# Integration of shared transport at a public transport stop: the intention to use means of transport in a multimodal transport system

J.S. Horjus
Master Thesis – Civil Engineering and Management – University of Twente
Internal supervisors: Prof. dr. ing. K.T. Geurs and Dr. K. Gkiotsalitis
External supervisor: S. Nijënstein MSc.
December 10, 2021

**Abstract**

This paper describes the results of a survey (N=710) surrounding the case study of Leyenburg, The Hague in which a scenario of integrating shared mobility at an existing public transport stop is proposed. This study aims to determine the intention to use shared and public transport in a multimodal transport network and the factors and user characteristics that affect this intention. As digital technologies become important in the integration of modalities by offering digital planning and payment options, it has raised a discussion regarding digital exclusion in transport services. Therefore, people's level of digital skills is included in this study as one of the user characteristics. Overall, of all the respondents, 15.7% intent to use the shared motor scooter, 15.0% intent to use the shared bicycle, and 10.8% intent to use the shared car when these modalities are made available at the public transport stop Leyenburg. A majority of the people who intent to use shared transport have not used it in the past year. The intention to use the bus or tram indicates a potential growth of the number of users when compared to the number of people currently using the bus or tram during their trip. From the group of people who intent to use the bus or tram, 64.8% of the respondents, around a quarter are currently not using it. Using an ordinal logistics regression analysis, the study has found that the intention to use shared transport is higher for people who are younger, have a high level of education and a high level of digital skills. In addition, having prior experience with shared transport in the past year and currently using multiple means of transportation during the trip are positively affecting the intention to use shared transport. The intention to combine shared transport with the bus or tram during a trip is similar to the intention to use shared transport and is related to similar characteristics, except for education. The intention to use the bus or tram is found to be mainly related to current transport usage and trip-specific factors and not to other user characteristics. For transport providers the results provide, among others, evidence that offering the shared motor scooter and bicycle would target the largest potential user group which are mainly young and highly educated people who also intent to combine the use of shared and public transport.

*Keywords*: shared mobility, multimodal transport, public transport, intention to use, digital skills

## 1. Introduction

The current growth of mobility in urban areas combined with the climate crisis has led to an increase in attention for sustainable transport in Europe and its development. Consequences of this growth are, for example, an increase of congestion, air pollution, noise pollution and stress for traffic safety (European Commission, 2017) (Hannon, McKerracher, Orlandi, & Ramkumar, 2016). These have led to sustainable transport related objectives in the European Commission's Green Deal document (European Commission, 2019). However, the increase of private car use is one of the main social transformations that has contributed to the growth of urban mobility and this also affects issues such as social development, social exclusion, and accessibility for people with reduced mobility (European Commission, 2017) (Schipper, Emanuel, & Oldenziel, 2020). In addition to traffic congestions, private car ownership also creates an increasingly difficult challenge for spatial development in dense urban areas. In the Netherlands, developers and municipalities are considering measures to reduce the parking need and thereby the space needed for parking (CROW, 2021). Hence, to address all these issues and improve transport sustainability, policies should expand beyond the common focus of reducing air pollution caused by cars.

The Green Deal document focusses not only on alternative fuels and clean vehicles, such as electric cars, but also on multimodal mobility systems as part of the sustainable solutions to the mobility issues described above, particularly in urban environments (European Commission, 2019). A multimodal mobility system is mostly used to describe the offering of multiple modes of public and shared transport in an integrated system. Here, shared mobility can be defined as the short-term access to shared vehicles according to the user's needs and convenience instead of owning a vehicle (Shaheen, Chan, Bansal, & Cohen, 2015).

The promotion of public transportation in its current form is seen as a way to address the sustainability impacts that are caused by high levels of private car ownership (Miller, de Barros, Kattan, & Wirasinghe, 2016). In addition, shared mobility is considered to be a promising new mobility system in the development towards sustainable transport, especially as it is able to address traffic congestion and $CO_2$ emissions (Rabbitt & Ghosh, 2016) (Taylor, et al., 2016). Furthermore, it is one of the measures proposed to reduce the parking need in urban areas (CROW, 2021) (Jorritsma, Witte, Alonso González, & Hamersma, 2021). Overall, developing and promoting public and shared transportation systems is considered as a way to address the issues regarding the ownership and usage of private cars.

However, attempts to promote a more frequent use of public transportation have only seldomly been successful (Spickermann, Grienitz, & von der Gracht, 2014). In addition, extracting the potential sustainability benefits of shared mobility requires an understanding on how to integrate shared mobility into the existing urban transportation system and improve its efficiency from social, environmental, and economic perspectives (Machado, De Salles Hue, Berssaneti, & Quintanilha, 2018). Nevertheless, combining the offering and promotion of shared mobility services with public transportation is seen as a way to address the growing pressure on urban transport systems as the various transport modes can together serve as a substitute to the private vehicles (Kamargianni, Li, Matyas, & Schäfer, 2016). Such an integrated system should offer more variety of transport by adding shared modalities while

being better able to integrate them within the existing urban transportation by building upon the foundations of public transport. However, other studies have shown that shared modalities compete with public transport, walking, and cycling without reducing the use of the private car. For car sharing, the study of Ruhrort (2020) showed that station-based services lead to a net reduction of car ownership. Shaheen, Cohen and Zohdy (2016) found that free-floating services contribute to a reduction of cars on the road, while Hülsmann et al. (2018) found that free floating car sharing does not negatively affect public transport use, but also does not reduce user's car ownership or transport-related $CO_2$ emissions. Two studies regarding bicycle sharing in the Netherlands showed that shared bicycles are often used as substitute for the bus, tram, metro, walking, using a private bicycle (Jorritsma, Witte, Alonso González, & Hamersma, 2021) or even the car (Ma, Yuan, Van Oort, & Hoogendoorn, 2020). Hence, it is important to ensure that shared and public transport complement each other in order to serve as an attractive alternative to private vehicles.

The integration of multiple transport modalities can be divided into a digital and a physical component (Zeng, Hidalgo, Mackie, & Schleeter, 2014). The digital integration encompasses the building blocks of information and fare integration, which are often aimed to be manageable by both service providers and passengers via digital information system on a real-time basis. The integration of infrastructure and operations of public transport and shared modalities is referred to as the physical integration (Zeng, Hidalgo, Mackie, & Schleeter, 2014). A physical location which enables, at a minimum, the physical integration of different means of transport is often described as a mobility hub. One of the general definitions of mobility hubs is: "recognisable places with an offer of different connected transport modes supplemented with enhanced facilities and information features to both attract and benefit the traveller" (CoMoUK, 2019). Creating hubs will require space, which as previously mentioned is already limited in urban areas. However, the availability of alternative transport at mobility hubs is expected to lead to the reduction of privately owned vehicles which will offset the initial space it costs to create a hub (Witte, Alonso-González, & Rongen, 2021).

In addition to the technical and organisational difficulties of digital and physical integration, this paper will consider the user-perspective as it requires a significant shift in people's behaviour to start using new or different means of transport. Hence, an understanding of what drives people in deciding whether to use the integrated transport system would improve the ability to develop an integrated transport system which is able to compete with private vehicles. To be a viable alternative, existing public transport users should value the integration of modalities, while it should also attract existing car and other private vehicle users to such a degree that they will reduce the use of these vehicles. The ambition is that the integration of public and shared mobility services can make both services more accessible and useful to a larger user group. However, literature published on this topic note that this can only be achieved if the barriers of making an effective scheme of shared mobility are accounted for during the integration process. Some of the important factors in addressing these barriers are inclusiveness, accessibility regardless of levels of ability, equity

in terms of fair distribution of cost, and a citizen-oriented approach where the users' needs are central (Machado, De Salles Hue, Berssaneti, & Quintanilha, 2018).

Various studies have recently attempted to determine factors that relate to people's decisions to use various modalities (see Chapter 2). These factors include user characteristics, such as age and education, and transport system characteristics, such as performance and the required effort to use it (Jahanshahi, Tabibi, & van Wee, 2020). The relationship between user characteristics and people's intention to use means of transport will contribute to understanding the potential of the various means of transport at a mobility hub and help identify possible limits of the systems in terms of, for example, inclusivity. Regarding inclusivity, people's digital skills can be an important user characteristic to consider as it describes people's ability and willingness to operate connected devices, regardless of their access to these devices (Durand & Zijlstra, 2020). Differences in the level of digital skills will especially be an apparent issue for accessibility and inclusivity of multimodal transport systems when the digital integration component becomes more important in the development of these systems (Shaheen & Cohen, 2018).

This study aims to determine the intention of potential users to use shared mobility and public transport when offered in an integrated transport system and differentiate this intention for various user segments. With this aim, the study contributes to both policy makers' and transport providers' attempts to create integrated transport systems that increase the use of shared and public transport. The research questions are defined as follows:

- What is people's intention to use the shared car, shared bike, and shared motor scooter when they are offered at a mobility hub together with the public transportation of bus and tram and how does this compare to the existing transport usage?
- Which user- and transport characteristics are related to people's intention to use any of the transportation offered at the mobility hub and affect the potential uptake of the multimodal transport system?

This paper addresses these questions by means of a case study concerning the existing public transport stop Leyenburg in the Dutch city of The Hague. A survey is conducted within the area of this case study in collaboration with the city's public transport company HTM. Chapter 2 contains a literature review on determining people's intention to use a mean of transport and the factors that can be related to this intention. Hereafter, Chapter 3 will provide more details about the methodology, including the case study, survey, and data analysis. In Chapter 4, the representativeness of the analysis will be discussed, and the study's results will be presented. Finally, Chapter 5 and 6 will contain the discussion and conclusion, respectively.

## 2. Literature review

The concept of shared mobility and its effect on existing transportation has increasingly been addressed in academic literature. The integration of public transport with shared transport in a multimodal system has also received growing attention, especially concerning the concepts of mobility hubs and digital integration of transport. Regarding this study's aim, a review will be provided of the literature in these domains covering the understanding of

people's intention to use a mean of transport and the characteristics of these potential transport users.

### 2.1. Intention to use a new transport system and the related factors

Determining the potential uptake of the multimodal transport system requires an understanding of the public's acceptance or rejection of this system as, according to Jahanshahi, Tabibi and van Wee (2020), "it has important implications on the success of attempts to persuade behaviour modification". In the case of this study, the desired behaviour modification is to get people to use one of the multiple means of transport at the hub for a trip or to conduct trips that combine multiple modalities. To understand what makes people modify their current behaviour, different researchers have studied theories and tried to develop models that could describe people's acceptance or rejection of ideas (Jahanshahi, Tabibi, & van Wee, 2020). In recent years, the Unified Theory of Acceptance and Use of Technology (UTAUT) model developed by Venkatesh, Morris, Davis and Davis (2003), Venkatesh, Brown, Maruping and Bala (2008), and Venkatesh, Thong and Xu (2012) is adapted and applied in the transportation research domain. The models contain various factors that are considered to influence people's intention to use a system.

Adapting from these original models and the methodology of Jahanshahi, Tabibi & van Wee (2020), as this is one of the most recent studies to apply the UTAUT model in a transportation context, the theoretical framework in Figure 1 presents, among others, these factors. Appendix 2A contains an overview of the original UTAUT constructs and provides studies that have used and proven the relation of these variables to the intention to use, for example, a mean of transport. The theoretical framework contains adaptations of the original UTAUT constructs of *Performance Expectancy, Effort Expectancy*, *Social Influence, Facilitating Conditions*, *Price Value,* and *Perceived Safety* to suit the purpose of this study. They are referred to as the general barriers to use transport. As such, the relation between the transport barriers and the intended use behaviour can be evaluated in this study. Travel time and number of transfers are used as transport barriers adapted from the UTAUT construct of *Performance Expectancy*. From the *Effort Expectancy,* multiple payment methods and ease of use are considered as factors. The remaining UTAUT constructs are adapted to, in respective order, the transport barriers of the opinion of others, facilities at public transport stops, travel costs, and feeling safe.

In addition, various user characteristics are considered in UTAUT models for transport such as age, gender, income, and education (Jahanshahi, Tabibi, & van Wee, 2020) (Venkatesh, Morris, Davis, & Davis, 2003) (Venkatesh, Thong, & Xu, 2012). Travel behaviour is added in this study as an adaptation of the experience variable found in the original UTAUT models. It encompasses the experience with transport such as cars, public transport, and existing shared means of transport. Finally, based on the importance of an individual's capabilities to being able to access transport systems, two additional user-characteristics are considered. Physical abilities are included as people with limited physical abilities can experience certain types of transport as less accessible and inclusive than others,

compared to people without these limitations (Kett, Cole, & Turner, 2020). The final variable is that of personal digital skills of which the current literature will be reviewed in section 2.3.

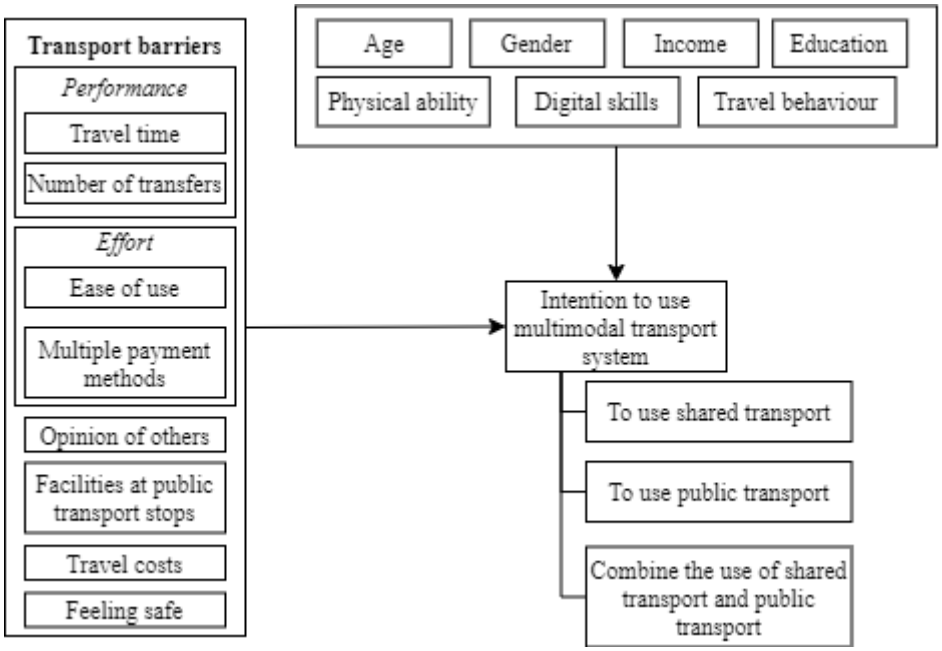


Figure 1 – Theoretical framework adapted from the UTAUT model (Venkatesh, Morris, Davis, & Davis, 2003) (Venkatesh, Thong, & Xu, 2012) and its recent application to the transport domain by Jahanshahi, Tabibi & van Wee (2020).

## 2.2. User characteristics of shared transport users

Following the user characteristics from section 2.1, literature is reviewed that has tried to determine their effect and relation in the domain of shared and multimodal transport systems. The success of new modalities and transport systems is influenced by the usage of the systems, which has led to a significant number of research aiming to characterise the users. Studies on bicycle sharing in five cities across the United States, Canada, and Mexico City in 2012 and 2013, showed that, in comparison with the general population, people that use shared bicycles tend to be wealthier, higher educated, younger and more often male (Shaheen, Martin, Chan, Cohen, & Pogodzinski, 2014) (Shaheen, Cohen, & Zohdy, 2016). A more recent study in The Netherlands, looked at the impacts on modal shift by comparing station-based and free-floating bicycle sharing systems (Ma, Yuan, Van Oort, & Hoogendoorn, 2020). It showed, for example, that male and multimodal commuters are more likely to use free-floating bicycle sharing. Another study in the Netherlands showed more than half of the Dutch car sharers is between 31 and 50 years old and slightly less than one-third is younger than 30 (Jorritsma, Witte, Alonso González, & Hamersma, 2021). It also found a relation between a higher shared car usage and single person households or households without children. In addition, the study found that primarily young people, males, and highly educated people use the shared bicycle.

Besides characterising users of these shared modalities, people that use multiple modalities during a single trip are also characterised in studies. Based on data from 2015 till

2017, research of KiM (2019) in the Netherlands determined that the use of multiple modalities in a single trip is higher for people aged between 18 and 30 years, with a higher income, with higher education, and for people that face a lower car availability. In addition, the level of urbanisation and trip motive affect people's decision of using multiple modalities in a single trip rather than one (KiM, 2019).

### 2.3. Digital skill as user characteristic affecting travel behaviour

The digitalisation in transport services, among which the mentioned aspects of digital fare and information integration, provides various advantages to multiple parties (Durand & Zijlstra, 2020). For travellers, the digitalisation in transport means instant access to travel information, and increased levels of customisation and flexibility. However, at the same time, the increased use of such digital technologies creates new rules which impose new requirements on (potential) users. Examples of such rules are the smart public transport cards (OV-chipkaart in the Netherlands) and the central role the smartphone has taken in the last decade (Durand & Zijlstra, 2020). Not everyone can or wants to follow the pace of these digital developments in transport services. From a literature review, Durand and Zijlstra (2020) show that this digital inequality is a complex and gradual process in transport services. Besides the access people have to electronic devices and an internet connection, the range of what they are able and willing to do with them also matters and is not directly dictated by their material access (Zhang, Zhao, & Qiao, 2020).

Online travel information makes it easier to access and possibly understand information that was previously unavailable or hard to find (Durand A. , Zijlstra, van Oort, Hoogendoorn-Lanser, & Hoogendoorn, 2021). With this reasoning, digital services can reduce the resistance to use transport services, especially for inexperienced users. However, people with a lack of knowledge on how to operate a smartphone and use features applied in online travel information services have, in general, a higher likelihood of having restricted access to this travel information (Zhang, Zhao, & Qiao, 2020).

The digital skills that are needed in transport services can be described as two types: medium- and content-related skills. Medium-related skills are the skills that relate to operating a digital medium. They are required to successfully develop content-related skills (Van Dijk & Van Deursen, 2014). Content-related skills relate to skills such as searching, finding, processing, and critically assessing information (Van Dijk & Van Deursen, 2014). In transport, if the experienced difficulty of selecting the right piece of travel information is too high it can result in people abandoning their journey (Lamont, Kenyon, & Lyons, 2013).

The digitalisation that is linked to the integration of shared and public transport will increase the necessity of digital skills to be able to use these types of transportation. Therefore, having a low level of digital skill becomes an additional barrier to transport and people with reduced digital skills might see their mobility options remain the same or even shrinking (Durand & Zijlstra, 2020). Following this trend, there is a risk of polarisation due to the digitalisation in transport services, which could result in transport-related social exclusion (Durand & Zijlstra, 2020).

Even for general purposes, Non, Dinkova & Dahmen (2021) concluded that around 23 percent of the Dutch respondents do not possess basic level of digital skills based on a survey of the OECD (2013). This survey used a computer-based skill test in which the digital skills, focussed around problem-solving in the technology-rich environments domain, were measured by letting respondents perform several tasks using mock-up websites and spreadsheets (Non, Dinkova, & Dahmen, 2021) (OECD, 2016). Based on Eurostat measurements collected from self-reported measures of the ability to perform tasks, around 20 percent of respondents aged 16 to 74 years in the Netherlands did not possess at least the basic level of digital skills in 2019 (Eurostat, 2021). From the same data, however, around half of the respondents from the Netherlands did possess an "above basic" level of digital skills in 2019, compared to the 33 percent average in the European Union (CBS, 2020a).

In addition to measuring the level of digital skills, studies have tried to link digital skills to certain demographic variables. The study of Non, Dinkova and Dahmen (2021), using the data of the OECD (2013), shows that regarding people on the Dutch labour market, the individuals with low digital skills are generally older, lower educated and more often female. Additionally, based on a literature study, Durand, Zijlstra, van Oort, Hoogendoorn-Lanser and Hoogendoorn (2021) conclude, in general, older people with lower income and education, and those who are part of minority groups are more vulnerable to digital exclusion from transport services.

### 2.4. Research gap and contribution of paper

From the literature above, most studies have focussed on understanding the modal shift caused by shared transport and the characteristics of the users of these new shared mobility systems. A study of KiM (2019) has found characteristics of people that use multiple modalities during a trip, but this characterisation is not linked to specific modalities. To understand the benefits of integrating shared and public transport, both physically and digitally, this paper focusses on understanding which factors influence the intention to use modalities in the system, including public transport, and how these factors compare for the various modalities.

In addition, with the development of shared transport, the digital component in transport is growing as some of the shared mobility systems offer only digital options to plan and pay a trip with a vehicle (Durand & Zijlstra, 2020). However, as seen in the literature above, various levels of digital skills exist, and a lack of these skills can result in transport-related social exclusion. Hence, this paper will study if digital skills affect people's intended use behaviour of transport modalities to get a better understanding of the possible extent of this transport-related social exclusion. In addition, the digital skill measures found in literature would only partly represent the presence of skills needed to operate the developing digital platforms for transport services. Hence, this study will develop a digital skill measure that reflects one's ability to perform tasks that are inherent to the digital services seen in the transport sector. This measure allows to evaluate the potential digital exclusion that can be caused by the digitalisation in transport, as seen in multimodal transport systems.

## 3. Methodology

To study this intention to use shared transport modes at a mobility hub a survey is conducted concerning a theoretical mobility hub based on an existing public transport stop. The mobility hub is defined as a location that combines the offering of the bus and tram together with the transport means of shared car, shared bicycle, and shared motor scooter. To understand the context of the results that will be presented in Chapter 4, the methods of this study will be stated below.

### 3.1. Case study

To conduct this survey, a case study has been developed in collaboration with HTM, a public transport company in the city of The Hague. The case study concerns the public transport stop Leyenburg in The Hague. This stop includes the transport modes of bus, tram, and HTM's 'HagaShuttle', a self-driving minibus. It is also located in a drop zone for the 'HTM fiets' and shared motor scooters from various providers can be used in the area surrounding the stop. The 'HTM fiets' is a bicycle sharing system using 65 designated drop zones where the bicycles (in total around 500) can be picked-up or returned. The use of these bikes is facilitated purely by the means of a separate app. Currently, a significant amount of these drop zones is located close to or at public transport stops (van Marsbergen, 2020).

For HTM, the average number of passengers getting into a bus or tram at Leyenburg on a working day pre-COVID-19 was 5,021 in October 2019. During the COVID-19 pandemic the number of passengers was 3,002 in September 2020 and 2,263 in March 2021. Overall, this classifies the stop Leyenburg as among one of the 20 busiest stops for HTM (HTM, 2021a). The public transport stop serves as a connection to the public transport network for people living in surrounding neighbourhoods and the people travelling to or from the hospital 'het HagaZiekenhuis'. In addition, it is used by travellers to switch between different vehicles in the public transport network, for example from bus to tram. In the summer of 2019, HTM started operating the self-driving minibus the HagaShuttle between the stop het the main entrance of the hospital as a last-mile connection (HTM, 2021b). However, during this research, the HagaShuttle was out of service. Overall, this variety of characteristics, such as being an important public transport connection for a neighbourhood, facilitating transfers between public transport modes, while also serving an important destination in the form of a hospital make this stop a suitable case to include people with a variety of travel behaviour in this study.

### 3.2. Survey

To collect the data required to address the paper's research questions, a survey has been developed that targets the following three groups of either current or potential users of the public transport stop:

- The public transport users currently travelling from, to, or via the stop Leyenburg.
- The visitors of 'HagaZiekenhuis'.
- People living in the vicinity of the stop Leyenburg.

Among the latter two groups is a mix of public transport users and non-public transport users which allows for an appropriate reflection on the views that both predominantly car and public transport users have on the potential mobility hub with integrated shared mobility. Both a paper and a digital version of the questionnaire were used to reach the three target groups. A flyer was created with a QR-code and a weblink that both direct to the digital questionnaire made using Qualtrics software (Qualtrics, 2021). The flyer is depicted in Appendix 3A. The paper-version of the questionnaire, see Appendix 3B, consists of four pages and was offered together with a return-envelope addressed to HTM. In an attempt to increase the response rate an incentive of a chance to win one of five gift cards worth 20 euros each was added.

The digital questionnaire was open from June 21st, 2021, to August 1st, 2021. During a period of two weeks, starting at June 21st, flyers and the paper version of the questionnaire were distributed among the three target groups. In addition, during the time of this distribution, a sandwich board was placed at the public transport stop containing the same information as the flyer. Finally, the digital version of the questionnaire was also shared on the website and social media page of HTM and on the internal platform for employees of the hospital.

In total around 4290 flyers have been distributed of which 2910 flyers were received by households in either their mailbox or by handing it to them in person (103 of the 2910 flyers) in the area surrounding the Leyenburg stop. The remaining flyers were distributed to people at the public transport stop and outside of the HagaZiekenhuis. The digital response rate because of the flyers is 8.11% (N=348). In addition, 146 paper questionnaires have been handed to people that indicated they preferred the paper version of which 131 were handed out at the public transport stop of in front of the HagaZiekenhuis. The other 15 were handed to people from households that were approached in person in a selected area in the neighbourhood based on the characteristics of age, income, and type of housing obtained from a CBS data set of 2017 (CBS, 2017). Overall, 48 responses were received on paper, resulting in a response rate of 32.88%.

Both the digital and paper version of the questionnaire were available in English and Dutch (see Appendix 3B and 3C, respectively). An English translation was offered to give more people the opportunity to participate, as a majority of citizens in The Hague have a migrant background (55.7%) and Dutch might not be their preferred language (Den Haag, 2020). A person with a migrant background is someone of which at least one of the parents is born outside the Netherlands (CBS, 2021). In addition, in literature, a relation is noted between ethnicity and digital skills (Durand A. , Zijlstra, van Oort, Hoogendoorn-Lanser, & Hoogendoorn, 2021) and therefore it is tried to make the questionnaire more accessible by offering another language besides Dutch. During the development of the questionnaire, it was tested and read in advance by 10 people, consisting of friends, family, employees of HTM and researchers from the University of Twente.

The content of questionnaire consists of four parts:

- 1 - Personal experience in travelling and digital activities in the past year

- 2 - Importance of the transport barriers
- 3 - Travelling to/from Leyenburg and the intention to use transport in the mobility hub scenario
- 4 - Personal information

Parts 1,2, and 4 contain questions concerning the factors and user characteristics included in the theoretical framework that might be related to people's intention to use certain means of transport in the multimodal transport system at the hub. For the digital activities, the questions ask about the frequency of performing activities that relate to the components of information/planning and payments on a smartphone. These two components were found to be key in the digital integration of multiple means of transport, as mentioned in Chapter 1.

These digital activities are used to measure people's level of digital skill relevant for app-based transport services based on the following self-constructed scale. Except for the first category, which will represent person's with no relevant digital skills at all, the categories will represent different levels of content-related skills that, as discussed in section 2.3, relate to, among others, searching, finding, processing and critically assessing information (Van Dijk & Van Deursen, 2014). The two questions related to the frequency of using an app to plan a trip with either public transport or one's own transport are evaluated together as a measure of the planning component. Only one of the two activities has to meet the requirement of the scale for it to qualify for that level. Hence, the experience of planning a trip via an app is included in the scale, irrespective of their preferred type of transport. The digital payment component for digital skills is included by considering the activity of using an app to transfer money to someone. The activity of using tap-to-pay is asked in the questionnaire but ultimately not included in the digital skill scale as the access to this feature is not equally shared among all people because not all banks support this feature. Moreover, due to correlation with someone's prior experience of using a shared means of transport, the activity related to the experience of reserving a mean of transport is not incorporated in the digital skill scale. This is done to prevent making it impossible to interpret the influence of digital skills on the intention to use a certain mean of transport. Nevertheless, the frequency of performing activities related to the components of planning and digital payment are used in the digital skill scale consisting of four categories with the following labels:

- Level 0 – No skills at all – No access to a smartphone, so not even general medium or content-related skills have been developed.

  A person in this level has not had any access to a smartphone in the past year.
- Level 1 – Low level of skills – used a smartphone but not frequently performed planning activities via an app.

  A person in this level has used a smartphone in the past year.
- Level 2 – Medium level of skills – used to plan a trip using an app but less used to do digital payment activities via an app.

  A person in this level has also, in addition to the above, planned a trip with either their own transportation or PT using an app at least *often*.

- Level 3 – High level of skills – used to do both planning and payment/reserving related activities via an app.

  A person in this level has also, in addition to the above, used an app to transfer money to someone at least *often*.

Part 3 of the questionnaire covers people's intention to use the various means of transport. The respondents are asked about this intention by sketching a scenario in which they would repeat a previously executed trip when shared mobility would be present together with the existing public transport near the origin of their trip. If they started their trip in the vicinity of the public transport stop Leyenburg, this was specifically mentioned as the location where the shared car, bicycle, and motor scooter would become permanently available at a fixed location close to the existing public transport (bus and tram). As the choice of mean of transport is often determined at the origin of the trip, people that indicated the area of Leyenburg to be the destination of their trip were provided a slightly different scenario. Here, the created scenario described the situation where the shared modalities would be permanently available at a public transport stop near their home. The statements related to the intention to use transport were asked for a future trip from the respondent's home to their destination in the area of Leyenburg. Regarding the digital integration of the modes, it was stated that trip could be planned, reserved, and booked using an app on a smartphone. The complete scenario description can be found in the questionnaire itself in Appendix 3B. Finally, part 3 of the questionnaire contained a few questions to control for the circumstances of the specific trip for which the statements about the 'intention to use' were answered.

### 3.3. Data analysis

The survey resulted in N=710 usable responses for the analysis after removing the empty responses and the responses of people indicating to be younger than 18. Using these responses, various descriptive statistics are obtained for the variables that contribute to the understanding of the respondent's user characteristics, including digital skills, and the intention to use shared and public transport. To analyse the relation between variables of intention to use a certain means of transport and the factors like the transport barriers and the user characteristics, a subset of responses is used containing N=538 cases. These cases are retained because they contained answers to at least one of the questions related to the intention to use means of transport. The study's main result will originate from an ordinal logistic regression analysis aimed to determine the influence of the independent variables of user characteristics, transport barriers, and other trip-specific factors on the dependent variables of intention to use types of transport in the multimodal transport system. For a more detailed definition of an ordinal logistics regression analysis and the statistics involved in the analysis, see Appendix 3D.

The analyses were executed using the software SPSS statistics. For the ordinal logistics regression analyses, the assumption of proportional odds is considered by using the test of parallel lines, where the assumption is upheld if the test is not significant (Liu, 2009). Additionally, the collinearity diagnostics of SPSS Statistics are used to check that there is no

multicollinearity among the independent variables. Here, tolerance values less than 0.1 (Menard, 1995) and VIF values greater than 10 (Myers, 1990) are considered to indicate an issue of collinearity among the independent variables.

An ordinal logistic regression analysis was executed three times, once for every ordinal dependent variable listed in Table 1 that refer to people's intention of using a certain mean of transport or combining the use of shared transport with the bus or tram. For each of the analyses, the same set of independent variables are used, as presented in Table 1. The Kendall's Thau correlation values among the ordinal independent variables do not exceed $\tau$= +/-.35 (see Appendix 3E for the complete results). Hence, none of the independent variables are omitted because of strong correlations between them.

Table 1 – List of variables included in the model for the ordinal logistic regression analysis.

| Independent variables | | Dependent variables |
|---|---|---|
| Frequent Car User | Country of birth | Intention to use shared transport |
| Frequent PT User | Limited physical ability | Intention to use bus or tram |
| Shared transport experience | Household composition | Intention to combine use of shared transport with the bus or tram |
| Digital skills | Transport barrier (TB) – Performance Expectancy | |
| Frequency of trip | TB – Ease of use | |
| Location of trip | TB – Multiple payment methods | |
| Origin/destination of trip | TB – Facilities at PT stops | |
| Nr. of transport means used during trip | TB – Feeling safe | |
| Gender | TB – Travel costs | |
| Age | TB – Opinion of others | |
| Education | | |

To satisfy the requirements of the ordinal regression analysis, three dummy variables are created for the nominal variable of household composition as it contained more than two categories. The dummy variables are created for the categories of *single parent*, *two persons without child(ren)*, and *two-parent*, with the category *single person* being the reference category. For people's current travel behaviour, three variables are extracted from the questions; one indicating if someone used a car at least weekly, one indicating if someone used public transport (train, bus, tram or metro) at least weekly, and finally a variable indicating if someone had any experience in the past year with either the shared car, shared bicycle, or shared motor scooter. Additionally, multiple independent variables are obtained by combining the results of several questions in the questionnaire. First, using a Principal Component Analysis (PCA) and Cronbach's alpha ($\alpha$) it is checked if the questions for the transport barriers related to Performance Expectancy (PE) and Effort Expectancy (EE) can be combined into their respective higher-level constructs. Only for PE this was found to be the case and with $\alpha = 0.63$ there is no reason to neglect the ability of the PE variable to describe the results of the two questions. See Appendix 3F for more details. For EE, the question

related to ease of use and the question related to having multiple payment methods for transport were not found to measure the construct of EE, with $\alpha = 0.43$ supporting this. Hence, both questions are kept as individual variables in the model for the ordinal logistic regression analysis. Secondly, the dependent variables describing people's intention to use means of transport include the results for both mobility hub scenarios used in the questionnaire. The two scenarios were used to make the situation clearer for the respondents, but to determine the general intention to use the means of transport, a distinction between the scenarios is not needed. The variable indicating which scenario the respondents answered the statements about (origin/destination of the trip) will however be considered during the analyses to control for unforeseen dependencies. In addition, the questions related to the intention to use a shared car, shared bicycle or shared motor scooter in the mobility hub scenarios are used to construct a new variable indicating the intention to use any of these shared means of transport. The highest response on any of these three questions is transferred to the new variable which then contains the same ordinal scale of disagree, neutral, agree.

A final important note regarding the methodology is that household income is not included as independent variable in the model because of the low number of useful responses on the related question. Only 354 out of the 538 responses for the regression analysis were useful for the income variable. A Kendall's thau correlation analysis shows a moderate and positive correlation of a person's income with the education variable ($\tau$=.29, p<.001) for the 354 useful responses. Hence, the level of education will be used as an indicator of the level of household income to be able to consider this variable in further analyses and conclusions in line with the study's theoretical framework.

## 4. Results

To answer research questions, this chapter will detail the results of the survey and the related data analysis. The first two sections will describe characteristics of the respondents, among which their representativeness compared to larger populations. Hereafter, the focus will be on the mobility hub scenario and the analysis of people's behavioural intention towards the use of means of transport in a multimodal transport system. This includes, in the final section of this chapter, the results of ordinal logistic regression analysis concerning the model as detailed in the section above.

### 4.1. Socio-demographic characteristics and representativeness of sample

The socio-demographic characteristics of the respondents are explored and compared with larger populations to check the representativeness of the collected data. Table 2 provides an overview of these characteristics and the distribution of all the respondents among the different categories.

The main comparison is made between the survey's respondents and the population of the municipality of The Hague, as most of the respondents live in The Hague. The data of the population is obtained from the Municipality of The Hague (2021) and CBS (2020b), the Dutch national statistical office. As can be seen in Table 2, the data from the survey has a higher response from females (59%) compared to the almost equal distribution of male

compared to female as is present in the population of The Hague. For the different age classes, a bias can be noted towards more people of age 55-74 years and less people of age 18-54 years compared to the population of the Hague. In addition, the respondents of the survey contain more highly educated (48.3%) and less low educated people (16.0%) compared to the general population (32.1% and 31.5%, respectively). Finally, for the household composition, the significant difference can be found in having less one-person households and more multiple-person households without children compared to the municipality statistics. Overall, these biases towards more female and higher educated respondents are not unexpected for a survey. In addition, the strong representation from older age categories is explained by the distribution strategy and might be caused by the hospital visitors among the respondents.

Table 2 – Summary of socio-demographic characteristics of the survey's respondents and corresponding percentages for the population of The Hague. The data for the population of The Hague for the variables of gender, age, and household composition originates from the Municipality of The Hague (2021) and the distribution of education levels from a study of CBS (2020b) which used data from the year 2018.

| | Sample Survey | Population The Hague | | Sample Survey | Population The Hague |
|---|---|---|---|---|---|
| **Gender** | N=575 | | **Household composition** | N=556 | |
| Male | 40.3% | 49.8% | One person | 33.9% | 47.1% |
| Female | 59.0% | 50.2% | Single parent | 7.3% | 9.3% |
| Other | 0.7% | | Two person without children | 33.7% | 22.6% |
| **Age** | N=557 | | Two-parent | 24.7% | 21.0% |
| 18-24 years | 9.9% | 11.5% | **Income household** | N=385 | |
| 25-34 years | 17.2% | 19.4% | < 25,000 euros | 19.2% | |
| 35-44 years | 12.7% | 18.2% | 25,000-45,000 euros | 45.7% | |
| 45-54 years | 16.0% | 17.7% | > 45,000 euros | 35.1% | |
| 55-64 years | 19.4% | 14.7% | **Country of birth** | N=563 | |
| 65-74 years | 17.4% | 10.9% | The Netherlands | 88.3% | |
| ≥ 75 years | 7.4% | 7.6% | Outside of the Netherlands | 11.7% | |
| **Education level** | N=574 | | | | |
| Low | 16.0% | 31.5% | | | |
| Middle | 35.7% | 36.4% | | | |
| High | 48.3% | 32.1% | | | |

Due to the distribution strategy, a large portion of the respondents are from a specific area surrounding the public transport stop Leyenburg. Hence, a sample of respondents from five PC4 areas (N=329) is compared with data from CBS (2020c). The five PC4 areas correspond with the area in which the flyers were distributed to collect responses for the survey. The comparison for this sample with the corresponding population showed very

similar results as the previous comparison of all respondents with the population of The Hague.

Table 3 – Comparison of socio-demographic characteristics of: shared bicycle users among survey respondents and HTM-fiets users (data from van Marsbergen (2020)); and public transport (bus, tram metro) users among the survey respondents and those from the 2017 OViN dataset for the municipality of the Hague (CBS & RWS, 2017). *The latter comparison only includes people that use public transport at least once a month.

| | Shared bicycle user | | Bus, tram metro user* | | | Shared bicycle user | | Bus, tram metro user* | |
|---|---|---|---|---|---|---|---|---|---|
| | Sample N=56 | HTM N=156 | Sample | The Hague N=452 | | Sample N=56 | HTM N=156 | Sample | The Hague N=452 |
| **Gender** | | | N=355 | | **Education level** | | | N=355 | |
| Male | 46.4% | 66.7% | 38.6% | 38.7% | Low | 10.7% | 3.2% | 16.3% | 18.4% |
| Female | 51.8% | 31.4% | 60.8% | 61.3% | Middle | 21.4% | 17.3% | 36.9% | 31.0% |
| Other | 1.8% | 1.9% | 0.6% | - | High | 67.9% | 77.6% | 46.8% | 48.2% |
| **Age** | | | N=348 | | Other | - | 1.9% | - | 2.4% |
| | | | | | **Household** | | | | |
| 18-24 years | 14.3% | 18.6% | 13.2% | 12.4% | **composition** | | | N=339 | |
| 25-34 years | 32.1% | 52.6% | 21.3% | 20.1% | One person | 47.3% | | 35.7% | 27.0% |
| 35-44 years | 17.9% | | 14.7% | 16.6% | Single parent | 5.5% | | 9.7% | 8.4% |
| | | | | | Two person | | | | |
| 45-54 years | 8.9% | | 12.9% | 15.9% | without children | 29.1% | | 31.6% | 28.5% |
| 55-64 years | 17.9% | 25.6% | 19.0% | 13.3% | Two-parent | 18.2% | | 23.0% | 31.4% |
| 65-74 years | 7.1% | 3.2% | 12.9% | 13.5% | Other | - | - | - | 4.6% |
| ≥ 75 years | 1.8% | | 6.0% | 8.2% | | | | | |

The representativeness of the data is further evaluated by considering the two subsets of people with shared bicycle experience and people that use public transport at least once a month, see Table 3. Comparing the shared bicycle users with van Marsbergen's (2020) study regarding the users of HTM's shared bicycle (HTM-fiets), the main difference is noted for the gender of the users. Two-thirds of the HTM-fiets users are male, while only around half of this study's shared bicycle users are male. The comparison of this study's bus, tram, and metro users with that public transport users in the municipality of The Hague from the OViN dataset shows quite similar characteristics. Only the household composition of the users differs among the two datasets for the categories of one person and two parent households. However, the age of the respondents that have used public transport at least once is also compared to the age of HTM's bus and tram users that answered a survey in Q2 of 2019. Appendix 4A provides a table for the comparison and even though the percentages are not one on one comparable, it shows that share of young public transport users is smaller for this study than it is for HTM's bus and tram users in total (Goudappel Coffeng, 2020a) (Goudappel Coffeng, 2020b).

Finally, comparing the respondents from the paper questionnaire with the digital respondents based on their age and digital skills shows that there is a significant difference in characteristics. 75% percent of the paper respondents (N=44) are older than 65 years, where this is 20.3% for the digital respondents (N=497). For digital skills, 88.1% of the paper respondents qualified for level 0 or level 1 digital skills, whereas only 30.7% of the digital respondents have these low levels of digital skill. Based on these characteristics, a significantly different audience is reached with the two types of questionnaires. The complete comparison can be found in Appendix 4B.

### 4.2. Descriptive statistics

In addition to the socio-demographic characteristics of the respondents, other moderating variables such as the travel behaviour and digital skills are considered to possibly influence people's intention to use means of transport. The results are summarized below to gain a better understanding of the measured variables before they are discussed in the context of the regression analysis.

#### 4.2.1. Frequencies of transport mode use

Figure 2 shows the frequencies of respondent's transport mode usage for the past year This spans the 12-month period prior to June or July 2021, when the survey was conducted. Comparing the use of public transport and the car among the respondents, 87.5% of the respondents has used the bus, tram, or metro at least once in the past year compared to 77.7% for the car. In addition, besides walking, the bus/tram/metro is the means of transport with the lowest percentage of people that have never used it in the past year. A main distinction in the figure is seen for the shared means of transport and the moped/motor scooter, where at least 87.5% has not used them. The percentage of people that have used the shared motor scooter or shared bicycle 1 to 5 days a year is higher compared to the shared car. Overall, 94.8% of the people have not used a shared car in the past year.

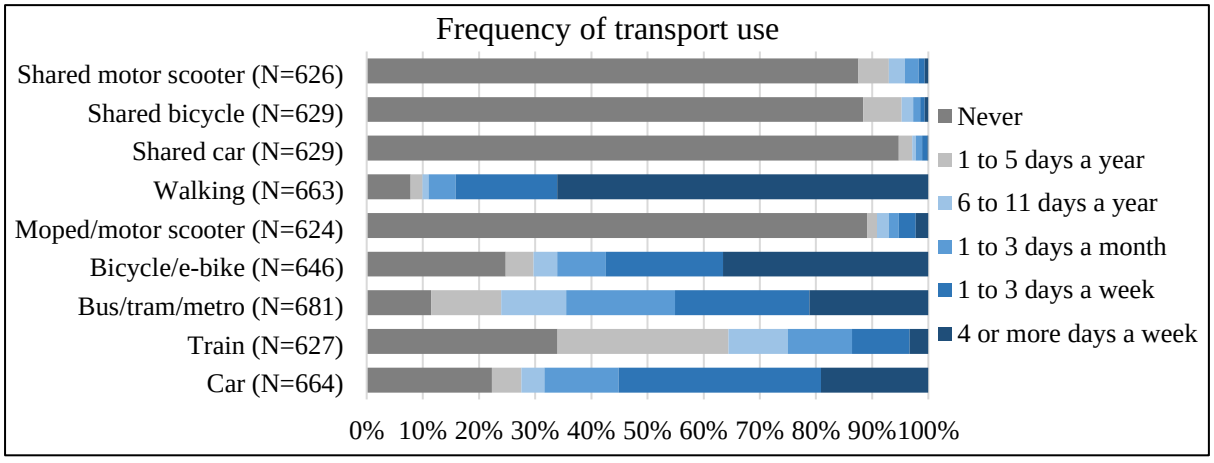


Figure 2 – Frequencies (in percentage) of the respondent's use of different means of transport in the past year.

For the regression analysis, the variables of frequent car user and frequent public transport user are applied, referring to people that use these means of transport at least once a month. From all respondents with relevant answers (N=649) 18.2% qualifies as both a frequent car and public transport user. 26.2% is not a frequent car user but does use public transport frequently, whereas 37.1% is a frequent car user but not a frequent user of public transport. Finally, the remaining 18.5% does not qualify for either frequently using the car or public transport. To better understand the distribution, only around a third of the frequent car users, use public transport frequently.

### 4.2.2. Digital skill scale

To understand the variation of digital skills among the respondents, Figure 3 shows the distribution of the respondents (N=698) among the four levels of digital skill as defined in section 3.2. First, 7.7% has never used a smartphone in the past year (level 0) and thus possesses no relevant digital skills for the app usage in the transport domain. Level 1 is a significantly larger group (30.4%) which represents the people that had access to a smartphone but not frequently used it for transport related planning activities. 22.2% of the respondents has used a smartphone and used it frequently to plan a trip (level 2). The highest level of skills (level 3) is possessed by 39.7% of the respondents and they have also frequently performed payment related activities on their smartphone in addition to the planning activities.

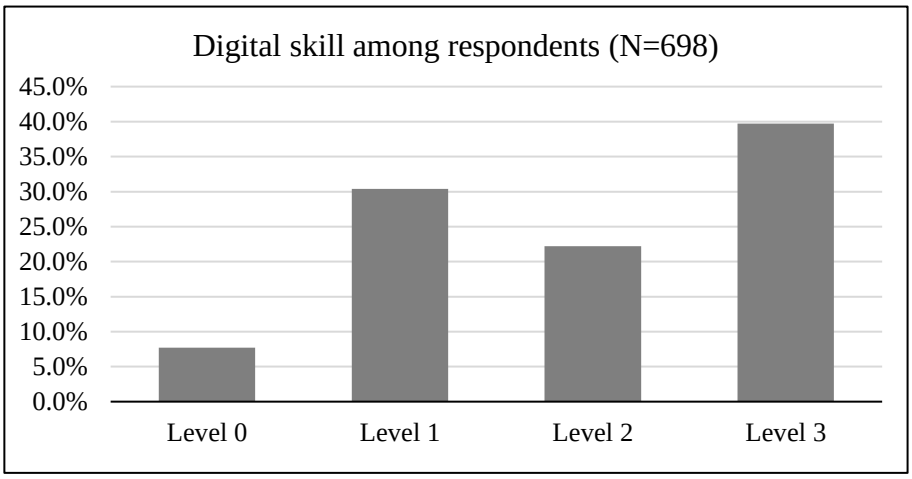


Figure 3 – The distribution of the four digital skill levels (explained in section 3.2) among the respondents of the survey (N=698).

In the theory of digital skills, relations were noted between age, education, and a person's digital skills, among others. In this study's analysis, a significant and a moderate to relatively strong correlation is noted between the digital skill measure and people's age ($\tau$=-.333, $p<.001$) and slightly more moderate correlation with people's education ($\tau$=.193, $p<.001$). An ordinal logistic regression analysis was performed to try to confirm these relations. However, the assumption of proportional odds was not met, so the use of an ordinal regression analysis is not justified in this case. The results of this attempt are, nevertheless, detailed in Appendix

4C. Among the other variables, a weak but statistically significant correlation is noted between digital skills and frequent car users (no/yes) ($\tau$ =-.089, p=.031) and frequent public transport users ($\tau$=.098, p=.016). Because of these weak correlations, digital skills are not expected to differ among people that use the car or public transport more than once a week compared to those who use them less than once a week. The full results of the correlation analysis with digital skills can be found in Appendix 3E. Other significant positive relations are found with digital skills for people with shared transport experience ($\tau$=.179, p<.001), number of means of transport they used during their trip ($\tau$=.114, p=.003), the transport barrier of performance expectancy ($\tau$=.169, p<.001), and the transport barrier of ease of use ($\tau$=.148, p<.001). Lastly, a negative relationship is noted between people's physical ability and their digital skill ($\tau$=-.135, p=.001), which might also be caused by, among others, the relationship between age and limited physical ability ($\tau$=.159, p<.001).

### 4.2.3. People's intention to use means of transport and their current use

To get an understanding of the overall intention to use the various means of transport included in this study, the results for these variables will be discussed below. First, Figure 4 shows that, for all three means of shared transport, less than 20% of the survey's respondents agreed or strongly agreed with the statement that they would intent to use the shared means of transport during their most frequent made trip in the past year, if these would be made available at a mobility hub nearby. Only 10.8% of the respondents intent to use the shared car compared to 15.0% for the shared bicycle and 15.7% for the shared motor scooter. The intention to combine the use of any of the shared means of transport with public transport is similar to that of the shared bicycle and shared motor scooter. This shows that it is not per definition an additional barrier to combine the use of shared transportation with public transport (bus or tram). Finally, the majority (64.8%) of the respondents intent to use (agree and strongly agree) the available public transport at the mobility hub during their trip. This compares to 57.2% of the same respondents (N=537) that indicated to currently use the bus, tram or metro during their trip.

To gain more insight in the potential usage of the modalities at a mobility hub, the current usage of the means of transport is compared with the people's intention. For the shared modalities, the variable of having any experience with shared transport is used, which is based on the usage in the past year as described in Figure 2. It does not reflect the use during the specific trip for which the intended use behaviour was asked. The general shared transport experience is used because, for the specific trip of the survey, each of the shared modalities was used by less than 10 respondents. The variable of having any experience with shared transport shows a significant correlation with the intention to use shared transport, with $\tau$=.335, p<.001, from appendix 4D. Nevertheless, of the 343 people indicating they do not have the intention to use shared transport (answered (strongly) disagree or neutral), 42 have used shared transport in the past year. Of the 131 people that intent to use shared transport, 72 have not used any mean of shared transport in the past year.

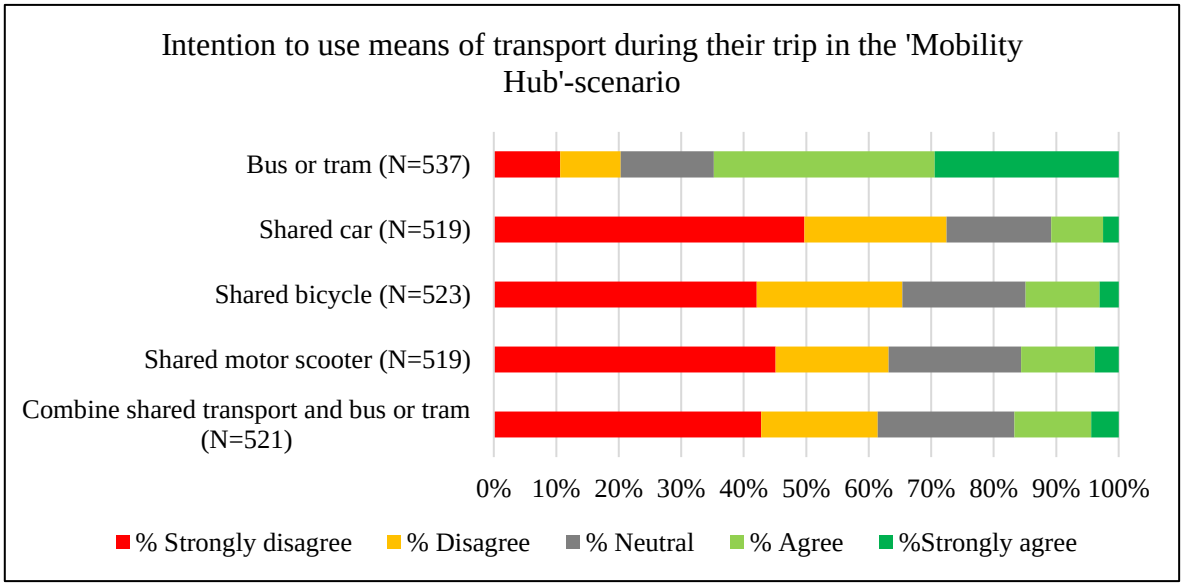


Figure 4 – Response to the statement 'I want to use a … as (one of) the means of transport during this trip'. The statement is answered in the context of either one of the future mobility hub scenarios as described in Chapter 3.

Table 4 below, shows that people's age and level of education relate significantly to whether someone belongs to one of the two groups of people. When comparing Table 4, to the characteristics of all respondents (summarized in Table 6), it can be noted that the two groups are generally younger. Interestingly, people with no prior experience but with the intention to use shared transport have a higher distribution in the age category of 18-24 years compared to the group that has prior experience but not intention to use shared transport. The latter group consists of more people in the group 35-44 years. Based on Table 4 and Pearson Chi-square results, it can be noted that the people that do not intent to use shared transport, even though they have experience, are more likely to not use the car on a weekly basis (not frequent). The people that intent to use shared modalities, but have not used them before, show a significant relation with the number of means of transport they currently use during their trip and their digital skills. Comparing the percentages with those of all respondents (Figure 3 for digital skills and Table 6 for number of means of transport during the trip), the people that intent to use shared transport without prior experience have more often level 3 digital skills and less level 0 or level 1 and they use more often three means of transport and less often two means of transport during their trip.

The overall experience with using the bus and tram is quite high, with 88.5% of the respondents (see Figure 2) having used it in the past year at least once. However, the modal shift for the specific trip questioned in the survey can be studied by comparing if they used the bus/tram/metro during their trip with their intention to use the bus/tram. This shows that of the 189 people that do not intent to use the bus or tram, 46 did use the bus/tram/metro during their trip. Of the 348 people that indicated they intent to use the bus or tram, 87 people do currently not use the bus/tram/metro during the trip.

Table 4 – Characteristics that significantly relate to either people that have no shared transport experience but who intent to use it, or people with shared transport experience that do not intent to use it for their trip. For each of these variables the distribution (%) is provided among the group of people, and the results of the Pearson Chi-square test with relation to whether someone belongs to the specific group of users.

| | No experience, with intention to use shared transport | | With experience, but no intention to use shared transport | |
|---|---|---|---|---|
| | % | $\chi^2$ | % | $\chi^2$ |
| **Age** | N=71 | | N=41 | |
| 18 -24 years | 25.35% | $\chi^2$=29.841 p<.001 | 14.63% | $\chi^2$=18.126 p=.003 |
| 25-34 years | 19.72% | | 24.39% | |
| 35-44 years | 19.72% | | 29.27% | |
| 45-54 years | 15.49% | | 12.20% | |
| 55-64 years | 11.27% | | 17.07% | |
| ≥ 65 years | 8.45% | | 2.44% | |
| **Education level** | N=72 | | N=42 | |
| Low | 4.17% | $\chi^2$=9.651 p=.008 | 9.52% | $\chi^2$=8.722 p=.013 |
| Middle | 33.33% | | 19.05% | |
| High | 62.50% | | 71.43% | |
| **Frequent car user** | N=72 | | N=42 | |
| No | 41.67% | $\chi^2$=0.494 p=.482 | 61.90% | $\chi^2$=4.973 p=.026 |
| Yes | 58.33% | | 38.10% | |
| **Nr. of transport means during TRIP** | N=72 | | N=42 | |
| One | 56.94% | $\chi^2$=6.759 p=.034 | 54.76% | $\chi^2$=0.388 p=.824 |
| Two | 12.50% | | 26.19% | |
| Three or more | 30.56% | | 19.05% | |
| **Digital skill** | N=72 | | N=42 | |
| Level 0 | 1.39% | $\chi^2$=18.894 p<.001 | 2.38% | $\chi^2$=3.861 p=.277 |
| Level 1 | 13.89% | | 23.81% | |
| Level 2 | 20.83% | | 19.05% | |
| Level 3 | 63.89% | | 54.76% | |

For the bus or tram, the characteristics of the two groups are summarized in Table 5 below, for the variables that have a significant relation with at least one of the groups. It can be noted that people who currently do not use the bus or tram during their trip, but intent to do this in the future are currently more likely to use a car frequently (at least once a week) and to use public transport not often compared to all respondents (in Table 6). Related to this, a high portion of this group (68.24%) currently uses only one means of transport during their trip, which is higher than all respondents combined. This is notably different to the group that currently uses the bus or tram during their trip but has no intention to do this in the future. This is likely to be inherent to their group, as they currently use the bus or tram, which is

more often used in conjunction with another means of transport, such as walking or cycling. Whether or not someone belongs to this group of current use but without intention to use also relates to people's age, where especially the group of 55-64 is large compared to all respondents (Table 6). Finally, the group that currently does not use the bus or tram during their trip but does intent to do this shows a significant relation to digital skills, with especially a large group having level 3 digital skills while level 2 is quite underrepresent compared to the distribution of all respondents shown in Figure 3 before.

Table 5 – Characteristics that significantly relate to either the people that do not currently use the bus or tram but who intent to use it, or the people who are currently using bus/tram/metro but do not intent to use the bus or tram for their trip in the future. For each of these variables the distribution (%) is provided among the group of people, and the results of the Pearson Chi-square test with relation to whether someone belongs to the specific group of users.

| | No current use, with intention to use bus or tram | | Currently using, but no intention to use bus or tram | |
|---|---|---|---|---|
| | % | $\chi^2$ | % | $\chi^2$ |
| **Age** | N=81 | | N=44 | |
| 18 -24 years | 6.17% | $\chi^2$=3.151 p=.677 | 11.36% | $\chi^2$=13.157 p=.022 |
| 25-34 years | 22.22% | | 18.18% | |
| 35-44 years | 13.58% | | 4.55% | |
| 45-54 years | 18.52% | | 13.64% | |
| 55-64 years | 17.28% | | 38.64% | |
| ≥ 65 years | 22.22% | | 13.64% | |
| **Frequent car user** | N=83 | | N=45 | |
| No | 31.33% | $\chi^2$=8.021 p=.005 | 55.56% | $\chi^2$=2.016 p=.156 |
| Yes | 68.67% | | 44.44% | |
| **Frequent PT user** | N=85 | | N=46 | |
| No | 78.82% | $\chi^2$=25.920 p<.001 | 54.35% | $\chi^2$=0.011 p=0.915 |
| Yes | 21.18% | | 45.65% | |
| **Nr. of transport means during TRIP** | N=85 | | N=46 | |
| One | 68.24% | $\chi^2$=7.692 p=0.021 | 28.26% | $\chi^2$=15.865 p=0.001 |
| Two | 17.65% | | 32.61% | |
| Three or more | 14.12% | | 39.13% | |
| **Digital skill** | N=87 | | N=46 | |
| Level 0 | 11.49% | $\chi^2$=11.770 p=.008 | 4.35% | $\chi^2$=1.360 p=.715 |
| Level 1 | 24.14% | | 23.91% | |
| Level 2 | 12.64% | | 30.43% | |
| Level 3 | 51.72% | | 41.30% | |

### 4.3. Comparison of respondents intending to use the three means of shared transport

The result shows that 56 respondents agree or strongly agree with the statement of intending to use the shared car, 78 respondents with the statement for the shared bicycle, and 81 respondents with the statement for the shared motor scooter. Table 6 outlines some of the key characteristics of these subgroups which will be used to analyse the groups and the differences between them. In addition, a comparison is provided to see if there is a significant overlap between the characteristics of the people intending to use the different shared means of transport.

In comparing the people that intend to use any of the shared means of transport with the characteristics of the complete sample some main differences can be noted. There is a significant relation between the intent to use any of the shared means of transport and people's age ($\tau$=-.308, p<.001), education ($\tau$=.121, p=.002), the number of means of transport they use during a trip ($\tau$=.094, p=.020), and the prior experience with shared transport ($\tau$=.353, p<.001). Appendix 4D presents a full output of the correlation analysis between the variables included in Table 6 and the intention to use any of the shared means of transport. Table 6 shows that the people who intent to use a shared means of transport are generally younger, higher educated, have likely used shared transport before and tend to use a higher number of means of transport during a trip.

#### 4.3.1. Comparison of potential users of shared cars, bicycles, and motor scooters

Among the shared means of transport, the people that intend to use the shared motor scooter tend to be younger and slightly lower educated than the potential users of the shared bicycle and shared car. The correlations between age and the intention to use each of these shared modes are significant (p<.001). However, for education there is no significant correlation (Kendall's thau) between the intentions to use shared car, shared bicycle, or shared motor scooter. Appendix 4D shows the full output of these correlations. The distributions of people that use a car and/or public transport frequently or not differ among the three means of shared transport, see Table 6. However, only for the shared scooter ($\tau$=.091, p=.034) and the shared car ($\tau$=.105, p=0.016) is the correlation with current car use significant. The current public transport usage only correlates with the intention to use shared motor scooter ($\tau$=.134, p=.002) and not with the intention to use the shared car or the shared bike, see Appendix 4D. From the people that intent to use a shared motor scooter a slightly higher percentage are frequent car and frequent public transport user. Finally, even when people that intent to use a shared mean of transport are generally using more means of transport during a single trip, this relation seems the strongest for people intending to use the shared bicycle. The correlations from Appendix 4D, show that the correlation between the number of means of transport used during the trip and the intention to use a shared bicycle is the only one that is significant with $\tau$=.088, p=.028.

Table 6 – Percentage distribution of answers among potential user characteristics for all respondents and the three groups that intent to use three means of shared transport.

| | | Intent to use: | | |
|---|---|---|---|---|
| | All respondents | Shared bicycle | Shared car | Shared motor scooter |
| **Gender** | N=575 | N=75 | N=56 | N=81 |
| Male | 40.3% | 36.0% | 42.9% | 35.8% |
| Female | 59.0% | 64.0% | 57.1% | 64.2% |
| Other | 0.7% | 0.0% | 0.0% | 0.0% |
| **Age** | N=557 | N=75 | N=55 | N=81 |
| 18 -24 years | 9.9% | 17.3% | 23.6% | 25.9% |
| 25-34 years | 17.2% | 33.3% | 29.1% | 34.6% |
| 35-44 years | 12.7% | 12.0% | 9.1% | 16.0% |
| 45-54 years | 16.0% | 12.0% | 14.5% | 9.9% |
| 55-64 years | 19.4% | 17.3% | 14.5% | 11.1% |
| ≥ 65 years | 24.8% | 8.0% | 9.1% | 2.5% |
| **Education level** | N=574 | N=75 | N=56 | N=81 |
| Low | 16.0% | 9.3% | 7.1% | 7.4% |
| Middle | 35.7% | 29.3% | 33.9% | 40.7% |
| High | 48.3% | 61.3% | 58.9% | 51.9% |
| **Household composition** | N=558 | N=75 | N=54 | N=79 |
| One person | 33.9% | 34.7% | 29.6% | 25.3% |
| Single parent | 7.3% | 8.0% | 9.3% | 10.1% |
| Together without children | 33.7% | 26.7% | 37.0% | 26.6% |
| Together with children | 24.7% | 30.7% | 24.1% | 36.7% |
| Other | 0.4% | 0.0% | 0.0% | 1.3% |
| **Country of birth** | N=563 | N=75 | N=55 | N=81 |
| The Netherlands | 88.3% | 90.7% | 87.3% | 92.5% |
| Other | 11.7% | 9.3% | 12.7% | 7.5% |
| **Frequent car user** | N=664 | N=75 | N=55 | N=79 |
| No | 44.9% | 45.3% | 40.0% | 40.5% |
| Yes | 55.1% | 54.7% | 60.0% | 59.5% |
| **Frequent PT user** | N=687 | N=75 | N=55 | N=80 |
| No | 53.9% | 45.3% | 56.4% | 45.0% |
| Yes | 46.1% | 54.7% | 43.6% | 55.0% |
| **Experience with shared transport** | N=622 | N=69 | N=50 | N=75 |
| No | 78.3% | 55.1% | 62.0% | 49.3% |
| Yes | 21.7% | 44.9% | 38.0% | 50.7% |
| **Nr. of transport means during trip** | N=573 | N=78 | N=56 | N=81 |
| One | 55.1% | 42.3% | 51.8% | 46.9% |
| Two | 22.9% | 17.9% | 16.1% | 19.8% |
| Three or more | 22.0% | 39.7% | 32.1% | 33.3% |

## 4.4. Results of ordinal regression analysis – intended use behaviour

This section will present the results of the ordinal logistics regression analysis for three dependent variables: intention to use shared transport, intention to use the bus or tram, and intention to combine the use of shared transport with the bus or tram. First, following the methodology discussed in Chapter 3, the inherent assumption of having no multicollinearity among the selected independent variables is checked. The collinearity statistics results can be found in Appendix 4E. From these statistics can be concluded that no multicollinearity exists among the selection of variables. Further assumptions and quality of the models will be discussed for each of the analyses individually in the sections below.

### 4.4.1. Intention to use any means of shared transport

The results for the analysis of the model with the dependent variable 'the intention to use shared means of transport' and 21 independent variables are described below (N=423). The model fit is checked based on the Chi-Square, Pearson, and deviance statistics (see Appendix 4F). Unfortunately, the Pearson and deviance statistics have contrasting results with p=0.007 for the Pearson statistic, and p=0.980 for the deviance statistic. This might indicate that this model could be improved to create a better fit with the observations. Based on the relatively decent sized $R^2$ measures, the model's prediction ability is confirmed. The complete output and analysis of these statistics can be found in Appendix 4F. This appendix also includes the output of the test of parallel lines of SPSS statistics, that indicates that the assumption of proportional odds is met for this analysis with p>.05.

For each of the ordinal logistic regression analysis, the complete results can be found in the appendices. Table 7 shows an extract of this analysis for the dependent variable of the intention to use shared transport. Here, only the independent variables with a significant, or almost, significant relation (p<.05) are shown. As the Wald statistic and related significance can contain inaccuracies (according to Field (2018), as elaborated upon in Appendix 3D) the likelihood ratio Chi-Square statistics are also obtained for each predictor variable as a whole, which are listed in Appendix 4F. When necessary, the significance values from these results will also be highlighted. Based on these results, digital skill is a significant predictor of the intention to use shared transport, as well as the experience with shared transport. The other two variables related to travel behaviour, the frequency of car and public transport use, cannot be marked as having an influence on someone's intention to use shared transport. Hence, whether someone uses a car frequently, or means of public transport does not affect their intention to use shared transport, based on these results.

For digital skill, the odds ratio of 0.203 for level 0, indicates that the odds of someone in level 0 to intent to use shared transport (answered agree) rather than not is 1/0.203 = 4.926 times smaller than that of someone with digital skill level 3. In the same way, with the odds ratio of 0.415 for level 1, the odds of someone with digital skill level 1 to intent to use shared transport rather than not is 2.410 (1/0.415) times smaller than that of someone with level 3 digital skills. For level 2 digital skills, the prediction value with respect to level 3, is not significant.

Moreover, having prior experience with shared means of transport significantly increases the odds of intending to use shared transport in the proposed mobility hub scenario ($p<.001$). The odds of someone with shared transport experience intending to use shared transport again in the future (answered agree) rather than not is 4.032 (1/0.248) times larger than someone without any experience with shared transport.

Based on Table 7 it can be said that two of the four tested categories of the transport barrier about the necessity of having multiple ways to pay for public or shared transport, show a significant relation based on the Wald statistic. However, the predictor as a whole, based on the Chi-Square likelihood ratio, has a significance of $p=.115$ from the tests of model effects in Appendix 4F. The same applies to the variable of frequency of trip, even though one category shows $p<.05$, the overall variable seems not to have a significant prediction value to the dependent variable.

The number of means of transport used during a trip is a significant predictor to the intention to use shared transport. However, the first category shows a significance just above $p=.05$. From the odds ratio, the odds of someone using two means of transport during their trip being intended to use shared transport rather than not is 2.320 times smaller than that of someone using three or more means of transport during their current trip.

Finally, the age and education of a person are also determined to be significant predictors based on Table 7. For the complete variables, this is confirmed by the significance of the likelihood Chi-square ratio, see Appendix 4F, with for age: $\chi^2(5)=23.488$, $p<0.001$ and for education: $\chi^2(2)=9.234$, $p=0.010$. For age, the odds ratios are relatively equal for ages 35-44, and 55-64. For the younger groups the odds ratio is large and shows the decrease in odds of intending to use shared transport rather than not as age increases. For example, based on the results, the odds ratio of someone aged between 18 and 25 years old being intended to use shared transport rather than not, is 9.649 times larger than that of someone aged 65 years or older.

Several independent variables from the model are not included in Table 7, as they do not have a significant role as predictor to the dependent variable of intention to use shared transport. This includes the location of the trip (whether the trip only takes place within The Hague or not), country of birth and physical ability. The latter is interesting because of the active modes of transport included in the shared transportation. However, this might have been affected by the combination of these modes into one variable, included shared car. The prediction value of the trip's origin or destination being HagaZiekenhuis or not is, as seen from Table 7, not significant with $p=.069$. This is relatively close to $p=.05$, but with additional conformation from the significance value of the likelihood ratio ($p=.070$), summarized in Appendix 4F, this variable is not considered as a predictor to the intention to use shared transport.

Table 7 – Parameter estimates of ordinal regression analysis with dependent variable: Intention to use shared transport (N=423). Only the independent variables that have at least one (almost) significant relation are shown. The full output is found in Appendix 4F.

| | | | | | | 95% CI for odds ratio | |
|---|---|---|---|---|---|---|---|
| | b | Std. Error | Wald | Sig. | Exp(B) | Lower | Upper |
| **Threshold** | | | | | | | |
| [Intention to use shared transport = disagree] | -3.718 | 1.363 | 7.440 | 0.006 | 0.024 | 0.002 | 0.347 |
| [Intention to use shared transport = neutral] | -2.349 | 1.356 | 3.003 | 0.083 | 0.095 | 0.007 | 1.341 |
| **Location** | | | | | | | |
| Digital skill = level 0 | -1.593 | 0.621 | 6.571 | 0.010 | 0.203 | 0.062 | 0.664 |
| Digital skill = level 1 | -0.879 | 0.301 | 8.516 | 0.004 | 0.415 | 0.228 | 0.755 |
| Digital skill = level 2 | -0.409 | 0.270 | 2.292 | 0.130 | 0.664 | 0.390 | 1.131 |
| Digital skill = level 3 | 0a | | | | 1 | | |
| Experience with shared transport = No | -1.393 | 0.277 | 25.201 | 0.000 | 0.248 | 0.143 | 0.432 |
| Experience with shared transport = Yes | 0a | | | | 1 | | |
| TB - Ways of paying = not important | -1.028 | 0.404 | 6.487 | 0.011 | 0.358 | 0.162 | 0.791 |
| TB - Ways of paying = a bit important | -0.748 | 0.412 | 3.294 | 0.070 | 0.473 | 0.209 | 1.071 |
| TB - Ways of paying = fairly important | -0.477 | 0.386 | 1.528 | 0.216 | 0.621 | 0.292 | 1.317 |
| TB - Ways of paying = important | -0.382 | 0.348 | 1.202 | 0.273 | 0.683 | 0.345 | 1.351 |
| TB - Ways of paying = very important | 0a | | | | 1 | | |
| Frequency of trip = 1 to 5 days a year | 0.537 | 0.422 | 1.624 | 0.202 | 1.712 | 0.744 | 3.935 |
| Frequency of trip = 6 to 11 days a year | -0.386 | 0.491 | 0.618 | 0.432 | 0.680 | 0.265 | 1.745 |
| Frequency of trip = 1 to 3 days a month | -0.775 | 0.381 | 4.133 | 0.042 | 0.460 | 0.215 | 0.988 |
| Frequency of trip = 1 to 3 days a week | -0.064 | 0.259 | 0.061 | 0.805 | 0.938 | 0.566 | 1.556 |
| Frequency of trip = 4 or more days a week | 0a | | | | 1 | | |
| Nr. of means of transport during trip = 1 | -0.498 | 0.269 | 3.427 | 0.064 | 0.608 | 0.355 | 1.040 |
| Nr. of means of transport during trip = 2 | -0.842 | 0.324 | 6.768 | 0.009 | 0.431 | 0.228 | 0.813 |
| Nr. of means of transport during trip = 3 or more | 0a | | | | 1 | | |
| Trip origin/destination = HagaZiekenhuis | 0.406 | 0.223 | 3.313 | 0.069 | 1.501 | 0.966 | 2.333 |
| Trip origin/destination = other | 0a | | | | 1 | | |
| Age class = 18-25 | 2.267 | 0.514 | 19.459 | 0.000 | 9.649 | 3.441 | 27.056 |
| Age class = 25-34 | 1.433 | 0.431 | 11.071 | 0.001 | 4.192 | 1.786 | 9.838 |
| Age class = 35-44 | 0.898 | 0.450 | 3.986 | 0.046 | 2.454 | 0.995 | 6.052 |
| Age class = 45-54 | 0.781 | 0.439 | 3.156 | 0.076 | 2.183 | 0.908 | 5.245 |
| Age class = 55-64 | 1.019 | 0.404 | 6.371 | 0.012 | 2.770 | 1.238 | 6.198 |
| Age class = 65 and older | 0a | | | | 1 | | |
| Education = low | -1.246 | 0.428 | 8.473 | 0.004 | 0.288 | 0.125 | 0.664 |
| Education = middle | -0.261 | 0.244 | 1.150 | 0.284 | 0.770 | 0.480 | 1.236 |
| Education = high | 0a | | | | 1 | | |

Link function: Logit.

a. This parameter is set to zero because it is redundant.

### 4.4.2. Intention to use the bus or tram

Next, the results of the second ordinal logistic regression analysis with the dependent variable being the intention to use the bus or tram will be discussed. For this analysis N = 424. For more details about the steps taken in the analysis, see the first analysis above. The model fit for this analysis is confirmed in Appendix 4G. The model's prediction ability is at a similar level as that of the previous model for the intention to use shared transport. The test of parallel lines of SPSS statistics results in p=.784, indicating that the assumption of proportional odds is met for this analysis.

The complete results of the ordinal logistic regression analysis for the intention to use the bus or tram in the mobility hub scenario can be found in Appendix 4G. An extract of it is listed in Table 8, which contains all independent variables that show a significance of $p<0.05$ for at least one of their categories. Based on this table, four variables are significant predictors, for each of their categories, of the intention to use the bus or tram. These are the variables of *Car user*, indicating if someone uses a car at least weekly, *PT user*, indicating if someone uses a train, tram, bus, or metro at least weekly, frequency of the trip, and whether the HagaZiekenhuis is an origin or destination of the trip. These same four variables also have a significant prediction value ($p<0.05$) according to the Chi-Square likelihood ratio from the tests of model effects as reported in Appendix 4G. Digital skill and the transport barrier of facilities at the transport stop are only a significant predictor with one or two of their categories and their prediction value is not confirmed by the Chi-Square likelihood ratio.

Non-frequent car users have a higher intention to use the bus or the tram compared to frequent car users. More specifically, the odds of a non-frequent car user to intent to use the bus or tram (answered agree) rather than not intent to use them (answered neutral or disagree) are 1.750 times larger than the same odds for a frequent car user. The relation between being a frequent public transport user or not and the intention to use the bus or tram in the future is even stronger. Here, the odds of frequent public transport users to intent to use the bus or tram rather than not are 6.024 times larger than the odds for a non-frequent public transport user.

An interesting relation is found regarding the characteristics of the trip for which the intention to use the bus or tram is answered. As the frequency of the trip increases, the intention to use the bus or tram during this trip decreases. This might be related to current mode usages, as from the correlation table in Appendix 3E, there is a relatively weak but significant correlation ($\tau=.127$, $p=.002$) between the trip frequency and whether or not someone uses public transport at least weekly.

In addition, whether or not the HagaZiekenhuis was an origin/destination in the trip affects the intention to use the bus of tram. This also directly related to the scenario description the respondents read, so this is an important note, which will be elaborated upon in the discussion. The relation is as follows: the odds of people travelling to or from the HagaZiekenhuis intending to use the bus or tram is 1.912 times smaller than those same odds for someone that does not travel to or from the HagaZiekenhuis during their trip. This can, for example, be explained by the reasons of travelling to the hospital such as, for example, giving a lift to someone who has reduced physical abilities.

Not every category of digital skill can be used as a predictor for the intention to use the bus or tram. This is especially notable when comparing it to the high and significant prediction value it had for the intention to use shared transport and, therefore, it will be explored further in the discussion in Chapter 5. Comparing the list of 21 independent variables with the significant predictor variables for the intention to use the bus or tram, shows that none of the socio-demographic variables, such as age, education, or type of household, are significant predictors. In addition, contrary to the analysis for the intention to use shared transport, the number of means of transport that are currently used during the trip do not predict the intention of using the bus or the tram.

Table 8 – Parameter estimates of ordinal regression analysis with dependent variable: Intention to use the bus or tam (N=424). Only the independent variables that have at least one significant relation are shown. The full output is found in Appendix 4G.

| | | | | | | 95% CI for odds ratio | |
|---|---|---|---|---|---|---|---|
| | b | Std. Error | Wald | Sig. | Exp(B) | Lower | Upper |
| **Threshold** | | | | | | | |
| [Intention to use bus or tram = disagree] | -2.650 | 1.645 | 2.595 | 0.107 | 0.071 | 0.003 | 1.808 |
| [Intention to use bus or tram = neutral] | -1.598 | 1.641 | 0.948 | 0.330 | 0.202 | 0.008 | 5.138 |
| **Location** | | | | | | | |
| Digital skill = level 0 | -0.353 | 0.595 | 0.353 | 0.552 | 0.702 | 0.225 | 2.193 |
| Digital skill = level 1 | -0.837 | 0.320 | 6.826 | 0.009 | 0.433 | 0.230 | 0.815 |
| Digital skill = level 2 | -0.410 | 0.312 | 1.721 | 0.190 | 0.664 | 0.359 | 1.229 |
| Digital skill = level 3 | 0a | | | | 1 | | |
| Car user = non-frequent | 0.560 | 0.266 | 4.427 | 0.035 | 1.750 | 1.031 | 2.971 |
| Car user = frequent | 0a | | | | 1 | | |
| PT user = non-frequent | -1.799 | 0.293 | 37.574 | 0.000 | 0.166 | 0.092 | 0.296 |
| PT user = frequent | 0a | | | | 1 | | |
| TB - Facilities PT = not - fairly important | -0.127 | 0.363 | 0.123 | 0.726 | 0.880 | 0.430 | 1.801 |
| TB - Facilities PT = important | -0.622 | 0.283 | 4.829 | 0.028 | 0.537 | 0.306 | 0.941 |
| TB - Facilities PT = very important | 0a | | | | 1 | | |
| Frequency of trip = 1 to 5 days a year | 1.588 | 0.494 | 10.334 | 0.001 | 4.893 | 1.909 | 12.546 |
| Frequency of trip = 6 to 11 days a year | 1.675 | 0.551 | 9.255 | 0.002 | 5.339 | 1.851 | 15.400 |
| Frequency of trip = 1 to 3 days a month | 1.082 | 0.410 | 6.976 | 0.008 | 2.951 | 1.301 | 6.695 |
| Frequency of trip = 1 to 3 days a week | 0.632 | 0.291 | 4.728 | 0.030 | 1.881 | 1.059 | 3.344 |
| Frequency of trip = 4 or more days a week | 0a | | | | 1 | | |
| Trip origin/destination = HagaZiekenhuis | -0.648 | 0.252 | 6.613 | 0.010 | 0.523 | 0.319 | 0.858 |
| Trip origin/destination = other | 0a | | | | 1 | | |

Link function: Logit.

a. This parameter is set to zero because it is redundant.

### 4.4.3. Intention to combine the use of shared transport with the bus or tram

For the last analysis, the ordinal logistic analysis was executed with the dependent variable of the intention to combine the use of shared transport with the bus or tram (N=421). The model fit is proven by the Chi-Square, Pearson, and deviance statistics, and results of the $R^2$ measures confirm the prediction ability for the model. The detailed results of these statistics can be found in Appendix 4H. The final consideration is the assumption of proportional odds. The test of parallel lines indicates that this assumption is met as p=.236.

The complete results of the ordinal logistic regression analysis for the intention to combine the use of shared transport with the bus or tram in the mobility hub scenario can be found in Appendix 4H. Table 9 shows an extract of this, containing all six independent variables that show a significance of p<.05 for at least one of their categories.

The additional check of significance, across the complete variables, based on the Chi-Square likelihood ratio confirms the significance of five of these variables (see Appendix 4H). These are experience with shared transport, digital skill, age, number of means of transport used during the trip, and the transport barrier of having more than one way to pay for shared or public transport. First, people with lower digital skill are less likely to intent to combine shared transport with the bus or tram during their trip. Only the prediction relation for people with level 0 digital skills is uncertain as the significance is just above p=.05. However, from the odds ratios, the odds of the people with level 1 and level 2 digital skills intending to combine both types of transportation (answered agree) rather than not are both around 2 times smaller than the same odds for people with level 3 digital skill. Interestingly, the difference between the b-value of level 1 and level 2 digital skills is not large, indicating only a small effect of frequently planning a trip via a smartphone app on the intention to combine the two types of transport. For the intention to use shared transport, levels 0 and 1 of digital skills were significant predictors, showing a slightly different prediction relation of digital skills between the two dependent variables.

Same as seen with the intention to use shared transport, the experience of travel with shared transport is a significant predictor for the intention to combine the use of shared transport with the bus of the tram. People without shared transport experience have a lower intention that those with this experience. More specifically, the odds of someone with shared transport experience to intent to combine the two types of transport rather than not is 2.890 (1/0.346) times larger than the odds for people without this experience. Interestingly, both the variables describing the travel behaviour with the car and public transport are not significant predictors here, which is similar to the first analysis with the intention to use shared transport.

The transport barrier of having multiple ways to pay for a trip with public or shared transport shows a significant negative relation with this intention to combine the two types of transport for the people that find this not important. In other words, people who find it very unimportant to have multiple ways to pay for transport are less likely to intent to combine the use of shared transport with the bus or tram than people who find it very important to have multiple payment options for a trip.

The variable of age is also a significant predictor for this independent variable. However, the b-values are smaller compared to the first analysis for the intention to use shared transport.

Table 9 – Parameter estimates of ordinal regression analysis with dependent variable: Intention to combine the use of shared transport with the bus or tram (N=421). Only the independent variables that have at least one (almost) significant relation are shown. The full output is found in Appendix 4H.

| | | | | | | 95% CI for odds ratio | |
|---|---|---|---|---|---|---|---|
| | b | Std. Error | Wald | Sig. | Exp(B) | Lower | Upper |
| **Threshold** | | | | | | | |
| [Intention to combine shared transport & bus/tram = disagree] | -2.685 | 1.399 | 3.685 | 0.055 | 0.068 | 0.005 | 1.018 |
| [Intention to combine shared transport & bus/tram = neutral] | -1.290 | 1.393 | 0.858 | 0.354 | 0.275 | 0.019 | 4.059 |
| **Location** | | | | | | | |
| Digital skill = level 0 | -1.339 | 0.691 | 3.757 | 0.053 | 0.262 | 0.068 | 1.015 |
| Digital skill = level 1 | -0.711 | 0.324 | 4.820 | 0.028 | 0.491 | 0.258 | 0.935 |
| Digital skill = level 2 | -0.622 | 0.286 | 4.712 | 0.030 | 0.537 | 0.308 | 0.937 |
| Digital skill = level 3 | 0a | | | | 1 | | |
| Experience with shared transport = No | -1.062 | 0.270 | 15.527 | 0.000 | 0.346 | 0.203 | 0.589 |
| Experience with shared transport = Yes | 0a | | | | 1 | | |
| TB - Ways of paying = not important | -1.310 | 0.430 | 9.267 | 0.002 | 0.270 | 0.114 | 0.642 |
| TB - Ways of paying = a bit important | -0.508 | 0.417 | 1.484 | 0.223 | 0.602 | 0.261 | 1.385 |
| TB - Ways of paying = fairly important | -0.417 | 0.389 | 1.149 | 0.284 | 0.659 | 0.308 | 1.410 |
| TB - Ways of paying = important | -0.293 | 0.343 | 0.730 | 0.393 | 0.746 | 0.376 | 1.482 |
| TB - Ways of paying = very important | 0a | | | | 1 | | |
| TB - Opinion of others = not important | -1.242 | 0.595 | 4.349 | 0.037 | 0.289 | 0.091 | 0.921 |
| TB - Opinion of others = a bit important | -0.973 | 0.636 | 2.341 | 0.126 | 0.378 | 0.110 | 1.305 |
| TB - Opinion of others = fairly important | -1.185 | 0.648 | 3.345 | 0.067 | 0.306 | 0.087 | 1.075 |
| TB - Opinion of others = important | -0.782 | 0.701 | 1.245 | 0.265 | 0.457 | 0.116 | 1.808 |
| TB - Opinion of others = very important | 0a | | | | 1 | | |
| Nr. of means of transport during trip = 1 | -0.676 | 0.274 | 6.088 | 0.014 | 0.509 | 0.296 | 0.875 |
| Nr. of means of transport during trip = 2 | -0.998 | 0.339 | 8.652 | 0.003 | 0.369 | 0.189 | 0.718 |
| Nr. of means of transport during trip = 3 or more | 0a | | | | 1 | | |
| Age class = 18-25 | 1.615 | 0.528 | 9.375 | 0.002 | 5.030 | 1.774 | 14.264 |
| Age class = 25-34 | 0.843 | 0.467 | 3.254 | 0.071 | 2.323 | 0.945 | 5.709 |
| Age class = 35-44 | 0.607 | 0.489 | 1.537 | 0.215 | 1.834 | 0.705 | 4.775 |
| Age class = 45-54 | 0.432 | 0.476 | 0.824 | 0.364 | 1.540 | 0.614 | 3.865 |
| Age class = 55-64 | 0.759 | 0.445 | 2.907 | 0.088 | 2.136 | 0.907 | 5.028 |
| Age class = 65 and older | 0a | | | | 1 | | |

Link function: Logit.

a. This parameter is set to zero because it is redundant.

In addition, only the first category, age between 18 and 25 years, has a significance below p=.05. Finally, people who currently use one or two means of transport during their trip are less intended to combine the use of shared transport with the bus or tram than people who are currently already using three or more means of transport. Hence, someone's existing experience and behaviour regarding the use of multiple means of transport during a trip is a significant predictor of their intentions to combine shared transport and the bus or tram during a trip. This effect is stronger than for the intention to use shared transport, where the b-value was smaller and the category of using a single mean of transport during a trip was not significant.

From the independent variables not included in Table 9, and thus not being a significant predictor to the dependent variable, education is considered to be interesting. From the first analysis, someone's level of education influences someone's intention to use shared transport during a trip. However, from this analysis it results that education does not influence if someone then intents to use this shared transport together with the bus or tram during the same trip.

## 5. Discussion

In this chapter, the results will be put into perspective by discussing the implications of certain decisions made regarding the survey and the data analysis as well as the implications of the sample characteristics. Finally, possible implementations of the results for transport providers will be discussed as part of the study's contribution to transport practise.

### 5.1. Implications of sample characteristics

The variables of age and education were both shown to affect people's intention to use shared transport. These are the variables that have shown a slightly different distribution among their categories when compared to the socio-demographic statistics of the municipality of The Hague and the neighbourhood surrounding Leyenburg. As both age and education were found to influence people's intention to use certain means of transport, the sample characteristics have implications on the study's result. An underrepresentation of younger age group has likely caused the intention to use shared transport to be lower on average in this study than it would be for the population of The Hague. On the contrary, the overrepresentation of highly educated people in this study's sample will have caused the intention to use shared transport to be higher for this sample than it will be in reality. Similar effects might be the case for people's level of digital skills based on the correlations found between digital skill and people's age and education.

The comparison of the public transport users of the sample with bus and tram users of HTM showed that the sample was underrepresented in younger public transport users. Hence, when interpreting results regarding frequent public transport users, similar cautions should be taken. This underrepresentation could have caused the percentage of public transport users who intent to use shared transport to be lower than it would in reality be for users of HTM's busses and trams. For the shared bicycle users of the study's sample, no implications are

expected as only their gender differed significantly from the HTM's shared bicycle users and this variable is not found to influence people's intention to use any mean of transport.

A limitation of this study is its inability to sufficiently compare the sample with The Hague's population based on the percentage of people with a migrant background. This is caused by the fact that the variable of people's country of birth does not accurately reflect whether people have a migrant background. Hence, the study was not able to determine if people's migrant background affects people's level of digital skills and their intention to use the multimodal transport system. As Durand, Zijlstra, van Oort, Hoogendoorn-Lanser and Hoogendoorn (2021) noted a relation between ethnicity and digital skills, future research should try to better include respondent's migrant background by determining their parents' country of birth.

### 5.2. Consideration of case study and survey characteristics

This study provides an insight into the potential of a collective offer of existing public transport options with the included shared modalities and the characteristics of the potential users via the data collected with the survey. However, the sketched integration scenario used in the survey certainly affects the relationships with the intended use behaviour found in this study. Hence, some of the results will be put into perspective. First, the integration scenario proposed in the survey emphasises the digital integration for the shared means of transport and does not specifically mention the need to plan and pay trips with the bus or the tram via an app. Therefore, the relation between digital skills and the intention to use the bus or tram, which showed a weak to almost no prediction value, is not a sufficient reflection of constraints on accessibility for people with low levels of digital skill when digitalisation increases for bus and tram transport. Further research is needed to understand if low digital skills would limit someone to take a trip with public transport if planning and paying should be done via an app.

In addition, a slightly different scenario was proposed to the people with the HagaZiekenhuis as origin/destination of their trip, see Chapter 3 for the details. The results of both scenarios are combined as it still describes the overall intention to use the included transport modes for people travelling to, from or via Leyenburg. However, it is important to note that thus not all respondents have considered the same public transport situation. Hence, the conclusions of intention to use the bus or tram cannot directly be linked to the characteristics of the bus and tram offering at the stop Leyenburg. It is interesting that the variable of trip origin or destination (whether the HagaZiekenhuis or not) affects the intention to use the bus or tram. People travelling to the HagaZiekenhuis have a lower intention to use the bus or tram. From previous research, trip motive is seen to affect mode choice, however, this has not been evaluated in this study. Nevertheless, the significance of the HagaZiekenhuis as origin or destination would imply that it is useful to further investigate the relation of trip motive with the intention to use a multimodal transport system. Going to the hospital is quite a unique trip motive in itself and, as employees of the hospital were also invited to participate in the survey, the trip motive of work could also be an underlying contribution to this significant relationship.

Another possible limitation is the effect of the COVID-19 pandemic, the related restrictions, and people's change in travel behaviour on people's perception of future transport use and their current use of transportation. The year for which respondents indicated their travel behaviour was completely affected by COVID-19. Hence, the noted differences between current use and intended use behaviour of the multimodal transport system could theoretically be smaller for, for example, public transport as people are using public transport less during the pandemic. For the intended use behaviour, it is uncertain to what extent people have considered the pre-COVID-19 circumstances or one of the various situations seen during the COVID-19 pandemic. Depending on the circumstances at the time, COVID-19 might also affect the conversion of intended use behaviour to actual use behaviour when a multimodal transport system is implemented.

Regarding the factors affecting people's intention to use means of transport, the importance people assigned to most of the transport barriers was not found to have a significant prediction value. The original UTAUT models from which these transport barriers were constructed are commonly used on new but existing systems or services, whereas this study evaluates a possible future scenario that is not implemented. Hence, the lack of a relation between these transport barriers' importance and the intended use of the multimodal transport system should not lead to neglecting these constructs or UTAUT models in future research. Especially not as research on this topic evolves towards more practise and pilot-based performance assessments.

### 5.3. Managerial implications

For transport providers, the case study of Leyenburg has shown that the intention to use the shared bicycle and shared motor scooter are higher than the intention to use the shared car. Similar user segments as those who intend to use shared transport are intended to combine shared and public transport. Hence, offering shared bicycles and shared motor scooters at a hub thus has a higher potential as this is a larger group with similar characteristics of those who want to combine these shared modalities with public transport. In addition, the intention to use public transport at the mobility hub is higher (64.8%) compared to the current use (57.2%) during trips to, from, or via Leyenburg. Following the analysis of the intended use behaviour, it is seen that there are significant differences in the factors affecting the intention to use shared transport or the bus or the tram. To target new users that intent to use shared transport, transport providers should consider an audience that is young and highly educated. The intention to combine the use of shared and public transport is affected by similar factors as the intention to use shared transport. This shows that as more of the potential shared transport users are captured, the group of people that wants to combine shared transport with public transport also grows. Hence, having these types of mobility hubs as recognizable places where shared transport modalities are placed such that an easy transition to public transport is possible, will facilitate the uptake of public transport. For further growth of shared modalities, the people who are older and less educated are an interesting group as they currently express a significantly lower intent to use shared mobility. Besides the consideration of digital skills, other barriers of using shared transport for these groups of

people should be discovered. The actual usage of multimodal transport systems will also be affected by additional factors regarding the system's implementation. Hence, it is recommended to conduct pilot studies and tests to evaluate the conversion of intended use behaviour of both public and shared transport to the actual use behaviour.

### 5.3.1. Digitalisation in transport

The various levels of digital skill characterised in this paper can predict the intention of using shared transport. Helping to improve people's digital skills, especially, in the context of the transport domain, would therefore contribute to the improvement of the potential uptake of the shared modalities. In addition, it emphasises the impact of the digitalisation in transport that has helped grow the interest in shared and multimodal transport on the intended use of potential user groups. For transport providers working on ways to integrate their own modalities, or potentially integrate modalities of different operators, it is recommended to consider the potential digital exclusion that can occur among existing users or potential new users. Offering different digital and non-digital options to plan and pay for trips would reduce the danger of digital exclusion. Involving the potential user in the development process of digital applications and mobility hubs could lead to a better understanding of how to deal with the various levels of digital skill. It could be useful to understand to what extent alternatives to application usage, such as dedicated machines/pillars at hubs for planning or paying, improve the intended use of transport for people with lower levels of digital skill.

### 5.3.2. Costs of operations and implementation

Another constraint for the implementation of a multimodal transport network is the cost of implementation and required operations. It is difficult to predict the costs, but the following aspects are important to consider. The redistribution of shared vehicles constitutes to a large part of the operational costs of transport sharing services (Arndt, Drews, Hertel, Langer, & Wiedenhöft, 2019). The required frequency of redistribution will depend on the implemented system, free-floating or station-based, and the density of the network. Especially the free-floating systems are labelled as expensive products due to the higher need for redistributions for the shared bicycle and shared car in the Netherlands (Jorritsma, Witte, Alonso González, & Hamersma, 2021). Hence, it is important to consider what type of service will be offered for the shared mobility stationed at mobility hubs. To clarify, this study's survey defined that the shared modalities could be parked anywhere after their use, referring to a free-floating system with the use of stations. However, as the number of mobility hubs increases, they might provide a network of shared mobility stations that would suffice for a station-based approach where it is obligatory to leave a shared modality at any one of the stations in the network. As such, the redistribution might be easier to manage as there are dedicated spots for every vehicle. However, the potential promise of shared mobility as the first- and last-mile transportation for the existing public transport cannot be fulfilled as long as people cannot travel to their house with the shared vehicle. Potential small neighbourhood hubs that only station shared means of transport could be a solution for this in a network of larger hubs that provide the integration with public transport as is central in this

paper. The various options available will likely all represent a different trade-off between quality of service and their cost. Further research should contribute to this understanding of the required quality of service and how this can be offered by the integration of shared modalities with existing public transport using a network of mobility hubs.

## 6. Conclusion

In this paper, the intention to use shared and public means of transportation in a multimodal transport network is studied by means of a survey within the case study of Leyenburg, The Hague (N=710). User characteristics, among which digital skills, and transport related characteristics are evaluated for their potential influence on people's intention to use shared transport and the bus and tram when they are physically integrated at the existing public transport stop.

When shared transport is offered at the existing public transport stop Leyenburg, 15.0% of the respondents intent to use the shared bicycle, 15.7% intent to use the shared motor scooter, and only 10.8% intent to use the shared car. Of the 131 people who intent to use any of the shared means of transport, 72 people have not used any of them in the past year. Capturing the latter group would result in an increase of shared transport usage. Of the 343 people who have no intention to use shared transport only 42 have used a mean of shared transport in the past year. From the survey, 64.8% of the respondents intent to use the bus or tram during their trip when shared transport is offered at the stop Leyenburg. This is higher than the 57.2% of people who expressed a current use of the bus, tram, or metro during their trip, indicating a potential increase in the number of bus or tram users. The results show that around a quarter of the people who do not intent to use the bus and tram when integrated with shared transport are currently using the bus, tram, or metro during their trip. However, from the larger group of people who intent to use the bus or tram (64.8%), around a quarter are currently not using it during their trip.

The study has determined several factors which influence the intended use behaviour of shared and public transport when they are integrated at a mobility hub. The intention to use shared transport is found to be higher for people with higher levels of digital skill, prior shared transport experience, who are younger, highly educated and those who used multiple means of transport during their trip. Largely the same characteristics are related to the intention to combine the use of shared and public transport, with only the influence of people's education not being significant for this intention. Nevertheless, in accordance with literature, people's age and education are found to correlate to people's level of digital skills and hence education cannot be neglected as a relevant user characteristic to determine this intention. Finally, one category of the transport barrier of having multiple ways to pay for transport was significantly related to the intention to combine shared and public transport. This might imply that having multiple ways to pay for travelling with multiple of these modalities supports its potential uptake. The other transport barriers are not found to be related to people's intention to use any of the types of transport. The intention to use the bus or tram is found to be mainly related to current transport usage and trip-specific factors. The intention is higher for both people who used public transport more than once a week and

people who used cars less than once a week in the past year. In addition, people who performed the trips to, from or via Leyenburg less frequent and those who did not travel to the HagaZiekenhuis had a higher intention to use the bus or tram.

With these results, this paper has contributed to the understanding of the intended use behaviour of multimodal transport system for different user segments. Besides these user needs, the potential of integrated transport systems at hubs could also be considered in future research by studying the impact of adding or removing means of transport at a hub on the actual usage of the different transport types. This would also further contribute to transport provider's considerations regarding the benefits and costs of mobility hubs. Finally, with the use of pilot studies, future research should attempt to evaluate the actual use behaviour of both public and shared transport when these are integrated. Comparing the actual use of the means of transport with the results of this study might help understand what factors are key in the maximization of the potential uptake of transport at a mobility hub.

**Acknowledgements**

A special thank you to all the people who contributed to this research. In particular to the employees at HTM who have supported my project and the survey at Leyenburg as well as to the supervisors from the University of Twente for their support during the research process. In addition, thank you to the HagaZiekenhuis' department of communication for sharing the questionnaire among the hospital's employees.

**References**

Arndt, W.-H., Drews, F., Hertel, M., Langer, V., & Wiedenhöft, E. (2019). *Integration of shared mobility approaches in Sustainable Urban Mobility Planning.* Berlin: German Institute of Urban Affairs (Difu). Retrieved from https://www.eltis.org/sites/default/files/integration_of_shared_mobility_approaches_in_sumps.pdf

CBS & RWS. (2017). *Onderzoek Verplaatsingen in Nederland 2017 - OViN 2017.* DANS. doi:https://doi.org/10.17026/dans-xxt-9d28

CBS. (2017, January 1). *Kerncijfers per postcode - PC6, 2017.* Retrieved May 26, 2021, from cbs.nl: https://www.cbs.nl/nl-nl/dossier/nederland-regionaal/geografische-data/gegevens-per-postcode

CBS. (2020a, February 14). *The Netherlands ranks among the EU top in digital skills.* Retrieved April 21, 2021, from CBS: https://www.cbs.nl/en-gb/news/2020/07/the-netherlands-ranks-among-the-eu-top-in-digital-skills

CBS. (2020b, April 20). *Opleidingsniveau naar gemeenten, wijken en buurten.* Retrieved from CBS.nl: https://www.cbs.nl/nl-nl/maatwerk/2020/17/opleidingsniveau-naar-gemeenten-wijken-en-buurten

CBS. (2020c, January 1). *Kerncijfers per postcode - PC4 2020 V1.* Retrieved September 20, 2020, from cbs.nl: https://www.cbs.nl/nl-nl/dossier/nederland-regionaal/geografische-data/gegevens-per-postcode

CBS. (2021). *Migratieachtergrond*. Retrieved December 8, 2021, from cbs.nl: https://www.cbs.nl/nl-nl/onze-diensten/methoden/begrippen/migratieachtergrond

CoMoUK. (2019). *Mobility Hubs Guidance.* Leeds: CoMoUK. Retrieved from https://como.org.uk/wp-content/uploads/2019/10/Mobility-Hub-Guide-241019-final.pdf

CROW. (2021). *Wat is het effect van deelauto's op autobezit? Onderzoek naar de invloed van de woonomgeving en het type deelautosysteem op de bereidheid om de privéauto weg te doen.* Ede: CROW. Retrieved from https://www.crow.nl/getmedia/89daa542-5f87-48e2-848d-99dcdd2b3cee/K-D108-Wat-is-het-effect-van-deelauto%E2%80%99s-op-autobezit.pdf.aspx?ext=.pdf

Den Haag. (2020). *Bevolking*. Retrieved April 9, 2021, from Den Haag in Cijfers: https://denhaag.incijfers.nl/dashboard/wijkprofielen/bevolking/

Durand, A., & Zijlstra, T. (2020). *The impact of digitalisation on the access to transport services: a literature review.* The Netherlands Institute for Transport Policy Analysis (KiM). The Hague: Ministry of Infrastructure and Water Management. Retrieved from https://english.kimnet.nl/publications/publications/2020/06/29/the-impact-of-digitalisation-on-the-access-to-transport-services-a-literature-review

Durand, A., Zijlstra, T., van Oort, N., Hoogendoorn-Lanser, S., & Hoogendoorn, S. (2021). Access denied? Digital inequality in transport services. *Transport Reviews*, 1-26. Retrieved from https://doi.org/10.1080/01441647.2021.1923584

European Commission. (2017). *Sustainable Urban Mobility: European Policy, Practice and Solutions.* Brussels: European Commission. Retrieved from https://ec.europa.eu/transport/sites/transport/files/2017-sustainable-urban-mobility-european-policy-practice-and-solutions.pdf

European Commission. (2019). *The European Green Deal. Communication from the commission to the European parliament, the European council, the council, the European economic and social committee and the committee of the regions.* Brussels: European Commission. Retrieved from https://eur-lex.europa.eu/resource.html?uri=cellar:b828d165-1c22-11ea-8c1f-01aa75ed71a1.0002.02/DOC_1&format=PDF

Eurostat. (2021, February 8). *Individuals' level of digital skills.* Retrieved April 21, 2021, from Eurostat: https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do

Field, A. (2018). *Discovering Statistics Using IBM SPSS Statistics* (5th ed.). Los Angeles | London | New Delhi | Singapore | Washington DC | Melbourne: SAGE.

Goudappel Coffeng. (2020a). *Rapportage OV-Klantenbarometer Metropool Regio Rotterdam Den Haag. Resultaten vierde kwartaal 2019.* Deventer: Goudappel Coffeng.

Goudappel Coffeng. (2020b). *Rapportage OV-Klantenbarometer HTM (bus). Resultaten vierde kwartaal 2019.* Deventer: Goudappel Coffeng.

Hannon, E., McKerracher, C., Orlandi, I., & Ramkumar, S. (2016). *An integrated perspective on the future of mobility.* McKinsey & Company. Retrieved from https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/Sustainability/

Our%20Insights/An%20integrated%20perspective%20on%20the%20future%20of%20mobility/An-integrated-perspective-on-the-future-of-mobility-article.pdf
HTM. (2021a). *HTM haltetypologie.* The Hague: HTM afdeling Reizigers.
HTM. (2021b). *Haga Shuttle*. Retrieved February 25, 2021, from HTM: https://www.htm.nl/ons-vervoer/haga-shuttle
Hülsmann, F., Wiepking, J., Zimmer, W., Hacker, F., Kasten, P., Schmolck, B., . . . Götz, K. (2018). *Share - Wissenschaftliche Begleitforschung zu car2go mit batterieelektrischen und Konventionellen Fahrzeugen.* Berlin/Frankfurt am Main, Germany: Öko-Institut/ISOE-Institut für Sozial-Ökologische Forschung.
Jahanshahi, D., Tabibi, Z., & van Wee, B. (2020). Factors influencing the acceptance and use of a bicycle sharing system: Applying an extended Unified Theory of Acceptance and Use of Technology (UTAUT). *Case Studies on Transport Policy, 8*, 1212-1223. doi:10.1016/j.cstp.2020.08.002
Jorritsma, P., Witte, J.-J., Alonso González, M. J., & Hamersma, M. (2021). *Deelauto- en deelfietsmobiliteit in Nederland. Ontwikkelingen, effecten en potentie.* Den Haag: Kennisinstituut voor Mobiliteitsbeleid (KiM). Retrieved from https://www.kimnet.nl/publicaties/rapporten/2021/10/05/deelauto--en-deelfietsmobiliteit-in-nederland-ontwikkelingen-effecten-en-potentie
Kamargianni, M., Li, W., Matyas, M., & Schäfer, A. (2016). A critical review of new mobility services for urban transport. *Transportation Research Procedia, 14*, 3294-3303. doi:10.1016/j.trpro.2016.05.277
Kett, M., Cole, E., & Turner, J. (2020). Disability, Mobility and Transport in Low- and Middle-Income Countries: A Thematic Review. *Sustainability, 12*, 589. doi:10.3390/su12020589
KiM. (2019). *Mobiliteitsbeeld 2019.* The Hague: Kennisinstituut voor Mobiliteitsbeleid (KiM). Retrieved from https://www.rijksoverheid.nl/binaries/rijksoverheid/documenten/rapporten/2019/11/11/bijlage-1-mobiliteitsbeeld-2019/mobiliteitsbeeld+2019.pdf
Lamont, D., Kenyon, S., & Lyons, G. (2013). Dyslexia and mobility-related social exclusion: The role of travel information provision. *Journal of Transport Geography, 47*, 1-15. doi:10.1016/j.techsoc.2016.07.001
Liu, X. (2009). Ordinal Regression Analysis: Fitting the Proportional Odds Model Using Stata, SAS and SPSS. *Journal of Modern Applied Statistical Methods, 8*(2), Article 30. doi:10.22237/jmasm/1257035340
Ma, X., Yuan, Y., Van Oort, N., & Hoogendoorn, S. (2020). Bike-sharing systems' impact on modal shift: A case study in Delft, the Netherlands. *Journal of Cleaner Production, 259*, 120846. doi:10.1016/j.jclepro.2020.120846
Machado, C., De Salles Hue, N., Berssaneti, F., & Quintanilha, J. (2018). An Overview of Shared Mobility. *Sustainability, 10*, 4342. doi:https://doi.org/10.3390/su10124342
Menard, S. (1995). *Applied logistic regression analysis. Sage University Paper Series on Quantitative Applications in the Social Sciences.* Thousand Oaks, CA: Sage.

Miller, P., de Barros, A. G., Kattan, L., & Wirasinghe, S. C. (2016). Public Transportation and Sustainability: A Review. *KSCE Journal of Civil Engineering, 20*(3), 1076-1083. doi:10.1007/s12205-016-0705-0

Municipality of The Hague. (2021). Retrieved September 23, 2021, from Den Haag in cijfers: https://denhaag.incijfers.nl/Jive/

Myers, R. (1990). *Classical and modern regression with applications* (2nd ed.). Boston: Duxbury.

Non, M., Dinkova, M., & Dahmen, B. (2021). *Skill up or get left behind? Digital skills and labor market outcomes in the Netherlands.* CPB Netherlands Bureau for Economic Policy Analysis. doi:https://doi.org/10.34932/eyz0-4g11

OECD. (2013). *OECD Skills Outlook 2013: First Results from the Survey of Adult Skills.* OECD Publishing. Retrieved from https://doi.org/10.1787/9789264204256-en

OECD. (2016). *Technical report of the Survey of Adult Skills (PIAAC).* OECD. Retrieved from http://www.oecd.org/skills/piaac/PIAAC_Technical_Report_2nd_Edition_

Qualtrics. (2021). Qualtrics software, Version June 2021. Provo, Utah, USA. Retrieved from https://www.qualtrics.com

Rabbitt, N., & Ghosh, B. (2016). Economic and environmental impacts of organised Car Sharing Services: A case study of Ireland. *Research in Transportation Economics, 57*, 3-12. doi:https://doi.org/10.1016/j.retrec.2016.10.001

Ruhrort, L. (2020). Reassessing the Role of Shared Mobility Services in a Transport Transition: Can They Contribute the Rise of an Alternative Socio-Technical Regime of Mobility? *Sustainability*, 12. doi:10.3390/su12198253

Schipper, F., Emanuel, M., & Oldenziel, R. (2020). Sustainable Urban Mobility in the Present, Past, and Future. *Technology and Culture, 61*(1), 307-317. doi:https://doi.org/10.1353/tech.2020.0004

Shaheen, S., & Cohen, A. (2018). Equity and Shared Mobility. *ITS Berkeley Policy Briefs*(6). Retrieved from https://doi.org/10.7922/G2MC8X6K

Shaheen, S., Chan, N., Bansal, A., & Cohen, A. (2015). *Shared Mobility: A Sustainability and Technologies Workshop - Definitions, Industry Developments, and Early Understanding.* Richmond, CA, USA: Transportation Sustainability Research Center, University of California, Berkeley and California Department of Transportation. Retrieved from http://innovativemobility.org/wp-content/uploads/2015/11/SharedMobility_WhitePaper_FINAL.pdf

Shaheen, S., Cohen, A., & Zohdy, I. (2016). *Shared Mobility: Current Practices and Guiding Principles.* Washington, DC: Booz Allen Hamilton Inc. Retrieved from https://ops.fhwa.dot.gov/publications/fhwahop16022/fhwahop16022.pdf

Shaheen, S., Martin, E., Chan, N., Cohen, A., & Pogodzinski, M. (2014). *Public Bikesharing in North America During A Period of Rapid Expansion: Understanding Business Models, Industry Trends and User Impacts.* San Jose: Mineta Transportation Institute.

Spickermann, A., Grienitz, V., & von der Gracht, H. A. (2014). Heading towards a multimodal city of the future? Multi-stakeholder scenarios for urban mobility.

*Technological Forecasting & Social Change, 89*, 201-221. doi:http://dx.doi.org/10.1016/j.techfore.2013.08.036

Taylor, B., Chin, R., Crotty, M., Dill, J., Hoel, L., Manville, M., . . . Sperling, D. (2016). *Between Public and Private Mobilit: Examining the Rise of Technology-Enabled Transportation Services.* Washington, DC: The National Academies Press. doi:https://doi.org/10.17226/21875

Van Dijk, J. A., & Van Deursen, A. J. (2014). *Digital Skills: Unlocking the information society.* New York: Palgrave Macmillan.

van Marsbergen, A. M. (2020). *Bicycle sharing programs: a complement or substitute of urban public transport? - A case study of a bicycle sharing program in The Hague.* Delft: Master Thesis for Delft University of Technology.

Venkatesh, V., Brown, S., Maruping, L., & Bala, H. (2008). Predicting Different Conceptualizations of System Use: The Competing Roles of Behavioral Intention, Facilitating Conditions, and Behavioral Expectation. *MIS Quarterly, 32*(3), 483-502. doi:10.2307/25148853

Venkatesh, V., Morris, M., Davis, G., & Davis, F. (2003). User acceptance of information technology: toward a unified view. *MIS Quarterly, 27*(3), 425-478. doi:10.2307/30036540

Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology. *MIS Quarterly, 36*(1), 157-178. doi:10.2307/41410412

Witte, J.-J., Alonso-González, M., & Rongen, T. (2021). *Verkenning van het concept mobiliteitshub.* Kennisinstituut voor Mobiliteitsbeleid (KiM) - Ministerie van Infrastructuur en Waterstaat. Retrieved from https://www.kimnet.nl/publicaties/rapporten/2021/05/31/verkenning-van-het-concept-mobiliteitshub

Zeng, H., Hidalgo, D., Mackie, K., & Schleeter, R. (2014). *SmartiCitiesDive*. (Word Resources Institute Cities) Retrieved February 17, 2021, from On the Move: The Future of Multimodal Integration: https://www.smartcitiesdive.com/ex/sustainablecitiescollective/move-future-multimodal-integration/219171/

Zhang, M., Zhao, P., & Qiao, S. (2020). Smartness-induced transport inequality: Privacy concern, lacking knowledge of smartphone use and unequal access to transport information. *Transport Policy*. doi:10.1016/j.tranpol.2020.08.016