Wayfinding information

A study about the relationship between the improvement of multimodal transfers and customer travel experience at large railway stations

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Charlotte Margot Schornagel

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Student number:	4113632	
Thesis committee:	prof.dr. G.P. van Wee	TU Delft
	dr.ir. M.Kroesen	TU Delft
	dr.ir. N. van Oort	TU Delft
	dr. N. Heeres	SWECO
	drs. N. van Dijk	SWECO

Preface

This thesis report shows the results of my graduation project. I consciously chose a few months ago to start with a specific research topic. I wanted to combine my interest in psychology and transport.

This study has been performed at SWECO. I want to thank Niels Heeres of SWECO for his guidance, support and advice. Furthermore, I would like to thank Nathalie van Dijk for her support and view from a psychological perspective. Besides, I wish to thank all the colleagues of SWECO who helped me and for making me feel welcome by showing their interest.

I want to acknowledge and show my gratitude for the support and collaboration received from my supervisors of the TU Delft; dr.ir. Kroesen, dr.ir van Oort and prof.dr.ir.van Wee.

Last but not least, I would like to thank my friends and family for their support and faith in me. I would also like to thank some people in specific: Franca Corthals, for her help with my English, Simone Rietbroek for her mental support, Gert-Jaap Koppenhol for all his help, Mark van Hagen for his valuable information about travellers and their experience, Deborah Sonneveldt and Ross Ruiter for just being there at SWECO and of course Wouter and Wouter for the funny hours during summer at TBM.

I wish you a pleasant read.

Charlotte Schornagel

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Executive Summary

The Dutch government aims for an optimization of chain mobility because of its positive effects on accessibility and viability of cities as well as customer travel experience. Transfers are important elements of chain mobility, but at the same time the weakest part, because they often involve resistance from the traveller. Multimodal transfers at large railway stations, however, are almost inevitable. Therefore, they must be improved to meet the traveller's needs. Appropriate wayfinding information that supports travellers to find their route in a railway station and its surroundings, from one transport mode to the next can contribute to this. Yet, the knowledge about existing multimodal wayfinding information, which should help the traveller to connect different transport modes, is limited. To be able to meet the traveller's needs, knowledge is required about the preferences of travellers regarding multimodal travel information when transferring at large railway stations.

Currently, there is a lack of knowledge about multimodal transferring passengers at large railway stations, which kind of wayfinding information they prefer and what factors influence their customer travel experience. Therefore, the objective of this research is to identify the wayfinding information preferences of transferring travellers at large railway stations, from train to bus, tram, metro or OV-bike. The relation between these preferences and customer travel experience is determined as well.

The research question is as follows:

What are the wayfinding information preferences of traveller types at large railway stations during a multimodal transfer from train to bus, tram, metro or OV-bike, and how are these preferences related to customer travel experience?

This research starts with a literature study and with exploratory interviews. The literature review aims to give insight into the existing types of wayfinding information and the relation with customer travel experience. In addition, the factors that influence the preferences of different types of travellers are identified. The literature shows that not much is known about wayfinding information in a railway station and its surroundings. Still, the literature about wayfinding in indoor and outdoor environments which is available is explored. Based on this literature and on the exploratory interviews with experts in the field of wayfinding information at Dutch railway stations, four categories of attributes are defined. These categories are: environmental features, signs & maps, digital information and verbal information.

As a result of the synthesis of the literature and of the exploratory interviews, a conceptual framework has been developed. Based on this conceptual framework, the effects of the attributes on the customers' travel experience are tested. Customer travel experience is explained by the variables of a traveller's perceived speed and perceived ease of a transfer. The effects of wayfinding information preferences on the ease and speed perceived are tested, by means of a stated preference experiment.

In the stated preference experiment only a limited amount of attributes can be included. Therefore a selection of attributes is made. The attributes selected for the survey are: a multimodal travel information app, a visible entrance or location of bus, tram, metro or OV-bike, signs & maps and a manned travel information kiosk. An online rating experiment is conducted in which respondents have been offered nine different profiles to rate their satisfaction. In these profiles, the attribute levels are clustered. Next to the rating profiles, the survey consists of additional questions. These questions have been about personal and travel characteristics like level of education and travel frequency. In addition, the type of NS traveller has been indicated by means of six different statements which are related to travel behaviour.

The respondents are recruited via social media. Moreover, employees of Sweco and colleagues of the TU Delft have been asked to cooperate in the survey. In total 285 respondents have filled in the survey. The sample is

not entirely representative for the population of Dutch train travellers, but closely corresponds.

The data collected are used to perform a factor analyses and a regression analyses. A factor analyses is performed because of significant correlations between the three variables of satisfaction, speed and ease. By means of the sum score method, a new factor has been created to represent the underlying factor. This new factor explains the variables of satisfaction, speed and ease together. Next, a general regression model is estimated based on the data. In addition, several sub models are estimated based on the type of NS traveller and on the personal and travel characteristics of the respondents. The sub models are estimated based on the type of NS traveller as well as age, education level, employment status, travel purpose, travel frequency, transfer frequency and mode choice for the transfer.

The results of the regression models give insight into the importance of the different attributes. When looking at the relative importance of the attributes, an app is valued the most important (43%). Thereafter, the visibility of the entrance or location of bus, tram, metro or OV-bike (29%) followed by signs & maps (25%). The manned travel information kiosk is valued of least importance, by only 3%. Regarding different types of NS travellers, there are no large differences between the wayfinding information preferences in the overall ranking of the attributes (1: app, 2: visibility, 3: signs & maps and 4: kiosk). Small differences are found between the main categories of must and lust travellers, however, concerning the relative preferences for the different attributes, must travellers consider the availability of an app slightly more important than lust travellers, 46% and 40% respectively. Lust travellers appear to have more time to orientate themselves on landmarks within the railway station and consider the attributes signs & maps (26%) as well as the manned travel information kiosk (5%) slightly more important than must travellers do (24%, 1%).

Furthermore, the results show slight differences between the six traveller types of NS. For traveller types who plan their trip in advance, an app is relatively more important than for those who do not prepare a trip or only a little. Travellers who prefer to have wayfinding information supplied instead of exploring themselves attach relatively more value to a visible entrance or location of bus, tram, metro or OV-bike. For travellers who prefer to use all types of wayfinding information in a railway station for confirmation of their chosen route both signs & maps and the manned information kiosk are relatively more important. In addition, traveller types who do not plan their trip at all, prefer the manned information kiosk slightly more than the other types of travellers.

The results show that customer travel experience of multimodal transfers could be improved by investing in multimodal wayfinding information. The best option to influence the customer travel experience would be providing the traveller with an app that shows a virtual route for finding their way from train, to bus, tram, metro or OV-bike. To get insight in the implications of the results, different scenarios are evaluated and interviews with experts in the field of railway station development are held. The results of the scenario evaluations show that, although an app is highly appreciated, wayfinding information merely provided by an app does not fulfill the current traveller's satisfaction. Travellers seem to prefer a combination of wayfinding information provided at the railway station itself together with an app providing wayfinding information.

The expert interviews are used to get insight in the implications of the results when looking at the process of railway station design. Based on these interviews, practical recommendations are given. Unambiguous policies regarding the provision of wayfinding information should be concretely determined in both the transport and management concessions. Moreover, the responsibility for managing the parties involved for the implementation should be taken by the government or an umbrella party that is responsible for the traveller's interest and the management between the different parties implementing. The results of this research offer leads in terms of the fulfillment of wayfinding information provision for the parties implementing. To meet the traveller's need a smart phone app for multimodal travel information is proposed. This app provides a virtual route from the train platform to the entrance or location of bus, tram, metro or OV-bike. Existing multimodal travel apps may provide opportunities to expand them with the right data in order to provide the traveller with virtual reality wayfinding information. Since NS is an important stakeholder, their are advised to optimize their door-to-door strategy for them would be to find out which data is required exactly to enhance their existing multimodal travel information app. Since facilitating travellers with a multimodal travel information app that provides virtual reality wayfinding information is considered not enough, a visible entrance of bus, tram, metro or OV-bike as well as signs & maps would complement the availability of such an app. Is it advised that, NS Stations and ProRail in co-operation with other stakeholders involved should explore the feasibility, cost and benefits of measures, in co-operation with in order to achieve (better) visibility of entrances or locations of bus, tram, metro and OV-bike or an uniform sign language in and outside the railway station.

There are a few limitations that could influence the validity of the results. Four points of criticism are discussed: the representativeness of the sample, the usage of the stated preference method, the attributes chosen and the set up of the experimental design used. The sample is not fully representative for the population of Dutch train travellers. The respondents are relatively younger and higher educated than the average Dutch train traveller. Considering the different types of train travellers as formulated by NS, two traveller types are absent or underrepresented. In addition, some attributes that are considered of influence have been excluded from the experiment. Further, simplifications of the attributes used in the survey could be interpreted in various ways which may have affected the results.

In addition, several recommendations are proposed to improve the study. This experiment should be repeated by replacing the original approach with the official approach of NS. Next to that, the simplifications of the attributes may be relevant for future investigation. The attributes of signs & maps as well as the manned travel information kiosk could be tested in a different way. Furthermore, there is a need to examine if the results which are now based on the transfer between train and bus, tram, metro or OV-bike are also applicable and appreciated for transfers between bus, tram and metro. Another direction for further research may be the empirical evidence of the effect between wayfinding information and customer travel experience. Subsequently, it seems to be relevant to research if an app providing a virtual route may also offer opportunities for people with a disabilities. On the other hand, safety issues regarding people using virtual reality apps for wayfinding seems to be an essential element for further research.

No large differences between types of travellers regarding wayfinding information have been observed. Therefore, people in general are likely to prefer to rely on wayfinding information by an app. These results are in accordance with the expectation that people are increasingly seeking for travel information on their smart phones.

All in all, the path to optimal wayfinding information for multimodal transfers, will not be easy, but improving wayfinding information can contribute to a better customer travel experience which positively affects chain mobility.

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List of Acronyms

Application	App
MaaS	Mobility as a Service
NS	Nederlandse Spoorwegen (Dutch Railway company)
OV-Bike	Public Transport bike
PAF	Principal Axis Factoring
PCA	Principal Component Factoring
RET	Rotterdamse Elektrische Tram
ROVER	Reizigers Openbaar Vervoer
RP	Revealed preference
SP	Stated preference

1
Introduction

This study is about the wayfinding information preferences of multimodal transferring travellers at large railway stations and its relation with customer travel experience. This chapter starts with the problem definition. After that, the boundaries are defined by means of the research objective, research questions and the scope. Then, the research approach is described. This chapter ends with stating the contribution of this research to science and practice and the thesis outline.

1.1. Problem definition

More than half of the world's population lives in cities today. By 2025, this number will rise to 66% (Block, 2015). As a consequence, especially major cities are becoming increasingly busy. This leads to a rise in the amount of traffic. Therefore, ensuring viability and accessibility to cities will be more challenging in the foreseeable future. In order to overcome this challenge, the Dutch government aims at organizing mobility in a more sustainable way, by investing in chain mobility (Ministerie van Infrastructuur Milieu, 2016). Chain mobility refers to a transport system of various modes, in order to make a seamless journey from door-to-door (Kleine and Heijningen van, 2017). As far as chain mobility is concerned, travellers choose the most optimal mode of transport for a certain distance in their journey. For shorter distances, for example, the bike can be used, whereas for longer distances public transport is likely to be more attractive. It is the combination of different modes that contributes to an efficient transport system. By reducing the use of cars, efficient chain mobility leads to positive effects in terms of accessibility, viability and travel experience of travellers (Provincie Noord-Holland, 2016). Therefore, the Dutch government aims at optimal chain mobility by the year 2040 in order to provide travellers with a fast, comfortable, reliable and affordable door-to-door journey (Ministerie van Infrastructuur Milieu, 2016).

When a large part of the door-to-door journey consists of public transport, its integration in the total journey plays an important role (Van Wee, 2006). Therefore, not only the Dutch government, but also the Dutch Railway company (NS) aims to provide this door-to-door journey for its passengers to be as comfortable, safe and reliable as possible (Nederlandse Spoorwegen, 2016). In order to do so, several initiatives have already been taken, such as the OV-bike, P+R facilities and Greenwheels. The question is, however, what else has to be done and can be done to realize more ambitions?

In order to stimulate chain mobility, effective and efficient connections between the various links in the mobility chain are essential. When looking at the door-to-door journey, multimodal transfers are almost inevitable. Over 28 percent of the Dutch rail travellers also use another form of public transportation during one journey (Lee et al., 2014). It is also known that the transfer is the weak part in the mobility chain (Savelberg and Bakker, 2010; Schakenbos et al., 2016). Transfers cause a certain resistance in the traveller. A lack of travel information, safety, reliability, station facilities as well as possible additional waiting time can influence the travellers resistance of a transition (Schakenbos, 2014). The quality of transfers have to be improved in such a way that travellers experience public transport better and choose it more often.

Transfers between different modalities should be optimal, in terms of customer travel experience. For this purpose, not only infrastructure and organization of public transport play a role, appropriate multimodal travel and route information for wayfinding at public transport hubs are essential as well. Transfers often take place at public transport hubs, such as railway stations. Many studies indicate these public transport hubs are important points in the mobility network and are often characterized as large and complex (Van Nes, 2002). Therefore, is is not easy for the traveller to find their route from one modality to the next. Multimodal wayfinding information should support travellers to find their walking route from one modality to the next. Currently local authorities, however, have identified a problem regarding this wayfinding information provision of multimodal transfers at public transport hubs (Vervoer Regio Amsterdam, 2017). The current wayfinding information is mainly present within the domain of one modality, such as a railway station or a metro station. In other words, route and travel information is given about transfers from train to train, or from metro to metro. Multimodal wayfinding information, to connect the different transport modes, is incomplete, inappropriate or even not present at all (Vervoer Regio Amsterdam, 2017). As a consequence, the current multimodal wayfinding information provision can be considered as insufficient to facilitate a door-to-door journey.

Information related to travelling, on the other hand, is developing. One can think of digitization such as MaaS (Mobility as a Service) that offers opportunities for new types of wayfinding information provision such as smartphone apps. The concept of MaaS facilitates travellers a door-to-door journey based on their individual requirements of a trip. A variety of transport modes can be used in this concept. A seamless transition between these different modes of transport seems to be essential. Route guiding, from modality to modality, through a user-friendly app offers opportunities to contribute to these seamless multimodal transfers. The question, however, arises to what extent there is a need, for the Dutch traveller, for new types of multimodal wayfinding information such as a smartphone app?

Before investing in multimodal wayfinding information provision it is important always to keep the traveller's perspective in mind, because the available multimodal wayfinding information is used by them. In addition, in order to improve the chain journey for the traveller, their travel experience plays an important role. It is relevant to understand what the preferences regarding multimodal wayfinding information are from a traveller's perspective and how travellers experience a journey. If these are known then these insights can be applied in practice to increase customer travel experience.

In view of the problem mentioned above, it is important to know what elements have already been studied in various fields of transfers, wayfinding information and customer travel experience. A variety of studies about transfers in chain mobility have been done. Keizer (2012) and Haarsman (2012) have studied transfers between trains and disutility in a Dutch context. These studies focus on transfer resistance due to timetables. To know about the duration of a trip it is important to understand the perceived transfer resistance. Four factors are identified as most important: transfer time, train frequency of a connecting train, type of transfer and number of transfers. It becomes clear that shorter trips generate more transfer resistance than longer trips. In addition, differences between various types of passengers regarding transfer resistance are identified. Transfer times longer than 4 minutes are experienced negatively by commuters, whereas this is the opposite for social-recreational travellers (Haarsman, 2012; Keizer de et al., 2012). The study of Wijgergangs (2016) also shows differences between types of travellers. This study focuses on activity choice behaviour of travellers such as visiting shops, during transfers at railway stations. Differences have been found between frequent and less frequent transferring travellers as well as between young and old transferring travellers. Less frequent transferring travellers need relatively more transfer time before visiting a shop in a railway station compared to frequent transferring travellers. In addition, younger travellers have more resistance for detours and crowding in a railway station than elderly ones (Wijgergangs, 2016).

From these studies it becomes clear that preferences with regard to transfer times and activity choice behaviour of shops in a railway station vary among different types of travellers. These studies, however, only consider a transfer within one modality, the train. Wayfinding information preferences probably depend on the type of traveller during a multi modal transfer. Therefore there is a need to explore multimodal wayfinding information preferences of different types of travellers, for example: Do younger travellers more than older ones prefer new types of wayfinding information, such as apps on their mobile devices more than older ones?

Despite the growing importance of multimodal transfers, scientific studies about the subject are limited. Schakenbos and Nijenstëin (2014) have studied the factors that influence multi modal transfers (Schakenbos, 2014). The importance of travel time, transfer time, costs and railway station facilities on the valuation of a multimodal transfer were estimated. Wayfinding and travel information are mentioned as important factors on the valuation of a multimodal transfer, but have not been taken into account in this study.

The relation between wayfinding information and multimodal transfers remains a knowledge gap. In addition, the effect of wayfinding information provision on customer travel experience has not been researched yet. Furthermore, it is important to know how these effects can be used for the designing process of multimodal railway stations. Understanding these relations and effects are relevant from a research point of view as well as for the viability and accessibility of cities in the foreseeable future. With respect to that, the objective of this study is elaborated on in the next section, taking all these factors into account.

1.2. Research objective

The objective of this study is to identify the wayfinding information preferences of travellers at multimodal railway stations during the transition from train to bus, tram, metro or OV-bike (public transport bike). In addition, the relation with customer travel experience is explored. Furthermore, it is important to know how these traveller preferences, and to what extent, have impact on the design of multimodal railway stations and to what extent. Recommendations are developed for the design of wayfinding at railway stations.

1.3. Research questions

In order to structure this report and to ensure all aspects of the research goal are included, the research is set up by means of research questions. A main research question is formulated followed by three parts of sub questions. These sub questions are related to the different steps of this research. The steps are elaborated on in the research approach, further on in this chapter. The main research question is as follows:

What are the wayfinding information preferences of traveller types at large railway stations during multimodal transfer from train to bus, tram, metro or OV-bike, and how are these preferences related to customer travel experience?

To answer this question, the following sub questions are formulated:

What is the definition of wayfinding information?
Which types of wayfinding information can be distinguished in relation to the railway station and its surroundings?
Which types of travellers can be distinguished, and which categorizations can be identified?
How does wayfinding information influence the customer travel experience?
What are the preferences of different types of travellers regarding wayfinding information?
What are the effects of different types of wayfinding information on the customer travel experience?

1.4. Scope

Since the train is the main mode of transport for the majority of the Dutch chain trips, railway stations are chosen as basis points in this research (Brouwer and Huijsmans, 2011). The existing wayfinding information differs between different types of railway stations. In this study only large multimodal railway stations (type 1) are taken into account. An elaboration on this type of railway station can be found in appendix A. This selection is based on the amount of travellers per year and the range of modalities at a certain railway station.

Since multimodal wayfinding information is most important for travellers going to an unknown destination (Rijkswaterstaat Dienst Verkeer en Scheepvaart, 2009), this research focuses on travellers transferring at, for them, unknown large railway stations.

Different modes of transport come together at multimodal railway stations. Bus, tram, metro and the personal bike are used mostly for access to and egress from these stations (Brouwer and Huijsmans, 2011). When travellers arrive at an unknown railway station, however, it is plausible that they will not use their own bike. Therefore, this research focuses on the transfer from train, to bus, tram, metro or OV-bike (Brouwer and Huijsmans, 2011).

The geographical demarcation concerns the railway station itself and the area around it, up to the area of bus, tram, metro and OV-bike. This is visualized in figure 1.1.

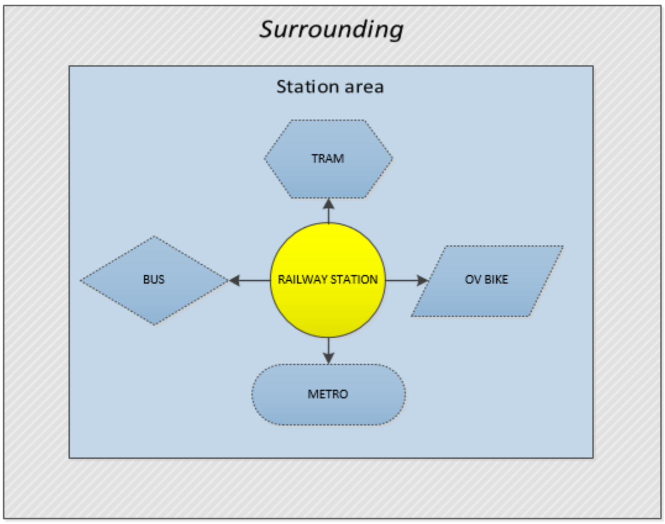

Figure 1.1: Geographical demarcation

1.5. Research approach

To answer the research questions the following approach is adopted. This research is divided into two main parts. These parts together contain the answer to the main research question. In the first part, an exploratory research and an experiment are executed. The main purpose of the exploratory research is to identify the main components of wayfinding information at railway stations. These components are determined by means of a literature study and exploratory interviews. The literature review aims to give insight into the components of wayfinding information and the relation with customer travel experience. Besides, exploratory interviews are used to support these insights from literature. As a result of the synthesis of the literature and the exploratory interviews, a conceptual framework is developed. The second part consists of a rating experiment based on the findings of the literature review and the exploratory interviews. In this phase, attributes are defined. These attributes are the most important elements of wayfinding information and are tested in a rating experiment. Then a data analyses is conducted that leads to the results of the rating experiment. Finally, interviews with experts are held to explore the implications of these results.

In figure 1.2 an overview of the structure of this study is shown.

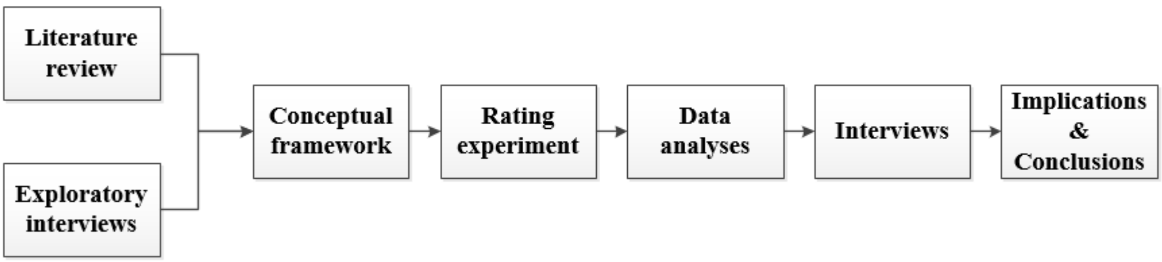

Figure 1.2: Methodology

Literature review
A literature study is done in order to find out what already has been researched in the field of wayfinding information. In this way, the knowledge gap between wayfinding and multimodal transfers becomes clear. The focus of this literature review is on the process of wayfinding in general and the relation with the railway station surroundings in particular. Besides, different types of wayfinding information are explored and types of travellers are addressed and categorized. In addition, the relation between wayfinding information preferences and customer travel experience is defined. As a result, a conceptual framework is developed and attributes are identified for the experiment. The method used for the literature review is elaborated on in chapter 2.

Exploratory interviews
Besides the literature study, exploratory interviews are used to select specific literature about wayfinding information in the railway station surroundings and the relation with customer travel experience. In addition, the exploratory interviews contribute to a better knowledge of the context of wayfinding information and to the identification of attributes. The literature study and the exploratory interviews are performed simultaneously in order to combine real life information with literature. The exploratory interviews are done among experts in the field of railway stations itself, travellers as well as information provision in railway stations. In appendix C the experts are listed.

Rating experiment
The rating experiment is based on literature and exploratory interviews. Data have been required in order to find out the influence of the attributes on wayfinding information preferences. Therefore, a stated preference survey is conducted. First, the most relevant attributes have been selected. Then the attribute levels have been determined. Next, based on the defined attributes, the survey questions are formulated. These questions concern perceptions, attitudes and other characteristics of the respondents. The purposes of these questions are:

- identifying differences in preferences between different types of travellers
- identifying the effects of different types of wayfinding information on customer travel experience

Subsequently an online pilot survey is drawn up and tested within a small group of respondents. Then, the final survey is set up and sent to a large group of respondents. Finally, the results of the survey are analyzed by means of a factor and a regression analysis. A detailed description of the these methods can be found in chapter 3.

Expert interviews
In the final phase of this research, several interviews with experts in the field of railway station design are held. These interviews serve as a supplement to the quantitative part of this study. In these interviews, the implications of the results are discussed in more detail. On the basis of the interviews, it is investigated how wayfinding information can be implemented in the (re)-design process of railway stations. Practical recommendations are made based on the findings of the interviews. A detailed description of the method used is described in chapter 5.

1.6. Contribution to science and practice
The scientific and social relevance are based on theoretical and practical research objectives. As mentioned before, there is an urgency to focus on chain mobility in the foreseeable future. Public transport is of great importance for chain mobility. In order to stimulate travellers to use public transport, the quality of transfers within the mobility chain must be improved. Multimodal wayfinding information can contribute to the quality of a transfer and to the improvement of the customer travel experience.

This research contributes to science because knowledge is gathered about attributes which are important regarding traveller preferences of multi modal wayfinding information at large railway stations, during the transfer from train to bus, tram, metro or OV-bike. This study also provides more insight in the relation between wayfinding information and customer travel experience.

Moreover, by clarifying the multimodal wayfinding information preferences of the traveller, a better understanding of the traveller's behaviour in a railway station environment is given. This insight can be used by the government as well as transport providers such as NS to optimize their door-to-door strategy. It can be taken into account for (re-)designing railway stations. By improving multimodal transfers and making the customer's travel experience better, public transport becomes a more attractive choice of mode. As a result, mobility in and viability of cities can be improved.

1.7. Commissioned

This graduation research is conducted in cooperation with Sweco Nederland. Sweco is an engineering company that plans and designs communities and cities of the future. Projects are executed in cooperation with the government as well as with other companies on both national and international scale. Transport and mobility are important themes in the cities and communities of the future. Therefore, the development of public transport hubs are vital. Sweco aims to increase knowledge about wayfinding information preferences, in order to improve their expertise on this topic. This knowledge contributes to optimal advice for their customers. Currently, advice regarding the development of public transport nodes are often developed from an engineer's perspective. The purpose of this research, however, is to get insight in the passenger's perspective with regard to wayfinding information at public transport nodes.

1.8. Thesis outline

In this research the wayfinding information preferences at large multimodal railway stations are explored. The research is structured as follows: chapter 2 gives an overview of the literature review and a conceptual framework is proposed, chapter 3 addresses the methodology and chapter 4 describes the results. Then, chapter 5 gives an overview of the implications of the results. Finally, in chapter 6 conclusions are drawn, recommendations are given and areas for further research are identified.

2
Literature review

This chapter elaborates on literature on wayfinding information and the relation with customer travel experience. First, the methodology of the literature review is discussed. Then, the definition and the process of wayfinding information is elaborated on. In addition, both different types of wayfinding information travellers are identified and the connection to customer travel experience is examined. Finally, conclusions are given and a conceptual framework is proposed.

2.1. Literature review methodology

The purpose of the literature review is to critically analyze the current scientific literature about wayfinding information. This has been done to check which research has already been done about wayfinding information. To determine the current state of research about wayfinding, the most recent literature on this subject is explored. In order to find the most relevant literature, various articles, journals and databases are used. The following keywords are put in Google Scholar: ”wayfinding”, ”human orientation”, ”navigation”. This has been resulted in several journals and books about these topics. Starting from this literature, the snowballing method is used to explore the references of these books and journals.

Besides the study in literature, exploratory interviews with experts are done. These interviews are used to find more specific literature as well as to verify and complement the information acquired from the literature. The selection of experts is based of their backgrounds and knowledge in the field of public transport, passenger behaviour and traveller information. The experts and their backgrounds can be found in appendix C.

2.2. Definition and process of wayfinding information

This research is about wayfinding information, but what is the definition of wayfinding information according to the literature on this subject? In addition, it is relevant to know how the process of wayfinding works. Knowledge about traveller behaviour is a prerequisite to understand how people give their attention to the available information in a railway station. How do people find their way in a railway station? Which processes affect the attention process?

The term wayfinding information is defined for this research. Yet, there is no unambiguous definition for wayfinding information in the literature. Therefore, the term wayfinding is further explored. Wayfinding literally means, ”finding the way”. It is all about finding one’s way in certain surroundings. There are several ways of describing the term wayfinding according to the literature on this topic:

Wayfinding can be described as a movement to a specific destination too far away from being observed by the traveller (Allen, 1999). Arthur and Passini (1992) explain wayfinding as the solution of a spatial problem. More recent literature of Farr (2012) describes wayfinding as: ”the process of finding your way to a destination in a familiar or unfamiliar setting using any cues given by the environment” (Farr et al., 2012, p.716).

When reading literature about this subject it becomes clear that wayfinding is related to the terms navigation and orientation. Montello (2005) and Passini et al.(1998) define wayfinding as a part of navigation (Montello, 2005; Passini et al., 1998). Montello (2005) explains navigation as ”the coordinated and goal directed movement of one’s self (one’s body) through the environment”(Montello, 2005, p.258). On the other hand, the wayfinding definition from Lynch (1960) focuses only on orientation. According to Lynch (1960), wayfinding is done by using external information to orientate oneself.

After having explored the explanations of the term wayfinding in general, it is interesting to know how human wayfinding works and which processes in wayfinding can be identified.

Three wayfinding sub processes in wayfinding can be distinguished (Arthur and Passini, 1992):

- Decision making and development of decision plans: making choices and creating an itinerary, determining the destination of the trip and defining the steps that must be taken to reach that destination.
- Decision execution: performing the choices made, transforming the itinerary into real behaviour; every decision must be transformed into behaviour.
- Information processing: receiving and processing the information of the environment; with the help of the information, orientation can be retained.

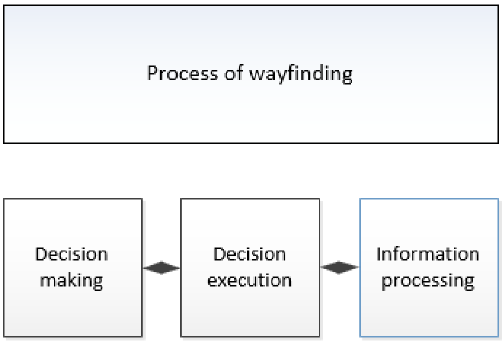

Figure 2.1: Process of wayfinding

As can be seen from figure 2.1, information processing is part of the wayfinding process. Thus, by using information from the environment people can orientate themselves. Since this research focuses on the available information in a railway station and its surroundings, it is relevant to understand how people give their attention to the available information. In other words, how does human information processing works?

2.2.1. Information processing

Information processing is done by comparing spatial representations with spatial perceptions or observations of real objects in the environment (Downs and Stea, 1977; Passini, 1977) . Spatial representations can be internal and external. Internal spatial representation is usually translated as spatial knowledge. This is the memory of a person of a certain environment (the knowledge of an environment). According to several studies, this memory is known as the mental or cognitive map (Arthur and Passini, 1992; Lynch, 1960). Lynch (1960) writes that people orientate themselves in a city using this cognitive map. Thus, the cognitive map is a mental (internal) representation of the environment and refers to the ability of an individual to understand the spatial characteristics of that environment (direct). An external representation, on the other hand, is the spatial knowledge of an environment that can be obtained by a real map (indirect).

Spatial perception, is about the perception of the environment by an individual. The cognitive map (spatial knowledge) is linked to this spatial perception (what people see) for wayfinding by an individual. According to several theories, the objects which are used for this process are defined as landmarks. Further elaboration on landmarks can be found in the next section.

When combining the various explanations found in the literature on wayfinding, the term *wayfinding information* is defined as follows:

"Wayfinding information is the information of a certain environment, needed by an individual to orientate themselves, in order to find one's way to a certain location" (Arthur and Passini, 1992; Downs and Stea, 1977; Fewings, 2001).

2.3. Types of wayfinding information in the railway station environment

From the previous section, it is clear that landmarks are important for wayfinding. Creating a cognitive map (spatial knowledge) starts with identifying landmarks in a certain environment. Therefore literature about landmarks is explored in this section.

2.3.1. Landmarks

In the literature, objects used as wayfinding information are defined as landmarks. According to Lynch (1960), a landmark is characterized by singularity, prominence and distance. Singularity is about its distinction from its surroundings by sharp contrast in difference in shape, position, age or cleanliness. Prominence is about the visibility of landmarks from different locations or how they are placed in prominent routes. The distant landmark is an identifying landmark. It is used to identify a city or a neighbourhood.

An almost similar categorization was defined by Sorrow and Hirtle (1999). Landmarks are defined as: "prominent, identifying features in an environment, which provide an observer or user of a space with a means for locating oneself and establishing goals"(Sorrows and Hirtle, 1999, p.37). Three categories of landmarks are formulated: visual, cognitive and structural landmarks. A visual landmark is characterized by its visibility in contrast with the environment. The cognitive landmark stands out because of its importance or unusual content, which can be historical or cultural. According to Sorrow and Hirtle (1999), cognitive landmarks are often more personal and therefore these landmarks are often missed by people who are unfamiliar with the environment. For example, a house of a friend can be a landmark for someone, whereas this is just a common house for someone else. The accessibility or prominence of a location is related to the structural landmark. Furthermore, structural and visual elements like signs are mostly used by people who are unfamiliar with the environment. Cognitive elements are mainly used when people are familiar with the environment (Sorrows and Hirtle, 1999).

A number of authors have written about the relevance of landmarks as wayfinding information. May et al. (2003) have written about pedestrian navigation. Landmarks are mostly used for wayfinding, in contrast to specific information about distance and street names (May et al., 2003). In addition, landmarks are used at decision points, where travellers have to choose a certain direction. At non decision points, however, landmarks are used as signs that confirm if the route has been chosen correctly.

Thus, landmarks can be defined as functional features or objects in the environment for choosing the right route to a certain destination as well as confirming a traveller's choice of route. The most important characteristics of landmarks are: visibility in an environment because of its location, distinction from the surroundings through unusual content and identification of a certain place. The strongest landmarks are a combination of all previous aspects.

2.3.2. Indoor and outdoor wayfinding information

Wayfinding conditions depend on the traveller's experience of the environment. Since this research focuses on wayfinding information in the railway station and its surroundings, this context should be explored further. When looking at wayfinding information related to railway stations, however, there is hardly any literature. Therefore, literature about wayfinding in the building (indoor) and urban environment (outdoor) is explored. Are there any differences between wayfinding information in these two areas?

In theories about wayfinding, a distinction is made between indoor wayfinding and outdoor wayfinding. Most studies are about outdoor wayfinding, but there are also a few studies about indoor wayfinding. First, the studies about indoor wayfinding are elaborated on. Then, the literature about outdoor wayfinding is discussed.

Indoor

According to Weisman (1981), four important environmental variables regarding indoor wayfinding can be distinguished. These variables are: visual access, architectural differentiation, plan configuration and the use of signs (Weisman, 1981). An explanation as well as specific examples of these environmental variables in a railway station are described below.

1) *Visual access* - The visibility of a landmark in a building is important. This depends on the place of orientation of a person. When persons orientate themselves in a building, it is easier when landmarks are categorized by certain areas. Furthermore, it is important to meet the expectations of a traveller, like seeing their next mode of transport such as buses or trams leaving the railway station.

2) *Architectural differentiation* - Architectural differentiation refers to the appearance of different areas in a building. A variety in interior features is important for travellers to recognize places, such as shops, waiting areas or entrances. By recognizing places, travellers can orientate themselves.

3) *Plan layout or layout of the building* - The configuration of a building affects the ease to orientate and finding one's way. A simple or symmetric design of a railway station results in easier wayfinding.

4) *Use of signs* - The use of signs and numbers provide identification or directional information for the traveller. A variety of signs and numbers is present in a railway station in order to guide the traveller towards the right direction or location.

A more recent study about indoor wayfinding has been done by Ohm et al. (2015). Four indoor wayfinding landmarks can be distinguished: architecture (pillars and fronts), function (doors, stairs and elevators), information (signs and posters), and furniture (tables, chairs, plants, fire extinguishers, benches and vending machines). Ohm et al. (2015) conclude that functional landmarks are most suitable for indoor pedestrian wayfinding, because these are recognized and named most easily (Ohm et al., 2015). This study indicates functional landmarks as doors, stairs and elevators are important wayfinding information elements in a railway station.

Outdoor

In the previous section, elements of indoor wayfinding have been discussed. In specific literature about outdoor wayfinding, Lynch (1960) distinguishes five groups of basic concepts for wayfinding in urban surroundings: paths, edges, districts, nodes and landmarks, see figure 2.2. Paths are recognizable routes along which passengers walk for example the footpaths in the railway station surroundings. Edges are boundaries between two objects, such as walls between entrances of different modalities. Districts are areas with specific and recognizable characteristics, for example the platforms of buses and trams. Nodes are places where a number of paths come together. This could be the entrance of the building of a railway station building for example. Landmarks in the outdoor environment are defined as external environmental features that can be recognized and indicate structure in a city. These landmarks can vary from very large to very small. General examples of outdoor landmarks are towers, domes or mountains. There are also mobile landmarks such as the sun or rivers. In the surroundings of a railway station, certain buildings or transport modes (bus, tram, metro) could be landmarks for wayfinding.

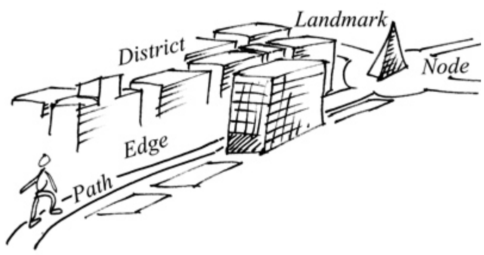

Figure 2.2: Landmarks of Lynch (1960)

When comparing the literature about in and outdoor wayfinding, it can be stated that environmental features, cues or objects (landmarks) are key elements for wayfinding in both indoor and outdoor areas. In the outdoor environment, landmarks could be present because they are part of nature for example the sun, the sea or trees. Certain features in an area, such as a road or a bridge could also be used as landmarks. This is also the case in an indoor environment. There are elements in a building that could help a person orientating, such as the architecture, design and the lay-out of a building. Moreover, elements like stairs and doors could serve as ways to orientate. Although these elements could all be called landmarks they are not specifically designed as such. These landmarks are not specifically planted in that area to serve as wayfinding information, but they are dependent on the person who is in that area. There are also landmarks that are put in surroundings on purpose with the aim to provide people with wayfinding information.

2.3.3. Added wayfinding information

In the previous section, the literature about landmarks is described. In practice, however, different systems for wayfinding information are specifically developed to help people finding their way. Current developments in the field of digitization of travel information also offer opportunities for wayfinding information provision. This section elaborates on different systems and types of wayfinding information for travellers in a railway station and its surroundings. What are the different types of wayfinding information and how can these be categorized?

Since there is hardly any literature about wayfinding information in a railway station, exploratory interviews with experts in the field of railway stations and the provision of information in the railway station are used to support the findings from literature about the provision of wayfinding information provision. A confirmation about the current types of wayfinding information used in the railway station has been given by these exploratory interviews. From these exploratory interviews it is clear that wayfinding information in a railway station and its surroundings can be divided into three main categories: *static*, *digital* and *verbal information* (Van Hagen, 2017; Van Kessel, 2017).

Static information

Fewings (2001) wrote about different types of communication for wayfinding by using static information. From this research, it becomes clear that two types of static information can be distinguished: signs and maps. This has been confirmed by the exploratory interview with Van Hagen (2017). For providing people with wayfinding information in a railway station and its surroundings, signs and maps can be used (Van Hagen, 2017).

Signs are special types of landmarks that directly inform, control, identify and provide information about the environment such as a building, road network or city. Another research shows that signs reduce the time people need to reach their destination (Butler et al., 1993). In addition, a more recent study shows a positive relation between the number of choices people need to make and wayfinding information. The conclusion of this study makes clear signs at decision points can support people finding their way (Baskaya, 2004).

Three main categories of signs can be differentiated.

- Directional signs
- Identification signs

- Reassurance signs

Directional signs are meant for guiding people directly to a place, object or event and are often used in city buildings. Identification signs name the place, object or destination. The position of both directional and identification signs is important. These signs must be located at decision points or nodes. Reassurance signs, on the other hand, have the function to reassure people that they have taken the right direction. In contrast to the previous two types of signs, reassurance signs are therefore located past decision points (Farr et al., 2012; Fewings, 2001).

Figure 2.3: Static information - Sign in a railway station

A map is another way to facilitate wayfinding information (Brouwer and Huijsmans, 2011; Fewings, 2001). Large public buildings usually have a leaflet such as railway stations, see figure 2.4. Different types of maps are: plans, views, fantasy drawings, directory & site maps and digital maps (Fewings, 2001).

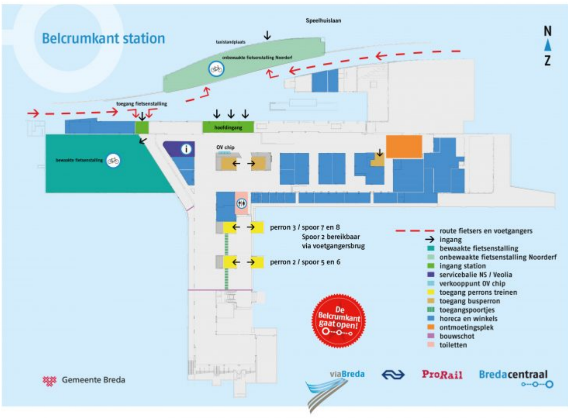

Figure 2.4: Map of railway station surroundings

Digital information

Digital information can be presented in a variety of ways. This type of information is not attached to specific equipment. Digital information can be spread over different networks, stored in several ways and used through different devices (Rutten, 2007).

Digital travel and route information in a railway station can be provided by digital screens or signs and maps such as dynamic information displays, locational signs and digital maps on location. Furthermore, smart phone applications (apps) can provide digital information. These apps provide travel information about timetables and routes. According to the literature, people are increasingly seeking for travel information on their smart phones (Huysmans, 2014). There are no theories and models available to explain the success of either apps in general or travel information apps. A theory why ICT applications in general are appreciated by users is in the G-model of (Collis et al., 2001). The three factors, ease of use, effectiveness and engagement are mentioned to be of importance. For travel information, the effectiveness of an app is of main importance. Travel information apps can be used to support people finding their way and offer the ability to get faster, cheaper, easier and more comfortable to a destination. An example of the current travel information app of NS can be seen in figure 2.6.

Figure 2.5: Dynamic information display

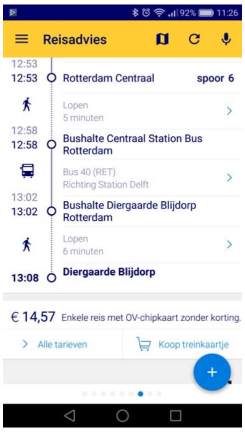

Figure 2.6: Travel information application

Verbal information

Verbal information or reassurance information can be given to passengers by people present at a the railway station or various types of devices (Dogu and Erkip, 2000). An example of verbal communication by staff in a railway station is the (manned) travel information desk (see figure 2.7). In addition, random travellers can give information about the route as well. Research from Casalo et al. 2011 shows that people sometimes prefer informal and personal information from other travellers, to prefer to information from professionals. Random travellers have nothing to gain if they share their knowledge with others travellers. Random travellers are therefore seen as objective and reliable (Casaló et al., 2011).

Figure 2.7: Travel information desk

2.3.4. Categorization of wayfinding information

The types of wayfinding information identified (environmental features, static, digital and verbal information) from the previous sections can be clustered. According to several studies, a distinction can be made between static and dynamic information sources (Black et al., 2017; Brouwer and Huijsmans, 2011; Rijkswaterstaat Dienst Verkeer en Scheepvaart, 2009).

- *Static information*. Static information gives information about a regular situation when no changes occur. It provides no real time information and is not updated daily. Examples of static information in a railway station are signs, timetables and route maps.
- *Dynamic information*: Dynamic information provides real-time information including changes from the regular situation. Digital signs and maps are examples of dynamic information.

The wayfinding information types previously mentioned are clustered by considering the distinction of static and dynamic information in a railway station.

First, are the environmental features (landmarks) discussed. These environmental features are considered as static information. The environmental features in an area can be divided into two categories: features or landmarks in the indoor and in the outdoor surroundings of the railway station. As described in the previous sections, the most important indoor features in a railway station are functional objects such as elevators, stairs and doors. The outdoor features are the paths, edges, buildings, entrances, roads, junctions, artworks, footpaths and bridges. Second, both signs and maps are elaborated on as types of static wayfinding information. As described before, signs & maps can be subdivided into different types of signs and maps, such as directional signs, identification signs and site maps.

The other two categories of wayfinding information, digital and verbal information, are considered to provide real-time information. The category of dynamic information can be split up into digital and verbal information. The digital information can be divided into digital information on screens and into mobile devices (through an app). The verbal wayfinding information can be provided by staff from an information kiosk at the railway station or can be given by random travellers.

An overview of this categorization is shown in figure 2.8.

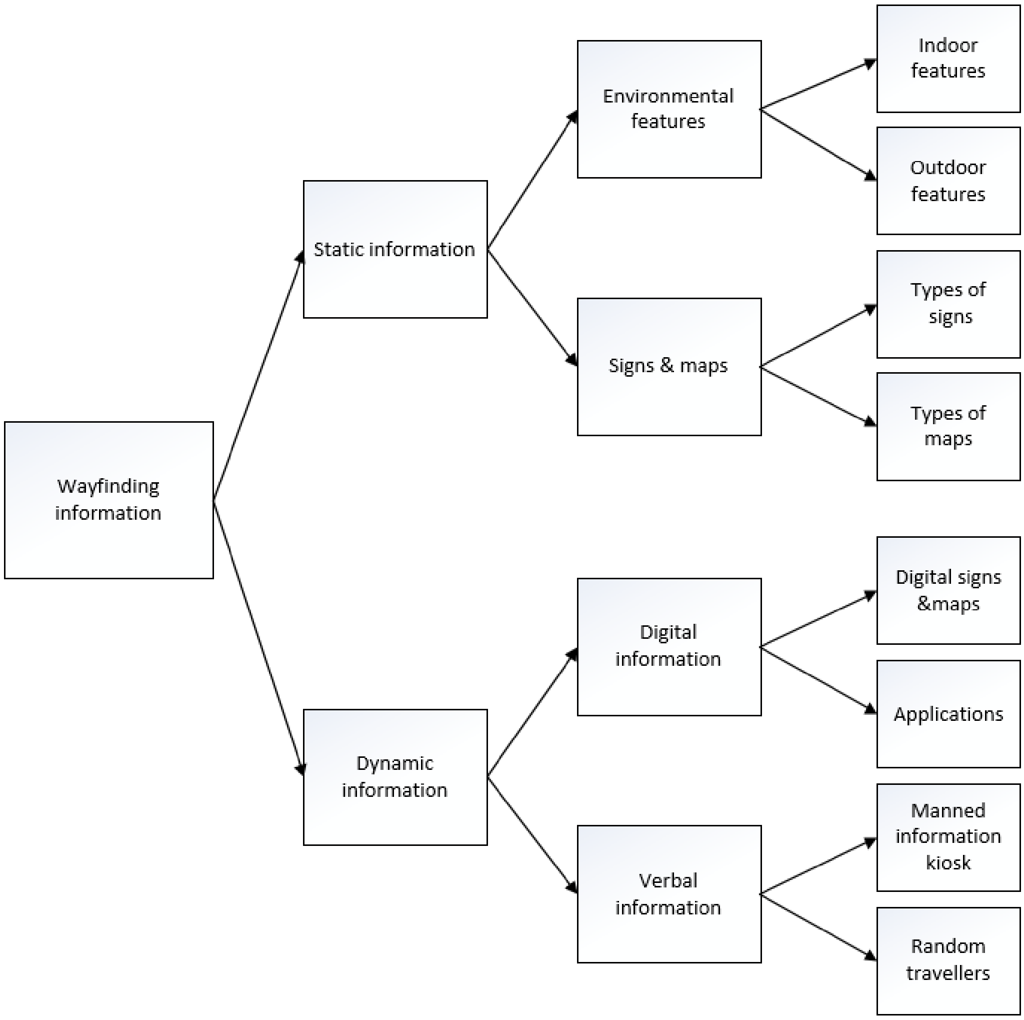

Figure 2.8: Categorization of wayfinding information

The principles of wayfinding information types in a railway station environment are determined. The next section elaborates on the users of these wayfinding information sources, the travellers.

2.4. Types of travellers

Since this research focuses on the traveller's perspective, it is important to know more about them. What are the purposes and characteristics of the traveller and are there any categorizations of travellers with regard to wayfinding information preferences?

2.4.1. Traveller characteristics

People finding their way depend on personal choices and characteristics. Dogu and Erkip (2000) write about internal human factors that affect knowledge, experience and ability of people to make decisions about finding their way. This includes factors such as: spatial orientation, cognitive mapping abilities, route strategies, language, culture, gender and biological factors, knowledge of the surrounding area, emotional state, transport mode, mobility, ability to read and understanding the language and a preconceived image of the site. It has to be mentioned that these factors are not independent. There are interactive relations between the factors, for example age can influence cognitive mapping abilities (Dogu and Erkip, 2000).

After having identified human factors that affect the wayfinding skills of people, it is relevant to explore literature about characteristics of travellers finding their way in a railway station. Brouwer and Huijsmans (2011) have looked into the differences between train travellers.

Each traveller has individual characteristics and preferences, but two main groups of people can be identified regarding wayfinding information. First, the group that seeks information from mainly wayfinding support systems such as LCD displays, signs and maps. Second, the group that mainly uses architectural and spatial relationships characteristics of the environment (Brouwer and Huijsmans, 2011).

In general individual capacities play an important role in the preference of wayfinding information. Experienced travellers know better what kind of information they are looking for. Therefore, the majority of experienced travellers routinely travel in a railway station. Even in a hurry and in the hectic environment of a railway station, this group is able to filter relevant information (Brouwer and Huijsmans, 2011).

Inexperienced travellers, however, do often have difficulties in finding their way in and around a railway station. This group of travellers is quickly disorientated in the busy environment of a railway station. In addition, travelling is accompanied by a certain amount of stress and this leads to difficulties in filtering the right information. Therefore, inexperienced travellers often seek information from employees or fellow travellers. This is often not about searching information, but getting confirmation (Brouwer and Huijsmans, 2011).

Travellers are often classified based on general personal characteristics such as gender, age, travel motive and travel frequency (Van Hagen and Nederlandse Spoorwegen, 2009). These characteristics are also known as "hard charactistics". From research of Van Hagen (2009), who studied specifically Dutch train travellers, it becomes clear that these hard characteristics, however, do not fully explain the travel behaviour of train travellers. Moreover, they do not give enough insight in the wishes and needs of train travellers during their trip.

Therefore, Van Hagen (2009) has developed an unambiguous segmentation instrument in which not only the hard characteristics but also "soft characteristics" of train travellers are incorporated. These soft characteristics refer to the psychology of travellers, the basis of travellers' motives, needs, motivations and values. The purpose of this segmentation instrument is to optimize existing and new products and services as optimally as possible to meet the wishes and needs of the traveller (Van Hagen and Nederlandse Spoorwegen, 2009).

According to Van Hagen (2012), depending on travel motifs such as the destination and context, travellers can be classified into six different need segments. Generic needs such as reliability, speed, safety, cleanliness, customer friendliness, security and rest are important for all segments of travellers. Based on travel needs, van Hagen (2012) has made a classification of types of travellers (Van Hagen and Excel, 2012). The next section elaborates on these different types of NS travellers.

2.4.2. Types of NS travellers

First, two main types of travellers can be distinguished, the must and the lust traveller. Must travellers are conscious users of the station. This category of traveller is characterized by a functional orientation, rush and focus during their journey. This group often travels because of obligations. Lust travellers, however, use the station for leisure reasons. For example, they are on their way to trips, private visits or holidays. In addition to the purpose of the trip, the attitudes and needs of this type of traveller differ. Lust travellers get pleasure from the trip, regardless of the destination, as opposed to must travellers who experience the journey as part of the daily routine (Van Hagen and Excel, 2012).

In addition to the categorization of lust and must traveller, van Hagen (2012) has made a segmentation of types of travellers. Based on their emotional needs, personal characteristics, travel behavior and preparation for the trip, six types of travellers can be distinguished: the explorer, the individualist, the functional planner, the certainty seeker, the socializer and the convenience seeker (Van Hagen and Excel, 2012). According to NS, the division is as follows: the explorer (11%), the individualist (12%), the functional planner (14%), the certainty seeker (14%), the socializer (25%) and the convenience seeker (24%). As can be seen from figure 2.9, these types can be categorized according to the must and lust travellers categorization (Van Hagen and Excel, 2012).

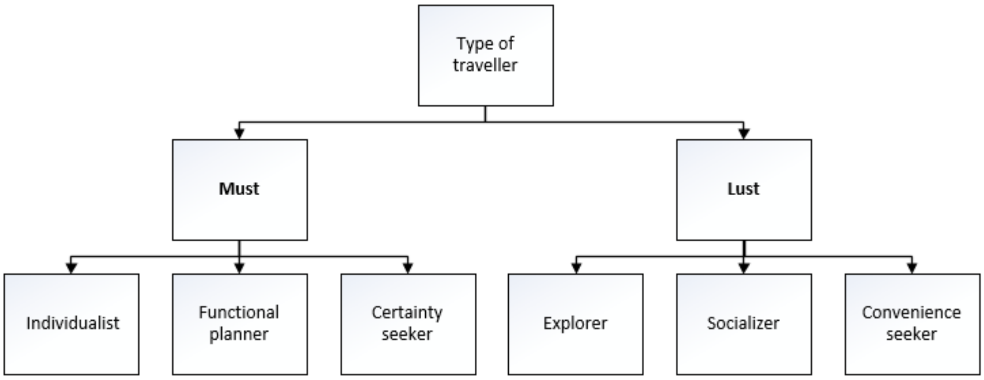

Figure 2.9: Types of NS travellers

Category of must travellers

The *individualist* is self-conscious, business like, status-sensitive, older and does often not work any more. The individualist's travel behaviour can be characterized by the following aspects: two thirds of this group mainly travels recreationally and one third travels business from or to work. With regard to the preparation of the trip, the individualist always plans the trip in advance and always has travel information nearby.

The *functional planner* is organized, calm, targeted and has everything under control. They are young and work. Their travel behaviour is characterized mainly by work or business travel. The preparation of a trip takes a short time because this group is used to the system. Only real time travel information is checked.

The *certainty seeker* is friendly, open, patient, social and involved. This group of travellers consists mostly of women of all ages. Their travel purpose is mostly recreational and sometimes for work. The preparation of a trip is always planned in advance, travel information is always at hand and this group continues to seek for confirmation, preferably at staff desks.

Category of lust travellers

The *explorer* is independent, flexible, trendy, business like, young, highly trained and works. This group frequently uses the train for work or business. The explorer prepares just before for departure or not at all. If necessary, websites or smart phones are used to request travel information.

The *socializer* is cheerful, friendly, positive, spontaneous and open to contact. This group consists of mainly women of all ages. Their travel behaviour is characterized by visiting family or friends. With regard to preparation of the trip: the socializer plans everything in advance, using everything and everyone and always has travel information ready.

The *convenience seeker* is carefree, relaxed, easy-going, spontaneous and positive. Convenience seekers are mainly young people, who usually travel for school or elderly(60 and above) who mainly travel for trips. Preparation of the journey takes place just before departure or during the trip. This group receives information instead of exploring by themselves.

As is clear from the previous sections, the psychology of travellers is important when it comes to wayfinding. Research shows that various groups can experience a trip in a different way. Therefore, it is considered relevant to take both hard en soft characteristics of travellers into account. The classification of Van Hagen, as described above, of NS types of travellers is therefore used further this study. The wayfinding information preferences of these types of NS train travellers are tested within the experiment in chapter 3.

As mentioned in the introduction, a better customer travel experience can contribute to a rising use of public transport. Therefore, the relation between wayfinding information preferences and customer travel experience is important to explore. The next section addresses this relation.

2.5. Customer travel experience

In order to improve the chain journey for the traveller, their travel experience plays an important role. It is important to understand what a traveller wants and how they experience a journey. What are the theories behind this customer travel experience and what is the relationship with the provision of wayfinding information?

This section elaborates on the relation between customer travel experience and wayfinding information. The pyramid of customers' needs in public transport, developed by van Hagen (2000), is illustrated in figure 2.10 (Van Hagen et al., 2000). This pyramid shows how people value the quality aspects of a transfer. The pyramid is analogous to the theory of Maslow, the lower layers being the most important. The top layers only become important when the quality aspects of the lower layers are met (Maslow, 1954).

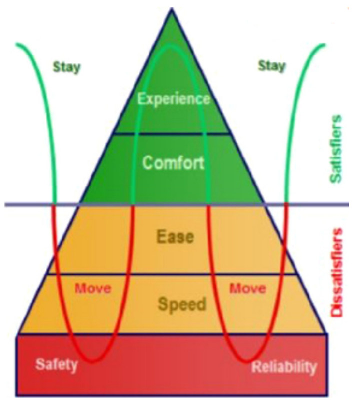

Figure 2.10: Pyramid of customer needs

The basic needs of the pyramid consist of safety and reliability. The other aspects are: speed, ease, comfort and experience. The red base is determined by the pre-conditions safety and reliability. Safety refers to social safety and is a prerequisite for the functioning of a public transport environment. When an environment is perceived as unsafe or if the expected service is not met, the place will only be visited by people without another option. Reliability refers to the expectations of passengers. If certain services are not present, which were expected by the customer in advance, people will be dissatisfied (Van Hagen, 2015).

The following two layers of the pyramid are yellow: speed and ease. Most people prefer a journey that is as fast as possible. Therefore, speed is the most important customer need. When this condition is met, an easy transition is important. Ease is characterized by good orientation, travel information and logical and unambiguous signposting. The last two layers in the pyramid are green. The one top level concerns comfort which relates to aspects such as indoor waiting areas, shops and other facilities. Finally, the green top level concerns experience. Experience refers to a variety of aspects such as architecture, cleanness, colours, smell and noise.

A distinction can be made between dissatisfiers and satisfiers. Speed and ease are mainly related to the movement through the railway station, whereas comfort and experience are relevant for spending time at the railway station. According to the pyramid, speed and ease are therefore dissatisfiers. These elements are assessed negatively by the traveller if their expectations are not met. Satisfiers are comfort and experience that are noticed when the transfer is evaluated positively by the traveller. The traveller is not immediately dissatisfied if these quality aspects score lower. It should be noted that the interpretation of positiveness may differ among passengers.

According to this pyramid and an exploratory interview with van Hagen (2017), it is assumed that wayfinding information is mainly related to aspects of speed and ease. Besides, safety and reliability are important conditions that already have to be there. It can be concluded that wayfinding information influences the complete customer travel experience of a transfer, but the layers of speed and ease are the factors to be influenced. It has to be mentioned, however, these findings are based on the research of van Hagen (2000). Empirical evidence of these findings has not been found yet.

2.6. Overview literature review

This chapter has explored the literature about wayfinding information and its relation with customer travel experience. In order to do so, the definition of wayfinding information is addressed and literature about wayfinding information in the context of a railway station is explored. Furthermore, a categorization of wayfinding information sources in a railway station is defined. In addition, characteristics of different types of travellers are identified. Finally, the relation between wayfinding information and customer travel experience is addressed.

For this research, the term *wayfinding information* is defined as follows: *"Wayfinding information is the information of a certain environment, needed by an individual to orientate themselves, in order to find one's way to a certain location"*.

Three wayfinding sub processes can be distinguished: making decisions, executing decisions and processing information. The focus of this study is on the processing information. Processing information is a comparison of spatial perception (what people see) with spatial representations (spatial knowledge of a place). Spatial knowledge (a mental map) can be existing knowledge because of familiarity with an environment or can be obtained indirectly through real maps of a certain area.

Creating a mental map of certain surroundings starts with identifying landmarks in a certain environment. Landmarks can be defined as functional features or objects in the environment for choosing the right route to a certain destination as well as confirming a travellers' choice of route. The most important characteristics of landmarks are: visibility in an area due to its location, distinction from the surroundings through unusual content and to identification of a certain place. The strongest landmarks are a combination of all previous aspects. The determination of a landmark, however, is subjective and individually specific.

When looking at types of wayfinding information in a railway station and its surroundings a distinction of four main categories can be made: environmental features (landmarks), static, digital and verbal information. These categories can be clustered into two main categories: static and dynamic information.

People finding their way can be based on personal characteristics. A categorization of train travellers is developed by NS. This categorization of train travellers is based on traveller's needs. Must and lust travellers as well as 6 types of NS travellers (the explorer, the individualist, the functional planner, the certainty seeker, the socializer and the convenience seeker) can be distinguished.

Finally, the relation between wayfinding information and customer travel experience is defined. Wayfinding information influences the complete customer travel experience of a transfer, but the elements of speed and ease are the factors considered to be influenced. These factors are assessed negatively by the traveller if their expectations are not met. Thus it is assumed that the customer travel experience increases when the wayfinding information provision during a multimodal transfer is improved.

2.7. Conceptual framework

The literature review illustrates relationships between personal characteristics and wayfinding information. These relations are the basis of a conceptual framework. The goal of this framework is to synthesize the aspects that are related to wayfinding information preferences and the relation with customer travel experience. The complete conceptual framework, which gives an overview of this chapter, is presented in figure 2.11. The part of the framework which is tested by the experiment is presented in figure 2.12. The relations between the different elements are discussed below.

The variables found to be of influence are combined in two groups of variables: environmental variables and human variables. The framework presents an overview of the relations between human variables, environmental variables, context variables, wayfinding information preference and customer travel experience.

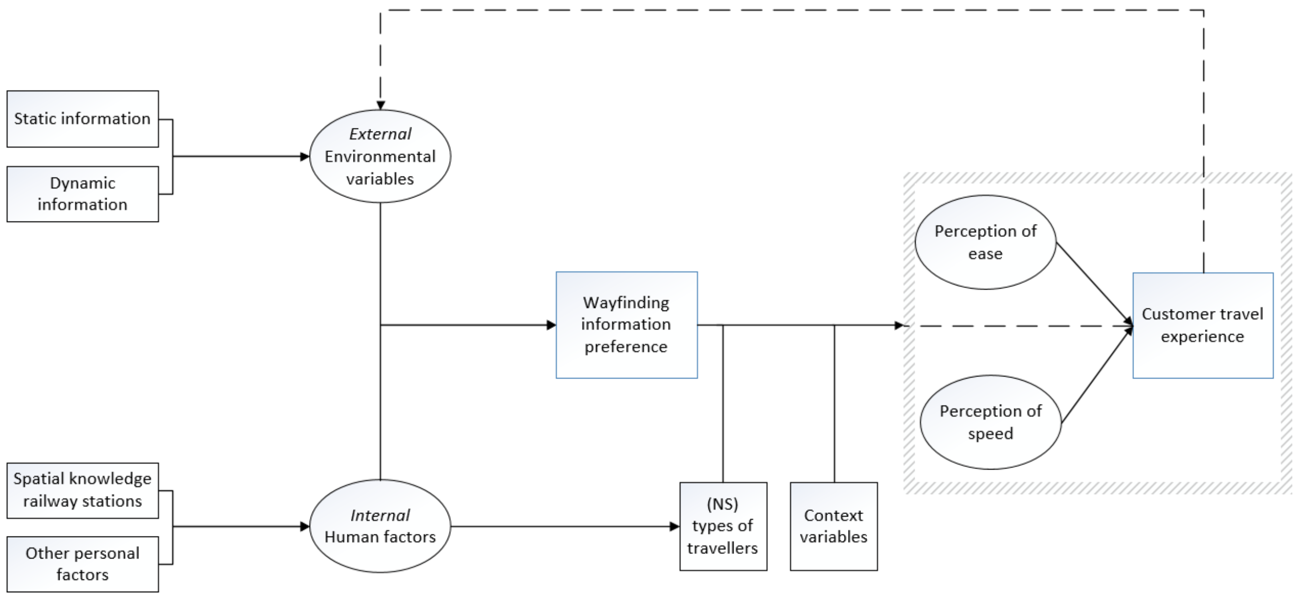

Figure 2.11: Conceptual framework wayfinding information

Environmental variables

According to literature study, environmental variables affect the decisions of people by features in the environment along a route. These environmental features are elements that can either be provide static or dynamic information in an environment of a railway station to support people in finding their way.

Static information can be provided by environmental features such as the complexity of the railway station, the visibility of landmarks, architectural characteristics, but also added information sources such as signs and maps can provide wayfinding information. The complexity of a railway station refers to its lay-out (design). A small railway station with a few platforms is easier to overlook than a large railway station with several alternative routes. Visibility of landmarks such as a shop, clearly defined pathways and prominent objects for people to notice are important for people finding their way. The architectural characteristics of a railway station are also important. Differences in areas and buildings in the railway station and its surroundings, in the architectural style, colour, size as well as the identifiability of building entrances contribute to people's orientation.

Dynamic information can be added or just available in the environment of a railway station. Added dynamic information in a railway station can be digital or verbal such as digital signs & maps, travel information apps, information kiosks or other travellers.

Human variables

The human factors that affect the wayfinding information preference of travellers consist of spatial knowledge of a railway station and other personal characteristics.

From literature study as well as from the exploratory interviews, familiarity with the railway station is considered as an important element that affects the spatial knowledge of persons of the railway station and its surroundings. The level of spatial knowledge is higher when people are familiar with the railway station and its surroundings. When people are familiar with railway stations, the general lay out of it and the location of certain landmarks may be easier to overlook. These landmarks can be a certain shop or painting as well as platform numbers which are often similar at different railway stations. When people are not familiar with the railway station and its surroundings, however, relatively less spatial knowledge about the railway stations and its surroundings is already present. Therefore, people that are less familiar with the railway station and its surroundings are assumed to rely more on added wayfinding information such as signs, maps, digital information and verbal information.

Furthermore, the spatial knowledge of a person can also be influenced by factors such as age, mental capabilities, gender, culture and biological factors (Dogu and Erkip, 2000). Young people, for example, may have less spatial knowledge of a railway station than elderly people, because it is plausible they relatively have travelled less during their live than elderly people.

Other personal factors that influence the wayfinding information preference of people are: the emotional state of a person, choice of mode of transport, travel purpose, working status, education level, the ability to read and understand the language (Dogu and Erkip, 2000). People feeling stressful might have other preferences than people who feeling relaxed. Research of Schakenbos (2014) shows bus, tram, metro as well as bikes are not perceived as homogeneously by transferring people. Therefore, the mode of transfer is likely to affect the wayfinding information preference of a person as well. The travel purpose of a traveller can be of influence as well. People travelling because of obligations are more in a rush than people travelling for leisure reasons (Van Hagen and Excel, 2012).

(NS) types of travellers

The preference for a certain type of wayfinding information might be individually specific, although travellers with the same characteristics may have the same preferences for types of wayfinding information. The categorization of NS traveller types determined by Van Hagen (2011) is used for this research. Two main categories of travellers are distinguished: must and lust travellers. Moreover, six types of travellers can be identified within these two categories.

The influence of travel purpose on wayfinding information preferences are explained in the exploratory interview with Van Hagen (2017). The way travellers feel depends on their travel motive. According to the distinction between must and lust travellers, must travellers are considered to be more in a hurry than lust travellers. Therefore, it seems likely that must travellers are mainly focused on choosing the fastest route to their destination. Waiting for wayfinding information at for example staff desks might be not as fast as looking at the individual wayfinding information on an app.

Context variables

The wayfinding information preference of a traveller not only depends on the type of traveller, but also on the context. A context variable which influences the wayfinding information preferences of travellers is the time of day.

The visibility of wayfinding information sources depends on the time of day by the effect of daylight. When it is dark outside, landmarks in the railway station surroundings are less visible than during the day. Furthermore, time of day can be interpreted in terms of peak hours. During peak hours, the railway station and its surroundings are more crowded and therefore might be more difficult to overlook.

Customer travel experience

As discussed in this chapter before, wayfinding information is considered as important for the way travellers perceive the speed of a transfer and how they perceive the ease of a transfer. By influencing the aspects speed and ease the customer travel experience is influenced as well.

A feedback loop can be seen between the customer travel experience and the environmental variables. For the design of a railway station as well as the provision of its wayfinding information, it is relevant to know how travellers experience this. Environmental features in a railway station can be improved, added or changed in such a way to meet the travellers' needs.

2.8. Conclusion

The conceptual framework developed illustrates the elements that are considered to affect a traveller's wayfinding information preference. In addition, the relation between wayfinding information and customer travel experience is considered to be explained by the traveller's perception of speed and ease of a transfer.

The conceptual framework is the basis for the experiment that is explained in the next chapter. Since not all relations in the framework can be tested within this research due to time limitations, only a part of the framework is tested within the experiment. The relation between wayfinding information preferences and customer travel experience is focused on. Further, the way in which wayfinding information preferences differ among the different types of NS travellers is explored. The context variables are eliminated in the experiment, because the survey would be too large if these effects were added. The part of the conceptual framework that is tested within the experiment is illustrated in figure 2.11.

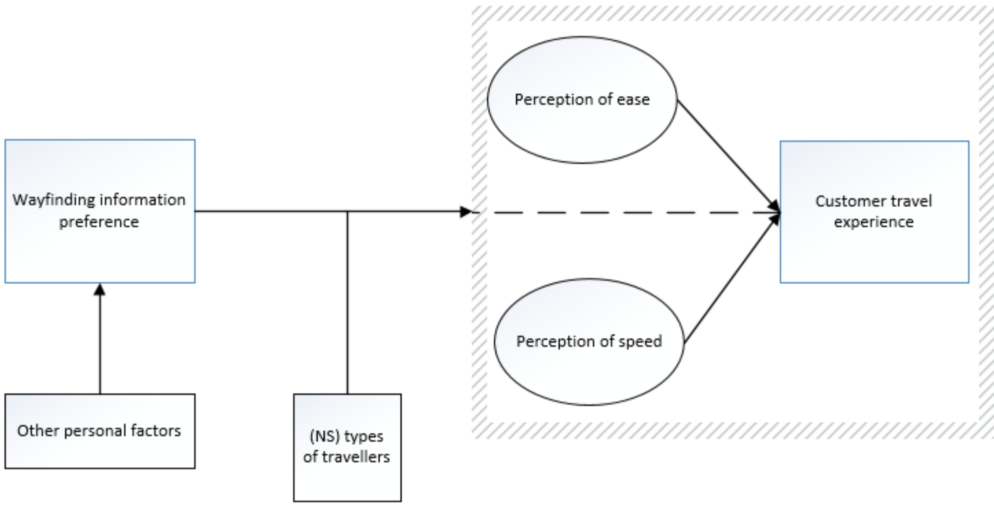

Figure 2.12: Conceptual framework wayfinding information

3
Survey

In this chapter the experiment is explained. In the previous chapter a framework is presented which explains the relation between wayfinding information and customer travel experience. To test the influence of wayfinding information components, data is required. Methods used to set up the data collection and the experiment are elaborated on. First, the method of data collection is described. Second, the attributes and the attribute levels are defined. Third, the design of the survey is discussed. Finally, the experiment design is discussed.

3.1. Introduction

In the previous chapter, a conceptual framework has been described. In order to test the relationship between the components of this framework, a stated preference experiment is used. An elaboration of this method is given in the next section.

3.2. Data collection method

There are two main data collection methods which can be used for generating choice data. These methods are 'Revealed Preference'(RP) and 'Stated Preference'(SP). The advantages and disadvantages of both methods are discussed in the next sections.

3.2.1. Revealed Preference

Revealed preference data show the real choice behaviour of an individual. These data are based on actual decisions of respondents. Therefore the reliability and validity of these data are high, which can be considered as the most important advantage (Louviere et al., 2000). Another advantage is the additional explanation that can be provided by the person who has drawn up the survey in case that people do not fully understand the survey (Louviere et al., 2000).

There are also drawbacks of RP data. The first one is the difficulty to get enough variation in the data to examine all variables of interest. Besides, strong correlations between different variables make it more difficult to indicate the effect of an individual variable. In addition, it is not possible to retrieve data about new situations that do not exist.

3.2.2. Stated Preference

The second method is the 'Stated Preference' method in which respondents choose between hypothetical situations. When making up situations it is easier to vary attributes. Moreover, hypothetical situations that do not (yet) exist can be tested.

By using the SP method, multiple observations per respondent can be obtained, whereas in the RP method, there is only one observation per person. As a result, a smaller number of respondents is required in an SP experiment. The main disadvantage of the SP method is the fact that the situations presented in the survey are hypothetical. Therefore, the actual choices remain unknown. In addition, the task complexity of a SP survey can affect the results. If the amount of attributes is too high or respondents do not understand the hypothetical situations in the survey, respondents may be not able to give the answer they had intended.

The stated preference method is used for this study. In this method new variables can be used that may explain choices such as satisfaction. New types of wayfinding information can be added to the survey in this way.

There are three different types of the stated preference method: the rating conjunct approach, the stated choice method and the ranking conjunct approach. The distinction between these methods is in the task for the respondents. In a rating conjunct approach respondents are asked to evaluate a combination of attributes (a profile) on a preference rating scale. In stated choice experiments, choices between profiles (alternatives) are observed. Individuals are asked to choose between two or more selection sets of combined attributes. In a ranking conjunct approach individuals are asked to rank combinations of attributes in a certain order. The respondents receive a set of profiles they have to rank while taking the overall preference into account (Molin, 2011*a*).

3.2.3. Rating conjunct approach

In this research the rating conjunct approach is used. By using this method it becomes clear which evaluations on scale are made by the traveller and how the attributes are appreciated by them.

Another reason for choosing the rating conjunct approach is because it is about traveller satisfaction, which is difficult to measure in a stated choice experiment. When asking respondents about their satisfaction about a set of attributes, a choice between yes or no is often not the preferred answer. Therefore, a rating scale can be considered as more sufficient. In addition, the rating conjunct approach measures the strength of the preference for each profile separately, while the stated choice method only evaluates the preference of an alternative compared to another alternative.

Besides, the rating approach is chosen instead of the ranking approach because the rating approach indicates relative preference between profiles. The ranking approach, on the other hand, only measures the preference order of attributes. Moreover, by using the rating conjunct method only one profile in time is presented to the respondents. Therefore the rating task is considered relatively easier compared to the ranking task in which a number of attributes have to be ranked (Molin, 2011*a*).

3.3. Survey design

This section elaborates on the survey that is used for collecting data. First, the rating experiment is described. Second the attributes selected and attribute levels in the survey are discussed. Finally, the design of the rating experiment is described.

3.3.1. Rating experiment

As described above, the relations between the components identified Fare tested by means of a rating experiment. This section elaborates on the design of the rating survey. In the survey, different profiles are presented to the respondents. In these scenarios, experimental variables are used, attributes are added or changed in order to test the effects.

The survey consists of two parts. In the first part general questions are presented to the respondents. From these general questions, the personal characteristics and travel behaviour of the respondents become clear as well as the NS type of traveller. In the second part, respondents are asked to rate situations on a rating scale. In addition, two additional rating questions are asked in order to indicate the effect on customer travel experience.

The second part of the survey starts with the description of a hypothetical situation. In this hypothetical situation the respondents are asked to imagine that they arrive at an unfamiliar and large railway station. Then they are explained that a transfer has to be made from the train to the bus, tram, metro or OV-bike. The hypothetical alternatives are presented as profiles. These profiles are a list of attribute values (Oppewal and Timmermans, 1993). The rating of each profile is expressed on a scale of 1 to 7, in which (1) is 'strongly disagree' and (7) is 'strongly agree'. The respondents have to rate the different profiles about wayfinding information sources on satisfaction. In addition, the respondents are asked to rate to what extend the presented combination of attributes (profile) corresponds with their perception of the elements of ease and speed of their transfer, in two extra questions. These questions are also on a rating scale (1 to 7) from 'does not contribute to the ease of the transfer' to 'strongly contributes to the ease of the transfer' and from 'does not contribute to the speed of the transfer' to 'strongly contributes to the speed of the transfer'.

Likert scale

Since the survey measures satisfaction which is difficult to measure, a rating scale is chosen. A Likert scale is a type of scale that is often used in surveys to make satisfaction measurable. On such a scale five to seven levels are generally used. Therefore, in this experiment, respondents are asked to rate the degree of satisfaction of each profile on a Likert scale that runs from 1 to 7, from 'strongly disagree' to 'strongly agree'.

3.3.2. Attributes and attributes levels

This section provides an overview of the attributes and attribute levels which are selected for using in the survey.

Different categories of attributes and other personal and travel characteristics that influence the wayfinding information preference are defined in chapter 2. Only a limited amount of attributes, however, can be included in the experiment. If using too many attributes, the survey would be too large. Therefore, a selection of attributes is made from the attributes mentioned in chapter 2. The attributes are selected on the following criteria:

(1) The attribute can be influenced with measures and can be used in practice for railway station design
(2) The attribute can be tested within in the rating survey
(3) There should be no overlap between the attributes

Below two tables are presented. First, table 3.1 refers to the attribute selection of the wayfinding information sources. Subsequently, table 3.2 shows the attribute selection of the personal and travel characteristics. This section elaborates on these choices.

Table 3.1: Selection wayfinding information sources

Attributes	**1**	**2**	**3**	**included**
Environmental				
Flow of travellers	No	No	No	No
Indoor elements	v	No	v	v
Outdoor elements	v	No	v	v
Signs & maps				
Signs	v	v	No	v
Maps	v	v	No	v
Digital information				
Signs & maps	v	v	No	No
App	No	v	v	v
Verbal information				
Random travellers	No	No	No	No
Manned travel information kiosk	v	v	v	v

Regarding table 3.1, the main categories of wayfinding information identified in chapter 2 are: environmental features, signs & maps, digital information and verbal information. With regard to the environmental features it can be seen from table 3.1 that the attribute of the flow of travellers is excluded from the experiment based on the three criteria. The flow of travellers in a railway station environment is not easily influenced by measures. Furthermore, it is not easy to test this attribute within a survey, because it is considered that respondents find it hard to imagine to follow other travellers than themselves in a hypothetical survey situation. In addition, the attribute of the flow of travellers correlates with the attribute of other travellers from the category of verbal information. The distinction between these attribute is considered too difficult to imagine for the respondents.

Besides, the indoor and outdoor elements (functional orientation objects) are excluded from the survey; the reason being that testing within the survey is considered too difficult. This is due to the same argument as mentioned before. It might be too difficult for respondents to imagine which element they use for orientation. Moreover, the usefullness of an object for wayfinding information differs among individuals as described in chapter 2. Therefore, the visibility of the entrance or location of the next modality is chosen as an attribute. The entrance or location of the next modality can be either inside or outside the railway station. By choosing this attribute, both the indoor and outdoor surroundings of the railway station are covered in the survey.

Then, the attribute of signs and maps is included in the survey. As can be seen from table 3.1, there is an attribute signs and maps, but there are also digital signs and maps. Since there is too much overlap between both static and digital signs and maps, the attribute 'signs & maps has been included as one attribute in the survey. The function of digital and regular signs and maps is the same. This means, signs & maps are both static and dynamic (digital).

The fourth category of attributes contains verbal information. As can be seen from table 3.1, and which has already been discussed, random travellers who might provide wayfinding information are difficult to be influenced by measures. It is also difficult to test this group of travellers in a survey. Therefore this attribute is excluded from the experiment.

Table 3.2: Selection personal characteristics

	1	**2**	**3**	**included**
Personal characteristics				
Gender	v	v	v	v
Age	v	v	v	v
Familiarity with environment	v	No	v	No
Travel frequency	v	v	v	v
Transfer frequency	v	v	v	v
Transfer mode choice	v	v	v	v
Trip purpose	v	v	v	v
Emotional state	No	No	v	No
Language	v	No	v	no
Spatial orientation	v	No	No	No
Cognitive mapping abilities	v	No	No	No

Looking at table 3.2, the attribute selection of personal characteristics is listed. The familiarity with the environment is excluded from the survey because this element is hard to be tested in a survey. The situations presented in the survey are hypothetical and therefore all respondents are unfamiliar with the environment. Moreover, the respondents have to imagine being at an unfamiliar station. In order to determine the travel behaviour of the respondents, travel frequency, transfer frequency, transfer mode choice and trip purpose are included in the survey. As can be seen from table 3.1 the emotional state, language, spatial orientation and cognitive mapping abilities are left out of the experiment. These attributes can hardly be tested in a stated preference survey, since these are hard to define. In addition, spatial orientation and cognitive mapping abilities are considered to be overlapping attributes.

The final selection of the attributes and attribute levels included in the survey is shown in table 3.3. These are elaborated on below.

Table 3.3: Attributes and attribute levels

Attributes	Attributelevels
App	No
	Written route
	Virtual route
Visibility location or entrance of next modality	No
	Yes
Signs & maps	No
	Yes
Manned travel information kiosk	No
	Yes

Since the rising use and development of digital devices, it is relevant to include the attribute of a multimodal travel information smartphone app. The main purpose of this app is to provide multimodal travel information. This involves the transfer and therefore the route from the train platform to the location of bus, tram, metro or OV-bike. The first attribute level concerns no availability of any app. The current multimodal travel information apps show the user a number or name of a platform, the route to go to a certain location or the entrance of bus, tram, metro platforms or OV-bike stations are often described. Therefore, the next level concerns an app which provides a written route. This written route describes the walking route from a train platform to the entrance or location of bus, tram, metro or OV-bike. The third level is a multimodal travel information app with a virtual view of the route from the train platform to the entrance or location of bus, tram, metro or OV-bike. An example of such a virtual reality route in an indoor environment is shown in figure 3.1.

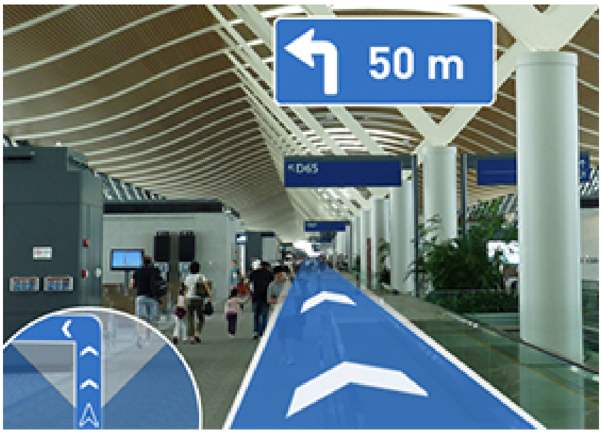

Figure 3.1: Virtual reality route in an indoor environment

The second attribute which is selected concerns the visibility of the location or entrance of the next modality (bus, tram, metro or OV-bike). For this attribute two levels are chosen (yes or no), whether the location or entrance of bus, tram, metro or OV-bike is visible or not from the moment of leaving the train at the train platform.

The next attribute concerns signs & maps, which refers as described before, to both static and digital signs & maps. These static signs and maps provide sinage for the route from train to bus, tram, metro or OV-bike by signs, numbers, names and visuals. For this attribute two levels are used, whether or not there are signs & maps are present in and in the railway station surroundings, yes or no.

The final attribute concerns a manned travel information kiosk, which is present in the railway station hall or not. It concerns an information desk with staff who provides multimodal travel information about the route to bus, tram, metro or OV-bike. Two attribute levels are included, not present (no) or present (yes).

3.3.3. Design of the experiment

This section elaborates on the design of the experiment. This design shows which hypothetical situations are included in the survey and presented to the respondents.

As described in the previous section, four attributes, with two or three levels are included in the rating experiment. A full factorial design would consist of 2 ˆ 4 * 3 ˆ 4 = 1296 profiles. This type of design concerns all combinations that can be made between the attributes en thus all main effects, interaction effects and higher order interaction effects can be estimated. This type of design, however, leads to great amounts of profiles which are too many to submit to the respondents (Louviere et al., 2000). Presenting too many profiles cause boredom or fatigue among the respondents which can affect the results (Oppewal and Timmermans, 1993).

The amount of profiles in a full factorial design is too large to present to the respondents. Therefore, in order to reduce the number of profiles for the respondents, a fractional factorial design is used. A fraction, a part of the full factorial design, is included in a fractional factorial design. This selection is not arbitrary, but it is such a selection that the attributes are orthogonal. Orthogonality means that there is no correlation between the attributes. This leads to the most efficient model estimation and smaller standard errors. Moreover, a smaller amount of observations is required.

In order to estimate the main effects, a balanced design is important. Within each attribute, each attribute level appears an equal amount of time in the set of profiles. Then, the effect of each attribute level on an attribute is based on an equal amount of observations. Therefore, the coefficients within each attribute are all accurate estimations.

Profile creation

The final design used for the survey of this study is orthogonal, but not balanced. The design is not balanced because of the amount of attributes and attributes levels. When the sample size is large enough, however, a balanced design is not essential. The profiles are constructed based on the experimental design. By using a basic plan, nine profiles are constructed. The final experimental design is shown in table 3.4. The numbers used in table 3.4 are explained below.

Table 3.4: Experimental design

Profiles	App	Visibility	Signs & maps	Kiosk
1	No	No	No	No
2	No	Yes	Yes	No
3	No	No	No	Yes
4	Written route	No	Yes	Yes
5	Written route	Yes	No	No
6	Written route	No	No	No
7	Virtual route	No	No	No
8	Virtual route	Yes	No	Yes
9	Virtual route	No	Yes	No

3.3.4. Presentation of survey

The survey is presented to the respondents in an online survey. The first part consists of general questions. In the second part the respondents are asked to rate the profiles. The presentation of the general questions and rating questions are discussed below.

General questions

The personal and travel characteristics as well as the NS type of traveller are determined by means of the answers to the general questions in the survey. According to the NS approach, the NS type of traveller can be determined. This method, however, consists of more than fifty statements that have to be considered. Due to limitations of the survey length in this study, it is not possible to use the NS approach to determine the type of NS traveller. Based on the advice of the developer of the NS approach, Van Hagen (2017), just one question to indicate the type of NS traveller has been used. This question concerns six statements which correspond to the travel behaviour of the six types of NS travellers. In the survey, the respondents are asked to choose one of these six statements. Based on this question, the NS categorization of must and lust travellers is made as well. The general questions and statements are shown in table 3.5 and table 3.6.

Table 3.5: Personal characteristics in the survey

Characteristics	Question	Answer options
Gender	*What is your gender?*	Man Woman
Age	*Wat is your age?*	....
Travel frequency	*How often do you travel, on average, by public transport?*	4 days per week or more 1-3 days per week 1-3 days per month 6-11 days per year 1-5 days per year (Almost) never
Transfer frequency	*How often do you transfer from train to bus, tram, metro or OV-bike?*	4 days per week or more 1-3 days per week 1-3 days per month 6-11 days per year 1-5 days per year (Almost) never
Transfer mode choice	*Which mode of transfer do you use, when making a transfer from the train?*	Bus Tram Metro OV-bike None
Trip purpose	*What is your main travel motive when using the train?*	Commuting Business School or Study Visit friend or family Holiday or day out Different

Table 3.6: NS type of traveller in the survey

Characteristic	Question
NS type of traveller	*Which of the following statements corresponds the closest to your travel behaviour, when you are transferring from train to bus, tram, metro or OV-bike?*
	1 I plan my trip beforehand and I always have travel information at hand.
	2 I prepare my trip by consulting actual travel information only.
	3 I plan my trip beforehand, always have travel information at hand, and often seek for confirmation at employees at the railway station.
	4 I do not plan my trip in advance. If necessary I consult the Internet or the app on my mobile phone.
	5 I plan my trip in advance and always have travel information at hand. I also like to use all kinds of travel information at the railway station, because then I can be sure to have the right information.
	6 I plan my trip just before I leave or during the trip itself. I like to receive travel information, but I will not look for it myself.

3.3.5. Rating questions

An example of a profile in the survey in shown in figure 3.2. The profiles are presented without showing examples as pictures. By showing specific pictures of the attributes, such as a type of sign or a location at a specific railway station, people may only rate the specific examples in the pictures. This may lead to unrealistic situations. Respondents do possibly not perceive the attributes in the same way and this may lead to less reliable results. Without showing examples as pictures of the attributes, is it clear that the situations are hypothetical and people do not just rate a specific picture, which is a mere example.

Travelinformation app	No
Visibility of entrance/location of next modality	No
Signs & Maps	No
Manned travel informationkiosk	No

Figure 3.2: Example of a profile

3.3.6. Pilot survey

A pilot survey was set up before the final survey was sent to the respondents. The pilot survey is tested among a small group of people that mainly consists of friends and colleagues of Sweco. One can ascertain whether the survey is sufficiently understandable because the survey method is not known by everyone. As a result, adjustments to the survey can be made.

The pilot survey was filled in by 15 respondents. After receiving feedback from the pilot survey respondents several improvements have been made. First, there were several small spelling mistakes. Secondly, problems with numbers which were not in the right order were solved. In addition, some ambiguous questions have been changed. Other points of criticism are the large amount of text (information) for the rating task. This point, however, is considered inevitable in a rating experiment. Some respondents suggest to show pictures, but as explained earlier no pictures are shown in this survey.

The final survey can be found in appendix B.

3.3.7. Recruitment of respondents

This study focuses on people transferring from train to another modality at a railway station in the Netherlands that is not familiar for them. Therefore, the survey is held under Dutch people who are able to travel by train individually. In this way respondents are not selected which are below a certain age (children) to travel individually or need guidance by other persons when travelling by train.

As a general rule of thumb, 30 respondents per profile are proposed in order to get reliable results (Molin, 2011*a*). This survey consists of nine profiles. This suggest that (9 profiles * 30 respondents) is 270 respondents and this amount is sufficient to collect enough data for reliable results.

In order to acquire the data from the respondents, the survey has been created and distributed with the online tool ”google docs”. The survey was published online at the website of SWECO NL and on social media (Facebook, LinkedIn) as well as on the website of Reizigers Openbaar Vervoer (ROVER). In addition, the survey has been distributed by mail to all employees of SWECO NL and the RET, friends, family and colleagues from TU Delft.

3.4. Conclusion

Based on the conceptual framework in chapter 2, a rating experiment is set up is this chapter. This rating experiment tests a selection of attributes which are related to multimodal wayfinding information. In addition, personal characteristics have been selected to indicate the travel behaviour of the respondents. From these attributes, a survey has been developed and sent to the respondents. The survey exists of two parts. First, general questions about personal characteristics and travel behaviour are asked and statements to indicate the type of NS traveller are given. The second part exists of the rating experiment in which the influence of the attributes on satisfaction, speed and ease is tested.

4
Results

In this chapter the results of the survey are discussed. First, the characteristics of the respondents are analyzed. Second, a factor and a regression analysis are executed to estimate the results of the rating experiment. Third, the effects of personal and travel characteristics on the attributes are tested. Fourth, the effects of the rating outcomes in different scenarios are explored. Finally, conclusions are given.

4.1. Descriptive statistics

In total 285 respondents have completed the survey. Since this study focuses on people transferring from train to another modality at a railway station, the personal characteristics of the respondents are compared with the statistics of personal characteristics statistics of Dutch train travellers. This comparison indicates whether the sample is representative for the Dutch train travel population of NS.

4.1.1. Personal characteristics

Since this study focuses on people transferring from train to another modality at a railway station, the population of this study is defined as Dutch train travellers.The answers to the first part of the survey provide insights into general personal characteristics such as gender and age as well as travel characteristics of the respondents. In addition, types of travellers are identified. The characteristics of the respondents are compared with the population. This comparison indicates whether the sample is representative for the Dutch train travel population.

In table 4.1, general personal characteristics such as gender, age, working status and level of education are shown. These characteristics are compared with the Dutch train travel population and discussed below.

Table 4.1: General personal characteristics

Characteristics	Sample %	Population %
Gender		
Men	59	48
Woman	41	53
Age		
<18	1	18
18-25	33	13
26-35	30	15
36-45	17	15
46-55	12	15
55-65	6	13
65+	1	12
Working status		
Full time working	61	-
Part time working	10	-
Schooling/Student	24	-
Retired	1	-
Unemployed	1	-
Different	3	-
Education		
WO/HBO	65, 26 (91)	38
MBO	4	42
HAVO/VWO,LBO/MAVO/VMBO	3, 1(4)	10

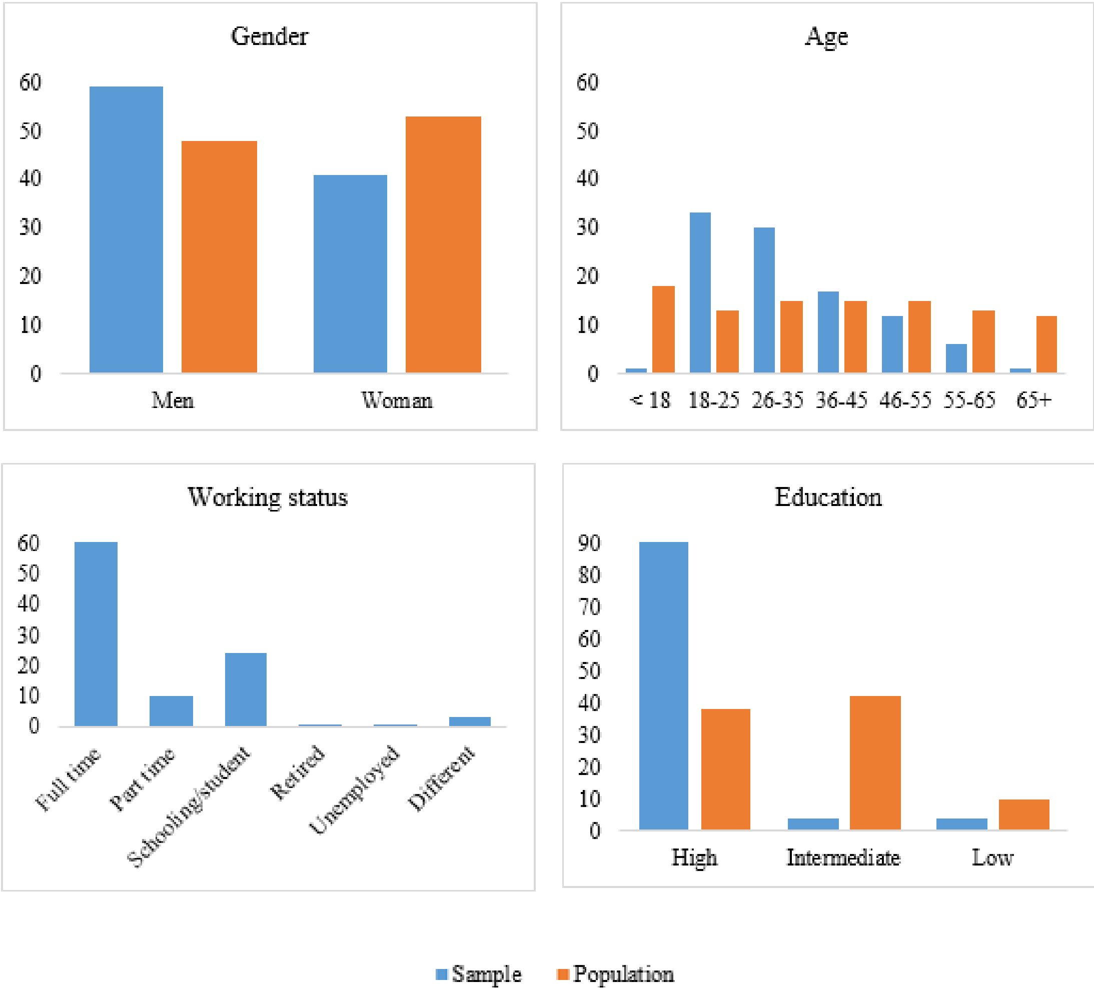

Figure 4.1: Personal characteristics

As can be seen in table 4.1, there are slightly more male respondents (59%) than female respondents (41%) in the sample. The population of Dutch train travellers, however, shows the opposite, 48% are men and 52% are women (Van Hagen and Excel, 2012).

Furthermore, the ages of the respondents are clustered into seven categories. The age categories of 18-25 and 26-35 account for more than 50% of the respondents. The ages below 18 and above 65+ are underrepresented. When looking at the statistics of the Dutch train population, it can be stated that the groups of respondents with ages of 18-25 and 26-35 are twice as large (Van Hagen and Excel, 2012) as the other age categories. This means, no completely reliable statements can be made about travellers below 18 and above 65. In other words, the results are mainly based on travellers between 18-65.

In addition, when looking at the work status of the respondents it can be seen most respondents (61%)work full time. Another large part, (24%), goes to school or studies. There is no specific data available about the work status of the Dutch train travel population. Therefore, there is no guarantee that these percentages are fully representative.

Besides, the majority of the respondents is highly educated (University or higher vocational education), respectively 65% and 26%. Within Dutch train travel population, however, this percentage is only 62%. The percentage of people from intermediate vocational education is much bigger 33% among the Dutch train travel population too. Appraisals with regard to lower educated people cannot therefore be fully generalized.

After having discussed the general personal characteristics, the travel characteristics of the respondents are shown in table 4.2.

Table 4.2: Travel personal characteristics

Travel characteristics	Sample %	Population %
Travel motive		
Commuting	41	45
Visit to family or friends	20	12
Business	13	3
School or study	11	26
Holiday or a day out	14	6
Different	1	8
Travel frequency train		
(Almost) never	11	-
1-5 days per year	8	7
6-11 days per year	9	7
1-3 days per month	21	11
1-3 days per week	20	19
4 days per week or more	31	57
Transfer frequency		
(Almost) never	18	-
1-5 days per year	10	-
6-11 days per year	12	-
1-3 days per month	22	-
1-3 days per week	21	-
4 days per week or more	17	-
Transfer mode choice		
Bus	48	-
Tram	16	-
Metro	13	-
OV-bike	9	-
None	14	-

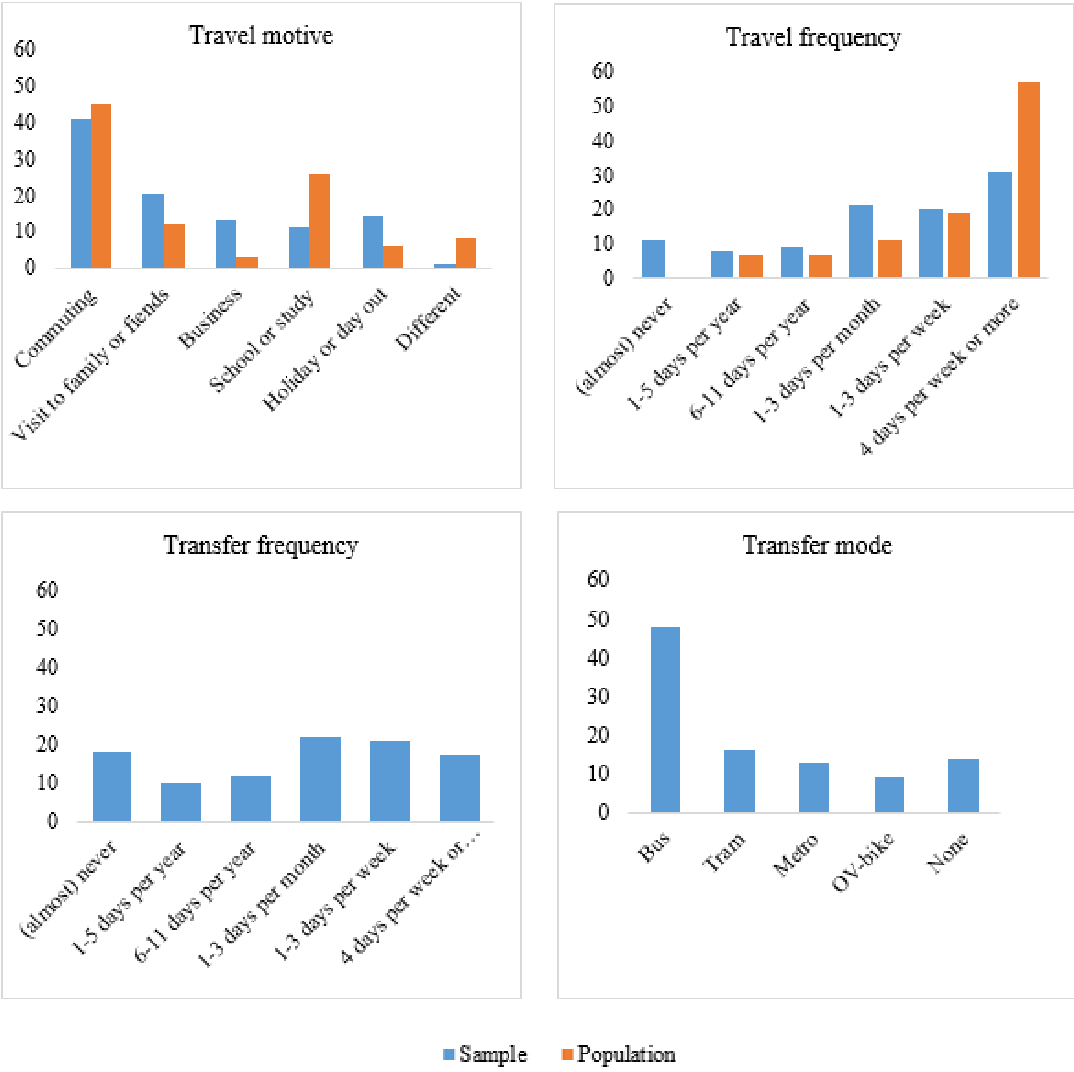

Figure 4.2: Travel personal characteristics

Regarding table 4.2, it can be seen the main travel motive of the respondents is shown to be commuting (41%). This percentage closely corresponds to the 45% of commuters in the Dutch train travel population. In addition, the respondents who visit family or friends (20%) as well as business travellers (13%) are a bit over represented compared to respectively 12% and 3% in the population of Dutch train travellers. On the other hand, the number of students accounted only for 11% in the sample, whereas this number is 26% among Dutch train travellers.

In addition, regarding train travel frequency there are also some differences compared to the Dutch train travel population. In the sample, 31% travels 4 days or more a week by train whereas this amount is 57% among Dutch trains travellers. Furthermore, the percentage of travellers who travel 1-3 days a month is slightly larger in the sample compared to the Dutch train travel population, respectively 21% and 11%.

On the other hand, the transfer frequency shows a slightly different picture compared to the train travel frequency. Most respondents transfer 1-3 days per month. Besides, almost half of the respondents (48%) makes use of the bus when transferring at the railway station. The tram accounts for 15% and the metro for 14%.

The OV-bike is used by 9% of the respondents. There is are no data available about the transfer frequency and transfer mode choice of Dutch train travellers. Therefore, no statements can be made about the representativeness.

Finally, a question to indicate the type of NS traveller is included in the survey. The percentages of types of NS travellers in the sample compared to the population are shown in table 4.3 and figure 4.3.

Table 4.3: Type of NS traveller

Category	**Type**	**Sample %**	**Population %**
Must	*Individualist*	26	12
Must	*Functional planner*	21	14
Must	*Certainty seeker*	-	14
Lust	*Explorer*	22	11
Lust	*Socializer*	22	25
Lust	*Convenience seeker*	9	24

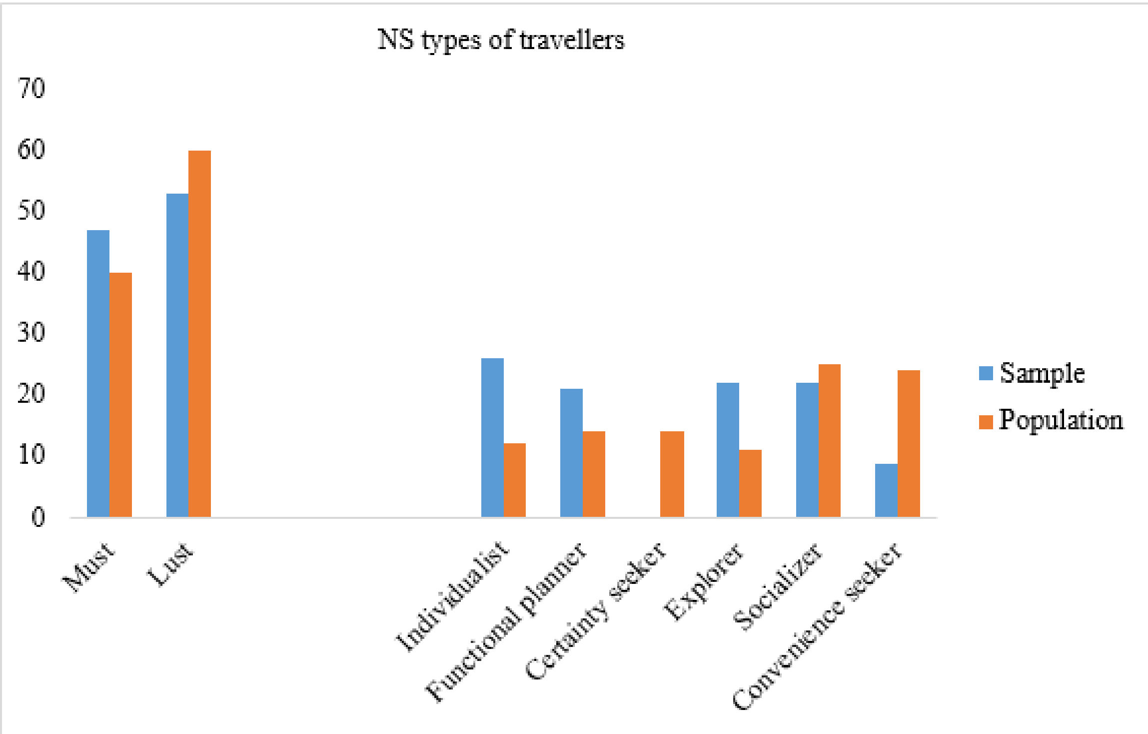

Figure 4.3: NS types of travellers in the sample compared to the population

As described in chapter 2, two main categories and six different types of NS travellers can be identified. As can be seen from the table 4.3, however, the division in the sample is slightly different. From the answers given in the survey, only 5 types of NS travellers can be identified. The certainty seeker is not presented in the sample and the percentage of convenience seekers is relatively lower compared to the population. On the other hand, the other types are a bit overvastrepresented. Nevertheless, there is a division of NS types of traveller's types in the sample in which the total percentage of lust travellers is slightly larger than the percentage of must travellers. This corresponds with the population.

Overall, it can be concluded that the respondents are relatively younger and higher educated compared to the population of Dutch train travellers. Respondents visiting to family or friends (20%) are a bit overvastrepresented as well as business travellers (13%). On the other hand, the number of students and less frequent travellers is relatively underrepresented. Regarding the different types of NS travellers, the certainty seeker and the convenience seeker are respectively not present and underrepresented, whereas the other NS types of travellers are a bit over represented. Nevertheless, the division of NS types of travellers corresponds to the population relatively closely.

As a result, it can be said the sample is not entirely representative for the population of Dutch train travellers, but closely corresponds. Therefore, the outcomes of the experiment need to be taken into careful consideration before generalizing to the population.

4.2. Factor analysis

According to the conceptual model in chapter 2, three different variables are included and tested in the survey; satisfaction, speed and ease. The nine given profiles given in the survey are rated by the respondents based on these three variables, the overall satisfaction, contribution to speed and contribution to ease.

Correlation indicates the strength of the linear relationship between different variables. This value is standardized and can be used for variables, which are measured in different units. The correlations between the variables satisfaction, speed and ease are shown in table 4.4. The correlations between the three variables are significant and above 0.8. Correlations between 0.7 and 0.9 are relatively high and indicate there are hardly any differences between the variables. If it seems there are no differences between variables, or in other words, variables measure the same aspect it is relevant to determine if variables can be explained by an underlying factor. An underlying factor can be determined by a factor analysis. In the next section, a factor analysis is performed and a new factor is created. This is shown in figure 4.5.

Table 4.4: Correlations between the variables

Variables	**Satisfaction**	**Speed**	**Ease**
Satisfaction	1	0.872	0.877
Speed	0.872	1	0.918
Ease	0.877	0.918	1

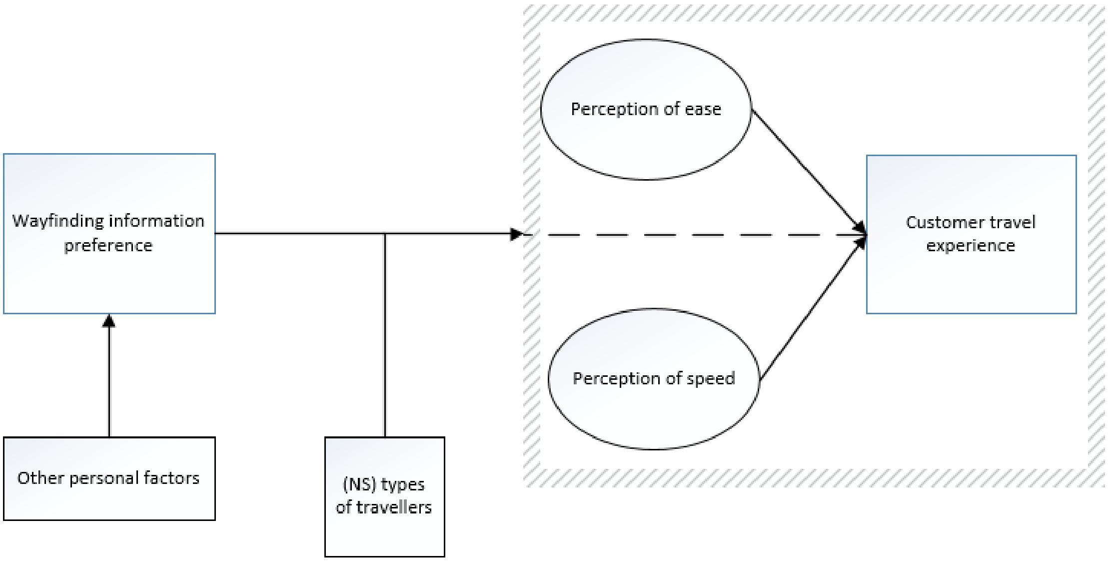

Figure 4.4: Underlying factor in the conceptual model

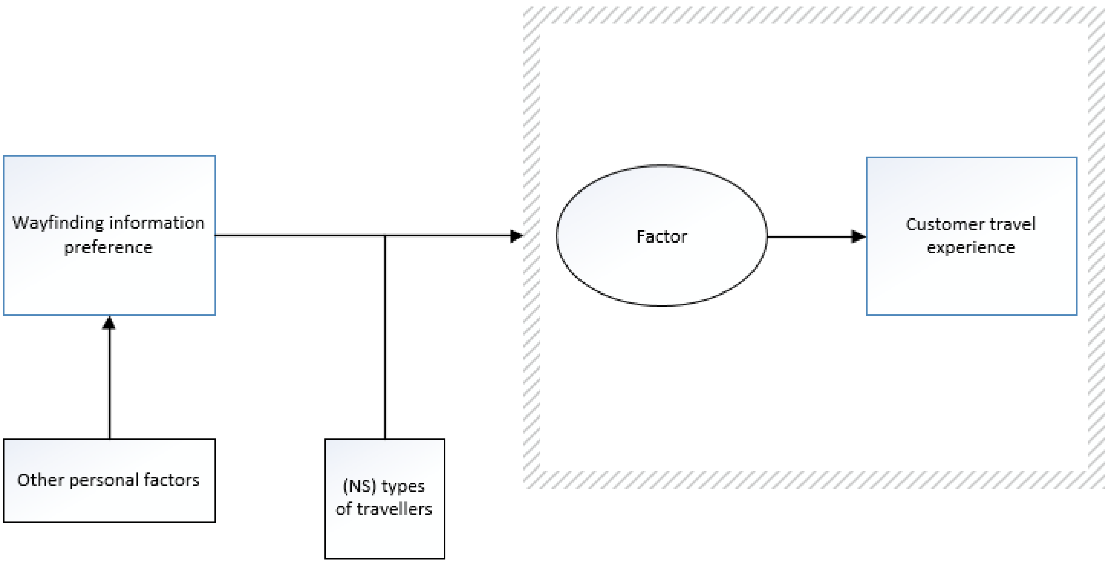

Figure 4.5: New factor in the conceptual model

4.2.1. Factor analysis approach

This section elaborates on the performed factor analysis. First, the purpose of the factor analysis is discussed. Then, the different steps taken to perform the factor analysis are discussed.

As mentioned in the previous section, a factor analysis examines whether the mutual correlations between variables can be explained by an underlying factor. This contributes to increase the validity and reliability of a measurement. Content validity means indicators are included for all relevant aspects. The reliability increases because accidental measurement errors fall apart.

In order to perform the factor analysis, the six steps factor analysis approach of Molin is used (Molin, 2011*b*):

1) Check if the data are suitable for a factor analysis. The number of respondents is larger than 100 (N > 100). The correlations are > 0.30.
2) Choose the between the method of principal axis factoring (PAF) and principal component factoring (PCA)
3) Determine the the number of factors
4) Check if all factors contribute to the model
5) Interpret the common factor
6) Construct the new variable (factor)

Regarding the first step, in order to test whether a factor analysis is useful, two conditions are important. The correlations should be higher than 0.3 and the number of respondents is larger than 100. As already discussed and can be seen from table 4.4, all correlations are higher than 0.3. Besides, there are 285 respondents, which is more than 100. Since both conditions are met, the factor analysis is considered useful.

Two main methods can be distinguished to locate underlying factors: the principal axis factoring and principal component factoring. These approaches differ in the used commonality estimations. Since it is expected there is an underlying factor, it is relevant to find the common variance. The method of PAF is used, because this method focuses on explaining correlations and the common variance. The method of PCA, on the other hand, focuses on explaining the variance. Therefore it is not possible to reproduce correlations between variables by using the method of PCA.

The process to determine the number of factors is called extraction. The factors retained are based on the initial eigenvalues. These eigenvalues give an indication of the substantive importance of the factors, in other words, how much of the total variance of the indicators can be explained by each factor. Therefore, it can be considered that only factors with large eigenvalues are retained (Field, 2013). An initial eigenvalue must be larger than one since each indicator declares a variance of one of itself. In order to achieve data reduction, one factor must explain more variance than a variable of itself. In table 4.5 the initial eigenvalues are shown. Since only one eigenvalue is larger than one, only one factor is retained. The eigenvalue of this factor is 2.779. Therefore, this factor extracts (2.779/3) * 100 % of the variance of the 3 indicators.

After extracting the factors, the loadings can be determined. Factor loadings are the loadings for each indicator on each factor and indicate the correlation between the factor and the indicators. The higher the factor load, the stronger the relationship between the factor and the indicator. As can be seen from table table 4.6, the factor loads are all larger than 0.7, which can be considered sufficiently. This indicates the indicators: satisfaction, speed and ease all explain the underlying factors to a large extent.

Table 4.5: Total variance explained

		Initial Eigenvalues	
Factor	**Total**	**% of Variance**	**Cumulative %**
1	2.779	92.641	92.641
2	0.139	4.625	97.266
3	0.082	2.734	100.000

Table 4.6: Factor loadings

	Factor 1
Satisfaction	0.914
Speed	0.956
Ease	0.959

After performing the factor analysis, a new variable is created to represent the underlying factor. There are three methods to define the new variable:

1) Factor scores: weighing variables based on factor load. This adds all variables that load on a factor are included, both high and low loading factors.
2) Sum score: only high-load variables are added, each variable counting with equal weight.
3) Surrogate variable: select only one variable.

The first method is based on factor scores, the main disadvantage of this method is that factors are based on a factor matrix that differs in each sample. Therefore the generalizibility to other samples or populations is small. The method of a surrogate variable is simple, but does not take all elements into account. This leads to a higher risk of high measurement errors. In general, the method of sum scores is preferred (Molin, 2011*b*). This method is considered simple and more likely to achieve the same results when using other samples. Therefore, the construction of a new variable by means of the sum score is chosen. First, the three variables are summed up. Then, the sum score needs to be scaled down. All three variables have the same measurement scale from 1 to 7. This means that 7 (scale) * 3 (variables) = 21. Subsequently, this number is divided by three (variables) in order to estimate the mean scale of the new factor. The new variable (factor), is called: satisfaction 2.0.

In a factor analysis, indicators are included that measure partially the same. The degree of overlap in those measurements is an indication for reliability. A greater reliability corresponds to lower measurement errors. Therefore, it is important to determine the reliability. In order to do so the formula of Cronbach Alpha is used. As can be seen from table 4.7, the value of Cronbach Alpha is 0.960. This value shows if an indicator can be removed. An indicator is removed if the value is larger than 0.960. The values of satisfaction, speed and ease are all smaller than 0.960. Therefore, they are all included in the new factor, satisfaction 2.0.

Table 4.7: Reliability Statistics

Cronbach Alpha	**N of Items**
0.960	3

4.3. Rating results

In the previous section, the new factor: satisfaction 2.0 is defined. The answers of the rating experiment are used to predict this new factor, satisfaction 2.0, based on the attributes (app, visibility, signs & maps, kiosk) defined in chapter 3. In the regression analysis, satisfaction 2.0 is the dependent variable and the attributes are the independent variables. With the regression coefficient, the utility contribution of each attribute level to the overall utility can be determined.

Since all attributes are nominal variables, effect coding is used. The attributes are coded with 1-,1 and 0. In case of two attribute levels, the attributes are coded with -1 and 1. In case of three attribute levels, 0 is also used as coding. In this case, 1 and 0 indicate if an attribute level is present or not. The third attribute level of -1 is calculated based on the other two. The coding of the attributes and attribute levels is shown in table 4.8.

Table 4.8: Coding of the attributes

Attributes	Indicator variable 1	Indicator variable 2
App		
No	-1	-1
Written route	1	0
Virtual route	0	1
Visibility		
No	-1	1
Yes	1	-1
Signs & maps		
No	-1	1
Yes	1	-1
Kiosk		
No	-1	1
Yes	1	-1

The outcomes of the estimated regression model are shown in appendix D. The correlation and the determination coefficient of the estimated regression model are shown. The correlation coefficient R is a measure for the common variance between the dependent and the independent variables. A correlation coefficient (R) can vary between -1 and 1. A value between 0.7 and 0.85 can be considered as a strong relation between the variables. The R of the estimated model is 0.713 and therefore it is clear that a strong relation between the variables exists.

In addition, the square of the correlation coefficient (R^2) concerns the determination coefficient. R^2 represents the proportion of explained variance. The value of R^2 varies between 0 en 1. A value between 0.7 and 0.85 indicates a strong relation between the variables and can be interpreted as a percentage. This percentage indicates the percentage of the variation in the outcome that can be explained by the regression model. The proportion of explained variance is 50.8%. In other words, the model with the predictors, determines 50.8% of variation in satisfaction 2.0. The other part is thus explained by other factors which are not included in the model.

Table 4.9: Values of the regression coefficients

Attributes	Part worth utility	P-value	Importance %
1) App			
No	-1.276		
Written route	0.429	0.000	
Virtual route	0.847	0.000	
			43
2) Visibility			
No	-0.718		
Yes	0.718	0.000	
			29
3) Signs & maps			
No	-0.621		
Yes	0.621	0.000	
			25
4) Kiosk			
No	-0.088		
Yes	0.088	0.001	
			3
Constant	**4.610**	**0.000**	

In table 4.9 the values of the estimated regression coefficients are shown.

The p-value indicates the significance of the regression coefficient. As can be seen from the third column in table 4.9, all p-values are smaller than 0.05. Therefore, all regression coefficients can be considered significant. In other words, there is connection between the dependent variable (satisfaction 2.0) and the independent variables (app, visibility, signs & maps and the kiosk). The second column presents the part worth utilities. The part worth utilities show, how much the attributes coded with 1, differ from the average utility (constant). In the third column the attribute importance (%) is shown. An indication of the attribute importance is determined by the absolute difference between the highest and the lowest attribute level, divided by the total range over all attributes.

The constant gives an indication of the average overall utility of all profiles. The value of the constant is 4.610. The satisfaction on the nine given rating profiles (scale 1 to 7) is on average 4.610. By taking the middle of the scale (1 to 7), a score between 3.5 - 4 can be interpreted as a sufficient score. When looking at the constant of 4.610, this number is above 4. Thus, the overall satisfaction about the four attributes of wayfinding information is slightly above average. In other words, the respondents are a little satisfied about the combinations of wayfinding information sources presented in the survey.

When looking at the relative importance of the attributes, the fourth column shows that an app is valued the most important (43%). Thereafter, the visibility of the entrance or location of bus, tram, metro or OV-bike (29%) followed by signs & maps (25%). The manned travel information kiosk is obviously valued of least importance, by only 3%.

Regarding the first attribute of an app, an overall increase in utility can be seen of 2.123 between no app available and an app which provides a virtual route. Further, the difference between no app available and an app which provides a written route is 1.705 is shown. This implies the relative satisfaction of travellers increases when an app, either with a written route or a virtual route, is available. When an app provides a virtual route instead of a written route, the utility increases by 0.418. Therefore, it can be said the utility rate is not linear since the utility increases, but less strong. It seems more disadvantageous when there is no app available at all than when an app with a virtual route is available instead of an app with a written route.

The visibility of the entrance or location of bus, tram, metro or OV-bike scores relatively second best. This attribute has the most impact on the total utility after the app. When the entrance or location of bus, tram, metro or OV-bike is visible, the utility increases from -0.718 to 0.718 with 1.436.

Signs & maps are valued relatively slightly less than the visibility of the entrance or location of bus, tram, metro or OV-bike by 25 %. The utility increases from -0.621 to 0.621 when signs & maps present instead of no signs & maps at all. This leads to an overall increase in utility of 1.242.

When looking at the utilities of the manned travel information kiosk, this type of wayfinding information is clearly the least valued compared to the other three attributes. The percentage of importance accounts for only 3%. The utility increases by 0.176 when a manned travel information kiosk is present at a railway station.

One can conclude that, respondents rate an app with a virtual route as the most important type of wayfinding information. The availability of an app in general is more important than the fact whether an app also provides a virtual route. Then, the visibility of the entrance or location of bus, tram, metro or OV-bike and signs & maps are the most important, though the visibility is considered slightly more important than signs & maps. The manned travel information kiosk is hardly attached.

4.4. Segmentation

The results in the previous section are based on the answers given by all respondents. This section determines, however, whether the results differ between the respondents. First, the differences between different types of NS travellers are determined. Then, an exploration of the effects of the general personal characteristics and travel characteristics is executed. Finally, conclusions are given.

4.4.1. NS types of travellers

Based on the conceptual model in chapter 2, differences between different types of NS travellers with respect to the wayfinding information attributes are expected. Therefore, the effects of different types of travellers on the attributes are tested. First, differences between must and lust travellers are examined then the differences between the 6 types of NS travellers are elaborated on. In table 4.10 and table 4.11, the regression model coefficients are shown for the different types NS of travellers.

4.4.2. Must and Lust travellers

As can be seen from the results in table 4.10, both types of travellers appreciate an app relatively the most. Must travellers prefer the app, however, slightly more than lust travellers. In addition, both types prefer a clear visibility of the entrance or location of bus, tram, metro or OV-bike as second best. Furthermore, it can be seen signs & maps and the kiosk are a bit more important for lust travellers than must travellers. The characteristics of must and lust travellers are described in chapter 2. By taking these characteristics into account, the results are analyzed below.

Table 4.10: Values of the regression coefficients - Must and Lust traveller

Attributes	Must	Lust
App		
No	-1.378	-1.186
Written route	0.486	0.379
Virtual route	0.892	0.807
	46%	**40%**
Visibility		
No	-0.719	-0.718
Yes	0.719	0.718
	29%	**29%**
Signs & maps		
No	-0.587	-0.652
Yes	0.587	0.652
	24%	**26%**
Kiosk		
No	-0.041	-0.129
Yes	0.041	0.129
	1%	**5%**
Constant	**4.660**	**4.566**

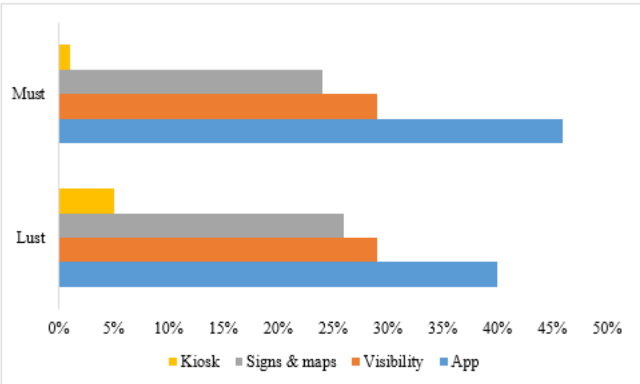

Figure 4.6: Preferences of must and lust traveller

A must traveller is characterized by functional orientation, rush and focus during their journey. In addition, this group travels because of obligations. Must travellers therefore can be seen as conscious users of a railway station. Lust travellers, on the other hand, use a railway station for leisure reasons such as private visits or holidays. In addition, lust travellers get pleasure from the trip, regardless of destination, as opposed to must travellers who experience the journey as part of their daily routine.

By taking the characteristics of the must and lust travellers into account, an interpretation of the results can be given. Must travellers travel beacuse of obligations and experience their journey as part of their daily routine. In addition, must travellers are often in a hurry and therefore are assumed to choose the fastest option to find their way. Therefore, these travellers are likely to prefer wayfinding information sources which support them in making a purposeful journey from A to B. By using an app, the must traveller is not dependent on the wayfinding information at the railway station itself. An app provides specific individual travel information which contributes to a fast journey.

On the other hand, lust travellers travel because of leisure reasons. They are assumed to be less in a hurry. As a consequence, they have relatively more time to look around and orientate in the railway station. As a result, the lust traveller seems to notice wayfinding information sources sooner in the railway station itself, such as signs & maps and a manned travel information kiosk.

4.4.3. 6 types of NS travellers

As described in chapter 2, must and lust travellers can be further categorized into six different types of NS travellers. Must travellers are: the individualist, the functional planner and the certainty seeker. Lust travellers are: the explorer, the socializer and the convenience seeker. As mentioned before, the certainty seeker is not presented in the sample of this study and therefore not taken into account.

From the results in table 4.11, no differences in the ranking of the attributes can be found. All types of NS travellers prefer an app above all, followed by the visibility of the entrance or location of bus, tram, metro or OV-bike, signs & maps and the manned travel information kiosk. There are, however, minor differences between the coefficients per attribute. These differences, per attribute, are elaborated on below.

Table 4.11: Values of the regression coefficients - Types of NS travellers

Attributes	**Functional planner**	**Explorer**	**Socializer**	**Individualist**	**Convenience seeker**
App					
No	-1.329	-1.15	-1.243	-1.417	-1.133
Written route	0.407	0.370	0.433	0.549	0.265
Virtual route	0.922	0.780	0.810	0.868	0.868
	45%	**38%**	**41%**	**46%**	**43%**
Visibility					
No	-0.772	-0.784	-0.647	-0.687	-0.730
Yes	0.772	0.784	0.647	0.687	0.730
	31%	**31%**	**26%**	**28%**	**32%**
Signs & maps					
No	-0.592	-0.643	-0.700	-0.583	-0.551
Yes	0.592	0.643	0.700	0.583	0.551
	24%	**25%**	**28%**	**24%**	**24%**
Kiosk					
No	-0.013	-0.149	-0.150	-0.063	-0.032
Yes	0.013	0.149	0.150	0.063	0.032
	1%	**6%**	**6%**	**3%**	**1%**
Constant	**4.596**	**4.687**	**4.472**	**4.710**	**4.506**

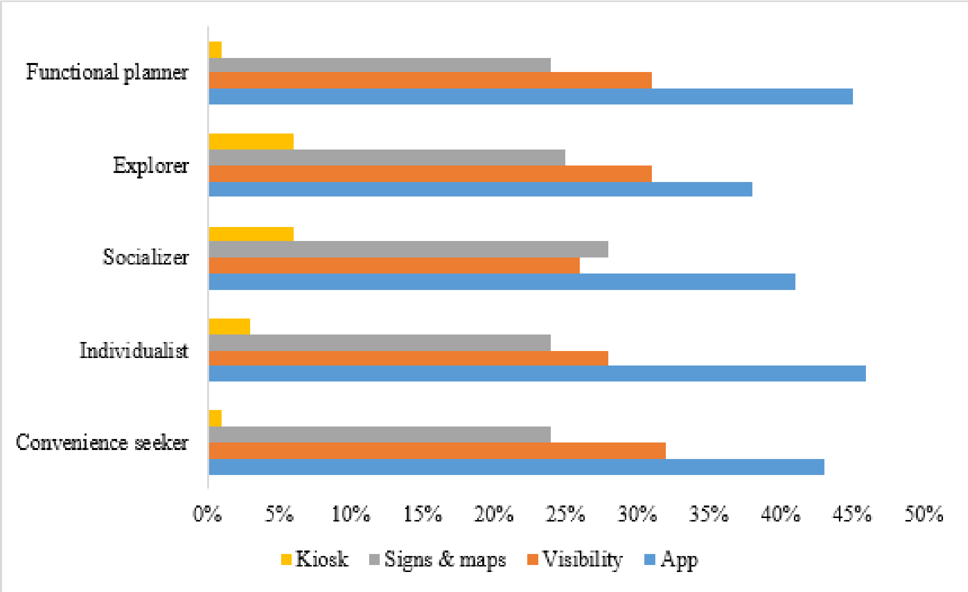

Figure 4.7: Preferences of types of NS travellers

App
The *functional planner* and the *individualist* prefer an app relatively more compared to the explorer.

Two factors characterize the individualist: they always plan a trip in advance and they always have travel information nearby. In addition, the functional planner prepares a trip in advance by using real time information. In contrast to the individualist and the functional planner, the explorer prepares a trip just before their departure or not at all.

An app provides the comfort of planning a transfer from train to bus, tram, metro or OV-bike in advance, which matches the characteristics of the individualist and the functional planner. Since the explorer prepares or does not prepare a trip, or just before departure an app seems to be less important.

Visibility
The convenience seeker considers the visibility of bus, tram, metro or OV-bike relatively more important than the socializer

Convenience seekers prefer to receive information instead of exploring by themselves. The visibility of the entrance or location of the next modality is relatively most preferred by the convenience seeker compared to the other NS types of travellers.

The individualist and the socializer especially think less of the visibility of the entrance or location of the next modality. This could be explained by the fact that, they always plan their trip in advance, so they are relatively less dependent on the visibility at the moment of leaving the train.

Signs & maps
The socializer attaches more value to signs & maps compared to the other types of NS travellers

The socializer plans everything in advance using everything and everyone and always has travel information nearby. This means that a socializer needs more than one type of travel information for a comfortable trip. That is presumably the reason that the socializer appreciates signs & maps more than the other types.

Kiosk
The explorer and the socializer prefer the manned travel information kiosk relatively the most compared to the other types of NS travellers

The socializer plans everything in advance using everything and everyone and has always travel information nearby. This means that, a socializer needs more than one type of travel information for a comfortable trip. Therefore, it can be explained the socializer relatively appreciate signs & maps more compared to the other types. In addition, the explorer is not a planner, therefore an information kiosk which is present at the railway station could be more appreciated by this type of traveller.

4.4.4. General personal characteristics

In this section, an exploration of the effects of the general personal characteristics of age, working status and education level is given. The estimated regression models are shown in appendix D. The most important results are elaborated on below.

Age

The results in table D.3 show that older people (45-65+) prefer an app relatively less compared to younger people (18-45). In addition, signs & maps are more preferred by the older generation than the younger generation.

A possible explanation for this is that elderly people are relatively less used to new technological developments such as mobile devices. Therefore, it is obvious that this group prefers signs & maps relatively more than the younger generation.

Working status

From the results in table D.4 it becomes clear that full time and part time working people as well as students have the highest preference for an app. Retired people, however, show different results. Their appreciation for signs & maps is much larger compared to the other groups and their appreciation for an app is much lower. These differences mentioned have to be taken into consideration, because the number of retired people in the sample are underrepresented. Therefore, these outcomes are not fully representative.

Education level

When looking at the level of education of the respondents, higher educated people (WO, HBO and HAVO/VWO) prefer an app more than other wayfinding information sources. Lower educated people (LBO,MAVO, VMBO and MBO) prefer signs & maps the most and prefer the app much less.

These differences are striking. It has to be stated, however, that the number of lower educated people in the sample is very low. Therefore these results could be coincidental.

4.4.5. Travel characteristics

In this section, the effects are explored of the travel characteristics: travel motive, travel frequency, transfer frequency and transfer mode choice are explored. The estimated regression coefficients can be found in table D.6, table D.7, table D.8 and table D.9 of appendix D. The most important differences are elaborated on in this section.

Travel motive

When dividing the respondents based on their travel motive, a preference for the app is present in all categories of travel motives (commuting, school/study, holiday or day out, visit family or friends), except for business travellers. Business travellers prefer the visibility of the entrance or location of bus, tram, metro or OV-bike and signs & maps to an app. Further, people travelling for a holiday or a day out or a visit to family or friends relatively prefer the app more than commuters and students.

From these results it seems to be people who travel because of leisure prefer an app relatively more than people who travel because of obligations. Probably people who travel because of leisure prefer to plan their trip in advance. When planning in advance, an app might be more suitable compared to the other attributes of wayfinding information. It is striking that business travellers, who are assumed to be obligatory travellers, prefer the app less and signs & maps more compared to the other obligatory travellers (commuters and students).

Travel frequency

Both frequent and less frequent travellers prefer an app the most compared to the other wayfinding information attributes. Less frequent travellers, however, prefer an app relatively more than frequent travellers. On the other hand, frequent travellers appreciate the visibility of bus, tram, metro or OV-bike and signs & maps relatively more compared to less frequent travellers.

Less frequent travellers are probably less familiar with a railway station environment. Therefore their knowledge about the railway station can be assumed to be relatively small. These travellers are likely to be more uncertain about their trip. Based on this, less frequent travellers are assumed to be more intended to plan their journey in advance. An app supports planning a trip in advance more compared to the other attributes. Frequent travellers are more familiar with the railway station. Therefore, their knowledge about the railway station is assumed to be better. For them travelling is a routine and planning in advance is not always necessary. More frequent travellers are likely to believe wayfinding information can be obtained, if necessary, at the railway station itself.

Transfer frequency

The app is preferred most in both less frequent transferring people and frequent transferring people. Less frequent travellers prefer the app only a little. The same explanation as mentioned before for the travel frequency could be an explanation for these differences. Less frequent travellers are likely to transfer less frequently as well. Therefore they are less familiar with the railway station and assumed to be more unsure. Therefore, they are more likely to plan a trip in advance. An app offers the opportunity to plan a trip in advance.

Transfer mode choice

There are minor differences between the results when looking at the transfer mode choice of the respondents. People transferring from train to metro and OV-bike, attach relatively more value to an app compared to people who transfer from train to bus and tram. Furthermore, people who transfer from train to OV-bike, do prefer the visibility of the entrance of the OV-bike hall to signs & maps.

The metro is often located under the ground. Therefore it is more difficult to see the entrance (s) or location(s) from inside the railway station. The same holds for the entrance(s) or location(s) of the OV-bike parking area. This entrance in a railway station cannot often be seen from the inside of the railway station. This in contrast to the entrance or location of tram, which is often outside, in the railway station surroundings. Therefore, it is logical that OV-bike users relatively prefer an app and the visibility of the OV-bike parking area entrance relatively more.

4.5. Conclusions

This chapter elaborated on the results of the rating experiment. The effects of the attributes (an app, visibility of the entrance or location of bus, tram, metro or OV-bike, signs & maps and the manned information kiosk), on the wayfinding information preference of the respondents are estimated by means of a regression model. Differences between different types of NS travellers as well as the effects of the personal and travel characteristics of the respondents are explored. There are hardly any differences between the types of NS travellers in the ranking of the attributes (1: app, 2: visibility, 3: signs & maps and 4:kiosk). There are some minor differences, however, between the values for the different attributes.

When looking at the two main categories of NS travellers, the lust and must travellers, conclusions can be drawn. It seems an app is preferred among must travellers, because an app provides specific individual travel information. This supports a must traveller in making a purposeful journey from A to B. Lust travellers seem to have more time for orientation in the railway station itself and therefore appreciate the wayfinding information in the railway station itself, signs & maps and a manned travel information kiosk, slightly more than the must traveller.

An app provides the comfort of planning a transfer from train to bus, tram, metro or OV-bike in advance, which matches the characteristics of NS types of travellers who prefer to plan in advance (the individualist and the functional planner). For traveller types that hardly prepare their trip and the time of departure not at all an app seems to be relatively less important. Travellers who prefer to receive information instead of exploring by themselves (convenience seekers) attach relatively more value to the visibility of the entrance or location of bus, tram, metro or OV-bike. Socializers who plan their trip in advance and prefer to use all types of wayfinding information for confirmation only one source of information is not enough. Therefore, socializers relatively appreciate signs & maps as well as the manned information kiosk more than the other types. In addition, explorers, who do not plan their trip at all, prefer the manned information kiosk a little more since they are more dependent on information at the railway station itself.

In addition, personal and travel characteristics affect the wayfinding information preferences. Elderly people attach more value to signs & maps and much less to the app, whereas young people prefer the app the most. Another striking result concerns the business traveller, who prefers signs & maps and the visibility of the entrance much more than an app. Further, more frequent travellers prefer signs & maps relatively slightly more and the app slightly less compared to people who travel less frequently. Less frequent travellers can be considered to be relatively less familiar with the railway station environment and therefore more unsure about their trip. Therefore they are likely to plan their journey in advance by using an app.

People transferring from train to OV-bike attach more value to the app and the visibility of the entrance of the OV-bike hall. It is assumed that since this entrance of the OV-bike hall is often located outside the railway station or under the ground, an app and the visibility of the entrance or location of the OV-bike hall are of more importance among OV-bike users than to people who transfer to bus, tram or metro.

5
Implications of the results

In the previous section, the results of the rating experiment have been discussed. Slight differences between types of travellers are identified regarding the preferences for wayfinding information. It seems to be relevant to get more insight in the implications of these results. Therefore, this chapter elaborates on the implications of the results. First, different scenarios based on policy implications are explored. Second, the results and evaluation of the scenarios are presented to experts in the field of railway station development. Finally, practical recommendations for the implementation of the results in railway station (re-)design processes are given.

5.1. Scenarios

Different scenarios are estimated using the outcomes of the regression model. These scenarios give insights in the effects of the attributes, after implementing a certain policy measure. The aim of this study is to get insight in the effects for railway station design. Scenarios are developed, by keeping this in mind. The preferences of types of travellers are taken into account within the scenarios as well. The next section elaborates on the different scenarios.

5.1.1. Scenario types

Regardless of the type of traveller (must or lust) an app that provides a virtual route is preferred most for multimodal wayfinding information. Therefore, it seems relevant to determine the effects of such an app in different scenarios.

The first scenario is based on the current situation in a railway station and the effect of the availability of an app or its absence. The entrance or location of bus, tram, metro or OV-bike is not always visible at railway stations. Therefore, both effects of the availability of an app for a railway station where the entrance or location of bus, tram, metro or OV-bike is either visible or not are estimated. In the second scenario it is explored if traveller needs are met if wayfinding information is only provided by an app, without any wayfinding information provided at the railway station itself.

The scenarios are estimated on the outcomes of the regression model. For both must and lust travellers, the utilities per attribute level are combined into a total utility. By comparing this total utility with the constant, the traveller satisfaction can be determined.

Scenario 1: Current situation railway station + app

The first scenario illustrates the current situation of a railway station, without the availability of an app. The entrance or location of bus, tram, metro or OV-bike is either visible or not. Both signs & maps and a manned travel information kiosk are assumed to be present. The utilities of this situation are shown in table 5.1 and table 5.2.

Table 5.1: Situation - No app available

Attributes	**Attribute level**	**Must traveller**	**Lust traveller**
App	*No*	-1.378	-1.186
Visibility	***No***	-0.719	-0.718
Signs & maps	*Yes*	0.587	0.652
Kiosk	*Yes*	0.041	0.129
Total utility		**-1.469**	**-1.123**
Constant		4.660	4.566

Table 5.2: Situation - No app available

Attributes	**Attribute level**	**Must traveller**	**Lust traveller**
App	*No*	-1.378	-1.186
Visibility	***Yes***	0.719	0.718
Signs & maps	*Yes*	0.587	0.652
Kiosk	*Yes*	0.041	0.129
Total utility		**-0.031**	**0.313**
Constant		4.660	4.566

As can be seen from table 5.1, the utilities are very negative for both must and lust travellers. When subtracting the numbers -1.469 and -1.123 from the constants (the average utilities), an indication of the satisfaction can be estimated. This resulted in an overall satisfaction of 3.191 for the must traveller and an overall satisfaction of 3.443 for the lust traveller. As mentioned before, the satisfaction is based on a scale from 1 to 7. Therefore, a utility of at least 3.5 can be considered sufficient. These numbers are less than 3.5 which indicate that both must and lust travellers are not satisfied in this situation. This combination of wayfinding information sources cannot be considered to be sufficient to meet the travellers' needs and wishes.

In table 5.2, the total utilities are -0.031 and 0.313. When adding these utilities to the constant, a total utility of respectively 4.629 and 4.253 is estimated. These values are both above 4, which indicates both must and lust travellers are satisfied in this situation.

In the next situation, an app which provides a written route for wayfinding information is available. The other attributes remain the same. The results of this improvement are shown in table 5.3 and table 5.4.

Table 5.3: Situation - App available with written route

Attributes	**Attribute level**	**Must traveller**	**Lust traveller**
App	*Written route*	0.486	0.379
Visibility	***No***	-0.719	-0.718
Signs & maps	*Yes*	0.587	0.652
Kiosk	*Yes*	0.041	0.129
Total utility		**0.395**	**0.460**
Constant		4.660	4.566

Table 5.4: Situation - App available with written route

Attributes	**Attribute level**	**Must traveller**	**Lust traveller**
App	*Written route*	0.486	0.379
Visibility	***Yes***	0.719	0.718
Signs & maps	*Yes*	0.587	0.652
Kiosk	*Yes*	0.041	0.129
Total utility		**1.833**	**1.878**
Constant		4.660	4.566

In table 5.3, the total utilities for both travellers show slightly positive numbers. The constants remains the same as in the previous situation, 4.660 (must travellers) and 4.566 (lust travellers). When summing up the constant and the total utility, the overall satisfaction of both traveller types is 5.055 and 5.026 respectively. This indicates the satisfaction has increased compared to the previous situation.

In table 5.4, the total utilities for must and lust travellers are 1.833 and 1.878 respectively. When comparing these utilities with the constant, an overall satisfaction of 6.493 and 6.444 can be estimated. Since these numbers are both near 7, it seems that both traveller types are very satisfied in this situation.

In the next situation, an app which provides a virtual reality route for wayfinding information is available. The other attributes remain the same. The results of the improvement of the virtual reality app are shown in table 5.5 and table 5.6.

Table 5.5: Situation - App available with virtual reality route

Attributes	**Attribute level**	**Must traveller**	**Lust traveller**
App	*Virtual route*	0.892	0.807
Visibility	***No***	-0.719	-0.718
Signs & maps	*Yes*	0.587	0.652
Kiosk	*Yes*	0.041	0.129
Total utility		**0.801**	**0.870**
Constant		4.660	4.566

Table 5.6: Situation - App available with virtual reality route

Attributes	**Attribute level**	**Must traveller**	**Lust traveller**
App	*Virtual route*	0.892	0.807
Visibility	***Yes***	0.719	0.718
Signs & maps	*Yes*	0.587	0.652
Kiosk	*Yes*	0.041	0.129
Total utility		**2.239**	**2.306**
Constant		4.660	4.566

Regarding table 5.5, the total utilities for both travellers are positive, 0.801 and 0.807. The constants remains the same as in the previous situation, 4.660 (must travellers) and 4.566 (lust travellers). When summing up the constant and the total utility, the overall satisfaction of both traveller types is 5.461 and 5.436 respectively. These values indicate the satisfaction has slightly increased compared to the previous situation, in which an app with a written route is available.

In table 5.6 the total utilities for must and lust travellers are 2.239 and 2.306 respectively. When comparing these utilities with the constants, a satisfaction of 6.899 and 6.872 respectively are estimated. Since these values are both very close to 7, it seems that both traveller types are very satisfied in this situation.

To summarize the results of the first scenario, a situation without an app for wayfinding information and a visible entrance or location of bus, tram, metro or OV-bike does not meet the travellers' needs of both must and lust travellers. Travellers are not satisfied when only signs & maps and a travel information desk provide wayfinding information. When the entrance or location of bus, tram, metro or OV-bike is visible as well as both signs & maps and the travel information kiosk are present, travellers are satisfied. The highest travellers satisfaction can be achieved when an app with a virtual route is available, as well as a visible location or entrance of bus, tram, metro or OV-bike and both sign & maps and the travel information kiosk.

Scenario 2: App only

The results show that the app is valued most important for wayfinding information. By taking the current digital developments of for example MaaS into account, it seems relevant to explore if travellers are ready to completely rely on wayfinding information provided by an app. In this scenario, it is assumed that there is no wayfinding information provided by at a railway station itself such as visibility, signs & maps and a kiosk. In the following situations, first the availability of just an app which provides only a written route is evaluated and second the availability of merely an app which provides just a virtual route is evaluated. The outcomes are shown in table 5.7 and table 5.8.

Table 5.7: Situation - App available with written route

Attributes	**Attribute level**	**Must traveller**	**Lust traveller**
App	***Written***	0.486	0.379
Visibility	*No*	-0.719	-0.718
Signs & maps	*No*	-0.587	-0.652
Kiosk	*No*	-0.041	-0.129
Total utility		**-0.861**	**-1.12**
Constant		4.660	4.566

The total utilities in a situation of the availability of merely an app which provides a written route are negative for both types of travellers. When looking at the must traveller, a utility of -0.861 is determined. By subtracting this amount from the value of the constant a total utility 3.799 remains. The total utility of the lust traveller is -1.12 is this situation. By subtracting this value from the constant, a total utility of 3.446 remains. Based on these utilities it is plausible that the availability of just an app which only provides a written route is not enough to meet a minimal travellers' satisfaction.

In the next situation, the availability of an app which only provides a virtual route is evaluated.

Table 5.8: Situation - App available with virtual reality route

Attributes	**Attribute level**	**Must traveller**	**Lust traveller**
App	***Virtual***	0.892	0.807
Visibility	*No*	-0.719	-0.718
Signs & maps	*No*	-0.587	-0.652
Kiosk	*No*	-0.041	-0.129
Total utility		**-0.455**	**-0.692**
Constant		4.660	4.566

In table 5.8 the total utilities are -0.455 (must traveller) and -0.692 (lust traveller). These values are subtracted from the constants. A total utility of 4.205 remains for the must traveller and a total utility of 3.874 is left for the lust traveller. These values are slightly higher than the previous situation. When assuming a minimal satisfaction between 3.5 and 4, this situation seems to be acceptable for the traveller. It is not ideal, however, because the satisfaction rate is relatively low.

One can conclude that although an app is highly appreciated, wayfinding information provided by merely an app does not fulfill the current traveller's satisfaction. Travellers seem to prefer a combination of wayfinding information provided at the railway station itself such as the visibility of the entrance of bus, tram, metro or OV-bike and signs & maps as well as individual wayfinding information by means of an app.

5.2. Exploration of actors involved

It is clear from the former section that a traveller wants to be provided with wayfinding information not only on demand and individually by an app but also at the railway station itself. The issue that now remains is what these findings mean for the process of (re-)designing wayfinding information at large railway stations. What actors are important in this process and what are their roles and responsibilities? The findings of this research when looking at the preferences of wayfinding information have been presented to experts who are actually involved in the process of developing railway stations.

5.2.1. Method

Clear recommendations about how to implement wayfinding information in transport hubs can be made by getting more insight into the roles of the various parties involved. In order to determine which actors influence the decision making process of a railway station design, various interviews have been had with experts in this field. These interviews serve as an addition to the survey of this study. In these interviews, the implications of the results have been discussed in more detail. How wayfinding information can be applied in the (re-)design of railway stations can be investigated on the basis of these interviews. The design of the interviews is discussed first in the next paragraph. Then the selection of interviewees is elaborated on. Finally the results of the interviews are discussed.

Interviews

Insight in the field of actors has been acquired by means of interviews with experts. A number of reasons are considered when choosing this research method in addition to the quantitative study in chapter 3. By means of expert interviews, in depth information about specific topics can be obtained in a relatively quick way. Interviews are also a suitable method, because they provide the researcher the opportunity to react flexibly on the situation of investigation and on the information that is researched or received from the experts. New directions that are not foresee in advance can be obtained in this way.

The interviews used in this study are semi structured. In a semi structured interview the questions are not (all) known in advance, but the subjects to talk about are. They start with a question or a number of topics that will be used during the conversation. The advantage of this way of working is that information about subjects is quickly available to the researcher. Moreover, further questions on specific topics can be asked if necessary. This in contrast to fully structured interviews which are not flexible and therefore not suitable in this situation (Longhurst, 2003).

The interviews are setup as one-to-one brainstorm sessions. The conversations start with a short introduction on the research and its results. This is done to show the experts in what fields the solutions are to be found. After the introduction, the topics of conversation are introduced to the experts by means of questions with the aim of getting to know how these people view this matter of different actors in the decision making process of railway stations. A few starting up questions are asked at the beginning of each conversation. New questions are asked after hearing the answers. The experts have been guided in such a way that the only focus possible is the knowledge relevant to the subject matter.

A list of relevant topics has been prepared in advance. The following questions guide the conversation with the experts:

- At which point in the planning or process of the railway station design are the relevant choices made concerning wayfinding information?
- What parties play a role in the development of railway station
- What issues will these parties take into consideration?
- How will these considerations be shown?
- What does this research mean for the choices to be made?

Notes have been made during the interviews. These notes are elaborated immediately after each interview, when the information provided is still the researcher's memory. Subsequently, all information obtained is combined into complete findings.

Experts

Expert interviews concern interviews with persons who are well informed about certain issues and/or persons who are socialized well in certain locations or situations. The experts have been selected on their expertise, but also on their availability and their willingness to cooperate. The main condition of selection is that the experts have knowledge of and experience in the decision-making processes in the development of railway stations in the Netherlands.

Four experts have been approached for the interviews. They all are experienced in designing railway stations and have knowledge of the different parties involved in this process. Experts from different departments at Sweco have been chosen, because the variation of backgrounds is considered to lead to different points of view and so the reliability of the results of the interviews is bigger.

5.2.2. Findings from the interviews

The requirements and preconditions for (re-)designing railway stations are determined in the planning stage of a project. These preconditions are set in the so-called management and transport concessions and concern the requirements for a railway station design as well as for transporters who operate in the railway station surroundings. In the next sections the roles of the parties involved on a institutional and a operational level are elaborated on.

Institutional level

The responsibility for making the concessions for the whole country is for the government. The ministry of I&M determines the requirements of a railway station design in management as well as in transports concessions as far as information provision in a railway station area is concerned. There are, on the other hand, also management and transport concessions that are meant for a certain region, set by local authorities.

On a national scale, NS is the executing railway organization (transport concession) and ProRail executes the management concession. NS is responsible for the operation of transport by train. ProRail is responsible for the physical integration, which involves the development and instalment of information at railway stations. On a regional level, local transport companies execute the transport concessions for bus, tram and metro.

Regarding the provision of wayfinding information, both ProRail and NS are responsible for providing optimal service to the traveller from door-to-door as stated in the concessions set by the government. Local transporters, on the other hand, operate in concessions of local authorities. The requirements regarding the provision of service of local transporters to the traveller can therefore differ per region. Moreover, the interpretation and implementation of the requirements are determined by the parties executing the concessions. Thus, the way they facilitate the service can be determined by the companies themselves as long as they meet the conditions of the concessions set by either the government or local authorities. In table 5.9 an overview of the parties and their responsibilities is shown.

Table 5.9: Parties involved

Actor	Responsibility
Government	Set up public transport policies in concessions
Local authorities	Set up public transport policies on a local level in concessions, in alignment with the government
NS	Carry out the transport as stated within the transport concession
ProRail	Carry out the management as stated within the management concession
Local transporters bus/tram/metro	Carry out the transport as stated within the local transport concession

Operational level

When looking at railway stations and the surroundings of its public space, the management is more complex. NS is the owner of the building of the railway station itself. The land around the railway station is usually managed by local authorities or another party that has got the rights for this area from the government in a management concession such as ProRail, NS or property developers.

Moreover, the parties involved not always have the same interests. Local authorities have their own interests to improve the attractiveness of their region. Moreover, ProRail, NS and local transporters not only have to accomplish their social role in providing optimal service to the traveller, they also have a commercial interest in which financial return is necessary in order to be able to continue managing their companies. As a result, the traveller's interest is not always the starting point for these parties.

5.2.3. Conclusions about policy and implementation

The ministry of I&M can set up a specific performance policy with regard to wayfinding information on a national scale by inserting this in the transport and management concessions. The concession holders are then obliged to fulfill these requirements. If their performances lag behind, the ministry of I&M can intervene. On a local scale, the concessions for transport and management of certain railway stations are set up by local authorities and can be different from the national concessions. The ministry of I&M can, however, direct the local authorities with overarching policies.

When looking at the implementation of the plans regarding wayfinding information in a railway station design, NS and ProRail are the major players. They can pursue national policies regarding wayfinding information as long as they meet the requirements set up in the concessions by the government. Since this research involves the railway station and the area around it, they are dependent on cooperation with local transporters and authorities when pursuing an unambiguous policy regarding wayfinding information. NS and ProRail are the responsible parties at all railway stations, but the local transporters and authorities differ per region. Therefore, the conditions in the concessions for local transporters may differ from the conditions in the concessions of ProRail and NS. Since the conditions in the concessions for local transporters can vary according to region, there is not one clear policy for the whole country. An overview of the parties and their relations is shown in figure 5.1.

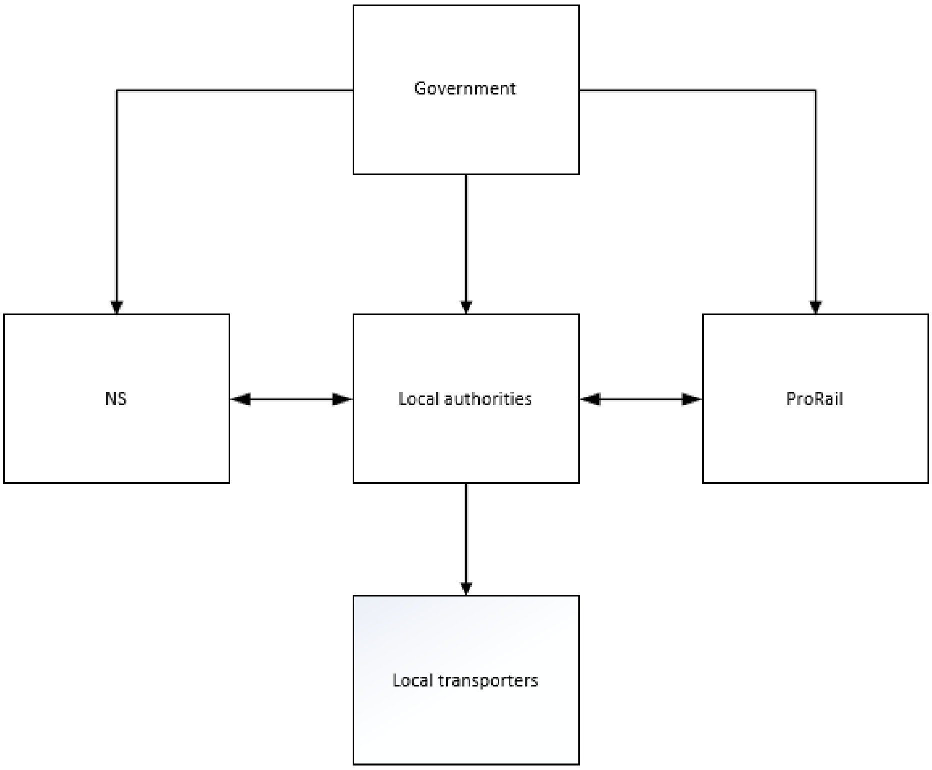

Figure 5.1: Relations between parties involved

5.3. Recommendations for practice

This study has been motivated by the need to get insight in the preferences of travellers regarding multimodal wayfinding information at large railway stations. This insight can be used by stakeholders involved for (re-)designing wayfinding information provision at railway stations. As mentioned in chapter 1, by improving wayfinding information for multimodal transfers, public transport becomes a more attractive choice of mode. As a result, mobility in and viability of cities can be improved.

Policy

For the final implementation of multimodal wayfinding information, it is important to create unambiguous policies regarding the provision of wayfinding information for the parties involved. The requirements regarding the provision of wayfinding information could be laid down concretely both in the management and in the transport concessions. The department of I&M will have to take on a directive attitude in order to develop a common point of view by setting the requirements on a national level. The responsibility of the implementation of these requirements, however, should be performed together by NS, ProRail and local transporters. Working together seems to be essential in order to create a united approach regarding the provision of multimodal wayfinding information. These parties, however, have different interests and therefore not always feel the traveller's interest as the main goal. For this purpose it recommended an umbrella party should be appointed that is responsible for the traveller's interest and arranges everything between the different parties. Such an umbrella organization can take interests of all parties involved into account and should structurally confer with partners. The umbrella party just manages the parties involved. The implementation is still the responsibility of these parties. The umbrella organization could be a new organization appointed by the government, but the government could also take on this role and be a directive party. Therefore to the ministry of I&M is advised to take up:

the provision of wayfinding information concretely into both the transport and management concessions and take the responsibility yourself or appoint an umbrella party to take the responsibility for managing the parties involved for the implementation.

Implementation

The results of this research offer leads in terms of the fulfillment of wayfinding information provision for the parties implementing. In order to reach optimal travel satisfaction, a multimodal travel information app that supplies the traveller with a virtual reality route providing guidance from the moment of leaving the train up to the moment of the location of the entrance of bus, tram, metro or OV-bike hall is recommended.

In order to realize such a successful multimodal app with integrated virtual reality possibilities, it is important to know which preconditions are required. Existing multimodal travel apps such as NS, 9292 OV and Google maps may provide opportunities. These apps already provide wayfinding information by means of a textual description (written route) and sometimes linked to a route map. In many of these apps, however, the correct data is not fully available yet, resulting in incomplete wayfinding information advice. Therefore, it seems essential to expand these existing apps with the right data in order to provide the traveller virtual reality wayfinding information. These data are likely to include new information and footage about the lay-out of a railway station and its surroundings. NS, being an important stakeholder, should make the right data of the railway stations and their surroundings available, because they are the owner of the Dutch railway stations. Therefore, they are advised:

to find out which data are required exactly to expand their existing multimodal travel information app of NS, with virtual reality wayfinding information in order to optimize their door-to-door strategy.

Such an app seems, however, not enough to reach optimal traveller satisfaction. It seems travellers need extra confirmation of their chosen route by wayfinding information which is provided in the surroundings of the railway station and in the railway station itself, by for example a visible entrance of bus, tram, metro or OV-bike or signs & maps. These types of wayfinding information could complement the availability of an app, which meets the aforementioned requirements.

To design a railway station in such a way that the entrances or locations of bus, tram, metro and OV-bike are visible from the train platform, might be a complicated and expensive operation. The provision of unambiguous signs & maps to complement a multimodal app is considered almost as effective. Moreover, the implementation of signs & maps is assumed easier and cheaper than changing the lay-out of a railway station. Regardless of the feasibility, for both alternatives, not only infrastructural measures need to be taken, but cooperation between local authorities, local transporters and NS and ProRail are required as well. Because ProRail also plays a very important role, they are advised:

to explore the feasibility, costs and benefits of infrastructural measures, in cooperation with the other stakeholders involved that have to be taken in order to realize (better) visibility of entrances or locations of bus, tram, metro and OV-bike or an uniform sign language in and outside the railway station.

6 Conclusion, Discussion and Recommendations

This chapter provides some conclusions that are derived based on the findings of this research. In addition, an answer to the main research question is given. Next, a discussion is examined and recommendations for science and practice are given.

6.1. Conclusions

In this study, the wayfinding information preferences of different types of travellers during a multimodal transfer from train to bus, tram, metro or OV-bike are analyzed. In addition, the relation between wayfinding information and customer travel experience is explored. Furthermore, the aim of this study is to provide insights that can be used for the optimization of the door-to-door journey by improving the design of Dutch railway stations.

This report starts with a main research question and several sub-questions. This section elaborates on the answers to the sub questions followed by the answer to the main question. To answer the essential question, the following sub questions are formulated:

What is the definition of wayfinding information?
Wayfinding information is the information of a certain environment, needed by an individual to orientate themselves, in order to find one's way to a certain location.

Which types of wayfinding information can be distinguished in relation to the railway station and its surroundings?
Two main categories of static and dynamic information can be distinguished. Types of wayfinding information in relation to a railway station and its surroundings can be divided into four subcategories: environmental features (landmarks), static, digital and verbal information. Environmental features as well as static information can be clustered in the main information category of static information. Digital and verbal information can be clustered into the main information category of dynamic information. The subcategories of types of wayfinding information can be split up further into specific attributes such as indoor and outdoor features, types of signs & maps, mobile devices, the travel information kiosk and random travellers.

Which types of travellers can be distinguished, and which categorizations can be identified?
Based on travel needs, two main categories of NS travellers can be distinguished: must and lust travellers. Must travellers are conscious users of a railway station and are characterized as travellers with a functional orientation. Rush and focus are the main elements during their journey. In addition, this group often travels because of obligations. Lust travellers, however, use the railway station for leisure reasons. Lust travellers get pleasure from the trip, regardless of their destination, as opposed to must travelers who experience the journey as an obligation and part of their daily routine.

In addition to the main categorization of lust and must travellers, a classification of different types of NS travellers can be made. Based on their emotional needs (personal features, travel behaviour and travel preparation), six types of travellers can be distinguished within the categories of must and lust travellers. Must travellers are classified in: the individualist, the functional planner and the certainty seeker. Lust travellers are divided in: the explorer, the socializer and the convenience seeker.

How does wayfinding information influence the customer travel experience?
The customer travel experience of a transfer can be explained by the pyramid of customer needs in public transport. Safety and reliability are pre-conditions of a trip and should be there from the start. The other layers of the pyramid that explain the customer travel experience are: speed, ease, comfort and experience. Speed, because people want their journey to be as fast as possible. Ease is the result of good orientation, travel information and logical and ambiguous signposting. Wayfinding information is considered mainly related to these two factors of speed and ease. If the travellers' expectations regarding wayfinding information are not fulfilled, they will be influenced negatively because of this experience. Wayfinding information influences the complete customer travel experience of a transfer, when they have effect on the factors speed and ease.

What are the preferences of different types of travellers regarding wayfinding information?
There are no large differences between the preferences of different types of travellers regarding wayfinding information during a transfer from train to bus, tram, metro or OV-bike. When looking at the main category of NS travellers, the must and lust travellers, both types do consider an (virtual reality) app of most importance for wayfinding information provision, 46% and 40% respectively. Next, the visibility of the entrance or location of the bus, tram, metro or OV-bike is considered of most importance by 29% for both types. Lust travellers appreciate the wayfinding information which is present in the railway station itself such as signs & maps and a manned travel information kiosk. They rate their importance slightly higher than the must traveller, 26% and 5% compared to 24% and 1% respectively.

Furthermore, the results show slight differences between the six traveller types of NS. For traveller types who plan their trip in advance, an app is relatively more important than for traveller types that not prepare a trip or only a little. Travellers who prefer to receive wayfinding information instead of exploring themselves attach relatively more value to the visibility of the entrance or location of bus, tram, metro or OV-bike. For travellers who prefer to use all types of wayfinding information in a railway station for confirmation of their chosen route, signs & maps as well as the manned information kiosk are relatively more important. In addition, traveller types who do not plan their trip at all, prefer the manned information kiosk slightly more than the other types.

In addition, regarding the explored effects of personal and travel characteristics the app appears most appreciated by younger people, whereas elderly people attach more value to signs & maps. Furthermore, less frequent travellers do appreciate the app slightly more compared to frequent travellers. People transferring from train to OV-bike appreciate the app more compared to transferring people to bus, tram or metro.

What are the effects of different types of wayfinding information on the customers' travel experience?
Wayfinding information influences the speed and the ease of a transfer. By influencing these factors, the total customer travel experience is influenced. The results show that the factors speed and ease are considered as equal entities when wayfinding information for a transfer from train to bus, tram, metro or OV-bike is concerned. Wayfinding information affects both factors speed and ease equally.

Since the app is considered the most important type of wayfinding information among both must and lust travellers, the availability of an app has the most positive influence on the factors of speed and ease. Therefore, this type of wayfinding information is considered to have to largest positive impact on customer travel experience.

After having discussed all sub questions, the main research question can be answered.

What are the wayfinding information preferences of traveller types at large railway stations during a multimodal transfer from train to bus, tram, metro or OV-bike, and how are these preferences related to customer travel experience?

Wayfinding information preferences of must and lust travellers during a transfer from train to bus, tram, metro or OV-bike are almost similar. Must travellers, however, consider the availability of an app as slightly more important than lust travellers, 46% and 40% respectively. As expected, lust travellers seem to have more time for orientation of landmarks in the railway station itself and therefore consider signs & maps (26%) as well as the manned travel information kiosk (5%) as slightly more important than must travellers (24%, 1%).

These preferences with respect to wayfinding information are of influence on the perceived speed and ease of a transfer from train to bus, tram, metro or OV-bike. By positively influencing the factors of speed and ease with appropriate wayfinding information, the total customer travel experience of a multimodal transfer can be improved. It can be concluded, the customer travel experience can be influenced the most by providing the traveller with an app that provides a virtual route for finding their way from train, to bus, tram, metro or OV-bike.

6.2. Discussion

After having discussed the conclusions of this research, it is also important to look at the validity of the results and possible limitations of the method. The next sections elaborate on the validity of the results and the limitations of this study. Next to that, recommendations for further research are given.

6.2.1. Validity

The results of the rating experiment are based on the answers of 285 respondents. First, it has to be stated that the data set used is not fully representative to the real population of Dutch train travellers. The respondents are relatively younger and higher educated. Furthermore, people transferring from train to bus are overvastrepresented in the sample. Therefore, if conclusions about the entire population of Dutch train travellers are generalized, these facts must be considered carefully.

The deviations from the population of Dutch train travellers might have affected the results. By looking at the relatively low amount of elderly people sample, an underestimation of the preference for a manned travel information kiosk is considered plausible. On the other hand, the preference for an app might be overestimated because people were relatively young and high educated in the sample.

The fact that the elderly people are underrepresented in the sample must be taken into consideration when looking at the results of this study that indicates an app is highly preferred for wayfinding information provision. Due to diminishing cognitive skills in the elderly, they experience the use of smart phones is as complex. The usage of smart phones and all their functions can be challenging since elderly people have cognitive constraints compared to younger people. In addition, elderly people often lack the interest in using a smart phone and believe that a smart phone is not necessarily needed (Mohadisdudis and Ali, 2015). Elderly people are, however, a significant part of modern day travellers. Moreover, people are becoming much older nowadays and are in general healthy enough to travel. Therefore, it is important to know the preferences of elderly people in wayfinding information and keep this group in mind when designing and implementing wayfinding information. While the sample of this study provides some valuable findings, more research is needed to verify the results. Therefore, it is recommended to look for elderly people with in a next experiment in specific.

Some further criticism to the sample may relate to the fact that, not only the low amount of elderly people may have lead to an underestimation of the manned information kiosk. Two types of NS travellers are underrepresented in the sample, the convenience seeker and the certainty seeker. From chapter 2, it is clear that these two types of NS travellers appreciate the availability of verbal information at staff desks. Since the certainty seeker is not present in the sample and the convenience seeker is underrepresented, this might have led to an underestimation of the manned travel information kiosk (staff desk).

People transferring from train to bus as well as high educated people were overvastrepresented in the sample. Based on the data, no significant differences between people transferring from train to bus and people transferring to tram, metro or OV-bike were found. On the other hand, differences between the preferences between low and highly educated people were found. It could have been that these differences were larger if these groups were represented by a larger amount of respondents.

6.2.2. Limitations

This section elaborates on the limitations of this study. First, general limitations of this study are elaborated on. Then, limitations regarding the methods used in this study are discussed.

General limitations

The results of this study show that there are no large differences between different types of travellers regarding wayfinding information, during a transfer from train to bus, tram, metro or OV-bike. It should be borne in mind, however, that this research focuses solely on the transfers from train to bus, tram, metro or OV-bike and the relation with wayfinding information preferences of travellers. When the focus is on transfers between bus, tram and metro, the results might be different. For this reason, it is not possible to reach a general opinion about the preferences of wayfinding information during a transition that does not focus specifically on the transfer from train to bus, tram, metro or OV-bike. A direction for further research is therefore to test whether the findings of this study regarding wayfinding information also apply to transfers between bus, tram and metro.

There are uncertainties which not have been taken into account in this study that might affect the results of this study in reality. As mentioned in the chapter 1, the world and our societies are changing rapidly. When looking at trends such as the development of flex work and MaaS the results may be affected. In this study the railway station is considered just as a point of transfer. The railway station is, however, no longer just a place to find your train. It is becoming much more than just a point of transfer. Railway stations are increasingly designed as places to meet each other, to work and to shop. It is possible, therefore, that this fact affects the travelling motives of people and the needs regarding wayfinding information in a railway station. Next to that, this trend of multi functional railway stations provides opportunities to complement wayfinding information preferences regarding transfers, with other preferences related to workplaces or shops in a railway station. It is considered plausible that the preferences for finding your way to a transfer are also apply for finding your way to workplaces or stores. This could therefore be a direction for further research.

SP method

The method of SP used is another characteristic of this research. The advantage of this method is that new attributes which do not exist yet can be added, such as the virtual reality app in this research. In SP experiments, however, no real behavior can be observed, since the answers of the respondents are based on hypothetical situations. Especially, the descriptions of the attributes used in the survey could be interpreted in various ways. In the survey of this research, respondents were asked to imagine to be at an unknown large railway station. The question is, however, if the respondents should keep that in mind when filling in the survey. The effects of the different attributes could therefore be influenced by other variables that respondents consider present.

The situations that have been rated are only in written language and presented without any pictures or photos in the survey. The explanation about the attributes is done in the beginning of the survey and not repeated later on. This might have made it more complicated for respondents to fill in their answers. Because there were no pictures or photos, it may not have been completely clear what was meant with each attribute or attribute level. In the survey there is a distinction between an app with a written route and an app with a virtual route. A virtual route might be understandable for young people are who used to this concept. Elderly people, however, and people who are not focused on modern devices may have been not able to understand such a concept at all. This of course could have been of influence on the assessment of the app for wayfinding information.

The question is whether travellers would actually make the same choices in reality. A method to capture this problem is to use revealed preference data. The SP and RP data sets could then be compared in order to check if respondents have the same preferences in real life.

Excluded attributes

Another limitation comes from the attributes excluded from the SP experiment. In order to reduce the complexity of the rating experiment, not all attributes identified being of influence on the wayfinding information preferences of people have been included in the rating experiment.

Other attributes which may of important influence are for example the emotional state and the cognitive mapping abilities of people travelling as well as the time of day, as mentioned in chapter 2. When it is peak hour, a railway station could be perceived differently, for example, a queue in front of the manned travel information kiosk might ban people from asking wayfinding information about their route there. Moreover, people feeling stressful might make other choices than people feeling relaxed.

A limited amount of attributes is taken into account in the SP experiment of this study. The effects of attributes like, time of day, emotional state and cognitive mapping abilities on travellers can provide additional knowledge about wayfinding information preferences of transferring passengers. Some of the excluded attributes are not easy to test in a stated preference study. Therefore, it would be more effective to gain insight in the effects of these kinds of attributes by using the RP method once again. In addition, the possible interaction effects between the attributes are a relevant topic for further research.

Simplifications of attributes

The simplifications of the attributes in the rating experiment could have been of influence on the choices of respondents. The attribute of a manned travel information kiosk has been used to illustrate verbal communication at a railway station. The results of this study indicate that the respondents were not much interested in this kind of wayfinding information for the transfer from train to bus, tram, metro or OV-bike. This does not mean, however, that people are never interested in verbal communication and human help. This does not have to be in the form of a fixed information point but could also consist of staff walking around. Therefore the results of this study may have been affected by simplifications of this attribute of verbal communication.

In addition, in order to reduce the complexity of the survey, the attribute signs & maps is treated as one entity. Within this category, static and dynamic ways of wayfinding information have been combined, which may affect the outcome. Results could have been different if static and dynamic signs and maps had been treated as separate attributes. People probably prefer dynamic/ real time information nowadays because of its being up to date all the time which leads to most efficient wayfinding information. One, however, cannot be sure about this because there was no differentiation between static and dynamic signs and maps.

The simplifications of the attributes may be relevant for future investigation. The attributes of signs & maps as well as the manned travel information kiosk could be tested in a different way. It is relevant to know which types of signs and maps people rely on. In addition, the appreciation of verbal information by for example staff walking around could be interesting for further research.

Experimental design

A fractional factorial design is used in the SP experiment. Only main effects could therefore be estimated. Interaction effects were considered of minimal importance. In reality, however, it might be possible that a staff employee advises people to look at their travel information app or send them to a certain map of the railway station, in order to orientate. Moreover, when an app informs a traveller to go to bus platform C2, a traveller might seek for signs in the environment that visualize this number.

Method to identify type of NS traveller

Reasons for the expected differences between types of travellers, their travel motive and travel behaviour as well as personal characteristics has been given in chapter 2. No large differences between types of travellers regarding wayfinding information, however, were observed. A possible explanation for this result could be the identification method of the type of NS traveller. In the survey of this research, the type of NS traveller is identified on the basis of six different statements. The approach used by NS, however, consists of over 50 questions to identify a type of traveller. Due to time limitations, this approach has not been used is this study. From chapter 2 it is clear that the determination of the type of NS traveller is based on various factors which are covered in the original method. By using a simplified method in this study, it is likely that the types of NS travellers are incorrectly identified and therefore the results are not fully representative for different types of NS travellers. The differences between the preferences for wayfinding information among the NS types of travellers might have been larger if the NS approach to identify the type of traveller had been used. In future investigations, it might be possible to use the NS approach of to identify the types of NS travellers in order to get more reliable results.

This issue can be partially covered since also personal and travel characteristics of travellers are analyzed. Based on this segmentation no large differences between the preferences of travellers are found either. Thus, the results of this study indicate that travellers prefer to use an app for wayfinding information the most, regardless the types of traveller. Therefore, it is likely that people in general do prefer to rely on wayfinding information by an app on their smart phones. These results are in accordance with the expectation from chapter 2, that people are increasingly seeking for travel information on their smart phones (Huysmans, 2014). Moreover, several studies confirm that the need of travellers if real time travel information before, during and after the trip is very high (Rijkswaterstaat Dienst Verkeer en Scheepvaart, 2009).

Final reflection to the results

When looking at the representativeness as well as other limitations of this study, final remarks can be discussed. A sample which is not fully representative does not indicate that the results are not useful at all. The estimations provide valuable information on the different attributes. The sample of this study consisted of mainly young, highly educated people. Therefore, the results indicates that an app is most appreciated for wayfinding among this group. This seems to be in accordance with the research of Hendriks (2012). This study shows that especially young, highly educated travellers, who often use their mobile phones tend to use more mobile travel information (Hendriks, 2012).

The number of available apps for smart phones that people can use has increased significantly over the past few years. As mentioned in chapter 1, MaaS is a development that has a lot of power for multimodal systems. The current study shows that, people appreciate the use of apps for wayfinding information very much. This finding suggest that people are ready for these new digital developments. This leads to opportunities to integrate wayfinding information in the concept of MaaS. Another interesting opportunity might be to integrate multimodal apps which provides wayfinding information, in for example, current apps that facilitate weather forecasts or daily news.

Regarding the recommendation of virtual reality integration in the existing multimodal travel app of NS, it is seems to be relevant to research if an app providing a virtual route may also offer opportunities for people with a disabilities. Sensors on obstacles along the route can be for example linked to Internet of things (IoT) and inform people about these obstacles in the route by displaying it within virtual reality.

Another result of this study indicates that the highest traveller satisfaction can be achieved when the an app is complemented by provision of wayfinding information in the railway station and its surroundings itself. This is in accordance with the conceptual framework from chapter 2, which states that environmental features (landmarks) are used for wayfinding information.

All in all, the results can be considered plausible and seem to be useful starting points for the planning and design of multimodal wayfinding information at railway stations in the Netherlands.

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A
Types of railway stations

A.1. Multimodal railway stations

This research focuses on large multimodal railway stations in the Netherlands. In order to define these multimodal railway stations, the number of passengers in and out is addressed. ProRail and NS categorize six types of stations. This categorization is described in the next section.

A.1.1. Railway stationtypes

Based on travel behaviour, stations can be classified into six user types Brouwer and Huijsmans (2011). The types provides handles to achieve consistency and distinctive features on the different station types. These six types are developed in such a way, that these provide assistance in determining policies. The six types are discussed below.

Type 1: Very large station in the center of a large city. The transport features are as follow: local public transport hub: bus, tram, metro, taxi etc. These stations are used by a large number of travellers and therefore there are very large running streams, many internal transfers en international connections. An example in the Netherlands is Utrecht Centraal.

Type 2: Large station in the center of a medium-sized city. This type of station is the node of local public transport: bus and tram. There are many travelers, large running streams and many internal connections. There are only national connections. An example in the Netherlands is Den Bosch.

Type 3: Suburb station with node function. Many travelers, sometimes large streams, regional, sometimes national connections, primary transfers with possibility of development to an arrival station, focus on peak. An example in the Netherlands is Rotterdam Alexander.

Type 4: Station at the center of a small town or village, for regional connections. Mainly for departing travelers. In addition, it is a transfer point for regional buses. An example in the Netherlands is Zwijndrecht.

Type 5: Suburb station without node function, regional connections and no OV button function. Focused on peak hours. An example in the Netherlands is the Vink.

Type 6: Station in an outdoor area near a small town or village. Only regional connections and serves as departure station. An example in the Netherlands is Lage Zwaluwe.

Since this research focus on large public transport hubs (stations), type 1 is used. Based on the number of in- and out passengers in 2016, the following stations have to deal with the highest amount Treinreiziger.nl (2017):

Station	# Passengers
Utrecht Centraal	181644 000
Amsterdam Centraal	174179 000
Rotterdam Centraal	91750 000
Den Haag Centraal	82057 000
Schiphol Airport	78896 000
Leiden Centraal	75699 000
Eindhoven	61844 000
Amsterdam Zuid	45771 000
Den Bosch	45397 000
Nijmegen	44044 000

In addition, a selection of the most recently renovated stations is explored. These stations are most developed in the field of wayfinding information.

Station	Renovated
Utrecht Centraal	2016
Den Haag Centraal	2016
Breda	2016
Eindhoven	2017
Rotterdam Centraal	2014

From these two lists, the three largest, in terms of number of passengers and recently renovated stations are chosen as reference scenarios. As can be seen from the tables, these stations are: Utrecht Centraal, Den Haag Centraal and Rotterdam Centraal.

B
Survey

Vragenlijst informatievoorziening op grote stations

Welkom bij dit onderzoek over informatievoorziening op grote stations. Het doel van dit onderzoek is om te bepalen in welke mate reizigers verschillende soorten reisinformatie waarderen als ze overstappen van de trein naar bus/tram/metro of OV-fiets.

De vragenlijst bestaat uit twee delen. In het eerste deel stellen wij u algemene vragen over uw achtergrond en uw reisgedrag. In het tweede deel leggen wij 9 situaties aan u voor. Bij elke situatie vragen wij hoe tevreden u bent over de gegeven informatie voorzieningen.

Het invullen van de enquête duurt ca 10 minuten.

Uw gegevens worden anoniem verwerkt.

Alvast bedankt voor uw medewerking aan dit onderzoek.

Voor eventuele vragen, kunt u contact opnemen met Charlotte Schornagel, afstudeerder civiele techniek aan de TU Delft, via het emailadres: charlotte.schornagel@gmail.com

Deel 1: Persoonlijke kenmerken

1 Wat is uw geslacht?

Man
Vrouw

2 Wat is uw leeftijd?

19

3 Welke van de onderstaande antwoorden beschrijft uw situatie het beste?

Studerend of schoolgaand
Deeltijds werkend
Voltijds werkend
Werkloos
Gepensioneerd
Anders, namelijk
Wil niet zeggen

4 Wat is uw hoogst genoten opleiding?

Geen
Basisonderwijs
LBO, MAVO, VMBO

HAVO/VWO
MBO
HBO
WO
wil niet zeggen

5 Hoe vaak reist u gemiddeld met de trein?

4 dagen per week of vaker
1-3 dagen per week
1-3 dagen per maand
6-11 dagen per jaar
1-5 dagen per jaar
(Vrijwel) niet

6 Hoe vaak maakt u een overstap van de trein naar bus/tram/metro of OV-fiets?

4 dagen per week of vaker
1-3 dagen per week
1-3 dagen per maand
6-11 dagen per jaar
1-5 dagen per jaar
(Vrijwel) niet

7 Welk van de onderstaande vervoermiddelen gebruikt u het vaakst, als u een overstap maakt vanuit de trein?

Bus
Tram
Metro
OV-fiets
Geen van allen

8 Wat is uw voornaamste reisdoel wanneer u gebruik maakt van de trein?

Woon-werk
Zakenreis
School of studie
Bezoek aan familie of vrienden
Vakantie of dagje uit
Anders, namelijk

9 Welke van de onderstaande beschrijvingen zijn het meest op u van toepassing als u overstapt van trein naar bus/tram/metro of OV-fiets?

Ik plan mijn reis van tevoren en ik heb altijd reisinformatie bij de hand
Ik bereid mijn reis voor door alleen de actuele reisinformatie te raadplegen
Ik plan mijn reis van tevoren, heb altijd reisinformatie bij de hand, en controleer vaak bij medewerkers of mijn reisinformatie klopt
Ik plan mijn reis niet van tevoren. Indien nodig raadpleeg ik een website of app op mijn telefoon
Ik plan mijn reis van tevoren en heb altijd reisinformatie bij de hand. Ook maak ik graag gebruik van alle vormen van reisinformatie op het station zodat ik zeker weet dat ik de juiste informatie heb
Ik plan mijn reis vlak voor vertrek, of tijdens de reis. Ook ontvang ik graag reisinformatie maar ik ga er niet zelf naar op zoek

Deel 2: Situaties
In de volgende vragen krijgt u 9 fictieve situaties voorgelegd.

Stelt u zich voor dat u met de trein aankomt, op een willekeurig groot onbekend station. U wilt een overstap maken van de trein naar een andere vorm van openbaar vervoer (bus, tram, metro of de OV-fiets).

In iedere situatie krijgt u een lijst te zien met 4 verschillende soorten reisinformatie om vanaf het moment dat u de trein uitstapt, naar uw volgende vervoermiddel te komen. De vraag is om per situatie uw tevredenheid over de gegeven combinatie van reisinformatie uit te drukken op een schaal van (1) tot (7). Vervolgens worden twee vragen gesteld in hoeverre de gegeven reisinformatie bijdraagt aan de 'snelheid' en het 'gemak' van uw reis.

In iedere situatie vragen wij uw mening over de volgende 4 soorten reisinformatie.

(1) Reisinformatie-app: Een app op uw mobiele telefoon, waarmee u uw reis kunt plannen van deur tot deur. In de onderstaande situaties wordt onderscheid gemaakt tussen: (a) geen app beschikbaar, (b) een app waarbij de route van de trein naar de locatie van het volgende vervoermiddel wordt beschreven. En ten slotte, (c) een app waarbij u virtueel kunt zien, hoe u de route van de trein naar het volgende vervoermiddel kunt lopen.

(2) Zichtbare ingang/locatie van het volgend vervoermiddel: De ingang of locatie van bus/tram/metro of OV-fiets is zichtbaar vanaf het moment dat u de trein uitstapt. Deze kan wel of niet zichtbaar zijn in de onderstaande situaties.

(3) Fysieke borden en kaarten/plattegronden: Bewegwijzering (borden, pijlen, nummers en namen), reisinformatieborden (actuele vertrektijden) en plattegronden. Deze borden en kaarten zijn wel of niet aanwezig in de onderstaande situaties.

(4) Bemande informatiekiosk: Een informatiebalie met medewerker, in de stationshal, waar u reisinformatie kunt krijgen over vertrektijden en opstappunten. Er is wel of geen (bemande) reisinformatiekiosk in de onderstaande situaties.

Verder zijn de termen 'snelheid' en 'gemak' als volgt te interpreteren:

Snelheid: uw reistijd is zo kort mogelijk en u hoeft zo min mogelijk te wachten op een station.

Gemak: uw overstap is overzichtelijk zonder veel gedoe. Reisinformatie en bewegwijzering helpen u makkelijk op weg en zijn voor u logisch en eenduidig.

---

9 Situaties

1

Reisinformatie app	Nee
Zichtbare ingang/locatie van het volgend vervoermiddel	Nee
Borden en kaarten/plattegronden	Nee
Bemande reisinformatiekiosk	Nee

a *Hoe tevreden bent u over de gegeven combinatie van reisinformatie?*

Zeer ontevreden 1 2 3 4 5 6 7 Zeer tevreden

b *In hoeverre draagt de gegeven combinatie van reisinformatie bij aan de snelheid van uw overstap?*

Draagt niet bij aan de snelheid van de overstap 1 2 3 4 5 6 7 Draagt sterk bij aan de snelheid van de overstap

c *In hoeverre draagt de gegeven combinatie van reisinformatie bij aan het 'gemak' van uw overstap?*

Draagt niet bij aan het gemak van de reis 1 2 3 4 5 6 7 Draagt sterk bij aan het gemak van de reis

2

Reisinformatie app	Nee
Zichtbare ingang/locatie van het volgend vervoermiddel	Ja
Borden en kaarten/plattegronden	Ja
Bemande reisinformatiekiosk	Nee

a *Druk uw tevredenheid uit over de gegeven combinatie van reisinformatie.*

Zeer ontevreden 1 2 3 4 5 6 7 Zeer tevreden

b *In hoeverre draagt de gegeven combinatie van reisinformatie bij aan de snelheid van uw overstap?*

Draagt niet bij aan de snelheid van de overstap 1 2 3 4 5 6 7 Draagt sterk bij aan de snelheid van de overstap

c *In hoeverre draagt de gegeven combinatie van reisinformatie bij aan het 'gemak' van uw overstap?*

Draagt niet bij aan het gemak van de reis 1 2 3 4 5 6 7 Draagt sterk bij aan het gemak van de reis

3

Reisinformatie app	Nee
Zichtbare ingang/locatie van het volgend vervoermiddel	Nee
Borden en kaarten/plattegronden	Nee
Bemande reisinformatiekiosk	Ja

a *Druk uw tevredenheid uit over de gegeven combinatie van reisinformatie.*

Zeer ontevreden 1 2 3 4 5 6 7 Zeer tevreden

b *In hoeverre draagt de gegeven combinatie van reisinformatie bij aan de snelheid van uw overstap?*

Draagt niet bij aan de snelheid van de overstap 1 2 3 4 5 6 7 Draagt sterk bij aan de snelheid van de overstap

c *In hoeverre draagt de gegeven combinatie van reisinformatie bij aan het 'gemak' van uw overstap?*

Draagt niet bij aan het gemak van de reis 1 2 3 4 5 6 7 Draagt sterk bij aan het gemak van de reis

4

Reisinformatie app	Beschreven route
Zichtbare ingang/locatie van het volgend vervoermiddel	Nee
Borden en kaarten/plattegronden	Ja
Bemande reisinformatiekiosk	Ja

a *Druk uw tevredenheid uit over de gegeven combinatie van reisinformatie.*

Zeer ontevreden 1 2 3 4 5 6 7 Zeer tevreden

b *In hoeverre draagt de gegeven combinatie van reisinformatie bij aan de snelheid van uw overstap?*

Draagt niet bij aan de snelheid van de overstap 1 2 3 4 5 6 7 Draagt sterk bij aan de snelheid van de overstap

c *In hoeverre draagt de gegeven combinatie van reisinformatie bij aan het 'gemak' van uw overstap?*

Draagt niet bij aan het gemak van de reis 1 2 3 4 5 6 7 Draagt sterk bij aan het gemak van de reis

5

Reisinformatie app	Beschreven route
Zichtbare ingang/locatie van het volgend vervoermiddel	Ja
Borden en kaarten/plattegronden	Nee
Bemande reisinformatiekiosk	Nee

a *Druk uw tevredenheid uit over de gegeven combinatie van reisinformatie.*

Zeer ontevreden 1 2 3 4 5 6 7 Zeer tevreden

b *In hoeverre draagt de gegeven combinatie van reisinformatie bij aan de snelheid van uw overstap?*

Draagt niet bij aan de snelheid van de overstap 1 2 3 4 5 6 7 Draagt sterk bij aan de snelheid van de overstap

c *In hoeverre draagt de gegeven combinatie van reisinformatie bij aan het 'gemak' van uw overstap?*

Draagt niet bij aan het gemak van de reis 1 2 3 4 5 6 7 Draagt sterk bij aan het gemak van de reis

6

Reisinformatie app	Beschreven route
Zichtbare ingang/locatie van het volgend vervoermiddel	Nee
Borden en kaarten/plattegronden	Nee
Bemande reisinformatiekiosk	Nee

a *Druk uw tevredenheid uit over de gegeven combinatie van reisinformatie.*

Zeer ontevreden 1 2 3 4 5 6 7 Zeer tevreden

b *In hoeverre draagt de gegeven combinatie van reisinformatie bij aan de snelheid van uw overstap?*

Draagt niet bij aan de snelheid van de overstap 1 2 3 4 5 6 7 Draagt sterk bij aan de snelheid van de overstap

c *In hoeverre draagt de gegeven combinatie van reisinformatie bij aan het 'gemak' van uw overstap?*

Draagt niet bij aan het gemak van de reis 1 2 3 4 5 6 7 Draagt sterk bij aan het gemak van de reis

7

Reisinformatie app	Virtuele route
Zichtbare ingang/locatie van het volgend vervoermiddel	Nee
Borden en kaarten/plattegronden	Nee
Bemande reisinformatiekiosk	Nee

a *Druk uw tevredenheid uit over de gegeven combinatie van reisinformatie.*

Zeer ontevreden 1 2 3 4 5 6 7 Zeer tevreden

b *In hoeverre draagt de gegeven combinatie van reisinformatie bij aan de snelheid van uw overstap?*

Draagt niet bij aan de snelheid van de overstap 1 2 3 4 5 6 7 Draagt sterk bij aan de snelheid van de overstap

c *In hoeverre draagt de gegeven combinatie van reisinformatie bij aan het 'gemak' van uw overstap?*

Draagt niet bij aan het gemak van de reis 1 2 3 4 5 6 7 Draagt sterk bij aan het gemak van de reis

8

Reisinformatie app	Virtuele route
Zichtbare ingang/locatie van het volgend vervoermiddel	Ja
Borden en kaarten/plattegronden	Nee
Bemande reisinformatiekiosk	Nee

a *Druk uw tevredenheid uit over de gegeven combinatie van reisinformatie.*

Zeer ontevreden 1 2 3 4 5 6 7 Zeer tevreden

b *In hoeverre draagt de gegeven combinatie van reisinformatie bij aan de snelheid van uw overstap?*

Draagt niet bij aan de snelheid van de overstap 1 2 3 4 5 6 7 Draagt sterk bij aan de snelheid van de overstap

c *In hoeverre draagt de gegeven combinatie van reisinformatie bij aan het 'gemak' van uw overstap?*

Draagt niet bij aan het gemak van de reis 1 2 3 4 5 6 7 Draagt sterk bij aan het gemak van de reis

9

Reisinformatie app	Virtuele route
Zichtbare ingang/locatie van het volgend vervoermiddel	Nee
Borden en kaarten/plattegronden	Ja
Bemande reisinformatiekiosk	Nee

a *Druk uw tevredenheid uit over de gegeven combinatie van reisinformatie.*

Zeer ontevreden 1 2 3 4 5 6 7 Zeer tevreden

b *In hoeverre draagt de gegeven combinatie van reisinformatie bij aan de snelheid van uw overstap?*

Draagt niet bij aan de snelheid van de overstap 1 2 3 4 5 6 7 Draagt sterk bij aan de snelheid van de overstap

c *In hoeverre draagt de gegeven combinatie van reisinformatie bij aan het 'gemak' van uw overstap?*

Draagt niet bij aan het gemak van de reis 1 2 3 4 5 6 7 Draagt sterk bij aan het gemak van de reis

10 Zou u de onderstaande soorten reisinformatie willen plaatsen in rangvolgorde, waarin (1) de meest gewaardeerde soort reisinformatie is en (4) de minste gewaarde soort reisinformatie?

Reisinformatie app
Zichtbare ingang/uitgang van het volgend vervoermiddel
Borden en kaarten/plattegronden
Bemande reisinformatiekiosk

C
Exploratory interviews

C.1. Purpose of the exploratory interviews

Exploratory interviews are used to capture specific literature about wayfinding in the railway station surrounding and the relation with customer travel experience. In addition, the exploratory interviews contribute to a better knowledge of the context of wayfinding information and to identify the attributes.

C.2. Procedure

Interviews are held among experts in the field of the development of multimodal railway stations, wayfinding information and customer travel experience.

Table C.1: Exploratory interviews

Interview	**Company**	**Who**	**Expertise**
1	Arcadis	Nanet Rutten	Development large railway stations
2	Royal Haskoning	Gert-Jaap Koppenhol	Wayfinding of passengers in a station
3	NS	Mark van Hagen	Customer travel experience
4	Prorail	Lidwien van Kessel	Information provision in railway stations
5	TU Delft	Winnie Daamen	Passenger behaviour
6	NS	Jeroen van den Heuvel	Railway station developer
7	Sweco	Mark van den Berg	Development Den Haag Central station

D Results

D.1. Regression model

Table D.1: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.713	0.508	0.507	1.26921

Table D.2: ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	4222.367	5	844.473	524.223	0.000
Residual	4094.918	2542	1.611		
Total	8317.285	2547			

D.2. Segmentation

Table D.3: Values of the regression coefficients - Age

Attributes	18-25	25-35	35-45	45-55	55-65	65+
App						
No	-1.451	-1.27	-1.429	-0.841	-0.95	-0.759
Written route	0.443	0.457	0.445	0.269	0.471	0.546
Virtual route	1.008	0.817	0.984	0.545	0.479	0.213
	47%	**42%**	**48%**	**33%**	**31%**	**22%**
Visibility						
No	-0.72	-0.742	-0.710	-0.639	-0.793	-0.576
Yes	0.72	0.742	0.710	0.639	0.793	0.576
	28%	**29%**	**28%**	**31%**	**34%**	**27%**
Signs & maps						
No	-0.567	-0.660	-0.571	-0.673	-0.686	-0.972
Yes	0.567	0.660	0.571	0.673	0.686	0.972
	22%	**26%**	**23%**	**31%**	**29%**	**45%**
Kiosk						
No	-0.090	-0.080	-0.007	-0.075	-0.135	-0.139
Yes	0.090	0.080	0.007	0.075	0.135	0.139
	3%	**3%**	**<1%**	**4%**	**6%**	**6%**
Constant	**4.629**	**4.621**	**4.555**	**4.614**	**4.580**	**4.627**

Table D.4: Values of the regression coefficients - Working status

Attributes	Full time	Part time	Schooling, studying	Retired	Unemployed	Different	No answer
App							
No	-1.286	-1.331	-1.370	-0.691	-0.604	-0.726	-0.355
Written route	0.422	0.458	0.445	0.568	0.174	0.474	0.235
Virtual route	0.864	0.873	0.925	0.123	0.430	0.252	0.12
	43%	**45%**	**45%**	**17%**	**23%**	**23%**	**17%**
Visibility							
No	-0.697	-0.760	-0.754	-0.565	-0.906	-0.672	-0.398
Yes	0.697	0.760	0.754	0.565	0.906	0.672	0.398
	28%	**31%**	**30%**	**23%**	**40%**	**31%**	**27%**
Signs & Maps							
No	-0.643	-0.596	-0.549	-1.176	-0.214	-0.756	-0.398
Yes	0.643	0.596	0.549	1.176	0.214	0.756	0.398
	26%	**24%**	**22%**	**49%**	**9%**	**35%**	**28%**
Kiosk							
No	-0.077	0.001	-0.089	-0.259	-0.628	-0.256	-0.398
Yes	0.077	0.001	0.089	0.259	0.628	0.256	0.398
	3%	**<1%**	**3%**	**11%**	**28%**	**11%**	**28%**
Constant	**4.583**	**4.626**	**4.634**	**4.691**	**4.557**	**4.220**	**6.071**

Table D.5: Values of the regression coefficients - Education level

Attributes	WO	HBO	MBO	HAVO/VWO	LBO,MAVO, VMBO	No answer
App						
No	-1.306	-1.383	-0.643	-1.301	-0.09	-1.019
Written route	0.424	0.479	0.373	0.366	0.021	0.593
Virtual route	0.882	0.904	0.270	0.935	0.069	0.426
	42%	**48%**	**32%**	**38%**	**16%**	**47%**
Visibility						
No	-0.765	-0.653	-0.466	-0.847	-0.469	-0.278
Yes	0.765	0.653	0.466	0.847	0.469	0.278
	29%	**27%**	**33%**	**29%**	**29%**	**18%**
Signs & maps						
No	-0.661	-0.532	-0.492	-0.868	-0.537	-0.319
Yes	0.661	0.532	0.492	0.868	0.537	0.319
	25%	**22%**	**35%**	**30%**	**33%**	**21%**
Kiosk						
No	-0.088	-0.072	-0.004	-0.191	-0.531	0.222
Yes	0.088	0.072	0.004	0.191	0.531	0.222
	4%	**3%**	**<1%**	**3%**	**33%**	**14%**
Constant	**4.589**	**4.602**	**4.409**	**4.922**	**5.047**	**5.921**

Table D.6: Values of the regression coefficients - Travel motive

Attributes	**Commuting**	**Business**	**School,study**	**Holiday, day out**	**Family, friends**	**Different**
App						
No	-1.237	-0.171	-1.235	-1.306	-1.411	-0.972
Written route	0.416	0.453	0.442	0.307	0.540	0.194
Virtual route	0.821	0.718	0.793	0.999	0.907	0.778
	40%	**25%**	**41%**	**49%**	**47%**	**32%**
Visibility						
No	-0.762	-0.687	-0.764	-0.637	-0.659	-1.000
Yes	0.762	0.687	0.764	0.637	0.659	1.000
	30%	**38%**	**30%**	**26%**	**26%**	**37%**
Signs & maps						
No	-0.637	-0.645	-0.590	-0.558	-0.554	-0.708
Yes	0.637	0.645	0.590	0. 0.558	0.554	0.708
	26%	**36%**	**24%**	**24%**	**22%**	**26%**
Kiosk						
No	-0.101	-0.022	-0.119	-0.016	-0.131	0.146
Yes	0.101	0.022	0.119	0.016	0.131	0.146
	4%	**1%**	**5%**	**1%**	**5%**	**5%**
Constant	**4.592**	**4.536**	**4.662**	**4.618**	**4.672**	**4.424**

Table D.7: Values of the regression coefficients - Travel frequency

Attributes	**(Almost) never**	**6-11 days per year**	**1-5 days per year**	**1-3 days per month**	**1-3 days per week**	**4 days per week or more**
App						
No	-1.148	-1.331	-1.237	-1.345	-1.268	-1.269
Written route	0.338	0.486	0.314	0.388	0.455	0.485
Virtual route	0.810	0.845	0.923	0.957	0.813	0.784
	46%	**49%**	**45%**	**45%**	**39%**	**39%**
Visibility						
No	-0.527	-0.615	-0.661	-0.715	-0.841	-0.750
Yes	0.527	0.615	0.661	0.715	0.841	0.750
	25%	**27%**	**28%**	**28%**	**32%**	**29%**
Signs & maps						
No	-0.575	-0.463	-0.624	-0.635	-0.643	-0.750
Yes	0.575	0.463	0.624	0.635	0.643	0.750
	27%	**21%**	**26%**	**25%**	**24%**	**29%**
Kiosk						
No	-0.039	-0.077	-0.029	-0.076	-0.141	-0.095
Yes	0.039	0.077	0.029	0.076	0.141	0.095
	2%	**3%**	**1%**	**3%**	**5%**	**4%**
Constant	**4.420**	**4.696**	**4.578**	**4.553**	**4.778**	**4.571**

Table D.8: Values of the regression coefficients - Transfer frequency

Attributes	(Almost) never	6-11 days per year	1-5 days per year	1-3 days per month	1-3 days per week	4 days per week or more
App						
No	-1.231	-1.299	-1.325	-1.364	-1.246	-1.199
Written route	0.422	0.505	0.318	0.413	0.457	0.435
Virtual route	0.809	0.794	1.007	0.951	0.789	0.764
	53%	**54%**	**55%**	**52%**	**48%**	**51%**
Visibility						
No	-0.615	-0.648	-0.680	-0.774	-0.791	-0.732
Yes	0.615	0.648	0.680	0.774	0.791	0.732
	15%	**15%**	**16%**	**17%**	**17%**	**17%**
Signs & maps						
No	-0.646	-0.568	-0.573	-0.621	-0.694	-0.571
Yes	0.646	0.568	0.573	0.621	0.694	0.571
	30%	**27%**	**27%**	**27%**	**30%**	**27%**
Kiosk						
No	-0.050	-0.093	-0.046	-0.091	-0.115	-0.108
Yes	0.050	0.093	0.046	0.091	0.115	0.108
	2%	**4%**	**2%**	**4%**	**5%**	**5%**
Constant	**4.564**	**4.718**	**4.619**	**4.669**	**4.599**	**4.512**

Table D.9: Values of the regression coefficients - Transfermode

Attributes	Bus	Tram	Metro	OV-Bike	None
App					
No	-1.276	-1.104	-1.415	-1.453	-1.224
Written route	0.477	0.298	0.491	0.405	0.371
Virtual route	0.799	0.806	0.924	1.048	0.853
	41%	**39%**	**46%**	**46%**	**44%**
Visibility					
No	-0.751	-0.709	-0.647	-0.794	-0.631
Yes	0.751	0.709	0.647	0.794	0.631
	30%	**29%**	**25%**	**30%**	**27%**
Signs & maps					
No	-0.642	-0.633	-0.610	-0.554	-0.589
Yes	0.642	0.633	0.610	0.554	0.589
	25%	**26%**	**24%**	**21%**	**25%**
Kiosk					
No	-0.099	-0.131	-0.125	0.093	-0.081
Yes	0.099	0.131	0.125	-0.093	0.081
	4%	**5%**	**5%**	**3%**	**3%**
Constant	**4.552**	**4.751**	**4.580**	**4.684**	**4.625**