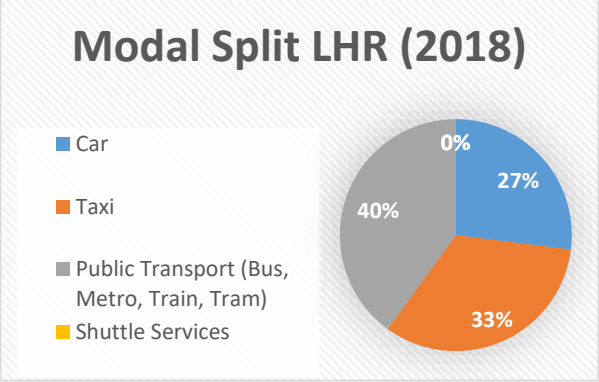


Figure 8 Modal Split London Heathrow

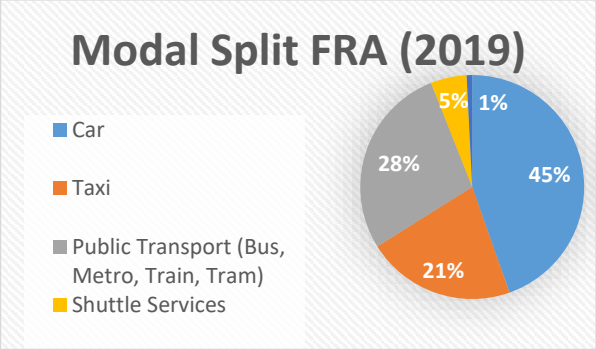


Figure 9 Modal Split Frankfurt Airport

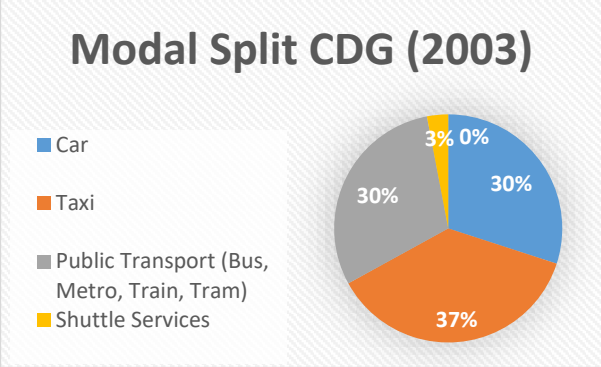


Figure 10 Modal Split Paris CDG Airport

All four airports have a relative high share of passengers that travel with public transport towards or from an airport, with Schiphol having the highest share of 46 % of its total O&D passengers and Frankfurt Airport having the lowest share with 28 %. These shares of public transport consist of bus, metro, train and tram. Therefore, the identity of public transport per airport can differ much and therefore may have its influence on the modal shares. To take train connections as an example, Frankfurt and Paris have a high share in high-speed long-distance trains because of the size of each country. Schiphol Airport is located in the Netherlands, which is a smaller country and therefore has a denser train network of which high speed trains play a less important role. Trains at Schiphol also serve almost the whole country of the Netherlands, which makes it more attractive to use the train at this airport. Rail connections at London Heathrow are mostly dedicated to London itself with the Heathrow Express for example. On the other hand, an underground/metro connection at Heathrow, being the Piccadilly line, is present in contrast to the other airports. The 0 percentage for shuttle service at London Heathrow is explained by the coach/shuttle being taken into account as a bus modality.

Further noticeable are the high modal shares for taxis at the airports of London and Paris. With

percentages of 33 % and 37 %, taxis are substantially more popular than at the other two airports. When comparing car usage at the four airport, Amsterdam, Paris and London show similar modal shares. Frankfurt however shows a higher share for car usage towards and from the airport.

Main lessons that can be learned in this case are that modal splits very much rely on the transport options at the airport and the transport culture in each country. Related to the transport options might be the presence of a train station at the airport, making the option of using the train more attractive. With transport culture it is meant that habits regarding mode choice can highly differ per country. The main example is the high modal share of taxis in England and France in contrast to lower shares in the Netherlands and Germany with respect to airport trips. These mode choices can however differ on various factors that thereby interact with habits of people when choosing modes, making the transport culture complex (table 1).

3.2. Stated Preference Data Integration Platform

A survey was held under air travellers about the integration platform. Questions that are asked relate to how they travel to and from the airport. Furthermore, questions about a proposed tool to integrate booking and payment of air- and public transport tickets will be asked to identify input on judging if the integration will have a demand. The survey was spread via social media, being LinkedIn and Facebook due to the restrictions with respect to the Corona Virus pandemic. The total amount of responses reached a number of 121, of which 90 were filled out completely.

In this survey, the most important question was to find out how likely respondents would make use of public transport when the integration platform is available versus how likely the respondents would make use of public transport from an unfamiliar airport in general. The responses were given on a scale from 0 to 100. Averages of both questions were as follows.

Table 4 Scores likeliness respondents to use public transport

Usage Public Transport from an Unfamiliar Airport	Score
Likeliness using PT in general	76.5 out of 100
Likeliness using PT with integration platform	80.8 out of 100

First notable element of the table above is the relatively high score of 76.5 of using public transport from a foreign airport in general. Concluded can thereby be that public transport without an integration platform is already considered as an attractive alternative to travel from airport to end destination. As has been mentioned in the expectations, the likeliness with the introduction of the integration platform is expected to be significantly positively different. Observed can be that the score for the likeliness with an integration platform is higher but is yet to be tested statistically. Testing the statistical significance of the difference, the t-test was used. The main t-test results are shown in the next table.

Table 5 T-test assuming equal variances

Statistic	Value
Hypothesis (difference means)	0
Degrees of freedom	183
T Statistic	-1.294
T Critical one tail	1.653
T Critical two tail	1.973

As has been mentioned in appendix H, the hypothesis in this t-test is that the means of both datasets are equal. This hypothesis can be rejected if t-statistic < - t-critical two tail and t-statistic > t-critical two tail. T-critical two tail is used because in this t-test inequality is tested. Since in this case - t-critical two tail < t-statistic < t-critical two tail (-1.973 < -1.294 < 1.973), this hypothesis cannot be rejected. This means that the difference found between the two questions is not significantly convincing enough. In practice this means that the introduction of an integration platform, statistically seen and according to this survey panel, would not have a significant influence on the usage of public transport from airports to an end destination.

A more in-depth analysis was done on the comparison between the questions on how likely a respondent will be making use of public transport without and with public transport tickets integrated with airline tickets. For this comparison the responses on both questions were compared and respondents will be categorized as having a positive, negative or neutral perspective towards the integration platform. In both questions, the respondents were asked to fill out how likely they will be using public transport from an unfamiliar airport on a scale from 0 – 100, for both in general and with an integration platform. In this case,

the respondents' perspectives were categorised as follows:

- Positive: A positive difference of more than or equal to 10 points on the scale, when an integration platform is introduced. (Example: 80 before, 95 after)
- Neutral: A difference range when an integration platform is used of -10 till +10 points on the scale. (Example: 80 before, 75 after)
- Negative: A negative difference of more than or equal to 10 points on the scale, when an integration platform is introduced. (Example: 80 before, 65 after)

Judging the respondents' perspectives on the introduction of integrating booking and payment of public transport and airline tickets was firstly done on the whole sample.

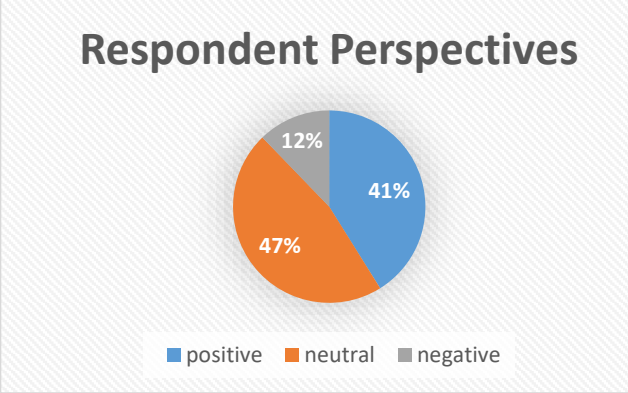


Figure 11 Perspectives of respondents towards the integration platform

The pie chart shows that most of the respondents have a neutral perspective towards the platform. The other big group in this case are the respondents that have a positive attitude towards integrating public transport tickets with airline tickets. With 12 %, the group that has a negative attitude is the smallest group.

Next step in the in-depth analysis was to research if specific groups (age, gender, education level etc.) have a relation with the responses that were given in the survey. The main question thereby is if the positive, neutral or negative perception of the integration platform is coming from a specific group within the panel. Following graphs show the responses for these specific characteristics.

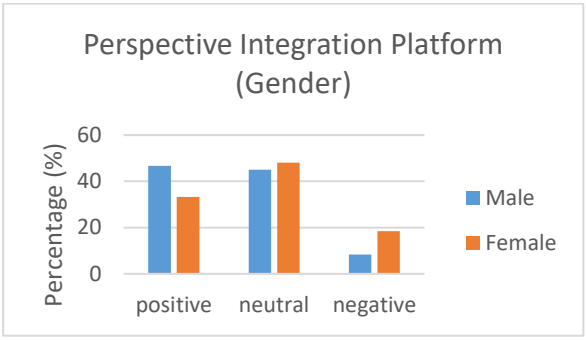


Figure 12 Perspective of genders towards the integration platform

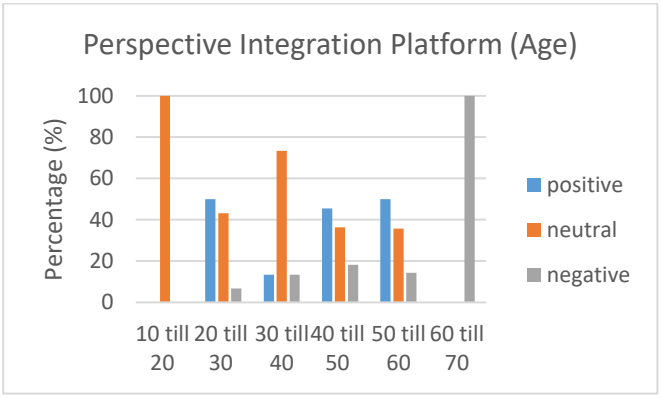


Figure 13 Perspectives of respondents divided in age groups

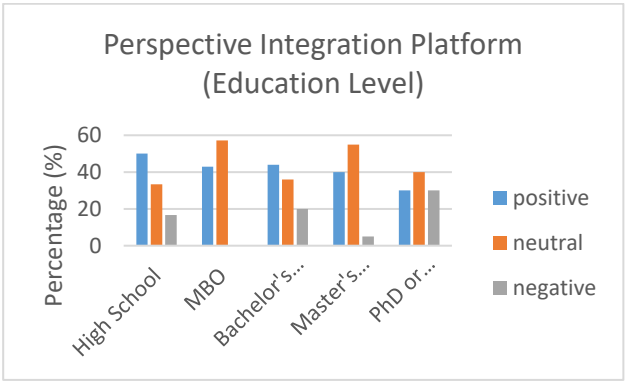


Figure 14 Perspectives between education levels

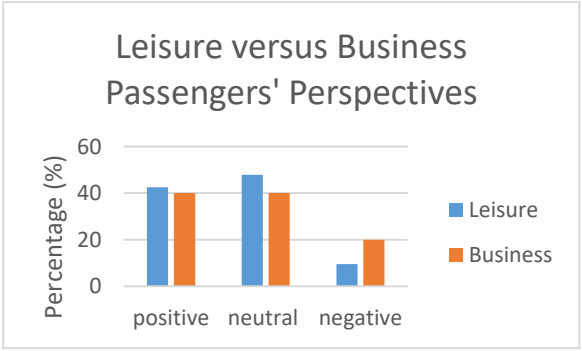


Figure 15 Leisure versus business travellers' perspectives

Therefore, from the in-depth analysis some results were found:

- When looking at gender, it seems that men are more likely to use the integration platform instead of women.
- The age group of 20-30 years old show the most potential with respect to the platform.
- Higher educated people, especially with a master's degree, tend to make use of the integration platform earlier.
- Leisure travellers seem keener to make use of the ability to book a public transport ticket beforehand than business travellers.

Conclusions and hypotheses should be made very cautiously given the panel in this research. However, outcomes of the survey are interesting and therefore a more detailed and sophisticated approach of another survey, especially with choosing your panel to create an equal number of male and female respondents, could be a next step with this topic. Hereby, promising groups for the integration platform could be sought for in more detail with the use of a latent class cluster analysis. With this research method, constructs are created from unobserved subgroups that are based on individual responses (Solutions, 2020). Eventually, groups found with the latent class cluster analysis could be compared with the groups that were found in this thesis.

3.3. Stakeholder Analysis

Next step was to elaborate on the desirability and feasibility of the integration platform with respect to the stakeholders that play a role. Therefore, relevant stakeholders will be identified and analysed on their standpoints and requirements regarding the integration platform. Furthermore, interactions will be explained as well and stakeholders will be placed in a power-interest diagram and problem-frame diagram. The stakeholders that were taken into account are:

- Airliners
- Public transport companies
- Governmental bodies
- Travellers
- Travel agencies/ticket platforms
- Mobility companies
- Airport authorities
- Taxi companies
- Car rental companies

The power-interest diagram is illustrated as followed.

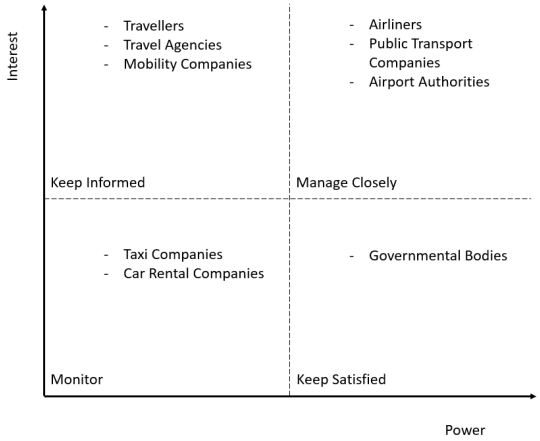


Figure 16 Power-Interest Diagram for the integration platform of air- and public transport tickets

Main players for judging the feasibility and desirability of integrating booking and payment of air- and public transport tickets, are the airliners and public transport companies themselves, and the airport authorities. These should therefore be managed closely when potentially implementing the integration platform. The high interest and power lays in the fact that direct sales come from the airliners and public transport companies and will therefore be the key players for enabling a third party to combine their tickets. The airport authority might oblige the airliners that are closely related to the airport to do so.

Besides wanting to know what specific power and interests are of stakeholders in this topic, standpoints for every stakeholder are of importance as well. The power-interest diagram does not feature if a stakeholder would oppose to the initiative or not. Hereby, a problem-frame diagram can be used. This diagram includes stakeholders who are characterized as an opposition or supporter to the initiative versus their stakeholder power. Given this structure, the diagram gives the ability to identify strong and weak opposition or supporters of the integration platform.

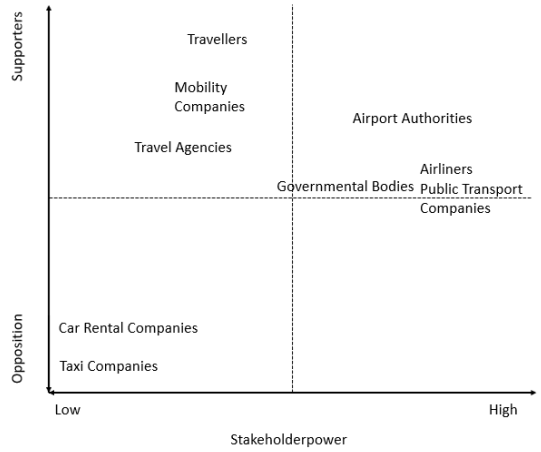


Figure 17 Problem-Frame Diagram for the integration platform of air- and public transport tickets

Figure 17 displays the supporters and opposition towards integrating booking and payment for air- and public transport tickets. Taxi and car rental companies are seen as the biggest opposition parties, despite their low stakeholder power in this case. Airport authorities would be slightly affected if the integration reduces their revenues at for example parking, but the integration might solve other landside transport related problems, such as congestion. This however might depend on the character of the airport being more national or hub orientated. Governmental bodies would be a supporter for this integration, but not the biggest. Travellers and public transport companies can be both supporters or opposition parties based on their approaches regarding landside transport, followed by travel providers, travel agencies and airliners. Travel providers and travel agencies might see opportunities for ticket sales. Airliners might see the integration with local public transport as an additional service, what can lead to higher popularity through air travellers.

3.4. Governance

From the literature review regarding this topic, it was identified that governance of public transportation is divided into two types of governance, namely competitive tendering and market initiatives/open access (Van de Velde, 2014). Furthermore, the trend has been discovered that the European Union has forced countries to involve more competition on public transportation lines in order to improve quality (EU competition policy in the transport sector, 2015). In the interview it was discussed if increasing competition would benefit the specific integration platform. This highly depend on how the public transport lines are being serviced and the card system that is handled. Imaginable is that when a country handles open access, often a monopoly is created by one public transport company. These sort of companies thereby would keep their ticket sale platform closed due to their dominance in the market. An example is Germany, where public transport governance is in principle open for access, though Deutsche Bahn has almost full control on the German rail network. Third parties in this case have almost no influence on ticketing. Increasing competition by governments allows for more tendering and control from governments, which leads to more open ticket systems. An open ticket system would thereby be more approachable for third parties to sell tickets via an integration platform for example and is therefore essential.

A comparison on ticketing systems between the Netherlands and England can be made. In the Netherlands the ticketing system is a single closed system, operated by TLS (Trans Link Systems). England on the other hand is more open, where public transportation consists of more ticketing systems across countries. Despite the fact that it consists of various ticketing systems, an organisation is present which implements all ticket systems to link public transport services. The Netherlands has integrated their ticketing systems further with respect to similarities in transaction for example. This has the benefit that the integration of booking and payment would be easier as the link towards all public transport modes can be made. On the other hand, the different ticketing systems in England might see the integration as an important addition, meaning that these might see it as a competitive addition maybe leading to a higher interest.

The interviewee is an expert in public transport governance. However, this subject also needs an aviation governance perspective. Within aviation similar developments have taken place with respect to privatization. Airports have namely become more private over the past years. Veeneman (2020) thereby takes the hypothesis that private airports are more willing to have a hub function, where airports more restricted by the government have a more national function. As a result of this, imagined can be that airports with governmental restrictions would pay more attention towards their surroundings. Therefore, these airports might put more energy in improving local public transport to/from the airport, than other bigger private hub airports.

Eventually this research is about integrating booking and payment for air- and public transport tickets. There are already links between air transport and public transport, though literature showed that these public transport services were serviced on a

larger scale. Veeneman (2020) mentions that this depends on what airliners see as destinations in their own network. To illustrate as an example, if an airline arrives at Frankfurt Airport, Berlin might still be an interesting destination. Berlin however is not part of their flight network and so therefore the airline would approach Deutsche Bahn to operate this line with a transfer. Why local public transport has not been implemented therefore seems a result of airliners not seeing more close by cities, villages and/or suburbs as an end destination of their customers.

Another mentionable aspect is the beforementioned importance of culture and habits in a country. This reflects in transport related choices that inhabitants of a country make. A biased judgement on a policy that this integration would not benefit public transportation beforehand, because of a country traditionally being more car orientated, can affect the potential of the integration platform of this research.

Last question of the interview was why the concept of integrating air- and local public transport tickets has not been done yet. Veeneman (2020) thereby sees complexity and resistance of linking the tickets and with additional disruptions such as delays as a main reason that this has not been implemented yet. For it to operate successfully, appropriate and sufficient coordination would be required. Thereby, the interviewee sees main roles between the airliner or ticket platform and public transport companies. Airports namely do not have an impact on ticket sales.

3.5. Conceptual Framework

With all the input that has been obtained via revealed and stated travel preference data, a literature review, interviews and a stakeholder analysis, a conceptual framework for integrating booking and payment for air- and public transport tickets can be displayed. The conceptual framework consists of two parts, which corresponds with frameworks that are designed from the stakeholder analysis, and the survey combined with findings from literature and interviews. Both frameworks consist of important factors that are found during the course of this research.

From the stakeholder analysis, seven main factors were identified being:

- Economic benefits
    - Depended on:
        - Margin in ticket sales, especially in public transport tickets
        - Volume of travellers willing to use the integration platform
- Customer satisfaction
- Transport culture
    - Split up in:
        - National transport habits
        - National transport agenda
- Service Economy
- Environmental goals
- Collaboration contracting
    - Important parties to contract:
        - Public transport providers
        - Airliners
        - Travel agencies/mobility companies
- Airport conditions
    - Divided into:
        - Environmental footprint
        - Parking: does the airport own parking lots?
        - Congestion issues

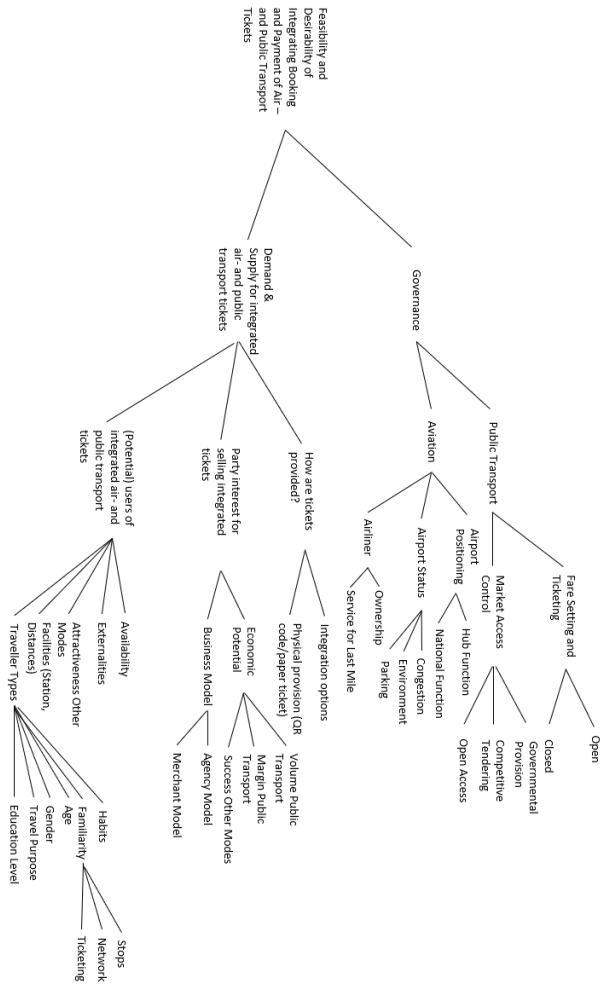


Figure 18 Conceptual Framework from literature, interviews and the survey

Besides the factors that were found from the stakeholder analysis in this analysis, other factors (and overlapping factors) were found from the survey, literature review and interviews. From the study it was identified that the factors for the feasibility and desirability for integrating booking and payment of air- and public transport tickets can be divided into two main groups. These are a group of factors related to governance and the other group with the demand for the integration platform. As can be seen, the framework consists of lines, which correspond with splitting up the factors in subfactor and sub-subfactors further on. This has been done, since particular factors rely on other factors by itself.

Noticeable between both frameworks is the fact that there is overlap with factors in both, but also factors that are present in the overview from the stakeholder analysis but not within the conceptual framework based on the survey, literature and interviews. Among the reasons for this is that the survey was mainly based on responses from travellers and that there was no literature available corresponding with this integration and the involvement of stakeholders within it, as this concept that is being researched in this thesis has yet to be implemented somewhere. Two factors from the stakeholder analysis that are not present in any possible way in the other framework, are service economy and environmental goals. At first, service economy would be between the travel providers, such as taxis, and airport authorities. This factor was not judged within the survey or literature. Lastly, environmental goals would mostly relate to goals that governmental bodies set and which they see as important. More specifically, transport emissions for example as a whole would be considered, instead of only specifically this topic as this is part of the bigger picture.

This section has shown two parts of the overall conceptual framework, which indicates the most important factors in judging the feasibility and desirability of integrating booking and payment of air- and public transport tickets. Both schemes show a high amount of factors that have an influence. Therefore, it can be concluded that the complexity of this integration is probably the reason for the fact that this concept researched in this study, has yet to be implemented by a party such as Booking.com or Expedia. Successfulness of this integration platform depends on various and diverse conditions, making the implementation of the integration platform a challenge for involved parties. These should namely go through a significant amount of criteria in deciding if these are willing to be involved in creating the integration platform. Criteria/factors named in the overall conceptual framework mostly need to fall in place at the same time.

3.6. Business Model Canvas and Market Potential

Another part in answering the main question of this research, is setting up a business model canvas. The business model canvas in this case is used to see how the integration platform can be economically beneficial. In the literature review, an overview of the building blocks was given. These will be explained for this specific scenario firstly, and will be put together in the overall canvas. Most elements are aimed to be related towards the findings from this research, with for example the results from the travellers survey, interviews with for example Tranzer, governance overview and stakeholder analysis. However, some practical elements outside of this study are needed as

well. These are more related towards the development of the corresponding application that comes with the integration, cost structure of the platform and the revenue streams. Brainstorm sessions with Royal HaskoningDHV led to some elements related to the practical implications of the platform, which need to be implemented. Most of these elements can be found in the key resources, key activities, channels and customer relationships, and costs and revenues.

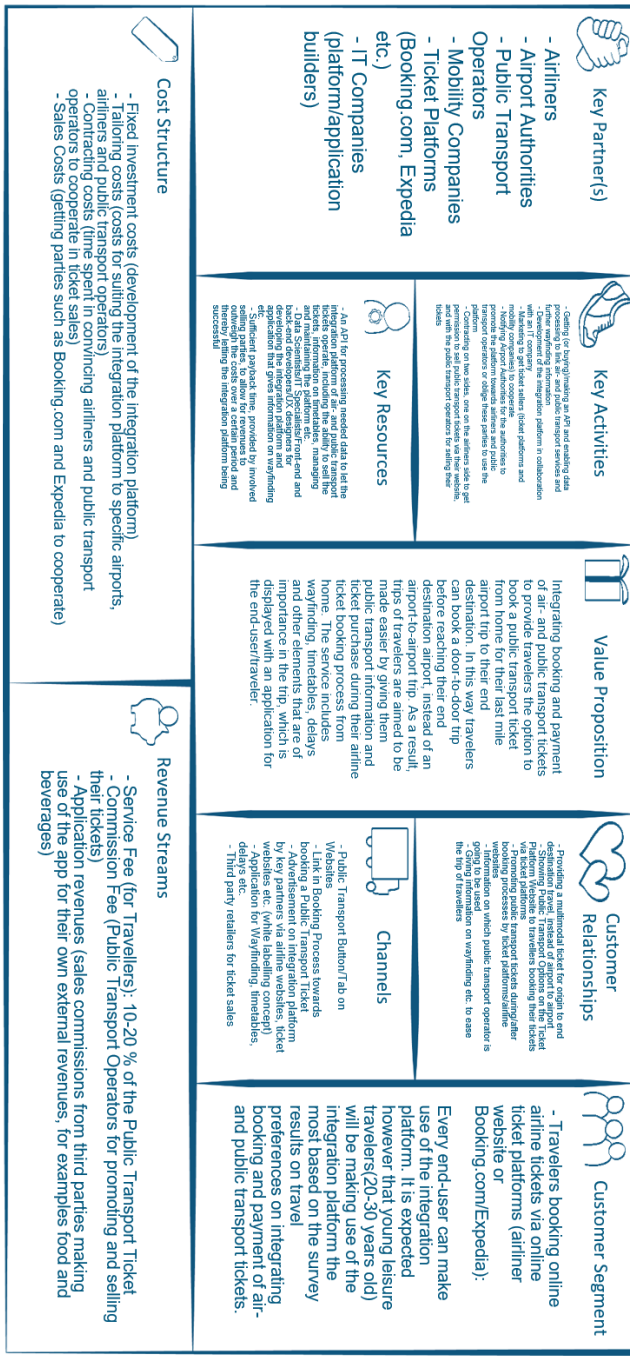


Figure 19 Business Model Canvas Integration Platform

The building blocks within the business model canvas link with each other. Overall, the main aim of the integration platform is described within the value proposition, as this is what is aimed for to reach as an end goal. At first on the left side, to involve key partners that are needed for the value proposition, key activities will be dedicated to provide tools to involve these key partners. Key resources depict the human and physical resources that are needed from these key partners to contribute to the value proposition. On the right sight of the canvas, the customer segment that is targeted with the value proposition is served via various channels to supply the value to them. With the customer relationships, the type of aid variations are described in order to achieve the value proposition for them. These blocks thereby stand on the cost structure, which explains the involved costs that need to be made to reach the value proposition, and the revenue streams that would come from implementing it.

The market potential of integrating public transport and airplane tickets depends on multiple factors, making it difficult to give a clear answer. In this thesis, the hypothesis is made that the age group of 20-30 would be most interesting for these integrated tickets. Given that this is a large represented group within the total amount of travellers, this would favour the market potential. However, the question would be if a high percentage of these travellers will really make use of the integration platform, leading to high enough revenues to weigh out the costs. Furthermore, getting airliners and public transport operators to cooperate based on business perspectives will be a difficult task. Eventually to test the economic feasibility of the platform, pilots at specific airports should be started to see what costs and benefits would be. As not only young travellers might buy integrated tickets, the platform should be available for everyone. After the pilot period, an evaluation would point out the most popular groups and how the ratio of benefit to cost ratio is.

Lastly, developments over the coming years need to be taken into account as well. A spectrum of 10 years in the future might lead to developments that hinder the integration platform. Examples are the developments of possibilities that Mobility as a Service could bring. Specifically, methods of payment in public transport could involve towards more general ticket sales by scanning with credit cards, QR codes of bank accounts on smartphones etc. (van Weele, 2018). This can lead to jeopardising the initiative of integrating air- and public transport tickets, since paying for public transport tickets in foreign countries would be made easier. On the other hand, the integration can

contribute to the idea of easing payment by still providing integrated information on wayfinding, timetables, delays and more.

4. Discussion

In the discussion section of this research, validity of this research is tested, results are interpreted, limitations of this research are discussed and possible implications of this study are named. Firstly, regarding the validity of this research the question should be asked if this study is repeatable and reliable. Literature that has been used are mostly from scientific sources, which implies that statements that are based on these sources in this study are of good quality and reliable. Furthermore, a large set of the conclusions that are made are based on the survey that was handed out. Results from the survey allowed to get insights on traveller preferences regarding the integration platform and also link this towards traveller types. However, observations made from these results might not be fully viable, as the panel of the survey was not weight out. Specific groups, such as young male respondents formed a majority within the sample, limiting to what extent comparisons could have been made. As has been mentioned, this can partly be blamed on the Covid-19 pandemic. Therefore, the situation where this study was held in should always be taken into account, which make the conclusions made not fully generalizable.

From the overall literature study that has been conducted in this thesis, literature was found on car travel and public transport to/from airports. Besides the fact that literature mentioned car travel to be popular still and highly used, governments had implemented policies to promote public transportation to/from their airports. Furthermore, it was mentioned that public transportation contains high value for stakeholders. Therefore results from the survey for example reflected literature, in the sense that public transport is extensively used. As the integration platform is aimed to ease the overall trip of travellers, it was expected that the interest for the platform would be significant. Based on the panel in this survey, the potential is shown, however not statistically convincing. The overall results however have shown that the integration platform could be a success when most requirements fall into place.

It has been mentioned shortly already, but mostly due to the Corona crisis this research consisted of some limitations. It mainly influenced the composition of the survey panel with the panel eventually not having the ideal ratio between response groups. This also holds for reaching out for interviews, as agendas of people became full. Furthermore, trade-offs between factors have not been tested in this research. This could have been done with a stated choice preference experiment, where this survey mostly gave an indication on the overall demand for the integration platform. The stated choice preference experiment could have identified the magnitude of the willingness to pay for the services of the integration. In combination with the latent cluster analysis, these willingnesses to pay could be assigned to the specific recognised sub groups.

5. Conclusions

The overall conclusion is formed by answering the main question of this thesis. It can be said that integrating booking and payment of air- and public transport tickets can be feasible and that certain (shares of) parties think it is or find it desirable.

However when looking at the feasibility of this integration platform, the number of requirements that will be needed to make this integration platform a success is very high and therefore makes it impossible to give a definitive answer. Furthermore, these requirements/factors that were identified in the conceptual framework and business model canvas mostly need to fall into place all at the same time, which probably would lead to lots of time that still needs to be spend to arrange the full operation of this platform. Another point of attention are the governance regimes of public transport and aviation that need to be taken into account. It was namely identified that these regimes can highly differ for each country and each form, either open or a more governmental provision orientated governance, which eventually has its effect on the feasibility of tickets being sold by third parties. Aviation governance also has its effect on the emphasis of airports and airliners take on landside accessibility via public transportation and therefore improving their services via this route. It can therefore be said that feasibility with respect to governance highly depends on the specific situation where the integration platform should function. A specific scenario therefore needs to be considered explicitly and as a result it can be concluded that a generic integration platform applicable for all is not feasible.

The other main aspect of this research was if this ticket integration would be desirable. A big part in determining this has been the execution of the survey. The survey has been thoroughly analysed and the main conclusions were that over the whole survey panel, the positive likeliness difference in public transport usage with integration platform was not statistically convincing enough. However, the more in depth

analysis definitely indicated interest from specific groups, such as young leisure travellers. Eventually, the question would be if this would generate enough volume to reach economic success. This mainly lies in the fact that margins in selling public transport tickets come with low margins. Furthermore, how the public transport market evolves need to be highly considered. Specific technological developments such as the contactless payment at public transport gates, might jeopardise this air- and public transport ticket integration initiative. On the positive side, the survey discovered that the most promising group for this integration platform are young leisure travellers. With the thought of the digital era developing even further, upcoming young leisure travellers might give extra volume to the usage of the integration in for example 10 years, where the current young leisure travellers are already being part of and stick with the concept.

All in all, it would take a sufficient amount of factors falling into place regarding feasibility and desirability to make the booking and payment integration of air- and public transport tickets a success. The research indicates that this is theoretically possible, but the question would be if initiating third parties are willing to take the risk to invest in this integration with all the uncertainties that come with it. Making this integration platform a success will require a lot of time and effort, where possible miscalculations regarding its potential and success are not excluded.

6. Recommendations

This thesis has led to certain results that could answer the main question of this research. However, there are possibilities for further research regarding this topic. At first, the airports that were taken into account are all part of the largest airports around the world with many facilities and large volumes of passengers per year. It has been described that the four airports have paid significant attention towards public transport connections. It can therefore be said that public transport to/from these airports are already well known among travellers that make use of these airports. Therefore, for another research it would be interesting how the effect of this integration platform concept would be on smaller airports with less facilities regarding public transportation and of which travellers are less familiar with. Factors like these might lead to more positive outcomes on feasibility and desirability of the integration platform and might induce third parties to initiate the integration.

Another element for further research is the traveller survey that was held during this research. Especially due to the appearance of the Covid-19 pandemic, tools to get a representative panel to fill out the survey was lacking. This made drawing conclusions more difficult as the ratio between types of respondents and the number of respondents was not ideal. Therefore for further research, another survey could be held that would be handed out to a larger panel, which is also more weighted out (for example the same amount of women and men, and/or similar age group sizes within the responses). A larger sample size would lead to more reliable conclusions and a chance for more statistical significant differences that are observed within the results. The outcomes of the survey in this research namely already showed high shares for positive/neutral responses towards the integration platform. Additionally, a latent cluster analysis can be used as a more detailed method to identify subgroups within the survey sample that could really point out the most important groups to achieve success of the integration platform for air- and public transport tickets.

Furthermore, practical recommendations for the industry are present as well. This research was done in collaboration with Royal HaskoningDHV for a potential proposition. Results of this research can be used for illustrating the possibilities with this integration platform and specifically Royal HaskoningDHV can use these results to look for potential collaborations with other mobility parties, public transport operators and airliners. By discussing the results, the relevant parties can be convinced in the potential of the integration platform, with the result of the integration platform becoming operational. The research recommendations that are mentioned in this section can also be a tool to build upon the reasoning and decision-making in that later stadium. Lastly, as this thesis has not identified costs to set up the integration platform, a specific costs study should also be dedicated for this.

Appendix B MaaS

This appendix concerns mobility as a service to get a better understanding of the concept.

Mobility as a Service Definition

A single interface with MaaS is often handled by an application. Various actors within the passenger transport industry have been stimulated by MaaS to develop a proactive attitude, being that these actors are taking MaaS into account in future scenarios (Jittrapirom, Marchau, van der Heijden, & Meurs, 2018). How the MaaS market will evolve in the future is being watched by policy makers, transportation planners, transport operators and citizens (Polydoropoulou, Pagoni, & Tsirimpa, Ready for Mobility as a Service? Insights from stakeholders and end-users, 2018). Several researchers have identified on where MaaS could contribute to: reductions in emissions related to transport (Hoadley, 2017), improvement of transport system reliability (Hietanen, 2014) and less dependence on private vehicles (Cole, 2018). The potential of the service is there and the system becoming even more popular in the future is possible.

According to Jittrapirom et al. (2018), the potential of MaaS has drawn increasing interest in the transport sector and even beyond. Hensher (2017) mentions that MaaS could change views of public authorities on the way these provide and subsidise their transport services, since MaaS offers the option to capabilities in conventional public transport services and improving customer experience. This gives the opportunity for these public authorities to provide accessibility-based concessions instead of mode-based. Modification of these concessions on the other hand can affect the efficiency of public spending on transport. (Jittrapirom, Marchau, van der Heijden, & Meurs, 2018) Furthermore, MaaS has the potential to increase usage of shared or public transport services. This can be done by offering a high level of convenience, which then may lead to drivers giving up on their private vehicles earlier (Holmberg, Collado, Sarasini, & Williander, 2016). Contribution to the performance of the transport system, such as decreasing the need of parking spaces, enhancing the level of accessibility and reducing congestion could be a positive result (EU, 2016). The ability of MaaS to connect services of business and public organisations in other cases, such as health care and tourism, makes the new transport service attractive for these sectors (Finger, Bert, & Kupfer, 2015).

Further Complications MaaS

For MaaS it is still complex to promote its developments. Results of the paper written by (Smith, Sochor, & Sarasini, 2018) comes with recommendations for policymakers and practitioners in promoting MaaS developments. At first, advisable would be to engage a set of strategic and operational key stakeholders, who are willing to govern MaaS within and beyond their own sector organizations, public or private. Secondly, developing formal and informal networks all based on geographical proximity to centres of power and which can lead to the creation of trust and social capital. Another aspect is to create a vision for MaaS to tackle sustainability problems. Making use of this vision and continuously revising this vision creates the opportunity of open innovations, which leads to risks that then need to be translated towards business opportunities for transport service providers. Also, pilots and implementations with financial capital from public and private sectors should be supported. Taking experiments with new institutional arrangements should be considered as well. These might have a positive impact on MaaS developments and as a result for sustainable travel behaviour as well. Lastly, continuous learning as part of an interactive and co-creative process is of importance. The aim hereby is to develop MaaS services and related business models, which are attractive for the end user.

Legislative matters also play a role in the successfulness of MaaS applications. The operation of MaaS faces challenges in users' perspectives, policy framework and business models (Li & Voege, 2017). Largest thread lies in the possibility that the global MaaS market might be dominated by a few big parties. It is therefore essential to create an appropriate policy framework that allows implementing MaaS services and

benefits for travellers, whilst preventing unfair competition. The study of Jittrapirom, Marchau, van der Heijden, & Meurs (2018) came up with a number of actions which should be taken from the begin phase in order to increase the robustness of a MaaS policy. First action is shaping the policy, which implies securing support from critical actors and collaborate with stakeholders by providing incentives for them to agree. Second action has to do with securing subsidies or funds for incentives to ensure service operations from the start. Lastly, launching the system should start slowly to fix any encountered malfunctions before the bigger large-scale launch.

MaaS State of the Art

Past few years has been a period where applications using the MaaS concept has developed. Some countries have been emphasizing the service more than others, with Finland and Sweden being global pioneers of MaaS applications (Smith, Sochor, & Sarasini, 2018). The first example of an application is Ubigo in Sweden. It was founded based on a scientific study which involved a pilot that was conducted in cooperation with the city of Gothenburg (UbiGo, sd). According to the results of this pilot, participants seemed to be reacting positively towards this new development. 3 % of the participants would rather continue with owning an own car than proceeding with using UbiGo. (UbiGo, sd) According to UbiGo, curiosity of the participants was the reason for this result and the convenience has led to UbiGo being implemented in the capital of Sweden as well, Stockholm, at the beginning of 2019.

The launch of Whim in Helsinki, Finland, has been recognised as the concept that drew international attention (Smith, Sochor, & Sarasini, 2018). MaaS Global, the developers of the app, state that Whim is the first all-inclusive MaaS solution commercially available on the market. (Global, sd) Users are provided with all city transport services in one step combining bike, car, public transport and more, all under a single subscription. Starting in Helsinki, it has spread its market towards other cities, such as Antwerp, Vienna and Singapore. UbiGo and Whim are apps that require cooperation with private and public providers, making these services dependent towards these. A similar application has been introduced in the French city Saint Etienne, named Moovizy (Transdev, 2019).

The incentives for both pioneers, Sweden and Finland, differed from each other. According to Smith et al. (2018) Sweden used the MaaS provider as a tool to promote the use of public transport and therefore linking it to sustainability goals, where the development in Finland was more market driven. This was namely due to the fact that Finland saw MaaS as an opportunity to enable growth within ICT and encourage public spending to counter the economic downturn in the country. Furthermore, the authorities in Finland played a major role in enabling MaaS services.

Literature Review MaaS

As mentioned by Djavadian & Chow (2017), demand for transit is often lacking by not providing enough efficiency and effectiveness for door-to-transit station services, which is stated as the ‘first/last mile’ transit problem. With new developments in information and communications technologies, alternative mobility options, such as MaaS, gained popularity as feeders to fixed route transit lines, such as subways. Furthermore, it has been observed that many transport markets are characterised as two-sided or multisided markets (Rochet & Tirole, 2003). Rochet & Tirole (2006) thereby define two- sided markets as markets in which one or more platforms enable interactions between the end-users and try to consider the two or multiple sides to convince both or more sides to cooperate.

Hensher (2017) researched how future bus contracts might change under a MaaS regime in the digital age. It concerns especially the potential issues it will bring. Concluded has been that a hybrid multi-modal state of affairs might be the best option as new contract setting, providing the possibility of contracts being designed in a way to be driven by mode-neutral customer experiences and the growing opportunity to focus on the concept MaaS. On the other hand, Hensher (2017) mentions that the hype for new mobility services

may not deliver the full solution, which supporters of for example MaaS are suggesting. Some further challenges are mentioned by Sochor et al. (2015) of which one of them being the mismatch between society's and customers' goal to reduce private car usage. Also, since public transport is partially subsidized through taxes, it is difficult for a MaaS provider to purchase public transport trips for less than a individual traveler with a monthly or yearly pass. The challenge hereby is to integrate public and private transport services. Another challenge is that public transport would be the core of a MaaS service. A MaaS provider must build collaboration with public transport providers and local authorities in charge of these. This will lead towards a question of policy for public actors versus a commercial question for the private sector service provider and thereby support from top management of a city or region is critical (Sochor, Strömberg, & Karlsson, 2015).

An example of a MaaS service being corporate MaaS showed that employees appreciated the concept, but that it also showed pitfalls for their needs and increased expectations (Hesselgren, Sjöman, & Pernestal, 2018). The requirement of a company policy was one of them. In designing MaaS systems besides meeting the users' requirements, it is also important to understand the connected practices (Hesselgren, Sjöman, & Pernestal, 2018). Stakeholder views are also of importance for the future role of MaaS. Differences in stakeholder processes depend on cultural and legislative contexts of various regions, as well as the historic collaboration networks with MaaS (Surakka, Härri, Haahtela, Horila, & Mirchl, 2018). MaaS could also lead to privacy issues. The work of Polydoropoulou, Pagoni, & Tsirimpa (2018) revealed that these are mainly driven from the exchange of tracking and credit card usage. It leads to significant concerns of end-users and this might affect the acceptance rate of MaaS.

As has been mentioned, letting public transport being the core of MaaS services is of high importance (Sochor, Strömberg, & Karlsson, 2015). The importance of public transport has been identified by Adhvaryu, Chopde, & Dashora (2019), especially in developing countries. According to them, good public transport enhances mobility and connectivity, especially for lower income groups enabling them to participate better in the labour market. This is beneficial for the economic growth, as well as for social equity.

The paper of Smith, Sochor & Karlsson (2019) found that MaaS can be developed in different ways and different purposes, leading to different impacts on traditional forms of public transport. People interviewed in this research also mentioned that appropriate inter-organizational innovation management is of importance. Too much regulation might bother the private sector to innovate and participate, eventually leading to unattractive MaaS. On the other hand, too little regulation might lead to MaaS not serving the public interest.

Whim (Global, sd) and UbiGo (UbiGo, sd) have been introduced as platforms that were groundbreaking as MaaS providers. Whim being developed in Finland also had to do with its attitude towards MaaS. Finland had a strong will and administrative push to be a pioneer and improving their MaaS services by opening up essential information and access to payment systems and ticket sales interfaces (Eckhardt, Nykänen, Aapaoja, & Niemi, 2018). In the past years, some precursors have been present which have similar identities as MaaS. One example is the WienMobil Card, which is a Mobility Card (Link, Heinemann, Gerike, Jonuschat, & Maryschka, 2017). Barriers were present when wanting to make use of inter- or multimodal transport. These Mobility Cards were partially a solution, since these enable the use of several mobility services and modes of transport.

DORA (Door to Door Information for Passengers and Airports)

Since MaaS considers various transport modes, aviation might play a significant role as well. Integrating air transport in the overall urban and regional transport systems has been examined with a project named DORA (Door to Door Information for Passengers and Airports) (Baumgartner, Kätker, & Tura, 2016). By integrating real time data and incident information, DORA closes the information gap between landside transportation and air transport, having as main goal to optimise and reduce travel time. Two innovations

enable this goal, namely a cross-modal incident management and information system ensuring accessibilty at all times. Another essential aspect is a multimodal information service for passengers, which provides trip recommendations for the shortest ways to/from the airport and inside the terminals. Lastly, technologies were explored for more time efficient procedures, such as waiting times at check in counters and indoor routing.

The Project took place from 2015 towards 2018, having a pilot in two cities that are connected frequently. These were Palma de Mallorca and Berlin, having approximately 700.000 pax/year (Baumgartner, Kätker, & Tura, 2016). Both cities were implemented in a trial consisted out of 500 real end users. A DORA platform was developed for this trial, which is displayed in figure 48. The platfrom consisted of requirements to operate it, namely a collection of universal services, open interfaces, scalable services and the services being highly transferable (Baumgartner, Kätker, & Tura, 2016).

When linking this information towards the levels of integration by Sochor et al. (2018), DORA aimed to integrate level 1 of MaaS, which is the integration of information. The DORA app therefore helps passengers to plan their trip and the writers stated that it will integrate services for a door-to-door journey planning, booking and ticketing for landside transport. However in the DORA trial booking and payment were only applied for public transport, car- and bike sharing (Project Objectives, 2016). Level 2 of integration corresponds with integrating booking and payment, but with DORA air transport tickets and public transport tickets have yet to be integrated on level 2. The DORA project held a pilot in Berlin by integrating ticketing services in the DORA app to enable passengers to buy regional public transport tickets beforehand (Willing & Schilling, 2016). Public transport tickets were stored in the app for control purposes.

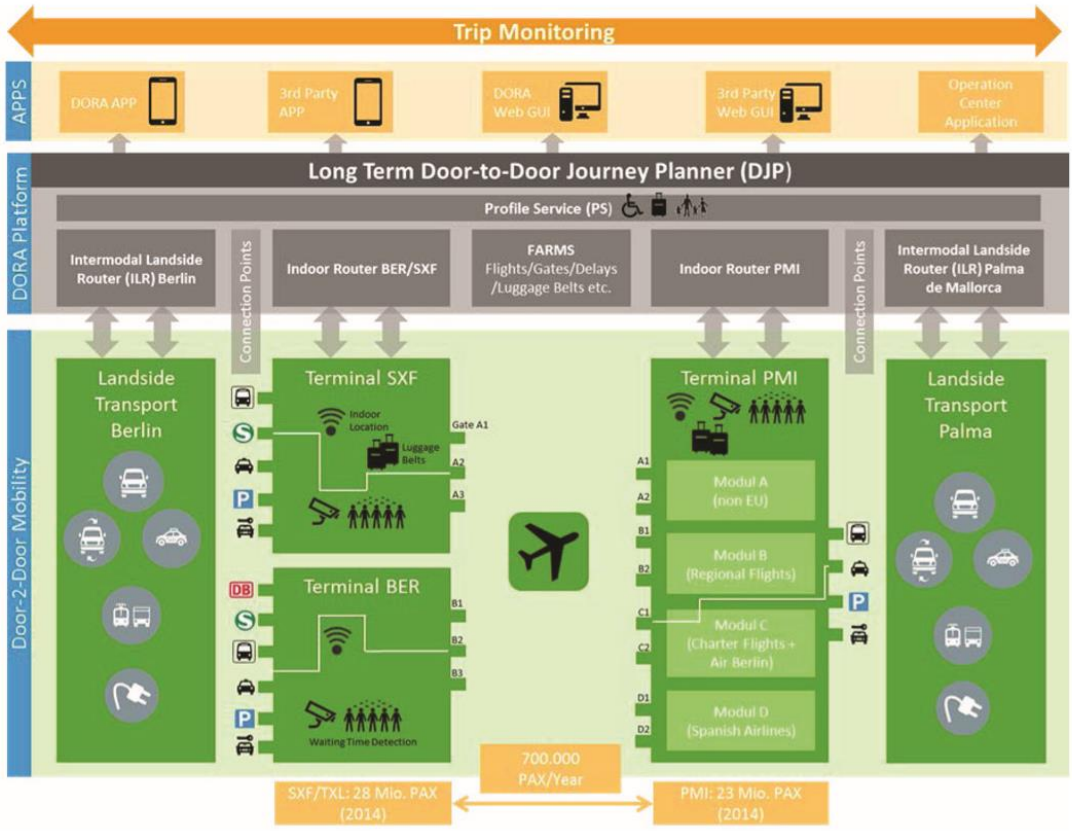


Figure 48 DORA Platform

Appendix C Access and Egress Modes Airports

The way that public transport companies provide their services and payment can differ between countries. Since this research consists out of various case studies, each city and corresponding country will be examined on how these provide public transport services and especially how booking and payment work for every case.

Amsterdam Schiphol Airport

Figure 49 Map Landside Schiphol

Public transport at Amsterdam Schiphol Airport consists out of train and bus connections. The train station of Schiphol Airport is located within the Schiphol Plaza and serves as an important hub in the rail network of The Netherlands. NS (Nederlandse Spoorwegen) provides the train service on a national level varying from Sprinter, Intercity and Intercity Direct Trains. International Train Services such as Thalys, ICE and Eurostar are present as well. Tickets of these international services can be bought at the NS Hispeed desks, where paper tickets for the national trains can be bought at a NS ticket machine (Train travel in the Netherlands, 2020).

Figure 50 Schiphol NS Station

The bus station of Schiphol is situated in front of Schiphol Plaza where various regional/city bus lines stop. One of these bus lines is bus number 397, which is called the Amsterdam Express Bus. It provides a direct connection to the city centre of Amsterdam (Go cross-country by bus, 2020).

Figure 51 Bus Station Schiphol

Various methods can be used to travel with public transport in the Netherlands and Amsterdam in this case. For a longer period of usage time, the 'OV Chipkaart' offers a solution, since it is a rechargeable card that can be used in train, bus, metro and tram. For a higher frequency of usage and longer period, the card can be a method of saving public transport costs. Another possibility is to purchase an Amsterdam Travel Ticket, which can be bought in the form of a one, two or a three-day pass. It includes journeys with train, bus, metro and tram rides in Amsterdam, and a trip with the Amsterdam Express Bus. Travel information for public transport in the Netherlands is provided by websites 9292.nl and ns.nl. 9292 offers information of trips involving all public transport modes (Travelling on public transport, 2020).

Figure 52 Ticket Machines NS for recharging cards and buying paper tickets for public transport

London Heathrow Airport

From London Heathrow Airport a selection of public transport is available in form of a bus, train or metro. Local busses are part of the 'Transport for London' network serving towns in west London. The local bus network does not serve the city centre of London, which in the form of a bus is served by coaches/shuttles (Travel by bus or coach, 2020).

Figure 53 TFL Bus at Heathrow Airport

London Heathrow is connected to a few rail connections to reach the city centre of London or the suburbs of the city. Firstly, a dedicated connection is present, which is the Heahrow Express that connects Paddington Station in the city centre with the terminals 2 and 3 in 15 minutes and terminal 5 in 21 minutes. Terminal 4 can be reached via a free transfer from terminals 2 and 3. The Heathrow Express is a dedicated

line, meaning that tickets for this line need to be purchased via its website. For frequent usage, a monthly or annual subscription can be taken in the form of a HEX travelcard (Commuting: Public Transport, 2020).

Figure 54 Heathrow Express

Transport for London also offers rail links to/from Heathrow Airport from Paddington station by serving terminals 2,3 and 4. Terminal 5 can be reached via a free Inter-Terminal transfer train. The service takes approximately 30 minutes and runs twice per hour. Tickets for this service can be purchased via a ticket machine for an individual ride, or travellers can make use of travelcards such as the Oyster card (Commuting: Public Transport, 2020). The Oyster Card is an electronic payment and access pass/card for public transport in the city of London, which London Heathrow can be used in these TFL trains, Heathrow Express, TFL Busses and the underground, and can be charged at charging machines and Oyster Ticket Shops in London. An alternative to the Oyster Card would be paying with contactless bank passes or a Travelcard, which will become an attractive alternative when the time period staying in London is around a week and is used frequently. This Travelcard then offers a 7-day pass. (De Oyster Card - De OV Chipkaart van Londen, sd). The underground, named the Piccadilly Line serves London Heathrow with 3 stops and connects it with central London (Commuting: Public Transport, 2020). This line is operated frequently. Furthermore, a possibility is to combine bus and train travel with national train links. These so called RailAir bus links serve cities such as Reading and Oxford.

Figure 55 Oyster Card London

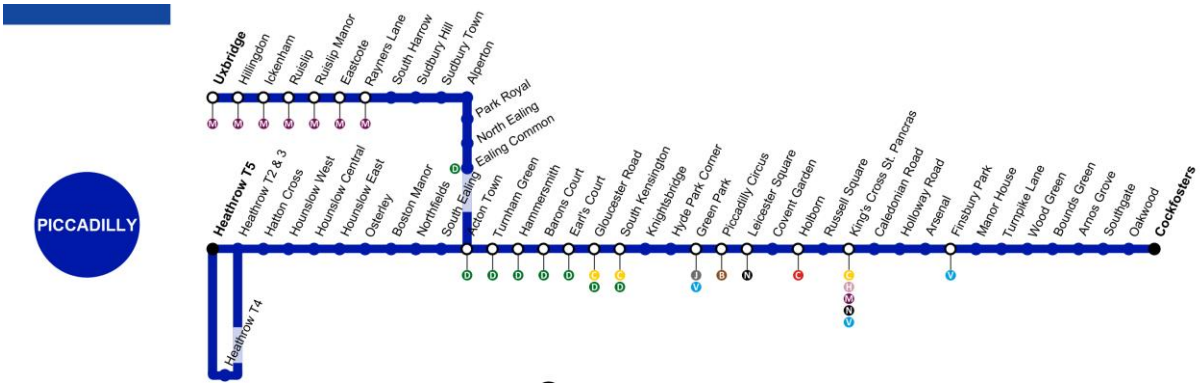


Figure 56 Underground: Piccadilly Line

Figure 57 TFL Rail Heathrow

Frankfurt am Main Airport

Such as the other mentioned airports, Frankfurt Airport also consists various public transport options to use a first or last mile airport trips. Both terminals 1 and 2 are served by the local bus network of Frankfurt. Busses offer services towards other surrounding cities besides Frankfurt, such as Darmstadt and Rüsselsheim. Besides the local busses, hotel shuttle busses and long-distance busses also serve the airport of Frankfurt. The Flixbus and Blablabus are two examples of long-distance busses that depart from the airport and specifically from P36, which is a parking lot (Arriving by bus, 2020).

Figure 58 Local Bus to Frankfurt Airport

Frankfurt Airport is also provided with rail connections towards Frankfurt and cities across Germany and even Europe. Long distance trains are operated by the ICE of the Deutsche Bahn. The local trains cover shorter distances towards Frankfurt but besides also to other cities, being Mainz, Aschaffenburg, Hanau and Wiesbaden. Lines or offered by the S-Bahn services or the Regional Express (RE). The airport's regional station is located on the ground floor of Terminal 1 (Easy Access by Train, 2020).

Figure 59 S-Bahn at the airport's regional train station

Figure 60 ICE at Frankfurt Airport Station

Public transport in Frankfurt is offered by the Rhine-Main Transport Association (RMV). Tickets for tram and metro can be bought at the corresponding stations at the ticket machines. Tickets for the bus can be bought on board. Another option is the Frankfurt Card, which offers you access to all the RMV transport modes for 24 hours and costs 22 euro. For national train lines tickets can be online on the website of the Deutsche Bahn and at the stations itself (Your guide to public transportation in Frankfurt, 2020).

Paris Charles de Gaulle Airport

Paris Charles de Gaulle airport is provided with bus and rail connections as public transport links. The airport contains various dedicated shuttles/busses that offer direct connections towards the city centre of Paris and thereby important iconic locations such as the Eiffel Tower or Montparnasse. Another shuttle service, called the Val d'Europe shuttle, serves a connection from Paris Charles de Gaulle airport to Disneyland Paris. Besides the dedicated shuttle, local busses also stop at the airport, which consist out of regular lines and night lines. The night busses connect the airport with various important railway stations in Paris. Regular lines by day serve the exteriors of the city centre of Paris and suburbs. Tickets for the shuttle busses can be purchased on board the busses but are often more expensive than if a traveller buys the ticket online

beforehand. The RoissyBus for example offers a trip for 13,70 euros if the ticket is bought on board and online. Tickets on Le Bus Direct will charge an extra euro for purchasing last minute on the bus itself. Local busses provide tickets on board as well (Paris-Charles de Gaulle by public transport, 2020).

Figure 61 A shuttle example: RoissyBus

Rail connections are divided into regional lines and the main lines covered by for example the TGV. The regional line is called the RER B, which connects the airport with Paris and its suburbs. There are two train stations at the airport being Aéroport Charles de Gaulle 1 and 2. The RER stops at Aéroport Charles de Gaulle 1, which serves terminal 1 and 3 of the airport. Station Aéroport Charles de Gaulle 2 serves terminal 2 and functions as a stop for main train lines, such as the TGV. If terminal 1 or 3 need to be used by the traveller, a free shuttle is provided called the CDGVAL, which serves as an automated metro. Tickets for the train can be bought online or at the stations (Paris-Charles de Gaulle by public transport, 2020).

Figure 62 RER B map

Figure 63 Aéroport Charles de Gaulle 2

Charles de Gaulle Airport is going to be equipped with a similar service as the Heathrow Express, namely the CDG Express. It will connect the airport with the Gare de l'Est train station in Paris. A trip is going to take approximately 20 minutes and runs four times per hour. The project is projected to be finished in 2025 (Présentation de Projet, 2020).

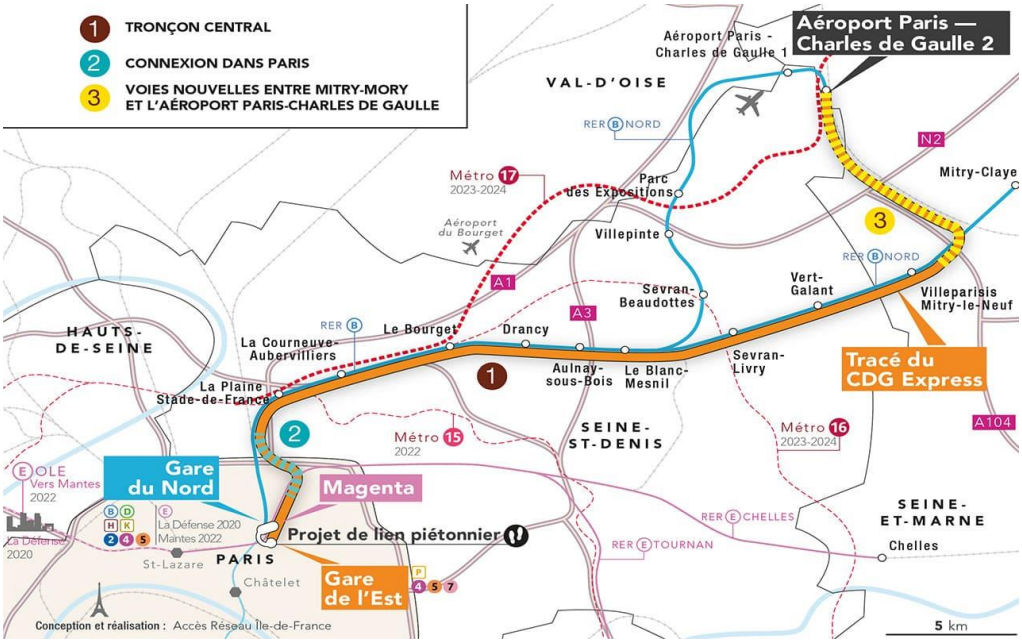


Figure 64 Projected lay out of the CDG Express

As a summary, tables will be given that give comparisons between the four airports. The access and egress modes have been described in detail and the first table gives an summary of which types of public transport are present at the airports.

Table 11 Public transport types at each airport

	Amsterdam Schiphol Airport	London Heathrow Airport	Frankfurt am Main Airport	Paris Charles de Gaulle Airport
Bus	Yes	Yes	Yes	Yes
Metro	No	Yes	No	No
Tram	No	No	No	No
Train	Yes (Regional and International)	Yes (Regional)	Yes (Regional and International)	Yes (Regional and International)
Dedicated public transport line	No	Yes (Heathrow Express)	No	Yes (CDG Express from 2025)

Furthermore, next table indicates the methods of payment of the public transport tickets. Also indicated was the fact if there is any possibility of integration via a mobility card.

Table 12 Ticketing and/or cards for public transport

	Amsterdam Schiphol Airport	London Heathrow Airport	Frankfurt am Main Airport	Paris Charles de Gaulle Airport
Mobility Card	Yes (OV Chipkaart)	Yes (Oyster Card)	No	No
Travel day passes	Yes (Amsterdam Travel Ticket)	Yes (Travelcard)	Yes (Frankfurt Card)	No
Single ride tickets	Yes	Yes	Yes	Yes

The tables roughly indicate the presence of public transport and level of integration at each airport. Chapter 5 indicated that the highest modal shares for public transport were with Amsterdam and London. This result links towards the level of public transport indicated in table 11 and 12, namely indicating the higher level of public transport comparing with Frankfurt and Paris.

Other Transport Modes

Chapter 5 indicated modal splits for each airport that are taken into account during this thesis. It identified that differences exist in modal shares across these airports. Therefore, in this section an analysis will be made on the travel times, distance to city centre and travel costs of these different modes in comparison with public transport. Modes that will be considered are the modes that are assumed to oppose the highest competition for public transport, which are car (also a distinction with parking) and taxi. Firstly, the distances between the airport and the city centres are shown. Distances are measured with Google maps/routes.

Table 13 Distances between airport and city centres

Airport	Distance to City Centre (km)
Amsterdam Schiphol Airport	23
London Heathrow Airport	26
Frankfurt am Main Airport	15
Paris Charles de Gaulle Airport	30

A further distinction can be made in travel costs and travel time from the airport to the city centres. The table represents the trip from the airport to the city centre, since this last mile trip is assumed to be most relevant

towards unfamiliar travellers. Travel costs for the car are based on data from mappy.nl, though this cost indication is based of having an own car.

Table 14 Comparison of travel time and costs for each airport

Airport	PT Travel Time (min)	PT Travel Costs (€)	Taxi Travel Time (min)	Taxi Travel Costs (€)	Car Travel Time (min)	Car Travel Costs (€)
Amsterdam Schiphol Airport	20-35	5.50 (train), 7.20 (train + metro), 6.50 (bus)	30	45-50	30	1.50 – 2.00
London Heathrow Airport	25-70	25-30 (Heathrow Express), 6-7 (metro)	40-60	50-80	40-60	2.00 – 3.00
Frankfurt am Main Airport	30-40	4.65 (train), 4.35 (bus)	15-30	25-35	15-30	1.00-1.50
Paris Charles de Gaulle Airport	40	10.30 (RER)	30 – 60	Around 50	30 - 60	2.00 – 3.00

Table 14 shows that Amsterdam and Frankfurt provide the lowest costs for public transportation with a relatively low travel time comparing to the other two airports. Schiphol shows a higher share for public transportation however, as has been seen in section 5.1. Table 14 furthermore shows low prices for travel costs for car. This is logical since these costs only consist of fuel costs. Fuel costs however do not represent the total costs for using the car, when the traveller uses his/her own car. Additional and the largest part of the costs to travel by car are the costs for parking. For this specific case, the long-term parking costs are taken into account, since most trips involving air transport will be longer than 1 day and therefore parking a car will be longer than 1 day as well.

Table 15 Long term parking costs

Airport	Long-Term Parking Costs
Amsterdam Schiphol Airport	€50 for the first 3 days, €6.50 for every additional 24 hours
London Heathrow Airport	€25-30 for the first 24 hours, €20-23 for every additional 24 hours
Frankfurt am Main Airport	€39 for two days parking, 7 days starting from €66 and holiday 7 days parking starting from €29
Paris Charles de Gaulle Airport	€120 for the first 7 days, €5 for every additional day

From the modal splits of all airports it was observed that Frankfurt Airport has the highest share of car trips and that the other three airports have a similar modal share for cars. The lowest parking costs for Frankfurt must be a reason.

Conclusion

Concluding this paragraph, it can be stated that every airport in this case has considered to provide public transport connections for their users. These connections vary in options across the airports. It has been observed that London Heathrow and Amsterdam Schiphol Airport have the highest shares in public

transport, which can be explained by the smaller scale network that is served by public transport compared to Paris and Frankfurt. The train connections at Schiphol airport serve as national connections and at London Heathrow even a metro line is present that offer direct connections towards the city centre of London. Frankfurt's train connections are served on a national level as well, though Germany is a larger country than the Netherlands explaining the lesser use of trains there. The RER in Paris serves a train connection towards the city centre, though some other factors such as safety (pickpocketing and robbery) play a role in the lesser usage (Donners, 2020).

The modal splits revealed that the airports in London and Paris had the largest shares of taxi trips in comparison with the other two airports. This is despite the fact that taxi prices of the airports to the city centres are all quite similar. It can be explained by the fact that people living in suburbs often opt to use a taxi instead of public transport. Furthermore, the overview of parking costs explains the highest share of car usage in Frankfurt, where Germany is also concerned to be a car orientated country.

From this analysis, it can be concluded that the factors that influence the modal choice to/from airports that were found in literature, reflect in the various modal splits of all four airports. Travel time and travel costs were often mentioned in table 1 (section 4.1.6) and results of modal splits are therefore relatable. The city centre of Amsterdam and London are faster accessible via public transportation than car and taxi, and the costs are lower. Public transport in the other two cities however is a slower option than car and taxi, which explain the higher shares for these two modes and those airports. All in all, the factors found in literature reflect in revealed data.

Related to the main question of this thesis, it can be concluded that travellers already making use of public transport, might appreciate being able to book and pay a public transport ticket beforehand. Other travellers using car and taxi might be interested as well by removing an obstacle of searching for a public transport ticket at a foreign airport, as the overall customer journey hereby is aimed to be improved.

Appendix D Stakeholder Descriptions

In this section the stakeholders will be described, which will include who these parties are, what these parties might require and what their role in this specific integration case would be.

Airliners (Transavia)

Figure 65 Transavia airplane

To get an insight on the perspective from an airline in this subject, an interview with the Dutch airline company Transavia was held (den Ouden, 2020). Questions were asked especially related to if there was any interest in integrating booking and payment of air and public transport tickets. By indicating with the question if they as a company have done any research on the demand from customers for a certain all in one concept of travelling, knowledge was obtained if Transavia thinks about intermodality. The representative of Transavia mentioned that research had been conducted on travellers' preferences on their first- and last mile airport trip and that they are familiar with the concept of MaaS. From their customer research, the result was that the market potential for incorporating public transport in their services is present. To distinguish themselves from other airlines, Transavia is further discovering this potential and has reached out to Tranzer, which provides a MaaS concept of linking various modalities for door-to-door trips. Transavia and Tranzer therefore agreed on a collaboration to work towards a pilot on a couple routes, which will start shortly somewhere in 2020 (speculation before Corona Crisis). It can therefore be concluded that an airline like Transavia thinks they would benefit from the integration. The airports on which Transavia flight to vary however. An airline like Transavia tends to make use of secondary airports, which have a point to point traffic function. This reflects with the finding in section 8.2, where the hypothesis has been made that a more national airport might pay more attention towards surroundings and therefore local public transportation.

From a market perspective, Transavia focusses mainly on leisure travellers with their high share of leisure destinations. Apparently, from their traveller research leisure travellers are interested in the usage of public transport. Transavia does provide extensions for landside transport, such as transfer services and car rental, though it is not seen as a major tool for them to provide door-to-door trips. Transavia assumes that visitors of their website will mainly be interested in their air transport tickets and would visit another provider/website for a total journey. Furthermore, the representative mentioned that car rental is seen as modality for next mile problems, which implies larger distances. The pilot with Tranzer therefore would be a sophiscated extension of Transavia's services.

Public transport companies

Since the integration platform will combine airplane and public transport tickets, the role of public transport companies is of high importance. An incentive that public transport providers would take into account is the structure of public transport governance that is handled in a certain country. Section 4.4.1, which concerned governance of public transport nowadays, describes that public transport markets are organised in a market

initiative structure or via competitive tendering. These natures of markets influence the performance rate of public transport companies, either these needing to comply to a service goal or revenue goal. If the integration platform lets more air transport travellers use public transportation, it can lead to more revenue and higher service usage for public transportation.

In order to let the integration platform function, public transport tickets should be able to be sold by a third party or collaborative party. This strongly depends on which party decides on the fare and ticket system that public transport in the specific region is in (Veeneman, 2020). These systems can either be open or closed and can have a link towards the governance of public transport in the region. With open access, public transport companies that have monopolies on certain lines might tend to have a closer approach on ticket sales for third parties. On the other hand, with competitive tendering the governmental body can choose to open up fare and ticket systems towards third party sellers. All in all, an open system for ticketing and fares would be more beneficial for an integration platform. Depending on the way how public transport companies obtain revenue is decisive for how these stand towards integrating their tickets with air transport tickets. A small indication was already made during an interview with the head of business development at Transport for London, Matthew Hudson (Hudson, 2020). The interviewee mentioned that the integration platform would not be an interesting option for Transport for London, as this party believes in contactless payment through entrance gates to increase the overall customer satisfaction. Integrating their tickets would imply that Transport for London would need to pay commission to a third party to sell their tickets and according to Hudson (2020), Transport for London would not cooperate as they believe in their own payment easing approach. Transport for London would also arrange additional services themselves. Due to crowded times during the coronacrisis, other public transport operators in the other cities were not interviewed. Hudson (2020) stated that pilots with contactless payment were running in Amsterdam and Paris, but an interview would confirm the standpoint of the operators in the other three cities.

Governmental bodies

Within the cases of the four airports, various governmental bodies would have influence on the desirability of an integration platform. Imaginable would be that the European Union would be on top of the hierarchy in the governance organisation structure. The European Union functions as a governmental body that set goals for governments of each EU country to fulfil. These goals can also relate to specific transport and environmental goals, which are relevant in this case. Policies of the EU support transport systems that meet the following challenges (Safe, sustainable and connected transport, 2018):

- Congestion
- Sustainability
- Air quality
- Quality of infrastructure
- Competition, as the EU faces fast developing transport markets in other regions.

As the European Union supports new innovative developments in transport, such as the development of MaaS, it can be assumed that the European Union would support the integration idea of combining public transport tickets with air transport tickets. In this way, public transport will be promoted, which as a result can lead to partly meeting the major challenges that are mentioned in this section.

The major challenges that are set by the European Union are guidelines for each EU country to comply to. In this research, governments of Germany, the Netherlands, England and France are taken into account. Each of these countries need to find solutions to reach the goals that the EU has set up. These solutions can vary throughout the countries, where a country can see integrating booking and payment of air- and public transport tickets as a helpful addition to fulfil the goals. On the other hand, each country might have its own focused solutions, which are assumed to be sufficient already. However, governments of each

country might see this as an additional solution for reaching better access to public transport for example, which might ease reaching their goals.

Each country has its own culture, so each country's culture can reflect in its transport culture. Habits of travellers play an important role in the transport culture, because habits often creates bias towards modal choices. These habits might be taken into account by governmental bodies and therefore new solutions might be rejected prematurely.

Travellers

Figure 66 Air travellers

Travellers are in this case the end users of the integration platform that might be provided. Chapter 6 indicated the results from the survey that was held on traveller's preferences with respect to integrating booking and payment of air- and public transport tickets.

Modal splits for each identified the various modal shares for each transport mode per airport. Imaginable would be that the travellers that already made use of public transport are keen on making use of the integration platform. It namely would ease their journey planning. On the other hand, knowledge for travellers that they are able to book a public transport ticket before travelling might be an incentive for travellers that would normally make use of a taxi or car rental. For these potential mode switchers, the integration platform can be interesting to use.

Travel Agencies (Booking.com/Expedia)

Figure 67 Booking.com

Figure 68 Expedia

The main incentive of travel agencies would be if an integration platform from their website can be a sufficient source of revenue generation. As has been mentioned in section 7.1, Booking.com makes use of the Agency business model and Expedia makes use of the Merchant business model. Booking.com will then ask commission for selling these public transport tickets and Expedia would firstly buy a batch of public transport tickets. This concept however has yet to be implemented on their websites, though it has been applied for extensions on taxi purchase and car rental. An explanation hereby could be that margins in providing these services are sufficient for travel agencies, such as Booking.com and Expedia. Since it is known that public transport is often subsidised by governments, margins are much lower. Parties like Booking.com however can implement public transport services, when the demand and therefore revenue would be high enough for investment.

An extension by travel agencies for public transport services can be an attractive option for travellers. Hereby, the service level of these agencies can rise and therefore travellers might tend to consult the travel agent.

Mobility Companies (Tranzer)

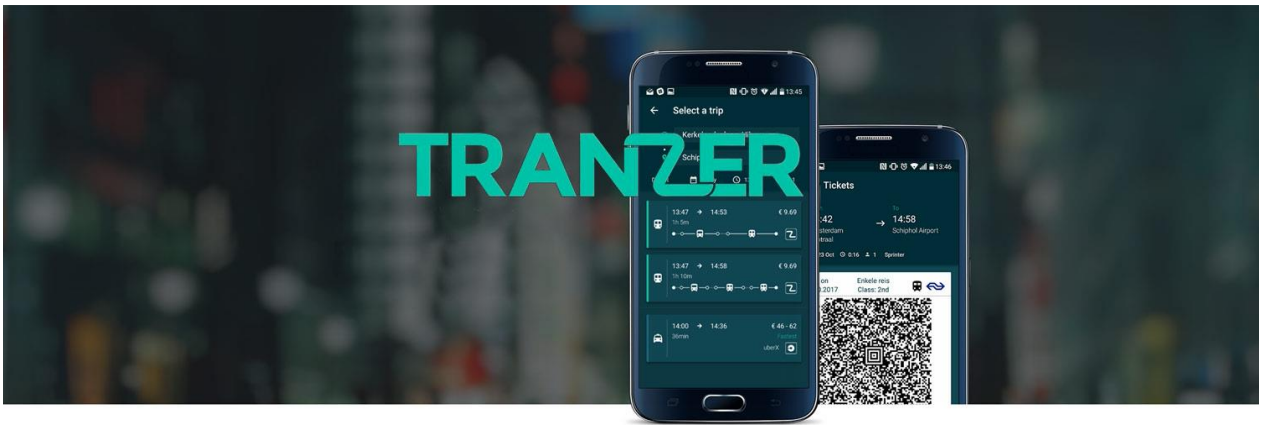


Figure 69 The Tranzer App

As has been mentioned, Transavia has already reached out to Tranzer to collaborate on involving air transport into MaaS services. Tranzer would hereby serve as a platform for Transavia customers to arrange their last mile trip at the end destination of the traveller. According to Tranzer themselves, they offer the best travel options and give insights in the effect of these options (time, cost and emission) (About Tranzer, sd). Through an interview with Sanneke Mulderink, one of the two founders of Lynxx which is the developer of Tranzer, gave further insights on how they as a company work. Since the launch of Tranzer, the app has spread over towards other countries besides the Netherlands, where Belgium, Italy and Germany have adopted the app in some parts of their countries. Further pilots with the app were held or are going to be held, for example with 9292 for not only searching the best travel plan but also being purchasing public transport tickets with it. Besides the contact that Tranzer has with Transavia, the app has also been introduced at KLM, which indicates the attention airliners are giving towards new developments to improve landside accessibility.

Tranzer's main problem in their market is that reaching propositions, according to Mulderink (2020), is a slow process. The explanation for this is the fact that contracting parties, such as public transport companies, is time exhaustive. Companies tend to hesitate to fully cooperate in the concept of Tranzer. Hesitations of these companies are mainly based on revenue motives and thereby that public transport companies think that Tranzer would be making a lot of profit. The business model of Tranzer consists of service costs from the transaction of the end-user and a small margin on the ticket sale from the public transport company, which is 5% (Mulderink, 2020). Therefore, public transport companies only offer full fare tickets to Tranzer to keep their own margin as high as possible. The assumption that the mass of public transport usage is high, motivates Tranzer to continue their business despite their low margins.

Similar to the case of integrating booking and payment of air- and public transport tickets, the Tranzer app mainly focuses on the unfamiliar traveller. Therefore, Tranzer has anticipated on the question from airliners to improve landside accessibility. Tranzer thereby comes with three requirements when a party wants to collaborate. These are that the collaborating party would need to have an own advanced API, Tranzer will build the whole segment from the app for usage in the specific case and that the app will be fully integrated with the operator (Mulderink, 2020).

Airport Authorities

Figure 70 Royal Schiphol Group

Figure 71 Heathrow Holdings

Figure 72 Fraport

Figure 73 Groupe ADP

Figure 70 till 73 show the airport authorities responsible for exploitation and operations at the airport. Each of these authorities are also involved in landside transportation at the airports. Accessibility is namely essential for their end-users in choosing to make use of the specific airports. However, it can be imagined that the main interaction of integrating the tickets would be between the ticket providers, which may be the ticket platforms or airliners on one side, and public transport companies on the other hand. Airport authorities are not responsible for these ticket sales. Their main focus are operations that relate to the airport. The integration can thereby influence the landside operations of the airport, meaning possible reducing congestion and probably parking problems.

Integrating booking and payment of air- and public transport tickets can however reduce the number of cars parking at the airport. Parking lots at the airport are often owned by the airport authority. In this way, revenue that is made from cars parking at the airport is obtained by the airport authority. Schiphol is an example, which owns parking lots. There are further private parking lots owned by third parties however, such as in Frankfurt where Holiday parking is possible. Given this knowledge, airport authorities owning parking lots might have problems with promoting public transport too much, since the authorities therefore would lose revenue.

As has been mentioned in section 9.2, hub airports might tend to focus on worldwide operations instead of focussing on the surrounding of the airport. However, airports like Schiphol, which is considered as a hub airport, still pays high attention towards landside accessibility (Veeneman, 2020). Schiphol Group has a close connection to KLM. If Schiphol Group finds the integration platform important, they might say to KLM to implement the integration of their tickets with public transport tickets and that KLM needs to inform their airline alliance as well.

Taxi Companies

Figure 74 London Taxi

Figure 75 Paris Taxi

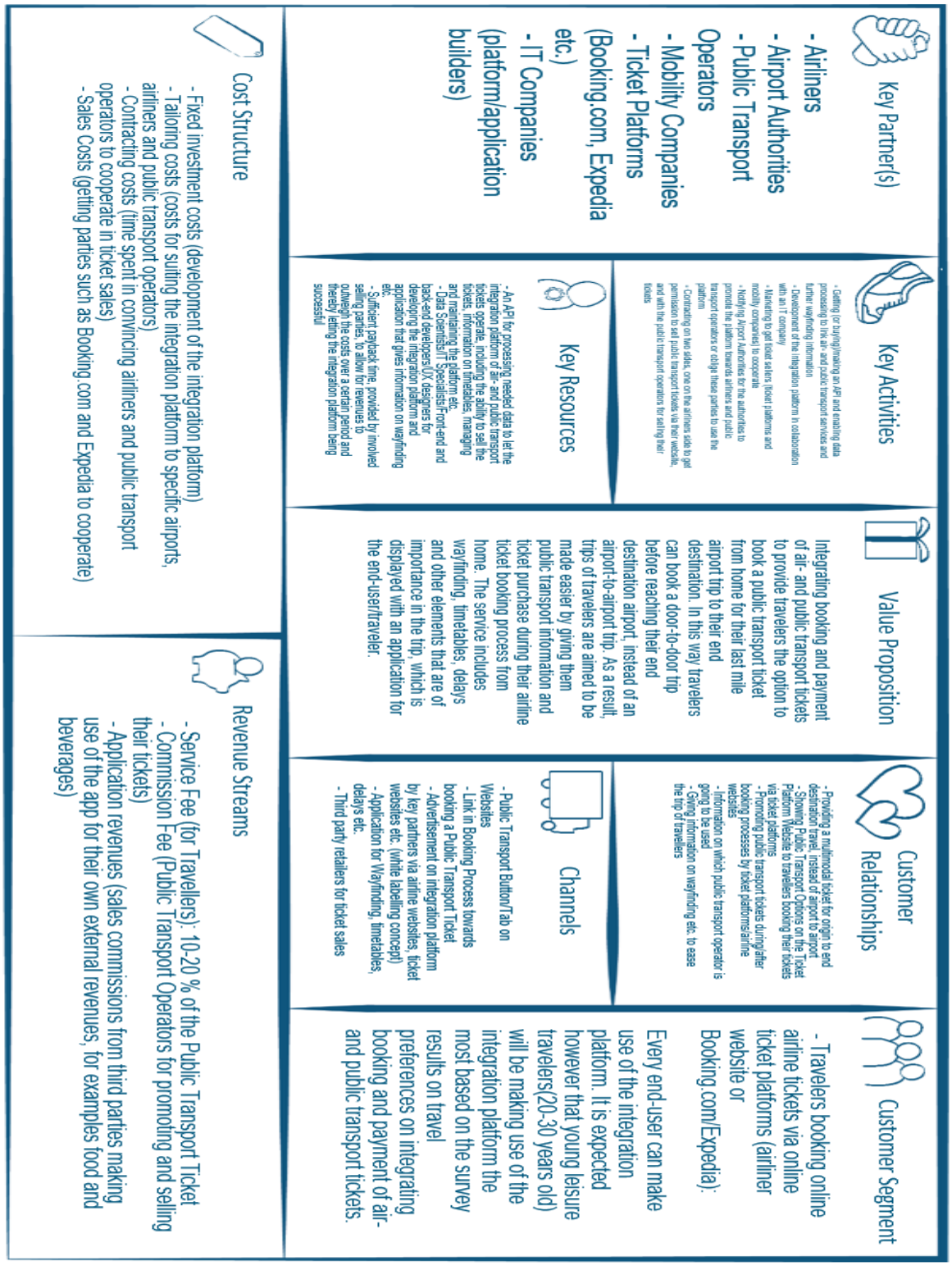
Modal splits of the airports showed that taxis still have high shares in the way people travel to/from airports. This was especially seen at the airports of London and Paris. Public transport is a competitor for taxi companies when it concerns first and last mile airport trips. If public transport connections will be improved by integrating these tickets with airline tickets, normal taxi travellers might see potential to switch to the usage of a public transportation mode. In this way, an integration platform might affect taxi operations. Taxi companies however do not play a role in ticket sales and have their main quality to be more flexible than public transportation. Taxi companies do not play a decisive part in judging the feasibility and desirability of this integration platform. These taxi companies are however seen as an opposition.

Car Rental Companies

Figure 76 Car Rental Companies

Car rental companies would also oppose to the integration of air- and public transport tickets, but to a lesser extent than taxi companies. Car rentals are assumed to be used for a longer period of the traveller's stay, instead of the single trips with a taxi or public transport. Same as taxi companies, car rental companies do not have a direct influence on airline and public transport ticket sales.

Appendix E Business Model Canvas



Appendix F Traveller Survey

Public Transport from Airports to your End Destination

This survey by the Technical University of Delft concerns questions about trips towards and from airports. Survey results will be used in a research on the feasibility and desirability of integrating booking and payment of air- and public transport tickets. Responses will be handled discretely and the survey will be filled in anonymously. ***Please assume that the situation does not include the circumstances of the Corona Crisis and in normal worldwide economic conditions.*** *Filling in the survey will roughly take 10-15 minutes.*

As has been mentioned, data received by the respondents will be used to identify the feasibility and desirability of integrating booking and payment of air- and public transport tickets. Data received will therefore be used in a master's thesis report. Also as has been mentioned, data will be provided anonymously and handled discretely. Received data will only be used in this research and is only accessible for the student and supervisors from the TU Delft and Royal HaskoningDHV. The anonymous character of the responses makes it impossible to link answers towards a specific individual. Data from this survey will be destroyed after finishing the thesis. Are you willing to participate in this survey?

0 Yes

0 No

--- Questions 1-8 will consider your last trip involving air travel.

1. Did you fly somewhere in the last five years?

   0 Yes (go to question 2)
   0 No (skip to question 6)

2. What was the last destination you flew to? Could you please fill out the airport (for example Schiphol) and final destination (for example city centre of Amsterdam, specific Hotel or family residence)
   Airport: _____
   Final destination: _____

3. What was the **purpose of that trip**?
   0 Business
   0 Leisure (Holiday, family visit etc.)

4. Where did **you buy the ticket** for that trip?
   0 At the site of an airline (e.g KLM or EasyJet)
   0 At the site of an air travel platform (e.g Expedia or Skyscanner)
   0 At the site of a business travel management agent (e.g Carlson Wagons Lits or BCD Group)
   0 At the site of a holiday travel agent (e.g TUI or Corendon)
   0 At a shop or kiosk
   0 Other: _____

5. **Which statement best describes your ticket** for that trip?
   0 The ticket was part of a larger package deal, including for example a hotel.
   0 The ticket was bought separately by me.
   0 Other: _____

6. For that trip, did you **consider to make use** of public transport (metro, bus, tram and/or train) from the airport to your final destination?
   0 Yes

0 No

7. And for that trip, **how did you travel** from the airport of your final destination?
   0 Car (Including Car Rental and Pick Up)
   0 Taxi
   0 Public Transport (Metro, Bus, Tram and/or Train)
   0 Bicycle
   0 On demand transport (Shuttle services, Uber etc.)
   0 Walking
   0 Other: _____

8. And for that trip, what were the most important **factors** in deciding which transport mode to use? *(Choose a maximum of 3)*
   0 Travel Time
   0 Access and Egress Distance (Distance to a Public Transport Stop or Parking Lot e.g.)
   0 Availability (Frequency, Waiting Time)
   0 Costs
   0 Comfort (Space, User-Friendly)
   0 Reliability (On-time travel, Capacity, Number of Transfers)
   0 Safety
   0 Environmental performance
   0 Other: _____

--- Questions 9-11 are about your experience(s) of using public transport (train, tram, metro or bus) from a foreign and/or unfamiliar airport to your end destination.

9. Have you ever bought a **public transport ticket at a foreign (and/or unfamiliar) airport**?
   0 Yes
   0 No

10. What do you consider to be the **main obstacles** for using **public transport ticket(s) at the foreign and/or unfamiliar airport**? *More than 1 answer possible.*
    0 **Finding** an available ticket machine or counter
    0 **Language(s)** on ticket machine(s) or at the ticket counter
    0 Finding the right **public transport service** to my destination
    0 Finding the right **public transport stop** nearest to my destination
    0 **Finding the right ticket type** at machine and/or counter
    0 **Payment options** at machine and/or counter
    0 **Waiting time** at ticket machine and/or counter
    0 Availability and/or attractiveness **alternative transport options** (car, Uber, taxi etc.)
    0 Other: _____

11. More in general, **how likely would you be making use of public transport** to/from a foreign (and/or unfamiliar) airport? Scale 1-10, where 1 = not likely at all and 10 = very likely
    _____

---Questions 12-14 consider the situation of being able to buy a public transport ticket from home, before reaching a foreign (and/or unfamiliar) airport. The questions provide options on which is the best way to buy these public transport ticket(s) and how these should be provided.

12. Please consider the situation in which **you receive your public transport ticket with your airline ticket**, so reducing the need to buy the ticket at the foreign airport. **How likely would you be**

making use of public transport to/from a foreign airport? Scale 1-10, where 1 = not likely at all and 10 = very likely

_____

13. If you could receive your public transport ticket together with your airplane ticket, how would you like the public transport ticket to be included?
    0 Public transport ticket **always included** with the airline ticket
    0 Public transport ticket **as a simple addition** in the airline ticket purchasing process, such as for additional luggage.
    0 Public transport ticket **as an extension after booking** an airline ticket, such as the option of renting a car beforehand (a button that provides the possibility to buy a public transport ticket after buying your airplane ticket online)

14. In which form would you prefer the **public transport ticket to be provided**?
    0 Paper ticket (to print yourself)
    0 On your phone or tablet (to show on your phone or scan at a gate)
    0 Smart card/mobility card (to pick up on the foreign airport).
    0 Other:_____

---Questions 15-18 are general questions.

15. To which gender identity do you identify yourself the most?
    0 Male
    0 Female
    0 Other
    0 Don't want to answer

16. What is your age?

    ____
    0 Don't want to answer

17. How many trips including air travel did you make in 2019?
    Business ____
    Leisure (Holiday, family visit etc.) ____
    Combined ____

18. What is the highest degree or level of education that you have finished?
    0 Some High School
    0 High School
    0 MBO
    0 Bachelor's Degree
    0 Master's Degree
    0 PhD or higher
    0 Trade School
    0 Don't want to answer

19. If you have any additional comments, please leave them here:

Appendix G Composition Survey Respondents

Respondent Types

At first, an overall view will be elaborated on which respondent types were present in the survey panel.

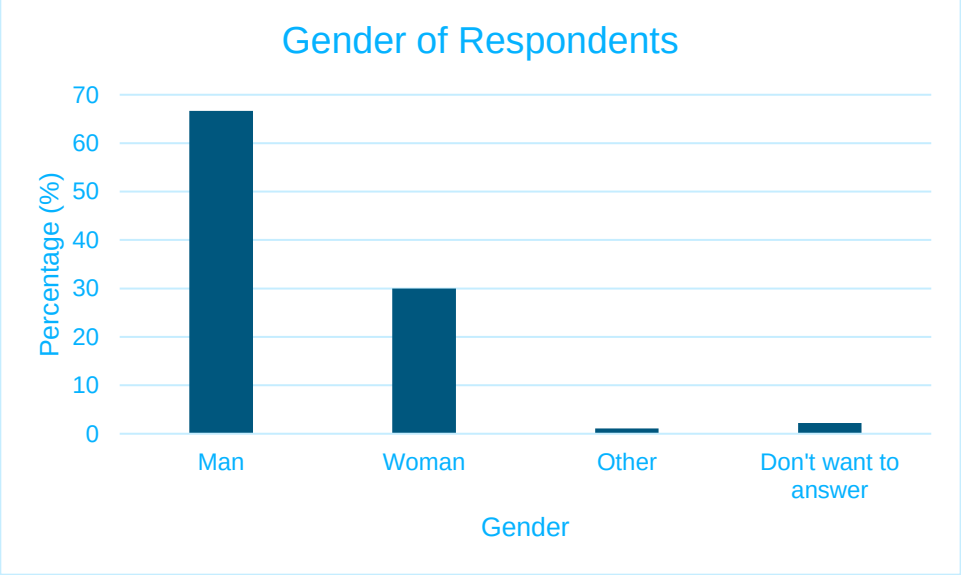


Figure 77 Gender of respondents

It is clear that the majority of the respondents were male, with a majority of two thirds of the total panel. 30 % of the survey panel was female and 3 % did not want to answer or answered with other.

Imaginable is the fact that ages varied throughout the whole pool of respondents. The table below shows facts about the ages and the graph shows the spread of ages of respondents.

Table 16 Ages of Respondents

Type	Age (years)
Average	34
Youngest	17
Oldest	67

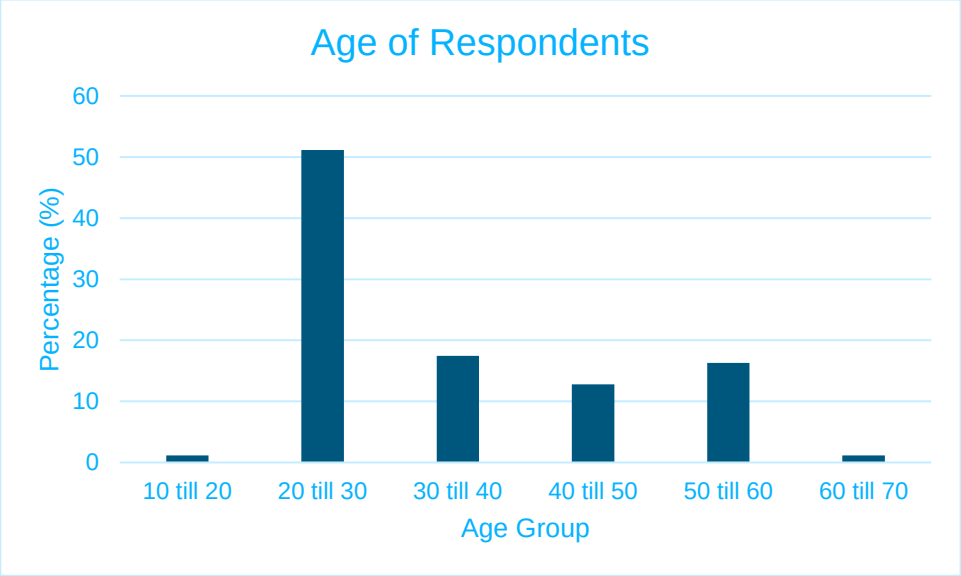


Figure 78 Age Ranges of Respondents

Before making the analysis, the assumption was made that the largest group of respondents will come out the group of 20-30 years old. The graph in figure 78 confirms this. Furthermore, the magnitude of respondents in the age group 30-40, 40-50 and 50-60 are similar. Age group 20-30 having the clear majority in this research needs to be taken into account in analysing the context questions in the survey.

Another assumption was made where most respondents are expected to be mostly highly educated because of the link with Royal HaskoningDHV and the TU Delft.

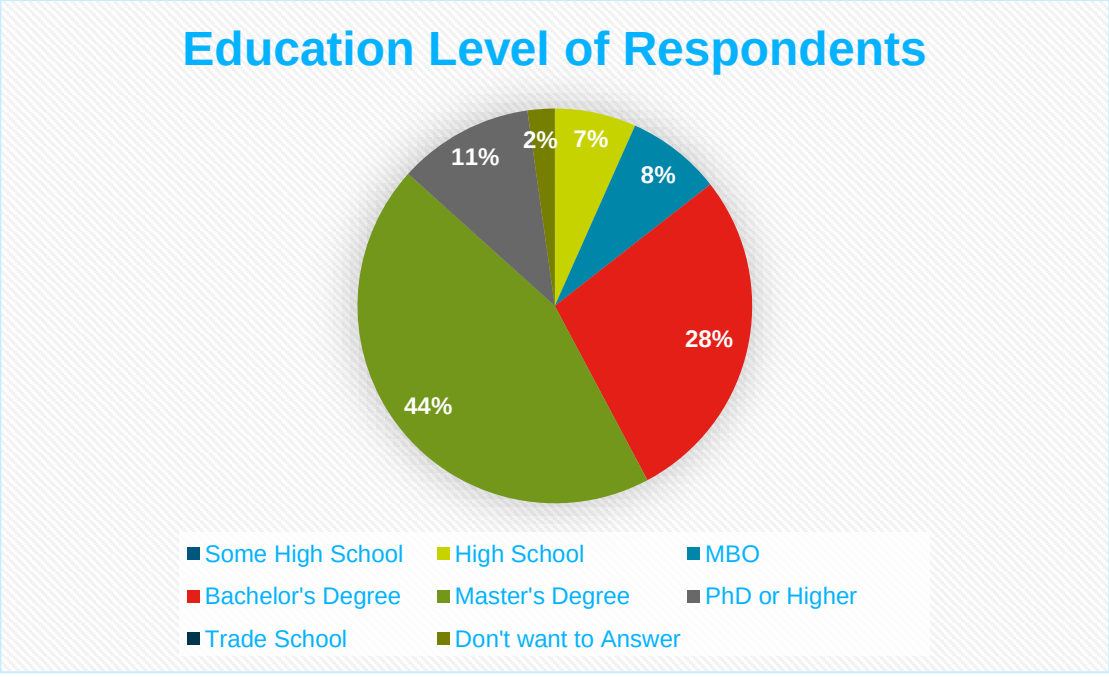


Figure 79 Education Level of Respondents

As can be seen in the graph the highest group of respondents had a master's degree, followed by the group having a bachelor's degree. The third largest group has a PhD or higher and therefore the hypothesis made

before is thereby confirmed. Besides the largest group of respondents being highly educated, it was assumed that the majority would be transport experts. This cannot be confirmed through the survey however, but this assumption needs to be kept in mind. Transport experts are familiar with how to cope with unfamiliar transport situations. This statement could have affected the outcomes for the respondents' interest in the integration platform.

An important aspect to mention is that the general characteristics of the respondents were asked at the end of the survey. The reason was to keep the respondents mostly focussed for the most important questions of the survey, which would therefore be asked in the beginning. During the process of filling out the survey, some respondents skipped a number of questions, which eventually led to 90 complete responses. In the beginning of the survey however, the number of responses of questions were higher. This may lead to some differences in significances of responses to particular questions.

Trip Characteristics Respondents

The first category of questions concerned the last trip of the respondents. Reflecting on the assumptions made beforehand, the assumption on the high usage of air travel was confirmed by the fact that only two respondents answered that he or she has not flown in the last five years. 114 participants answered that they have used air travel in the last five years. However, 98 respondents have fully filled out the questions regarding this category because skipping the following questions.

An important aspect is to find out which travel purpose the respondent had with his or her last trip. The purpose was split in either leisure or business.

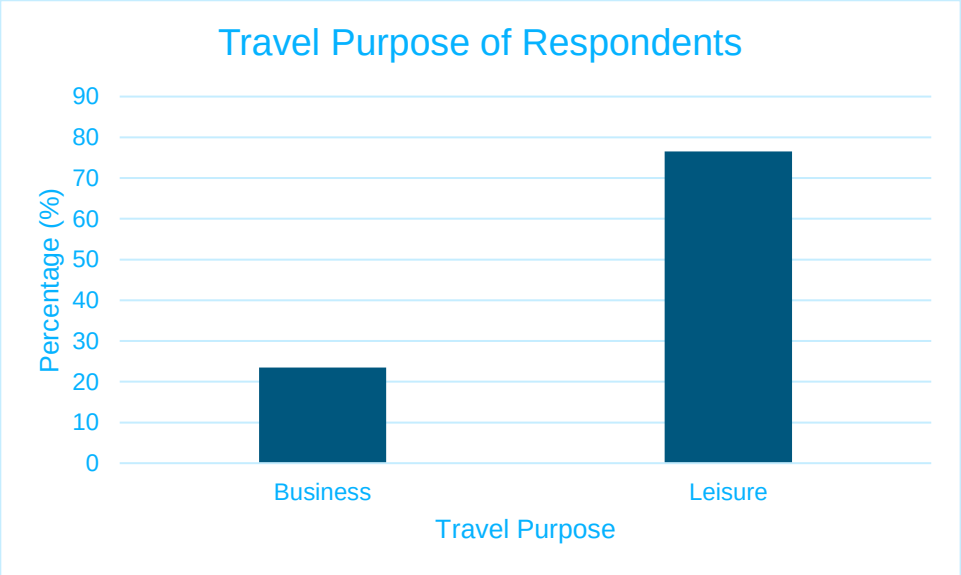


Figure 80 Travel Purpose of Respondents

The largest group of respondents had a leisure purpose for their last trip with air travel. Linking this towards the types of respondents that filled out the survey, the eventual outcome of this is logical. Most respondents were between the age of 20-30, which might be less likely to travel to foreign countries for business purposes. This might however be a questionable statement, as only the last trip of the respondent was asked. A question at the end of the survey would reveal the total amount of leisure and business trips involving air travel in in 2019.

Table 17 Trips involving air transport in 2019

Type	Number
Average number of business trips in 2019	1.80
Average number of leisure trips in 2019	2.65
Respondents having more business trips in 2019	10
Respondents having more leisure trips in 2019	73

Besides the last trip indication of the respondents, the overall trip history of last year indicates that the majority is a leisure traveller when using air travel. This can be concluded from the fact that the average number of leisure trips is higher than business trips, and 73 respondents filling in more leisure trips than business trips with 10 the other way around. The reason for that both numbers do not completely sum up to 90 (number of total responses), is that there were respondents that had an equal number of business and leisure trips, no trips involving air travel in 2019 or that a respondent misunderstood the question by involving all transport modes leading to high amounts. The last argument was the reason to neglect this response type.

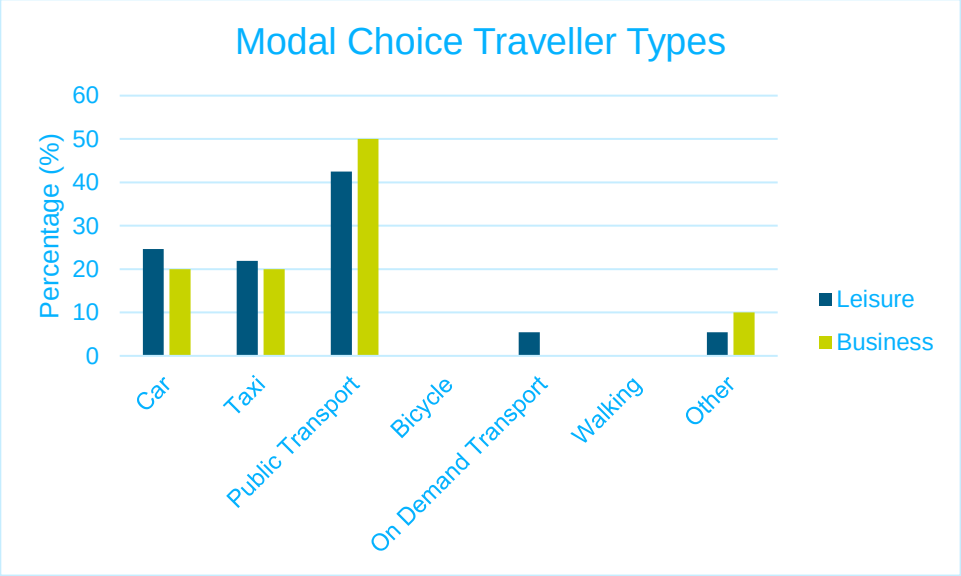


Figure 81 Modal choice of the two different traveller types

In the data, information was obtained which modal choice the two types of travellers have made, which is shown in the graph above. Noticeable is the fact that the spread of both leisure and business with respect to modal choice is similar with the majority of both groups of travellers choosing public transport. Concluding, it seems that in this sample for both leisure and business travellers, public transport is the most preferred transport mode. A bias on Dutch respondents for example however, needs to be taken into account, since public transportation in the Netherlands is of a high level.

Furthermore, questions were asked about how and where respondents bought their airline ticket for their last trip involving air travel.

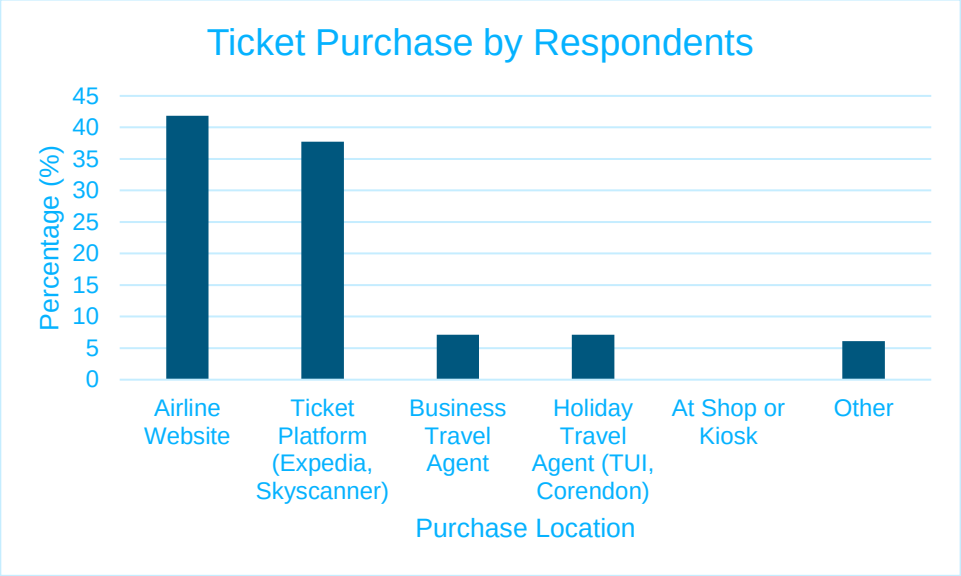


Figure 82 Ticket Purchase Location

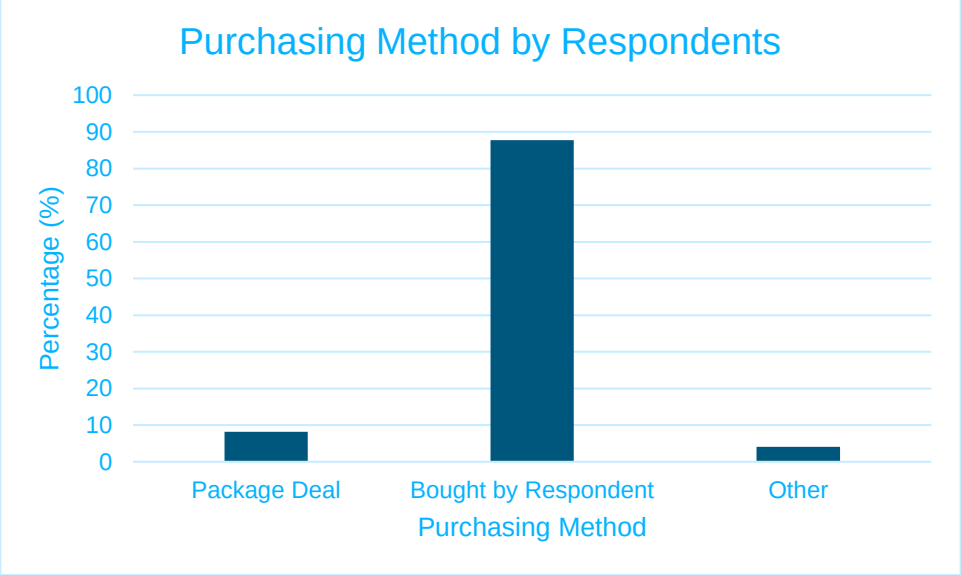


Figure 83 Purchasing Methods

The results coming from the survey reflect with the findings from literature study stating that online travel agents/websites became more popular over the years. Outcomes from the responses on these questions confirm that people tend to buy their airline tickets independently and online. Direct websites of the airlines or websites of ticket platforms therefore are the most popular. The main response of people choosing other, was that someone else bought a ticket for the respondent.

Modal Choice Last Mile Trip from the Airport

The next questions in the category regarding the trip characteristics were supposed to find out the modal choice of the respondents. Questions were asked if the respondents considered public transport for their last trip, which transport mode the respondent used to travel to his/her end destination and the most important factors for the respondent in choosing which transport mode to use to/from an airport. Firstly the results are shown if respondents considered using public transport.

Table 18 Consideration to use Public Transport for the Last Trip

Consideration Public Transport	Percentage (%)
Yes	63.3
No	36.7

Table 18 shows that a slight majority of the respondents considered using public transport for their trip to their end destination from the airport. An even more important point is the revealed data provided by the respondents and specifically on which transport mode was used for the last mile trip.

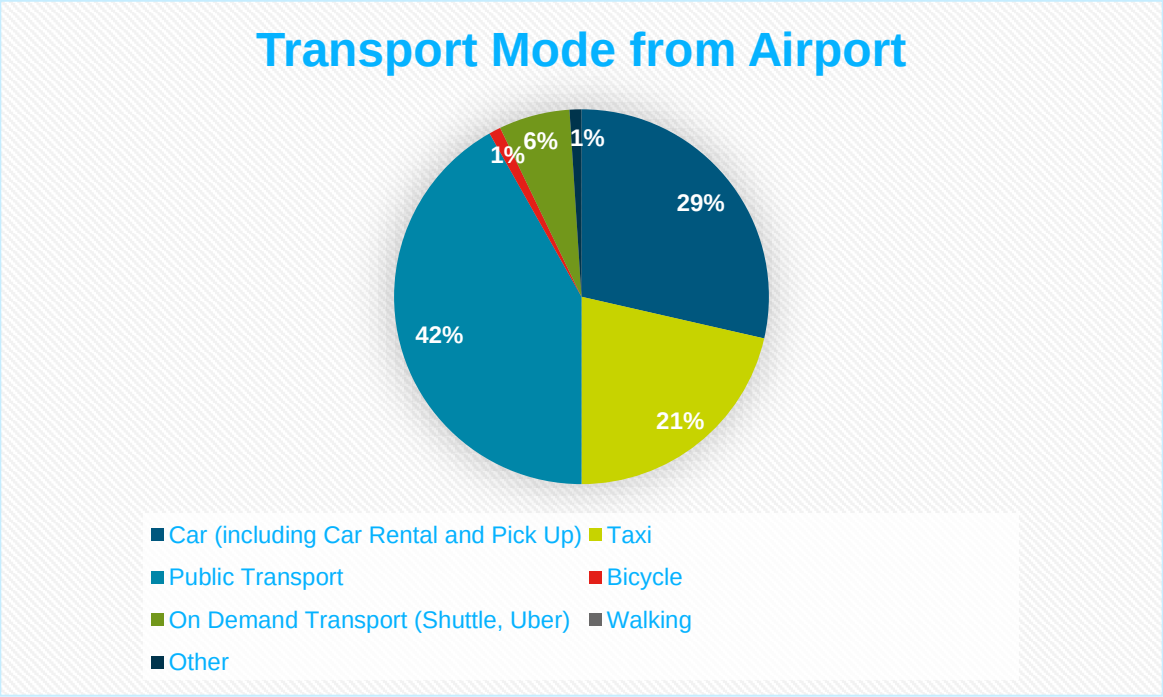


Figure 84 Revealed Data on which Transport Mode was used

An interesting finding is that most respondents made use of public transport for their trip from the airport to their end destination, which was around 40 %. Public transport was followed by car travel (including car rental and pick up) and taxi. Given the last trips of the respondents indicates that without integrating public transport tickets with airline tickets, public transport modes are already highly used and can be categorised as one of the most popular transport modes from airports.

The respondents were also asked to indicate the most important factors that they take into account when making a modal choice for travelling from an airport to their end destination. Factors that were introduced as option are discussed in section 10.2.

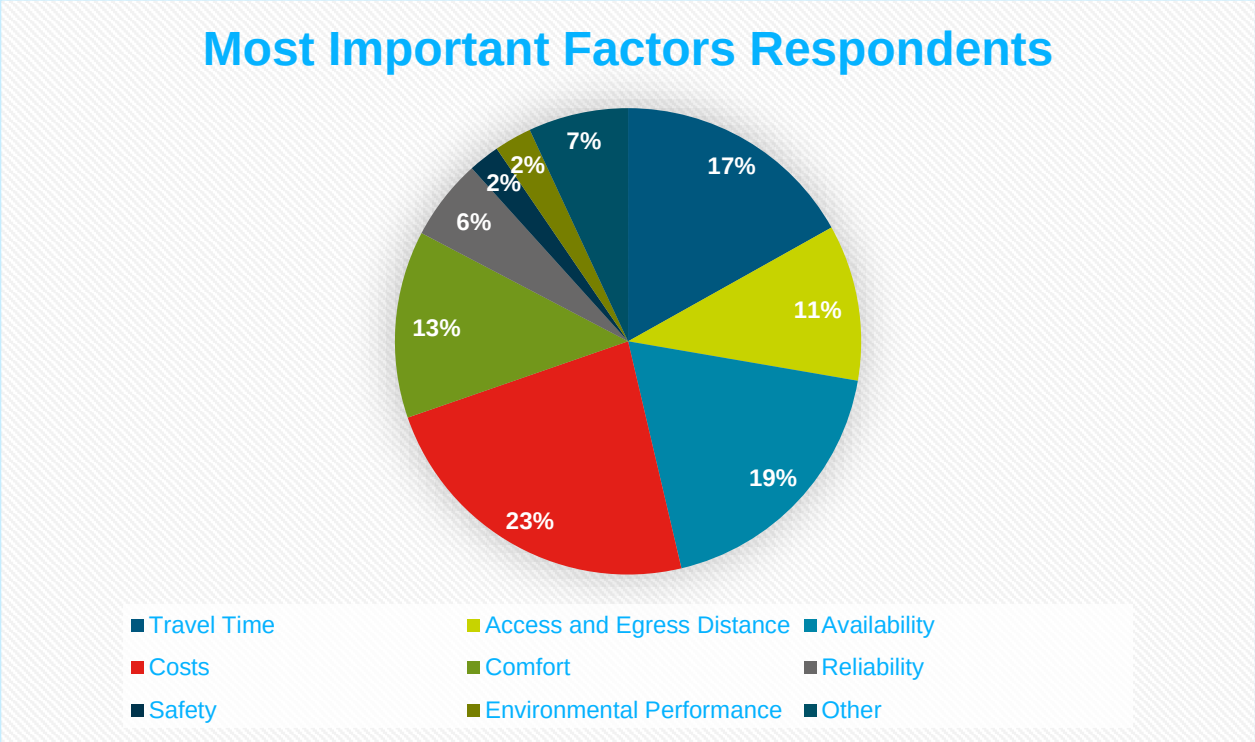


Figure 85 Modal Choice Factors Respondents

The results reflect the expectations, being that travel time, availability, costs and comfort would be valued as most important factors. Order of the factors however is slightly different than the ranking in table 8, where baggage (comfort) was mention the most. Comfort namely ranks the lowest of the four most important factors. Costs are apparently the most important factor for respondents of the sample, followed by travel time and availability. The outcome of costs being the most important factor could relate to the high amount of revealed usage of public transport. Public transport is namely assumed to be the cheapest alternative to travel from the airport, when the airport is fully unfamiliar.

Experiences with Public Transport at Unfamiliar Airports

Experiences that were asked towards the respondents mainly related towards the purchase of a public transport ticket. The questions corresponded with if the respondent had ever bought a public transport ticket at a foreign/unfamiliar airport and what the respondents would say are the biggest obstacles in buying a public transport ticket at a foreign/unfamiliar airport.

Table 19 Purchase public transport ticket at an unfamiliar/foreign airport

Has ever bought a Public Transport Ticket at an unfamiliar/foreign Airport	Percentage (%)
Yes	89.5
No	10.5

The table indicates that most of the respondents have bought a public transport ticket at an unfamiliar airport before. As has been mentioned, the follow up question was to ask what the respondents experienced or would experience as obstacles in buying these tickets.

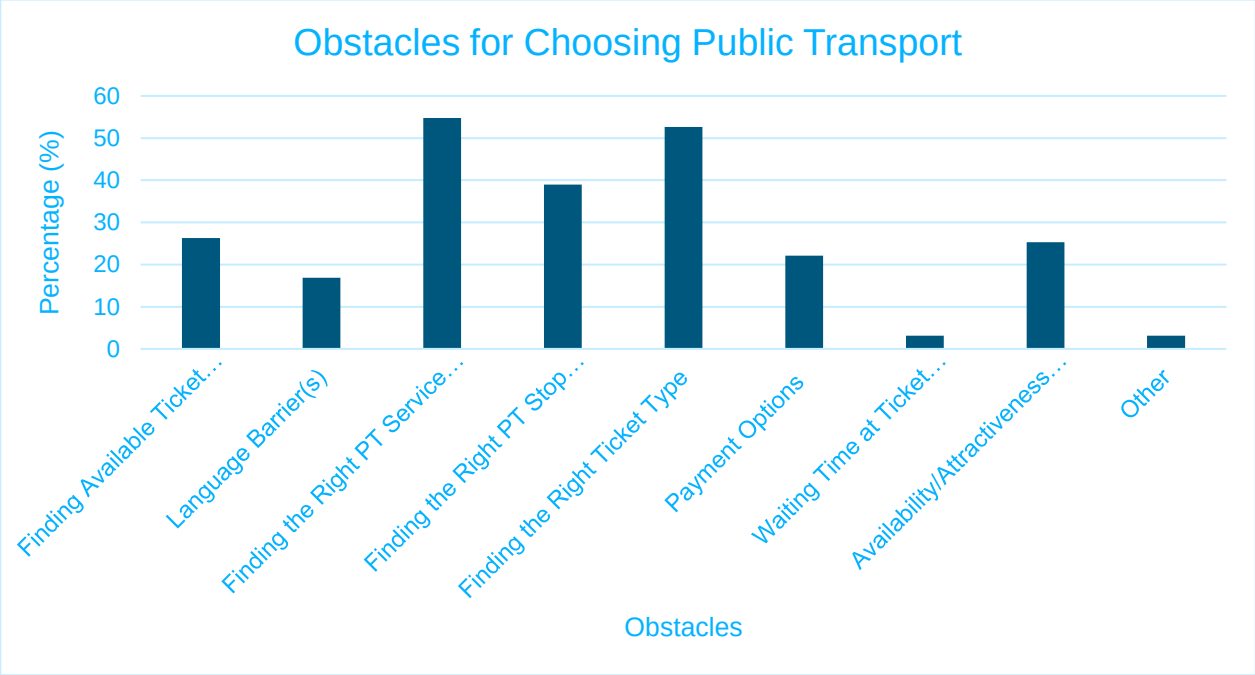


Figure 86 Obstacles purchasing public transport ticket

The most important obstacles the respondents indicated were finding the right public transport service to their end destination and finding the right ticket type that the respondents should buy. Both obstacles were answered by 50-55 % of all respondents. The next most important factor was finding the right public transport stop nearest to the destination. Payment options, finding available ticket machines/counters and availability/attractiveness of other transport modes were more or less equally important. Responses reflect that respondents would mainly experience unfamiliar characteristics of public transport at a foreign airport are the biggest obstacles, which has been mentioned in the expectations as well. Noticeable is the fact that respondents would not experience language barriers quickly, which can also be seen as an unfamiliarity.

Appendix H t-test Likeliness using Public Transport with the Integration Platform

The t-test is a statistic that is used to determine if the difference between two means of two datasets is significantly big enough according to the sample sizes (Kenton, 2020). It is used as a hypothesis tool, where often the hypothesis in the test is that the means of both datasets are 0, meaning that there is no difference between the two means.

To identify which specific t-test to use, the following steps need to be used.

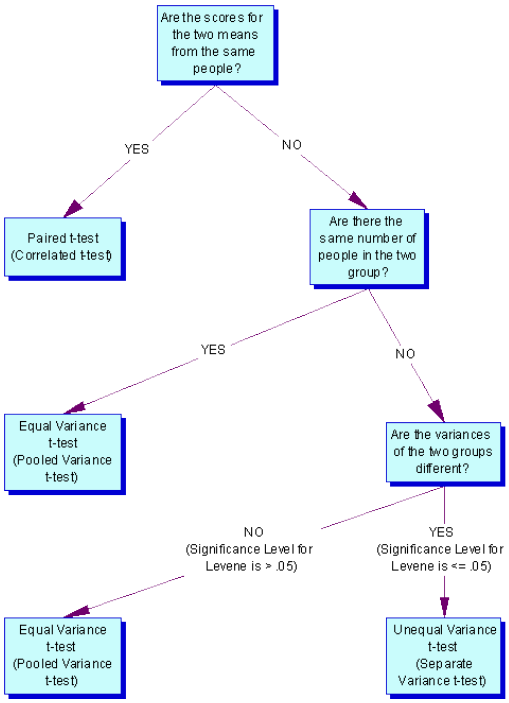


Figure 87 Steps in deciding which t-test to use (T test, sd)

The first question asked in this case is if the two means of the two datasets are equal. Looking at table 13, the answer to this question is no, meaning a paired t-test is not the correct method to use. Following this step, it should be indicated how many responses were given per dataset. The question on how likely respondents are making use of public transport in general from an unfamiliar had 95 responses, where the question with the integration platform implemented had 90 responses. Therefore, before practicing a t-test on the two datasets, a F-test needs to be executed to calculate the variances of the two datasets. The variance of a dataset is defined as a measure to determine how far observations in a dataset is spread out. It is thereby described how much a random number would differ from the expected value (Variance, 2020). The F-test can be done with Excel. Hereby, the F value is calculated, which is the ratio between the variance of one dataset with the other. The hypothesis in this test is that the variances of both datasets are equal, which can be rejected if the calculated F value is larger than the critical value (one-tailed) for F, which is calculated by Excel.

Table 20 F-value

Type of F-Value	Value
F-Value of Datasets	1.097
Critical F-value (one-tailed)	1.415

Since it is given that the F value of the datasets is not larger than the critical F value, the hypothesis cannot be rejected, meaning that the variance might be the same (at a confidence level of 95 %). Due to this statement, eventually the equal variance t-test should be used.

Table 21 Statistics two datasets

	PT in general	PT with integration
Mean	76.537	80.778
Variance	519.14	473.10
Observations	95	90
Degrees of freedom	94	89

The table shows the degrees of freedom of each dataset, which is defined as the number of observations minus 1. Therefore, the sum of total degrees of freedom in this case is 183.