Have they missed the tram?

A case study on well-timed public transport in new housing developments

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Summary

Timing in public transport is crucial. It determines, for example, whether you arrive on time at the railway station, which is important for your chances of making or missing your connection. In this research, another type of timing is considered, namely of the development of public transport facilities and the impact of this development on the use of these facilities.

An important policy topic in spatial planning and transport policy is that of improving accessibility. In transport policy, the goal is to accommodate faster travel, and to make it cleaner and safer. Next to travelling by passenger vehicle, bicycle, or on foot, one of the transport alternatives available to people is the use of public transport. In current spatial planning in the Netherlands, one of the goals is to provide new housing developments with access to a well-timed and adequate public transport network. However, the terms well-timed and adequate have not been further defined. Early implementation of a public transport network leads to high costs in the beginning, as the number of residents in a new neighbourhood is low, initially. But what if such an early implementation would lead to more public transport use by future dwellers?

One of the thoughts that triggered this interest was that, if a public transport network would be developed in the first stages of a new housing development, residents may start using this public transport instead of their cars. This could result in less car-oriented travel patterns and more public transport users. From a contrasting point of view it may not matter when access to a public transport network is established, because residents of new housing developments tend to be more mobile and, therefore, more likely to use a form of personal transportation. According to this view, it is unlikely that an early and adequate public transport network would influence this behaviour.

Research

This study analyses the effect of timing, with respect to the implementation of light rail based public transport in new housing areas, and how much use is made of it. For this study, three comparable new housing developments with differently timed light rail realisation were selected. These cases were compared with other new housing developments in the Netherlands. Furthermore, the cases were analysed on accessibility, self-selection and migration. With these factors, and public transport use in the areas, the effect of timing was analysed. Part of the research was to conduct a survey in the three case study areas.

The main research question of this research is:
To which extent does the time of implementation of light rail transport in new housing areas affect the local use of public transport?

In the Netherlands, the large-scale new housing developments of the past decades are called Vinex locations (named after the Fourth Spatial Planning Document (*Vierde Nota Ruimtelijke Ordening Extra*) by the Dutch Ministry of VROM). The Vinex locations are large-scale new-housing areas on appointed greenfield locations. Most of these locations were previously used as farmland. One of the goals connected to these Vinex locations was to reduce the increase in passenger vehicle traffic.

Three Vinex locations in the municipality of The Hague were chosen for this case study; Wateringse Veld, Ypenburg and Leidschenveen. As they are situated within the same municipality, the data sources are the same for all districts. In addition, the quality of their current public transport facilities are comparable, all three districts have access to a frequent light rail service. In Wateringse Veld, the development of new housing started in 1996, and a year later, in 1997, tram line 17 was established in the south of the district. In Ypenburg, construction was also started in 1996, but a tram line (15) did not become operational until

2002 – when 30 per cent of the houses had been built. In both districts, the light rail system connects them to The Hague central station. In the Vinex location of Leidschenveen, construction was started in 1997, and during the first decade, there was no light rail service connecting the area to the central station of The Hague. In 2007, a metro and tram station was built in the centre of the district, connecting it to the city of The Hague and, in a southern direction, to Zoetermeer and Rotterdam.

Results

To study the effect of the timing of public transport, many factors were analysed. First, the case study areas were compared with other Vinex locations in the Netherlands. This showed that Vinex locations in the Netherlands were later and less well-connected to any form of quality public transport. Light rail systems are important to the case study districts in The Hague, but only cover 4 per cent of the Vinex land area. This is due to the fact that only the main cities have such a light rail systems.

Subsequently, the characteristics of the case study areas were compared. This analysis showed that Wateringse Veld has the largest share of adult residents with a driving licence, and the group of people that are the main user of a car is the largest in Wateringse Veld. However, Wateringse Veld also has the highest number of students and those that own a student public transport card. These characteristics are positively related to public transport use. For other characteristics, such as demography and spatial planning, the districts are comparable. Only Wateringse Veld has twice as many elderly residents, which could have influenced the mobility figures for the district.

Even though the districts are located within the same municipality, there are many differences in accessibility. Leidschenveen has, using transportation by car, access to the most residents and facilities. With regards to access to other residents, the results for public transport were comparable. In the areas of facilities, jobs, shops and schools, Leidschenveen scored the best. Wateringse Veld has the most facilities accessible to cyclists. When looking at the travel time ratio, Leidschenveen again scored highest. From the results, a frequent use of public transport was expected in Leidschenveen for 2009. The results for Ypenburg and Wateringse Veld were expected to be comparable.

Self-selection plays an important role in travel behaviour research. The causality between living environment and travel behaviour can work in two directions. Therefore, the preferences of the residents in the case study areas were analysed. The results from the survey showed that, for public transport users, public transport facilities are important. Furthermore, transport facilities seemed the least-important aspect for people considering a move to a certain area.

The migration patterns influenced the group of people that had no public transport facilities available to them during their first years in the district. These patterns were relatively slow, in each of the three districts, compared to other areas in The Hague and the Netherlands.

Finally, the use of public transport and the effect of timing were analysed. The use of public transport was analysed according to different parameters. The results showed that Wateringse Veld had the highest modal split for tram or metro in 2006, while in 2008, Leidschenveen had the highest number of people getting on or off the metro at the light rail station. These differences between case study areas can partly be explained by the number of trips per person, per day. Looking at the frequency of public transport use (April 2010), Leidschenveen had the highest share of frequent users.

From the variables that explain the light rail use in the case study areas in 2006, can be deducted that the districts themselves play a significant role. Although another data source

for 2010 showed the districts to not be significantly different. Therefore, timing could have an influence on public transport use, albeit temporarily.

Conclusion

Based on the analyses in which the three cases are compared, it is concluded that timing of public transport does have a small effect on its use, visible in the number of people that used the light rail services in the case study areas.

When considering the realisation of public transport facilities in newly urbanised areas, it is important that the factors that influence the use of such public transport are taken into account. Furthermore, as resources are not unlimited in public transport projects, the importance of early implementation needs to be weighed against other aspects, such as connections, frequency and quality of these services. This research shows that there is no clear evidence that early realisation makes a large difference to the way public transport is used in a particular area. Therefore, policymakers need to take this into account when considering such early realisation. The frequent use of public transport in Leidschenveen indicates that other aspects of public transport facilities may play a more important role.

Content

Preface

Past January many things changed in my life. Next to starting my master thesis; I also moved to Deventer. After a first chaotic week, with painting and moving, I could start with my research plan. This appeared to be a struggle, defining a complicated topic to structured and clear research plan. This was not the only hurdle at the time; also the weather was not cooperative. Both I, just returned from Indonesia, and the Dutch trains were not prepared for the cold. This meant standing in the cold in Amersfoort for almost an hour every day realising the importance of well-timed public transport. Happily some weeks later spring started, bringing better weather, shorter waiting periods, repaired trains and an almost finished research plan. So I could focus on the real research.

This thesis was the first time I conducted a scientific research alone for such a long period. It came with ups, cycling trough Leidschenveen in the sun, and downs, sitting at home with a concussion. Seven and a half months after the start I am proud to present the final version as result of this special period.

In this preface I like to thank a number of people that were important the past period. First of al, my supervisor, colleague and roommate at PBL Hans Nijland. Thanks for giving me the chance to perform this study at the PBL, for all advice and for developing my music taste. With Hans I would like to thank my UT supervisors Karst and Bas, for all input that made this thesis to what it is. Sander thanks for all jokes and serious comments. Also thanks to all other colleagues at PBL for the help and the nice working environment.

Furthermore, I would like to thank Peter van de Vijver from the Municipality of The Hague and Jan Termorshuizen from the Region Haaglanden for all information. Without your data I was not able to do this research.

I wished it was possible to thank every person I met the past seven years separately, unfortunately, I can only name a few. Janneke without you this thesis would not be the same. Thanks for everything, and see you sometime in the next step. Mattie thanks for being you, for living in the same house with me and being there at the moments that were heavy or fun. I loved to have a working day at home together. All other people: thank you very much!

Last and certainly not least I like to thank my parents, Willem and Marike, for always being there supporting me no matter what crazy plan I had this time.

Elske Olthof
Bilthoven, August 2010

1 Introduction

Timing in public transport is crucial. It determines, for example, whether you arrive on time at the railway station, which is important for your chances of making or missing your connection. In this research, another type of timing is considered, namely of the development of public transport facilities and the impact of this development on the use of these facilities.

Each day around 1 million travellers use the public transport network in the Netherlands. Still, the role of public transport in the total mobility is not larger than 5 percent of the trips and 11 percent of the kilometres travelled (Berveling et al. 2009). Public transport can contribute to accessibility, quality of life and social participation. The main part of the public transport trips are travelled during rush hours, to work or education. At these moments the roads are crowded, which increases the potential of public transport as alternative. Furthermore, use of public transport increases the quality of life because an average traveller kilometre in public transport produces half the negative external effects of an average traveller kilometre by car. This is based on emissions, unsafety and use of space of busses and trains in the Netherlands. For the group of adults without a driving license public transport is an important transport mode. 35 percent of the kilometres they travel are by public transport, next to 35 percent as a car passenger. This makes good public transport essential for connecting people with their destination, and providing a reasonable alternative to the car (Berveling et al. 2009).

Considering public transport many different aspects determine the use of public transport in an area. On one hand the type of people and their travel preferences play a role. On the other hand spatial characteristics and the availability of public transport also influence the use of public transport.

1.1 Background

An important policy topic in spatial planning and transport policy is that of improving accessibility. In transport policy, the goal is to accommodate faster travel, and to make it cleaner and safer. Next to travelling by passenger vehicle, bicycle, or on foot, one of the transport alternatives available to people is the use of public transport. In the current memorandums on spatial development, Nota Ruimte (MVROM 2006), and transport, Nota Mobiliteit (MVW 2004), one of the goals is to provide new housing developments with access to a well-timed and adequate public transport network. However, the terms well-timed and adequate have not been further defined. The Directorate-General for Public Works and Water Management, currently, works with the unwritten rule that new housing areas must have easy access to public transport on completion of two thirds of the houses. Therefore, the group of first new residents have no alternative but to use cars or bicycles.

The Nota Ruimte is published by the Dutch Ministry of Housing, Spatial Planning and the Environment. The ministry is interested in the effect of the time of implementation of public transport realisation in new housing developments. Early implementation of a public transport network leads to high costs in the beginning, as the number of residents in a new neighbourhood is low, initially. But what if such an early implementation would lead to more public transport use by future dwellers?

One of the thoughts that triggered this interest was that, if a public transport network would be developed in the first stages of a new housing development, residents may start using this public transport instead of their cars. This could result in less car-oriented travel patterns and more public transport users. From a contrasting point of view it may not matter when access to a public transport network is established, because residents of new housing developments tend to be more mobile and, therefore, more likely to use a form of personal transportation. According to this view, it is unlikely that an early and adequate public transport network

would influence this behaviour. The characteristics, such as education, labour participation and the stage of life (age, children) explain their high mobility pattern (Snellen et al. 2005).

1.2 History of urban planning in the Netherlands

The Netherlands has a long history of intervention in the developments of urban form by spatial planners. In the seventies and eighties of the last century a policy of concentrated decentralisation of urban land was implemented by prohibiting the growth of small rural settlements and developing designated growth centres (de Vries 2000). During the 1980s a policy for compact urban growth was formulated in the Vierde Nota Ruimtelijke Ordening Extra, Fourth Spatial Planning Document (MVROM 1990). The implementation started in the nineties. In the beginning of this century the Fifth Physical Planning Memorandum was published. The Netherlands is confronted with a multitude of interests that compete with each other for the scarce space. Interest groups have to choose how to share this space. Currently, the Nota Ruimte (MVROM 2006) is used in the Netherlands. The document presents a change in the tendency of centralised spatial planning policy; spatial planning becomes further decentralised.

In the next section special attention is paid to Vinex locations. These are housing developments built in the past twenty years in greenfield locations. This development was founded in the fourth memorandum.

1.2.1 Vinex locations

With the implementation of the Fourth Spatial Planning Document, Vinex locations (named after the Memorandum) became a concept in Dutch spatial planning. In this Memorandum appointed municipalities for the implementation of this policy. In the Memorandum different types of building sites are distinguished: locations within the boundaries of the 1971 city, greenfield locations and other developments. The Vinex locations are large-scale new housing areas on appointed locations. Most locations were previously used as farmland. One of the goals connected to these Vinex locations was to reduce the increase in passenger vehicle traffic. Concentration of housing in or near existing urban centres was pursued to achieve this reduction. Enabling the daily functional relations, connected to living and working, to take place on the scale of the urban region. The location of housing, employment and facilities should ensure optimal accessibility by public transport, and for walking and cycling (MVROM 1990). Some criteria for Vinex development locations are: locate the Vinex location within an urban district or assigned urban centre; in, on or near existing urban areas and with optimal accessibility by public transport and for walking and cycling. Furthermore, the neighbourhoods itself should also have quality public transport facilities and a quality network for walking and cycling (Snellen and Hilbers 2007).

A critical note from Deen (2003) shows that not everything is perfect at the Vinex locations. From the start of development of Vinex areas public transport appeared to be a problem. The promised public transport is not or scarcely available, and is therefore no alternative to the car. Not only the infrastructure for public transport is lacking; the exploitation is a problem as well. The Ministry of Transport, Public Works and Water Management only agrees to realise public transport facilities that haven expected cost-effectiveness of 50 percent.This means that the flow of travellers has to be large, which is not (yet) the case at newly built housing sites with only a few hundred residents.

Snellen et al. (2005) observed travel behaviour in residents of new housing districts sites in the period between 1995 and 2003; comparing Vinex locations with other new and existing housing districts in the Netherlands. Their research shows that the high mobility rates of residents of new housing can be explained mostly by the population composition in these areas. The residents of new housing are part of population groups that travel much, such as parents with children. On the large-scale Vinex locations car use is the highest in kilometres

per person per day, in comparison with other districts. If these locations have a better provision of services and quality public transport the use of public transport could be up to 12 percent higher.

1.3 Reading instructions

In this report the second chapter discuss the framework around this study, based on a study of scientific literature. In chapter three the design of this study is presented with the research objective and research questions. Chapter four elaborates on the method of analyses to answer the research question. The fifth chapter discusses the results from the analyses. Chapter number six concludes this master thesis with the conclusions, limitations and discussion. Furthermore, it discusses the opportunities for future research.

2 Framework

There are various variables that determine the use of public transport. It is not only the availability of the bus next door, also social characteristics, such as income, phase of life, etc determine the demand. In Figure 2.1 the interdependencies between these factors are given in a diagram. On the left side are the aspects that influence the mobility demand presented, the right presents the public transport supply. In coherence with other transport supply this determines the use of public transport.

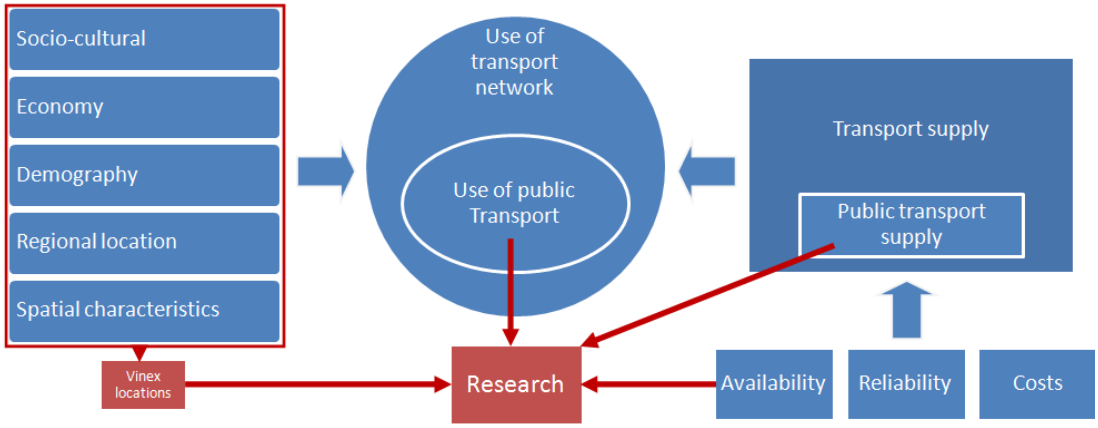


Figure 2.1: Model public transport within the system (Adapted from Savelberg (2007: pp. 18))

In Figure 2.1 the scope of this research is represented, pointed out with the red marks. The focus of this study is the use and supply of public transport in large-scale Vinex locations. Public transport supply exists of three factors, i.e. availability, reliability and costs. The last two are important factors in determining the use of public transport, but beyond the scope of this study.

In this chapter the framework around the research objective is described. The essential concepts are explained, and the current state of scientific research is described. The first section focuses on public transport; section two explains urban planning. In the last section the synergy between public transport and land use is described.

2.1 Public transport

Public transport in the Netherlands was responsible for about 5 percent of the trips and 11 percent of the travel kilometres (2004-2007). In the western part of the Netherlands, the Randstad, these numbers are higher with about 8 to 9 percent of the trips and 16 to 18 percent of the kilometres. In this section first the public transport supply is discussed, and it concludes with the use of public transport.

2.1.1 Supply

Currently, in most urban areas public transport has difficulties in competing with the travel time of cars, except during rush hours. During the peak periods, cars lose time in traffic jams, while public transport has shorter average waiting periods because of more frequent departures. Therefore, it is mainly for journeys to and from work and school that public transport is able to compete with cars (Naess 2004).

Public transport can serve many purposes and objectives. TNO (2005) concludes 'public transport should be a reasonable and reliable alternative; it does not always have to be the best option' in their research on public transport in urban networks. Public transport has many values for different stakeholders:

- For the vitality of the city centre a good access by public transport is important;
- Households are interested in a next door connection with limited transfers to the rest of the city;
- Companies and organisations near public transport hubs profit of a good accessibility within the city's core; and
- Public transport plays an important role toward achieving a sustainable city (Banister 2005).

The demands on an optimal public transport system are formulated by TNO (2005). The main connections to the centre locations should be quick, reliable, frequent, have enough stops and have enough capacity. In the sub centres Park and Rides are important to provide the possibility to change from transport mode. The accessibility of companies and services should be linked with the main traffic flows.

Access and egress are weak links in a public transport chain (Krygsman et al. 2004). These determine the availability and experience of public transport. Initiatives aiming at improving access and egress hold potential to significantly reduce public transport trip time. Figure 2.2 shows the travel time in percentage of the total travel time for the travel components of public transport. This shows that in the Netherlands the access and egress takes a large portion of the travel time by public transport. Only in distances above 25 km the actual time inside the public transport vehicle reaches the 40 percent.

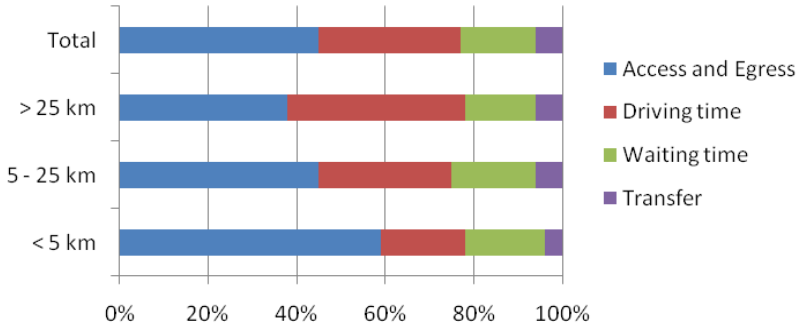


Figure 2.2: Share of travel time components in weighted travel time by PT (Hilbers et al. 2009)

2.1.2 Public transport use

In the introduction of this section Figure 2.1 shows the interdependency diagram of public transport. The focus of this section is the use of public transport. This is determined by the demand and supply of public transport and other transport modes. In the Netherlands there are different types of public transport, from flexible busses to high speed trains. When these are using the same network, i.e. train tracks used by intercity trains and local trains, the capacity of the network is lower in comparison with a homogeneous train service. For some travellers the local trains are important to access the public transport network. For other users the existence of local train service results in a lower frequency and longer travel times. Therefore, planning of public transport is always balancing between the needs of different users (Hilbers et al. 2009).

In the Netherlands public transport is mainly used for long distance travels (train) (Savelberg 2009), and for local travel movements inside the main cities (busses or local rail based public transport) (Hilbers et al. 2009). Over long distances public transport is able to produce better competing travel times in comparison with the car. Over a longer distance the share of

access and egress time becomes less, see also Figure 2.2. The use of public transport increases when the travel time ratio[1] on a corridor is lower than two. MuConsult (2000) endorse that public transport is mainly used for long distances as well. The average distance in 1999 per movement for public transport is 27.9 km while for the car this is 12.7 km.

Hilbers et al. (2009) studied the effects of improvement of the public transport supply, spatial policy and flanking policies with a traffic model (i.e. road pricing, public transport prices, parking prices). They found that improvement of public transport supply, spatial policy and flanking policy together has the same effect as expected from these policies separated. Still, combining these policies in implementation has the best perspective. Flanking policies, such as road pricing cause a shift in the travel demand, and the public transport demand increases. With these additional travellers the public transport supply can be improved. In the study the possibilities of improving the access and egress transport is addressed as well.

The research of Susilo and Maat (2007) shows that access to a car and commuting distance are the main factors that determine whether commuters travel by private car or public transport. Their research focuses on commuting trends in the Netherlands in the period 1995 – 2005 based on analyses of the National Travel Survey. They found that access to a car increases the likelihood of car usage significantly, and reduces the probability of using public transport. The use of private cars is lowest among highly educated commuters. For long distances Dutch commuters tend to use public transport more than private cars. Commuters from urbanised areas are more likely to use public transport than commuters from less urbanised areas. Inside the Randstad area and its main cities, commuters tend to use more public transport than commuters outside this area. The influence of car availability is growing continuously in the last decade, both in encouraging the use of cars, and reducing the use of public transport.

Van Hagen (2004) shows that the perception of the travel time for the public transport users is longer than the actual travel time. Rail passengers experience the access and egress twice as long as the actual travel time. The time at the platform feels even three times as long. Moreover, Givoni and Rietveld (2007) found that the access and egress facilities have an important effect on the general perception of travelling by rail. Their study is based on the Dutch Railways customer satisfaction survey from September 2005. Furthermore, the quality of the stations is important. In the Netherlands the most-important modes to travel to a railway station are walking, bicycle and public transport. The availability of a car does not have a strong influence on the choice of access mode to the station (Martens 2004).

Some people will never use a car, for others the train is no option. The group in between of these two are the ones that can be influenced to use public transport. The research of Van Exel and Rietveld (2009) shows in analyses of travel survey data that 42 percent of the car travellers had public transport as an realistic option. Car users over-estimated travel time by public transport compared to the actual travel times. The research shows that when this perception would be more accurate, two third of the car travellers that, currently, do not see public transport as an option, would consider it and use it from time to time. This underlines the importance of a good perception of public transport. Also factors, such as image and comfort determine the use of public transport by travellers (Berveling et al. 2009). Currently, in the Netherlands public transport has a negative image. This is caused by many factors, such as supply, demand and communication. Next to working on the supply and access and egress, much can be gained by improving the image of public transport. Different groups of travellers have different demands on the services of public transport, these are represented in the segmentation model of Van Hagen (2009). By anticipating on the needs of the travellers the appreciation of the traveller will probably increase.

[1] Travel time ratio: Travel time by public transport / Travel time by car during peak periods

Concluding adequate public transport can be described as a reasonable alternative in the transport system, with good access and regress facilities that reduce the travel time. Different demands of users should be weighted to find a workable balance.

2.2 Urban planning

Many researches have been conducted on the ability of spatial planning to influence travel behaviour. This section discusses some literature, which addresses this connection, in connection with public transport.

Reviewing several empirical studies conducted in different countries Naess (2004) shows that the location of the residence relative to the city centre is the urban structural characteristic, which exerts the strongest influence on travelling distances, modal split between car and non-motorised transport, and energy use for transport. The analyses of Cervero (2002), based on a normative model in Maryland US, reveals that intensities and mixtures of land use significantly influences the decision to drive a car, be a passenger, or take public transport, while the influences of urban design tends to be more modest.

Van Wee and Maat (2003) evaluate a selection of Dutch studies, mainly empirical analyses, on the interaction between land use and transport. They conclude that in Dutch research there is no convincing evidence found to support the supposed relationship. This is also underlined by the research on the National Travel Survey (1998) of Schwanen et al. (2004). They evaluate the consequences of the Dutch national physical planning policy for an individual's travel behaviour. The analysis suggest that the spatial planning policy has been most effective in preserving high rates of cycling and walking in the large and medium-sized cities, in particular for shopping trips. Furthermore, Wee and Maat (2003) address some differences of the Dutch situation in an international context. The high shares of cycling and the compact design of the Netherlands makes the urban environment and transport characteristics quite unique.

In Halcrow (2009) an extensive literature study is executed, about 250 papers have been reviewed. Starting from the early pioneers, such as Newman and Kenworthy (1989) to current research with assessment of co-linearity between characteristics, causality and self-selection, i.e. Naess (2009). Europe and the US have a different base of urban planning. In the US this is more privately financed, which caused more low density urban sprawl. In Europe urban planning is a governmental issue, and cities are developed in a more compact manner. The conclusion of the Halcrow study is that, all things being equal, there are significant associations between the built environment and travel behaviour, also when socio-economic characteristics and attitudes have been accounted for. The trip length and mode share are most likely to be affected by the form of the built environment.

2.2.1 Self-selection

In transport and spatial science self-selection is an important issue. Does the location influence the travel behaviour of its residents, or do residents chose a location, which suits their travel needs? Meurs and Haaijer (2001) underline the existence of this question as well. Their research using the tijdsbestedingsonderszoek (time-spent research) shows that an increased public transport supply led to increase of public transport use compared to car use, but as they state the direction of causality is open to discussion. Also Cao et al. (2007) press the urgency of research in this area. This section shortly discusses two studies on self-selection with a different point of view.

Pinjari et al. (2007) state that land use and transportation system attributes are often treated as exogenous variable in models of travel behaviour. These models ignore the potential self-selection processes that may play a role wherein households and individuals choose to settle

in neighbourhoods that are consistent with their lifestyle and transportation preferences, attitudes and values. The simultaneous model of residential location choice and commute mode choice (Pinjari 2007) shows that both observed and unobserved residential self-selection effects do exist. However, even after accounting for these effects, it is found that built environment attributes still have an impact on commuter mode choice behaviour.
Naess (2009) counters the positions that self-selection of residents into geographical locations matching their travelling preferences precludes researchers from drawing firm conclusions about influences of residential location on travel. By the reasoning that if households self-select into areas that meet their travel preferences, it seems self-evident that urban structure matters. His research is built on qualitative interviews in the urban areas of Copenhagen and Hangzhou. It shows that there exists a significant relationship between residential location and travel, regardless of travel-related residential preferences.

2.3 Public transport and urban planning synergy

Though the previous sections discussed public transport and urban planning separated, it is also possible to link these two together to achieve a clearer view on the influence of public transport and urban planning on each other.

In transit oriented development urban development plans are designed based on transit systems. This can improve the efficiency of land use and public transport operations. The strategies discussed in literature were organised into three dimensions by Cervero and Kockelman (1997): enhancing development density to increase transit ridership; mixed land use development to improve public transport passenger convenience; and pedestrian-oriented walkways and transfer systems to increase the use of mass-transit.

There are different types of public transport cities in the world. Some cities have a long term vision on public transport, such as Copenhagen. The city adapted its five finger vision for rail based development just after World War II. Other cities invested in technology and adapted public transport to serve their city, such as Karlsruhe with it a track sharing system. Cervero (1998) distinguishes four different types of successful transit cities:

- Adaptive cities: transit-oriented metropolises that have invested in rail systems to guide urban growth for purposes of achieving larger societal objectives. Regional master plans are needed to create this build form.
- Adaptive transit: these are places that have largely accepted spread-out low-density patterns of growth, and have sought to appropriately adapt transit services and new technologies to best serve there environs.
- Strong-core cities: integrated transit and urban development within a more confined, central city context.
- Hybrids: workable balance between concentrating development along mainline transit corridors and adapting transit to efficiently serve their spread-out suburbs and exurbs.

In the Netherlands different types of cities can be observed, but due to the compact city policy of the past decades there are no large-scale low density growth patterns. In a few cities metropolitan high densities can be observed. Other cities have dense cores, but going further to the edges of the cities the densities drop. Moreover, the cities did not develop along rail systems; therefore, the cities probably need to be developed, such as hybrids. These cities concentrate the inner city development along transit corridors, and adapting the public transport system to serve the spread-out suburbs.

An important issue in the use of public transport are the facilities and densities at public transport hubs. Ritsema van Eck et al. (2005) suggest concentrating services near public transport nodes, and increasing urban density. In their explorative simulation they found that these do have potential to increase travel time and distance efficiencies. Furthermore, they state that spatial planning needs to address a life-style oriented approach for the

configurations of residential areas. Also Bertolini and le Clercq (2003) propose land-use policy in seeking concentration of large-scale offices and regional facilities around public transport nodes, to reinforce transport links in their analyses of the metropolitan area of Amsterdam.

3 Research design

This chapter discusses the research design, starting with the objective. In the second section, the research model is visualised. In section three the research questions are described. The fourth section describes the scope of the study. In section five the case study areas are described. And, finally, in the last section the conceptual model is presented.

3.1 Objective

The focus of this study is public transport in new housing developments. In some of these areas public transport is realised before houses are being built. In this case the residents have the possibility to travel by public transport from day one. In other areas the public transport comes later, and the travel behaviour of residents is settled in a pattern without using public transport.

In this research the effect of timing, with respect to the implementation of public transport in new housing areas, on the use of public transport is studied. This topic is narrowed to the effect of timing of light rail services. Light rail systems reach into the housing areas and, therefore, are close to the residents. Rail based transport tend to have a higher status, and these are therefore more likely to be used. The objective is formulated below:
The objective of this study is to analyse the effect of the time of implementation of light rail transport in new housing areas on local use of public transport.

3.2 Research model

Based on the objective and the framework of the research, Figure 3.1, the research model is presented. This model gives the structure of this study. For Vinex locations (a) the development of the transport system was reviewed (b). Three comparable cases were selected with a different time of implementation of public transport realisation (c). For the case study areas accessibility, self-selection and migration (d) were analysed. With these factors and public transport use in the areas, the effect of timing was analysed (e).

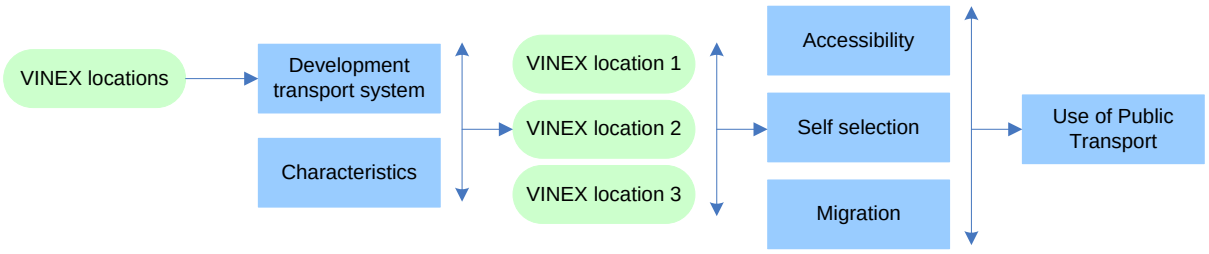


Figure 3.1: Research model

3.3 Research questions

To reach the objective a main research question was formulated. The main research question of this research is:
To which extent does the time of implementation of light rail transport in new housing areas affect the local use of public transport?

To answer this question several sub questions were formulated. For analyses of the effect of the timing of public transport three cases were used. The cases are at first sight comparable Vinex locations, except for the development of public transport. The first question analysed the realised development of the public transport in Vinex locations, and compared the results with the case study districts.

a. *How is public transport set up for Vinex locations, in general, and what are the differences with its development in the case study areas?*

In question b the districts were compared in detail on characteristics, such as demography, spatial characteristics, etc.; see also Figure 2.1.

b. What are the characteristics of the case study areas, and do these influence the use of public transport?

Question c compared the development of the different transport modes in the districts. These were measured in accessibility of the district for different transport modes.

c. Does the level of accessibility of the areas influence the use of public transport?

To analyse the effect of the timing of public transport an additional three questions were formulated. The first analysed the existence of self-selection in this study.

d. Does self-selection affect the use of public transport in the case study areas?

Migration can affect this study in two directions. Migration patterns could affect the effect of timing, and the realisation of public transport could affect the migration to the district. On the second relationship there was no data available; therefore, only the influence of migration patterns on the use of public transport was analysed in question e. The migration patterns could influence the number of people that had no public transport facilities available to them during their first years in the district.

e. Do migration patterns influence the use of public transport?

Finally, the focus is on the public transport use in the case study areas.

f. What is the effect of the time of implementation of light rail services on the use of public transport?

3.4 Scope

This research has the following boundaries:

- The spatial focus of this research are Dutch Vinex locations. These are large-scale new housing projects developed from scratch. This means that there is no transport network at the starting point and, therefore, this network has to be fully developed. In Vinex locations the ambitions on the sustainable mobility of the residents was an important aspect and, therefore, one should expect that good public transport network were realised.
- The Vinex locations used are situated in the Randstad. The Randstad was chosen because many Vinex locations are located in this area (Lörzing et al. 2006). Furthermore, the public transport network is more developed in the Randstad compared with other areas in the Netherlands. Moreover, the Randstad is the area in the Netherlands that has the most congestion and, therefore, public transport has the possibility to have a competing travel time (Hilbers et al. 2006).
- The main transport modes in the Netherlands are car, bicycle and public transport (Schwanen et al. 2001). Therefore, these modes were used in the accessibility analyses. In case of public transport, the focus is on light rail.

3.5 Case study

To study the effect of the time of implementation of light rail three cases in the Netherlands were selected. The selection of the cases was based on two criteria. First of all, the characteristics of the districts, they had to be comparable except for the implementation of the public transport network. Next to the characteristics; the availability of data was an important criterion.

In the current situation the districts should have adequate public transport, with a comparable service level. In one district quality public transport should be established before the start of the new housing construction. In the other districts quality public transport should be established at a later moment in during the construction of the housing area. The other

transport characteristics needed to be comparable, for example accessibility of highways and possibilities to use bicycles.

For the data analyses it was convenient to have three districts in the same municipality, so the data sets are similar. Furthermore, data should be available on demography, development of the road network, development of the public transport system and development of the public transport use. In the municipality of The Hague there are three large-scale Vinex locations with a different timing of public transport development, this made The Hague a suitable case for this study. For a map of the case studies in The Hague see Figure 3.2.

The municipality of The Hague and Stadsgewest Haaglanden (urban region Haaglanden) have several data sets, which could be used for this study. The Dutch Mobility Research (MON) conducted, on request of the municipality, an oversampling in The Hague in 2006 and 2009. Unfortunately, the research of 2009 is not available yet. The data from 2006 could be used to calculate the public transport use in the districts, and to determine the orientation patterns. Furthermore, there are counts available for the tramlines for a period of six years. For the counts infra red equipment was used. For some years the counts became unreliable because of the implementation of the OV-chip card. With positioning of the OV-chip card checkpoints, the infra-red counters were blocked and, therefore, produced unreliable counts.

The municipality of The Hague has three Vinex locations, Wateringse Veld, Ypenburg and Leidschenveen, with different timing of the implementation light rail services. In Wateringse Veld, the development of new housing started in 1996, and a year later, in 1997, tram line 17 was established in the south of the district. The districts had an intended number of 6,500 new houses. In Ypenburg, construction was also started in 1996; with a total amount of 10,500 planned houses. A tram line (15) did not become operational until 2002 – when 30 per cent of the houses had been built. In both districts, the light rail system connects them to The Hague central station in approximately 25 minutes. In the Vinex location of Leidschenveen, construction of 6.800 houses was started in 1997, and during the first decade, there was no light rail service connecting the area to the central station of The Hague. In 2007, a metro and tram station was built in the centre of the district, connecting it to the city of The Hague and, in a southern direction, to Zoetermeer and Rotterdam.

All three districts were chosen as case studies areas. For Leidschenveen and Ypenburg there was a limitation in the data set, but it was still possible to compare the districts.

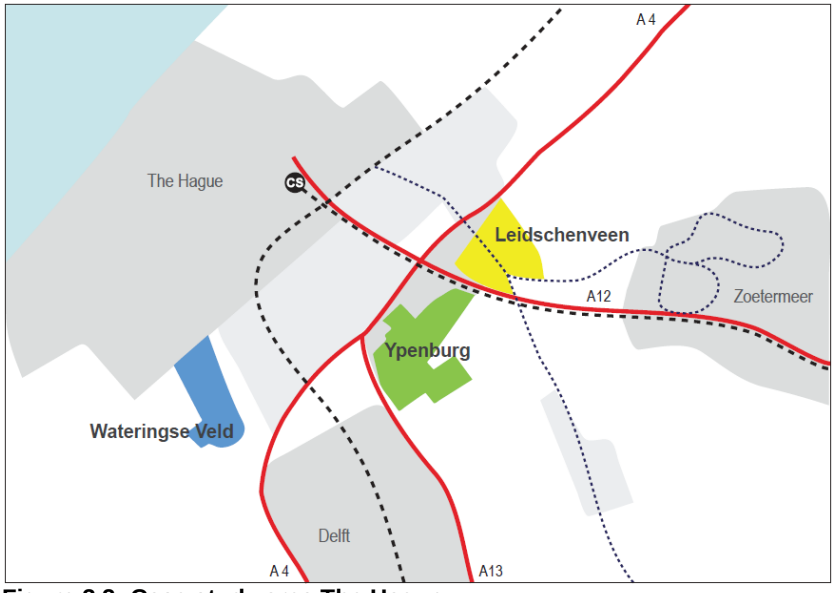


Figure 3.2: Case study area The Hague

3.6 Conceptual model

A conceptual model describes the function relationships between the components of a system. The model gives a delineation of the research, the influencing factors and the relations between these factors. The system in this study is public transport use in an urban area. The conceptual model of this research is presented in Figure 3.3. The conceptual model is based on the model for public transport use, Figure 2.1, and the research model, Figure 3.1.

The model relates public transport use and the effect of the time of implementation with other factors in the system. The factors are divided in two groups, supply and demand. The first contains all spatial and personal characteristics, as well as self-selection. Both spatial and personal characteristics, in particular travel preferences, influence self-selection, next to the migration patterns. All the demand factors together determine the demand travel of an individual. Demand and supply together determine the travel behaviours. The travel behaviour again is related to the use of public transport and other transport modes.

On the supply side, the public transport facilities and other transport modes are presented. For these the accessibility and the availability determine which transport mode is used. The time of implementation is related to the public transport facilities as this determines whether it is available or not. Also the migration patterns are related to the time of implementation as these determine the group of people that had no public transport facilities available to them during their first years in the district. The availability of transport supply is also related to travel preferences. The preferences of an individual, partly, determine which transport modes are available.

A special relation in the model is the link between the time of implementation and the use of public transport. This research studies the existence of this relationship.

In this study the interactions from the conceptual model were analysed with a large number of existing data sources, such as travel surveys and road networks. Moreover, a survey was conducted to provide the missing information on self-selection and its relation with other factors. The competitiveness between the transport modes was analysed by comparing travel times and facilities. Regression analyses were used to combine different factors of the model.

The used method has the advantage that it provided information on all factors presented in the conceptual model. The main disadvantage is that not all information is combined in one analysis and, therefore, some interactions were only estimated.

The methods are described in detail in chapter four.

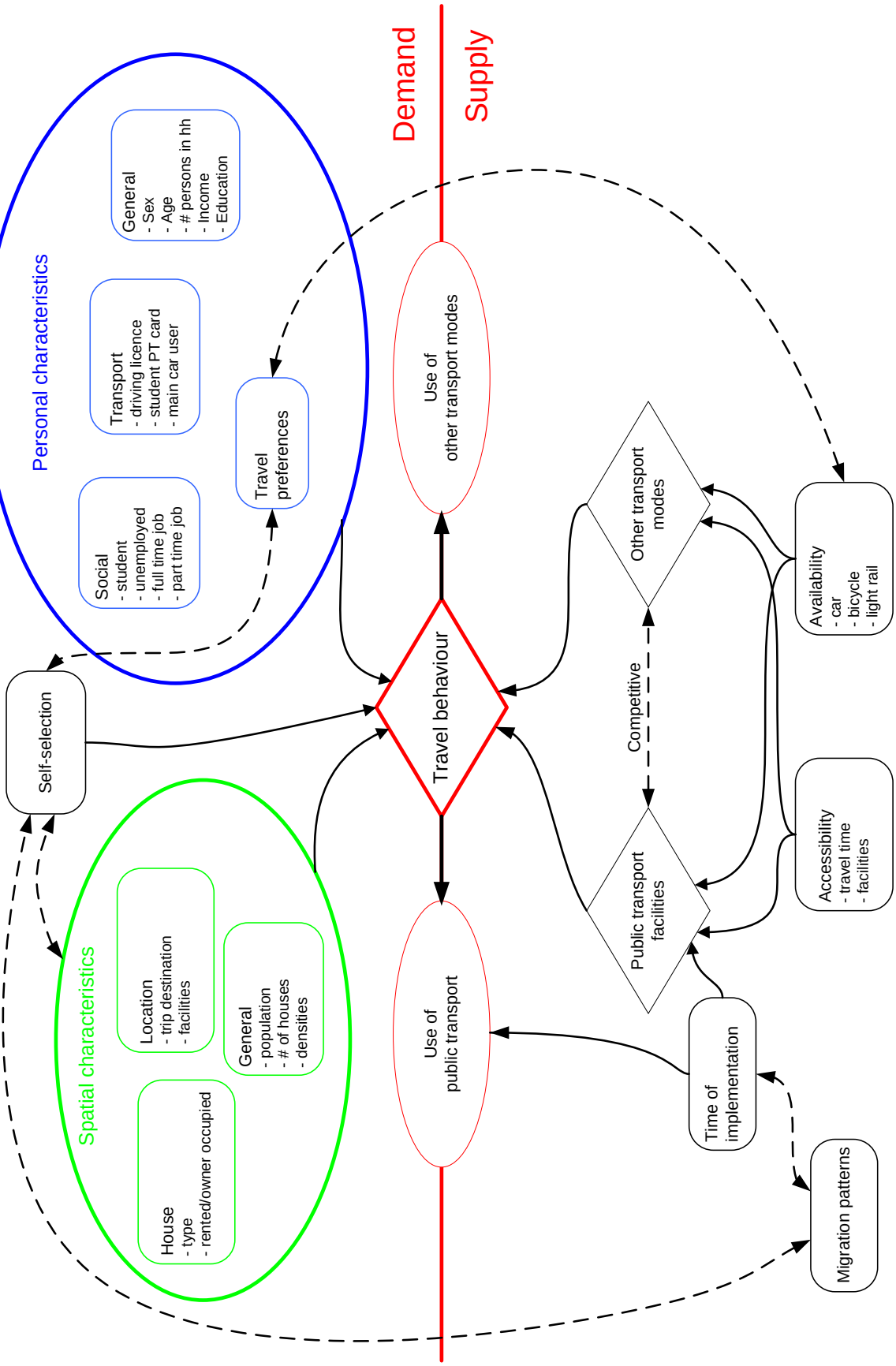


Figure 3.3: Conceptual model

4 Methods

This chapter discusses the methods used for the analyses of the research questions. The results of the analyses are considered in the next chapter. The first section describes the data used in this study. In the following sections the methods for each research question are discussed, following the order of the research questions (see section.3.3).

4.1 Data sources

For the analyses primary data and secondary data was used. The primary data consisted of a survey conducted in the three study areas, and the secondary data consisted of several different data sources providing information on housing, transport and local characteristics.

4.1.1 Primary data

The survey was conducted in the three large-scale Vinex locations of The Hague. The population for the survey consisted of the addresses within a 500 meter boundary from the light rail stations. These residents were considered well connected to the light rail facilities. A random sample[2] with an a-select start was drawn of 50 respondents in each district. The districts were still developing, this meant that some houses were still constructed, and an up to date address list was unavailable. For Wateringse Veld and Ypenburg this was not a problem, but in Leidschenveen a few large apartment blocks near the metro station were not listed in the resident and dwelling register (source Netherlands Environmental Assessment Agency). Therefore, the addresses from these apartment blocks were added to the register. From the new list the random sample was drawn.

The survey consisted of 26 questions, starting with mobility patterns, mobility and migration preferences and ending with some general questions. It took the respondents around 7 minutes to fill in the questionnaire. For the questions and the development of the survey see Appendix I: The Survey. It was a written survey, but it could also be conducted face-to-face. Around 20 percent of the surveys were conducted face-to-face. Each address was visited in person on weekdays between 4 and 9 p.m. The residents were asked if they wanted to participate in the survey, and if not the reason was asked. The survey was filled in face-to-face, or an appointment was made to collect the written survey, so respondents could fill it in on another moment. When the respondents were not home at the appointment the address was visited again at least one more time. If there was nobody home during the first visit the survey with an accompanying letter was put in the mailbox. On another day this address was visited again to collect the survey, or to ask the residents if they would like to participate in the survey. Again, if the residents were not at home the address was visited at least one more time. Some of the addresses were visited five times to get a completed survey.

The total response rate was 61 percent, which gave the survey a high reliability. From the non-respondents 42 percent did not respond because they were not at home, 55 percent was not willing to participate and the last 3 percent was deaf or did not speak Dutch. The second category was diverse, male/female, young/old, and living from apartments to detached houses. Therefore, the bias, which could occur by the non-response in this survey, was little. The people that were not at home did not actively choose to not participate. A part of this group was missed by accident. This group was probably not a certain type of people, therefore, the bias from these non-respondents was considered to be small. Single persons have the highest chance of being not at home. Many single persons were still questioned perhaps because of the frequent visits. Another part of the people that were not at home are probably hyper mobile persons, being away from home most of the time. This group could produce a bias because they have unusual travel behaviour. Their results differ probably for

[2] Random sample drawn by random.org which generates random numbers from atmospheric noise.

transport aspects. However, in all districts the chance of missing hyper mobile persons were the same and, therefore, it could not lead to major differences between the districts.

The data obtained from the survey was used for answering research questions on self-selection and migration. For a detailed description of the survey see Appendix I: The Survey. The results of the survey that are not used in the analyses are presented in Appendix II: Results from the survey.

Scientific intermezzo

According to Garner (2005) a personal post-it on a message or memo results in a quicker and better response. This technique was tested in this research, hoping it would result in higher response rates. On half of the surveys a yellow post-it with the hand-written message "Hello, Could you help me by filling in this survey? Thanks! Elske" in Dutch was added. The results showed that there existed no relationship between the presence of a post-it on the accompanying letter and the participation in the survey, see Appendix III: Post-it analyses

4.1.2 Secondary data

In this study several secondary data sources were used. In this section these data sources are shortly described and an overview is presented in Table 4.1. This overview also gives the year of the data set. The data sources are numbered and referred to by this number in this chapter.

[1] Dutch Mobility Research (MON). A survey was conducted through the whole of the Netherlands, the respondents were asked to keep a traffic diary of a certain day. The municipality of The Hague requested the MON to conduct additional surveys in 2006. This resulted in an extensive database with at least 500 respondents per quarter for The Hague. Furthermore, it is also available for the Netherlands.
[2] Tram counts. This source contains counting data for each tram line in The Hague. The data consists of the number of people that get on and off the tram per station on an average working day.
[3] Public transport stops. This is a geographical data set containing information on all the public transport stops in the Netherlands in a certain year. It has information on the name, stop frequency, type, service area and quality of the public transport stop.
[4] Navteq network. This is a network layer, providing information on the road network in the Netherlands and maximum driving speeds per road.
[5] National Road File. This data set contains information on the road network in the Netherlands. It is used in addition to the Navteq network layer because it is available for a longer period.
[6] Resident density data set. This is a data set on the number of residents in a 500x500m raster for the Netherlands.
[7] Resident and dwelling register. This register contains all exact addresses in a point layer.
[8] Housing mutation register. It contains information on mutations on the housing market, new housing, demolished houses and renovations.
[9] LISA office register. Yearly registration on geographical level of all establishments of companies and institutions. For each establishment the address, number of jobs, male/female employees and other attributes are registered.
[10] Dutch research in housing (WoON) This survey maps housing preferences and conditions. WoON and its predecessor WBO can be used to give insight in living preferences, household characteristics and the residence.

[11] District monitor The Hague[3]. This online database provides information on several themes, such as housing, demography and safety in The Hague. Most data is available for several years on district level.
[12] The National Accessibility Map[4].This is an online database providing information on accessibility in the current situation, and predicts accessibility in 2020. Furthermore, it provides information on the number of jobs and residents reachable within certain time spans for different transport modes in peak and off peak periods.
[13] The bicycle route planner[5]. This website is a route planner for bicycle users. The base is a road map with additional information on bicycle lanes and the conditions on route.

	Name / source	Type	Scale	Year
[1]	Dutch Mobility Research (MON) Municipality of The Hague	SPSS	The Hague / Netherlands	2006
[2]	Tram counts Region Haaglanden and HTM	Excel	The Hague	2002 - 2004, 2006, 2008
[3]	Public transport stops Reisinformatiegroep	ArcGIS (point)	Netherlands	1998, 2003, 2005, 2008
[4]	Navteq network layer Navteq	ArcGIS (network)	Netherlands	2005 - 2009
[5]	National Road File (NWB) Rijkswaterstaat	ArcGIS (line)	Netherlands	1997 - 2008
[6]	Resident density data set Statistics Netherlands	ArcGIS (raster)	Netherlands	2000 - 2008
[7]	Resident and dwelling register PBL[6]	ArcGIS (point)	Netherlands	1995 - 2008
[8]	Housing mutation register Statistics Netherlands	ArcGIS (point)	Netherlands	1995 - 2006
[9]	LISA office register LISA foundation	SPSS	Netherlands	1997 - 2008
[10]	Dutch research in housing (WoON) VROM[7]* and Statistics Netherlands	SPSS	Netherlands	2006 - 2009
[11]	District monitor The Hague Municipality of The Hague	Online (website)	The Hague	Several
[12]	The National Accessibility Map. Project Transumo by Goudappel Coffeng	Online (website)	Netherlands	2010 – 2020
[13]	Bicycle route planner Province Zuid-Holland	Online (website)	South Holland	2010

Table 4.1: Secondary data sources

4.2 Public Transport in Vinex Greenfield locations

Research question a

How is public transport set up for Vinex locations, in general, and what are the differences with its development in the case study areas?

The implementation of public transport in all large-scale Vinex locations was analysed in research question a. The results were compared with the case study areas in The Hague.

[3] denhaag.buurtmonitor.nl
[4] www.bereikbaarheidskaart.nl
[5] www.fietsersbond.nl/fietsrouteplanner/
[6] Netherlands Environmental Assessment Agency
[7] Ministry of Housing, Spatial Planning and the Environment

This made it possible to see how the case study areas correspond and differ in the time of implementation of public transport from the other Vinex locations.

The public transport development was analysed with data on public transport stops [2]. For 2003, 2005 and 2008 the relative area in the Vinex location served by public transport was calculated with overlay techniques in ArcGIS. This was done by drawing buffers around each public transport stop. The influence area [2] differed by the type of public transport. The intercity train stations have a service area of 3 km, where normal train stations only have an area of 1.5 km. The metro stations have an influence area of 750 m. All the other public transport stops for trams and busses have a service area of 500 m. The influence area of an intercity station is larger because people tend use it for longer distances and, therefore, accept a longer access time. With overlay techniques the percentage of the Vinex locations served by public transport was calculated, see also Figure 4.1.

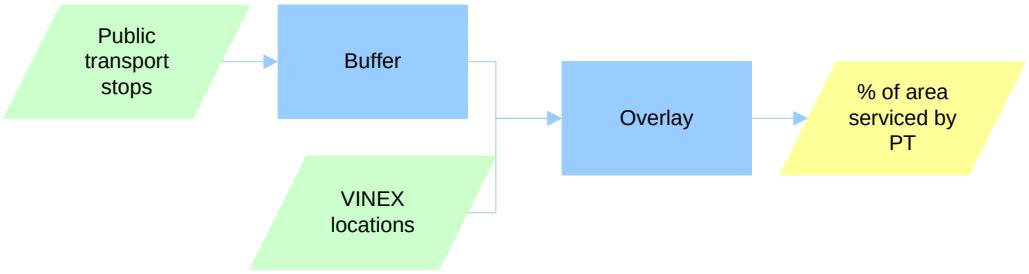


Figure 4.1: Method to calculate the service area of public transport in the Vinex locations

4.3 Study area

Research question b

What are the characteristics of the case study areas, and do these influence the use of public transport?

In this analysis the case study areas are compared. First, several characteristics that influence the public transport use in a district are compared. According to Bakker and Zwaneveld (2009), bases on the National Travel Survey for 2007, there are three main groups using public transport:

- Adults without an driving licence;
- Adults that are not main user of a car;
- Students.

Adults without a driving licence have different travel patterns compared with people with a driving licence. For 35 percent of their kilometre travelled they use public transport, for the group with a driving license this is 8 percent. Adults without a driving licence are mainly presented in the age classes between 18 and 25 and 67 and older. The young adults are 25 percent of the group, for 50 percent male and 50 percent female. In the group of elderly 20 percent is male and 80 percent female; these women are from the period that driving licenses for female were not common. From the age of 80 most people do not have a driving license (anymore). The group adults that are not main users of a car also have a higher use of public transport. For 23 percent of their kilometres travelled they use public transport, instead of the 5 percent of the people are the main user of a car. Around 46 percent of the adult population are the main user of a car. For students public transport is an important transport mode, for about one third of their travel kilometres they use public transport (Bakker and Zwaneveld 2009). A part of the students are also part of the group adults without a driving license.

The group adults with a driving license is much larger; therefore, from the amount of train kilometres about 70 percent is made by persons possessing a driving license (Bakker and Zwaneveld 2009). For the main car user of a car this number is inverted, around a quarter of the train kilometres are travelled by persons that are the main user of a car. Students are responsible for one third of all travelled train kilometres. For the bus, tram and metro kilometre the people without a driving licence are responsible for 50 percent of the kilometres. 83 percent is made by people that are not the main user of a car. The students add up to almost half of the kilometres by bus, tram and metro.

With the District Monitor of The Hague [11] and the Dutch Mobility Research (MON) for The Hague [1] the three case study districts were checked for the characteristics described above. The districts were, moreover, compared on more general characteristics, such as spatial planning and demography. The survey conducted for this research was compared with these characteristics. This makes it possible to see whether the sample of the survey represents the population in the districts or not. For the survey only a subset of the total population of the areas was used, see also section 4.1.1, i.e. the residents that live on walking distance of the light rail stations. Therefore, it was not possible to calculate weight factors to correct the survey as the composition of the population was not exactly known. The samples were random selected, and thus they are assumed to be a representative reflection of the population in these parts of the districts.

4.4 Accessibility

Research question c

Does the level of accessibility of the areas influence the use of public transport?

This section describes the accessibility analyses in the three districts. In section 4.2 the calculation of the area of a Vinex location serviced by public transport is described, for accessibility these analyses are extended. The accessibility was measured by two indicators, service area and accessibility of main destinations, for three transport modes. The three modes are car, bicycle and light rail services. The service area was calculated to review the opportunities of the residents from the district to access other residents, jobs and facilities. Moreover, the access to the main destinations was calculated. As Beverling et al. (2009) state people do not choose their travel behaviour based on averages. Even though public transport scores well in a district, the situation on the most-popular links provides additional information. Therefore, access to the main destinations was calculated for three transport modes. This measured the competitiveness on popular links between the transport modes. The combination of these indicators provided information on the competitiveness of public transport and the opportunities for the residents to use public transport. These factors both influenced the use of public transport and were used to explain the difference between the districts.

Within the districts the accessibility is different from location to location. Especially in large districts, such as Ypenburg the local differences could be large. Therefore, the districts were divided in several sub districts. For each sub district the centroid of the dwellings [7] for each year was calculated. For each centroid the accessibility indicators were calculated. The accessibility of district is the average accessibility of the centroids weighted by the number of residents [5]. This is shown schematically in Figure 4.2.

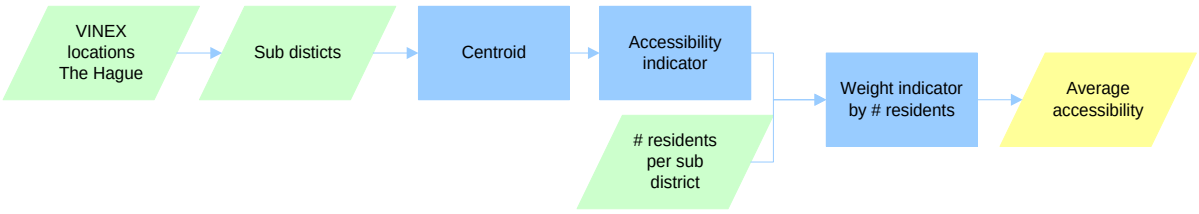


Figure 4.2: Method to calculate average accessibility per district

The next section discusses the method for the service area indicator. Section 4.4.2 discusses the accessibility of the main destinations.

4.4.1 Access to residents and facilities

The first indicator analyses the amount of residents, jobs and services accessible within a certain time period. For each transport mode the 15 and 30 minute service area was calculated. The indicator was calculated every three years starting in 1997, when the districts were starting to construct. The number of services and shops in the service area were calculated with the LISA [9]. The number of residents were calculated with the resident density data set [6] starting in the year 2000.

To analyse the accessibility by car the Navteq network [3] was used. With the NWB [4] the oldest Navteq layer was reviewed to see the changes in the transport network. This shows that the highway connections were realised before the construction of the case study areas, see Appendix IV: Development road network. Therefore, the oldest Navteq network, 2005, was used to provide information for the years 1997, 2000, 2003. It was possible that in other parts of the service areas connections were established during this period. In the course of time of this study it was not possible to review the complete transport network between Rotterdam and Amsterdam.

The network analyst in ArcGIS was used to calculate the service area of 15 and 30 minutes along the network, see Figure 4.3. With overlay techniques the number of jobs, shops and schools within the areas were calculated. This provided information on the accessibility in off peak periods. For the peak periods the National Accessibility Map [12] was used. To fit the National Accessibility Map with the calculation of this research, first, the current situation in off peak periods was obtained. The ratio between the number of jobs calculated and found by the National Accessibility Map is then known. With this ratio the situation in the peak period was calculated for 2009, see formula 4.1 and 4.2. The same method was used to determine the access to residents for the peak periods.

$$j_{ratio} = \frac{j_{car\ map}}{j_{car\ LISA}} \quad * \qquad (4.1)$$

$$j_{peak} = \frac{j_{car\ map}}{j_{ratio}} \qquad (4.2)$$

j_{ratio} : *job ratio*

$j_{car\ map}$: *# jobs National Accessibility Map*

$j_{car\ LISA}$: *# jobs service area LISA*

j_{peak} : *job ratio in peak periods*

** the same formula was used to calculate the # of residents*

It was not possible to calculate the access to residents and jobs during peak periods for the earlier years. With the total congestion delay and total vehicle time the impact of traffic jams in the earlier years could be estimated. However, the influence on the number of reachable residents and jobs was too uncertain. The total congestion delay only has influence on

certain routes and, therefore, it could influence certain areas with many resident or jobs. This made the results too unreliable to present the situation in those years.

The accessibility by bicycle of the service area was determined with buffer techniques. A buffer gives an indication of the accessibility by bicycle, but in case of boundaries, such as canals and highways the results are less reliable. Nevertheless, a buffer was used because there was no detailed data available on bicycle lanes. In the Netherlands there are many short-cuts for cyclists; these were not listed in the Navteq network. The bicycle route planner [13] was used to check reliability of the results for 4 points on the buffer. If there were large differences the buffer was adapted to fit better to reality. CBS (s.d.) measured that the average cycling speed in the Netherlands is 12 km/h. Therefore, a buffer of 3 km (15 minutes) and 6 km (30 minutes) around the centroids was calculated with ArcGIS. With overlay techniques the amount of jobs and services within these areas were calculated.

For light rail accessibility the tram and metro schedules were used. There was only information available on the current tram and metro schedules. Therefore, these were used to calculate the service area of light rail transport. The service area was calculated on a driving time inside the tram of 25 minutes. The access time was estimated on 5 minutes for each sub district. Only destinations with maximum one transfer were considered; a transfer had an expected waiting time of 5 minutes, most services depart 8 times per hour in the morning peak hour. The hidden waiting time was not taken into account because there was no detailed data available. Furthermore, considering the morning peak hour people had probably adapted their waking time on the moment they have to arrive at a station.

The service area at the destination station was calculated with a buffer of 300 m. The average comfortable walking speed is 4.9 km/h (Bohannon 1996), thus 400m in 5 minutes. With an estimated waiting time of one minute, for traffic lights, the walking distance in 5 minutes is 300m. Again with ArcGIS overlay techniques the number of residents and facilities within the service area were calculated.

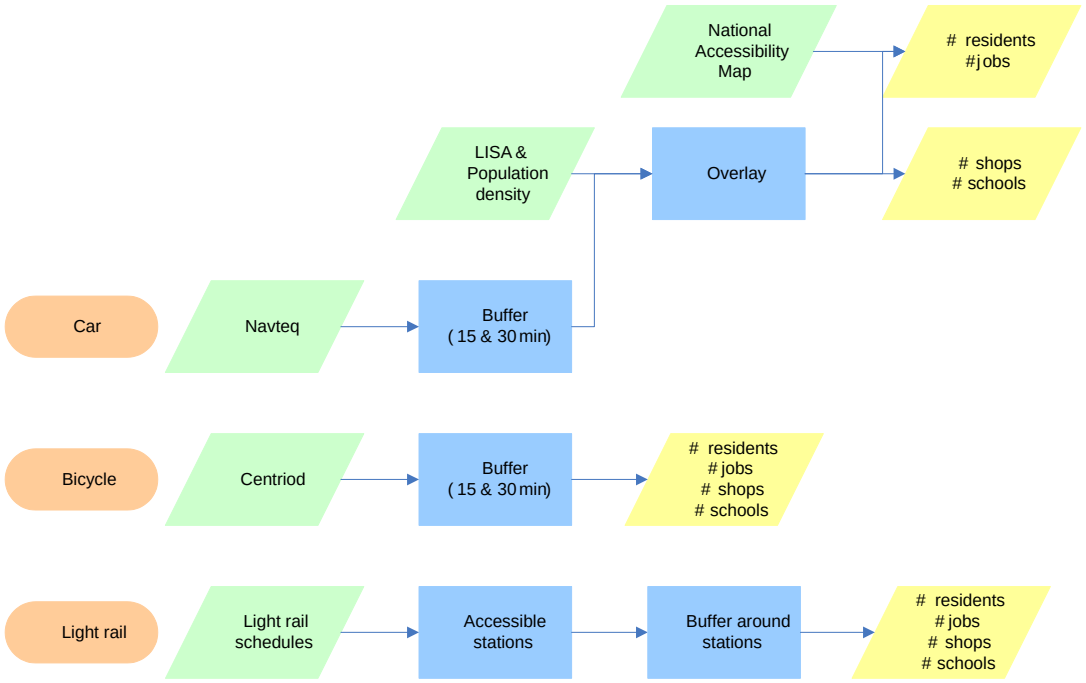


Figure 4.3: Method for calculating the service area

4.4.2 *Main destinations*

The second indicator links the accessibility with the orientation pattern of the resident. The travel time to reach the main destinations was used. This way the competitiveness of public transport could be estimated. For light rail only destinations with maximum one transfer were taken into account. A transfer means waiting time and a chance to miss a connection. Van Hagen (2004) shows that time which is spent by the traveller on the station counts as three times the driving time, therefore, transfers are negative for the experience of using public transport.

The main destinations were the top 10 destinations for the residents, excluding their own district. The MON The Hague 2006 [1] was used to find the main destination. For these analyses only residents of the district and the trips to or from the district were selected (see Figure 4.4). The trips that did not start or end in the district were excluded, because they did not provide information on the accessibility of the district itself. In the MON The Hague 2006 only the main travel mode was listed. Consequently, trips that start and end by walking or cycling, but had as main transport mode tram, were listed in the survey as tram. However, the real starting point of a trip was registered and selecting the districts filtered the trips that start or end in the district. The percentage of trips to an area was calculated; the area could be districts in The Hague as well as towns in the rest of the Netherlands. For the calculation the two most-used postal codes from the destination area were selected.

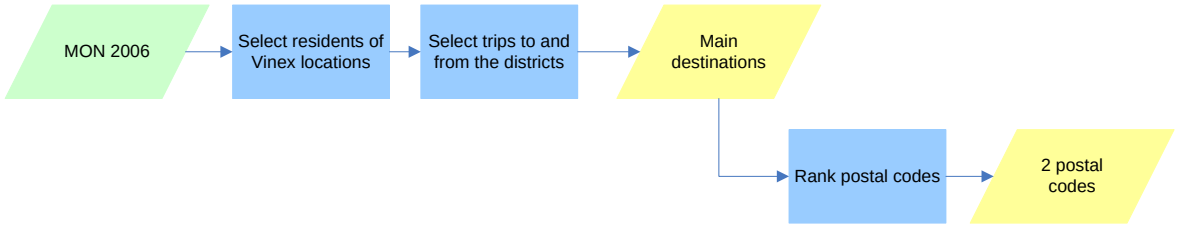


Figure 4.4: Method to determine main destinations

For the main destinations the travel time by car, bicycle and light rail were calculated. For car the Navteq network [3] of 2006 was used in ArcGIS. These results were compared with the output of the National Accessibility Map [12] (Figure 4.5). The results showed that the travel times are comparable and therefore, the travel times during peak hours from the National Accessibility Map were used. Bicycles were considered to travel along the bicycle route planner [13] with a speed of 12 km/h (see previous section). For public transport the access and egress time was estimated because this information was not available. Furthermore, only relations with less than three transfers were considered. TNO (2005) states that good public transport has not more than one transfer within the urban area. The travel time to the main destinations with different transport modes was calculated using the orientation pattern.

To review the competitiveness of light rail versus car journeys the travel time ratio (Savelberg 2009) was used. This ratio was calculated using formula 4.3. The same formula was used to calculate the competitiveness between light rail and cycling.

$$tt_{ratio} = \frac{tt_{publictransport}}{tt_{car\ peak}} \quad * \qquad (4.3)$$

tt_{ratio} : *travel time ratio*

$tt_{publictransport}$: *travel time light rail* [min]

$tt_{car\ peak}$: *travel time car peak period* [min]

**the same formula is used to calculate the tt for bicycle*

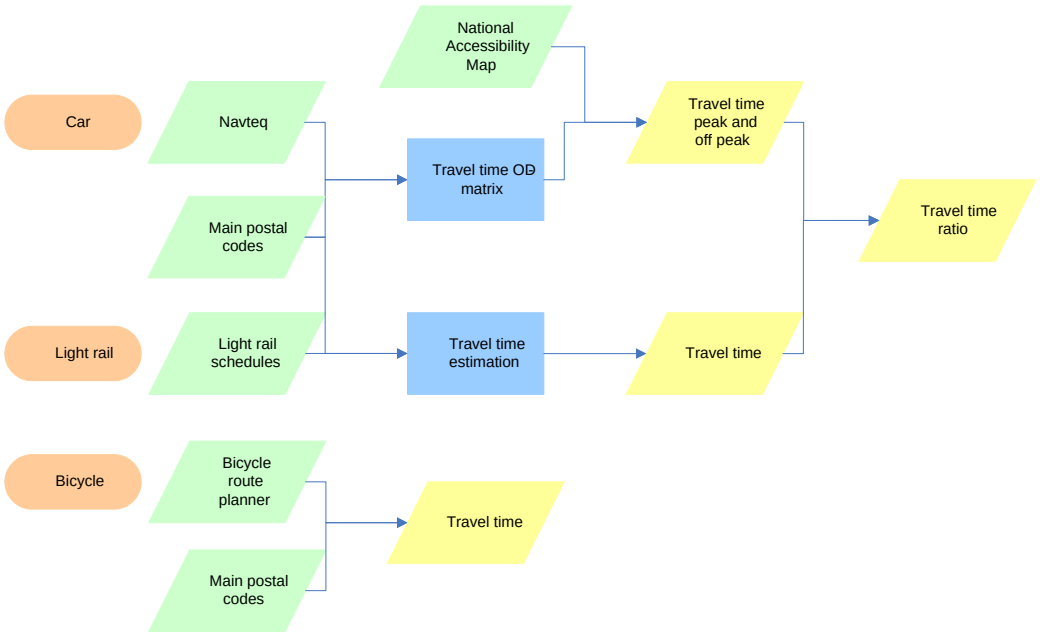


Figure 4.5: Method to calculate the travel time ratio

4.5 Self-selection

Research question d

Does self-selection affect the use of public transport in the case study areas?

The causal relationship between urban planning and travel behaviour is influenced by self-selection. Do people adapt their travel behaviour to their surroundings and the supply, or do people live in neighbourhoods that satisfy their travel needs? To reflect this relationship self-selection is part of the research. Different methods can be used to analyse self-selection. In this research a survey was used to question residents of the districts on travel behaviour and migration choices. In the survey two methods are used. The first method asked the respondent to value the motivation for considering a move to the area. The respondents were asked to value price, type of house, neighbourhood, location and transport. The respondents could divide 10 points between the five aspects. By this the importance of the aspects became clear. The respondents were asked as well to value the transport aspects, such as location near the highway, parking facilities, existence of bicycle lanes and public transport facilities, in the same manner. In the second method the respondents were questioned to value different transport modes, namely car, bicycle, bus, light rail and train. This made it possible to analyse whether all public transport 'lovers' live in one district.

To analyse the results of the survey statistical method were used. The sample size of the survey was limited because of the time span of the research.

WoON [10] provided the possibility to study self-selection as well. The WoON data set provided information on the use of public transport for commuter traffic, and the interest and value that residents give to public transport. The differences in use, interest and value of public transport were visualised for the years 2006 and 2009.

4.6 Migration

Research question e

Do migration patterns influence the use of public transport?

Research question e analyses the effect of migration patterns on the local use of public transport. The migration patterns influences the group of people that had no public transport facilities available to them during their first years in the district. In the districts with late implementation of light rail facilities a part of the residents moved to the area when the light rail facilities were not finished (yet). Therefore, the residents are more likely to develop a car-oriented travel pattern. The speed of the migration patterns determines the size of the group of people that had no public transport facilities available to them during their first years in the district.

There were several sources available for data. The organisation for state agents has a register for house sales; unfortunately, this register was not available for this research. The cadastral administrator in the Netherlands could provide information on the number of migrants in an administrative boundary. This information was also not available at reasonable costs. Therefore, alternative data sources were sought.

The municipality of The Hague provided information on migration in the District Monitor [11]. For Wateringse Veld data on migration was available from 1995. For Ypenburg and Leidschenveen this was 2002, the moment the districts became part of the municipality of The Hague. This data could be compared with migration numbers in other districts in The Hague and the average of The Hague and the Netherlands.

The Dutch Research in Housing or WoON provides information on the year the residents moved into their house and the construction year of the house. Combining this information provided the possibility to observe the migration patterns of the residents.

4.7 Use of public transport

Research question f

What is the effect of the time of implementation of light rail services on the use of public transport?

The use of public transport in the area is analysed with three data sources. The methods are described in the next sections. The first discusses the modal split, the second discusses the counts and the last describes the method for the regression analyses.

4.7.1 Modal split

To calculate the modal split of the residents the MON The Hague 2006 [1] was used. Two types of modal split were calculated, for trips and distances. The modal split of trips was calculated for the trips those start or end in one of the districts and which were made by the residents of the district. The influence of the timing in the development of public transport on the residents in the area was researched. Therefore, there was no interest in the mobility patterns of the residents in other areas or in the travel behaviour of non-residents in the area. Moreover, for all trips of the residents the modal split in distance was calculated. The average number of trips for the residents is also calculated.

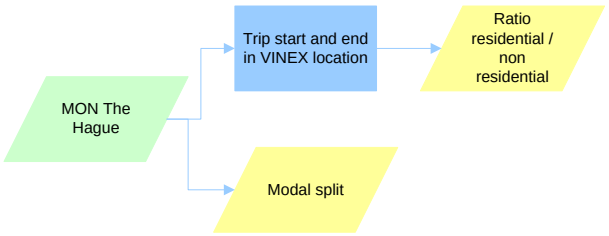


Figure 4.6: Modals split and ratio between residents and non-residents using the MON The Hague 2006

4.7.2 Counts

The region Haaglanden provided information on the infra-red counts [2] from light rail stations. The data set only provided information on the number of people getting on and off the tram or metro on an average working day. The counts from stations in the districts were used to calculate the number of tram users per 1000 residents. The analyses are visualised in Figure 4.7. The method was the same for each year.

The MON The Hague 2006 was used to calculate the ratio between the residential and non-residential light rail users in the area (see Figure 4.6). As the MON The Hague 2006 covered the municipality of The Hague it was only possible to find the ratio between The Hague and the case study areas. The national MON 2006 was used to check whether travellers from other regions of the Netherlands travel to the case study areas. The ratio was used to calculate the number of local residents that use the light rail facilities.

The tram stations in the three districts were determined. All stations within 250 meter of the district were selected. For some residents these stations are within walking distance. For each year the counts per district were summed. A buffer was created around the tram stations. The service area of a tram station was estimated on 500 m, which is approximately six minutes walking, and it is a general accepted number. The amount of residents [5] within these buffers was calculated with overlay techniques in ArcGIS. For each district the ratio calculated from the previous paragraph was used to find the number of residential light rail users that use public transport. Then the number of trips per 1000 residents was calculated.

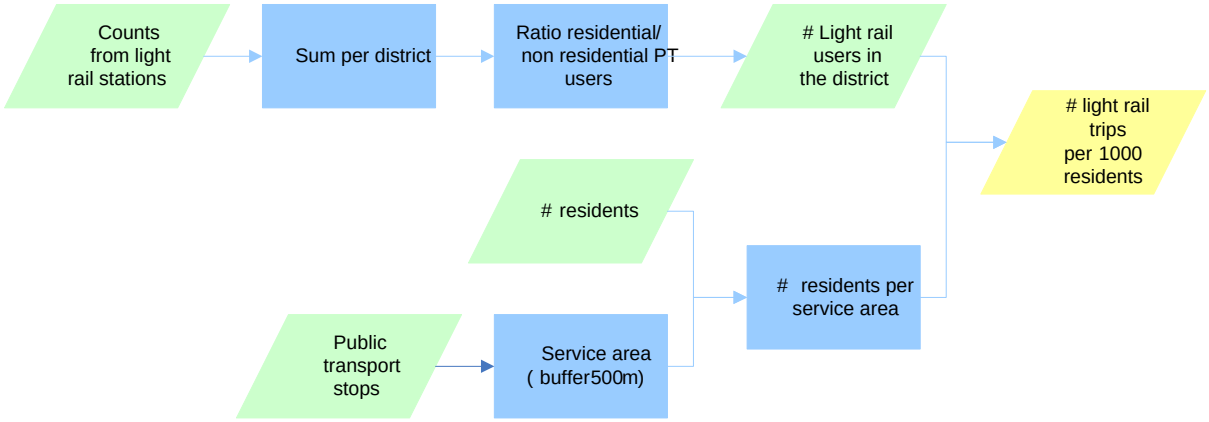


Figure 4.7: Method to calculate the number of tram users per 1000 residents

4.7.3 The effect of timing

The effect of the time of implementation of light rail facilities was determined using regression analyses. With these analyses the differences between the districts could be determined. The survey 2010 and the MON the Hague 2006 [1] are used in the analyses. A logistic regression or logit model was used for the analyses. This technique is used for a binary outcome variable and both categorical and continuous predictor variables. Logistic regression is based on the logistic function, see formula 4.4 and 4.5. In the analyses the

regression coefficients (β) are estimated. To assess the quality of the logit models the co-linearity diagnostics are determined and a correlation matrix is analysed.

$$f(z) = \frac{e^z}{e^z + 1} = \frac{1}{1 + e^{-z}} \qquad (4.4)$$

$f(z)$: *dependent variable*

With z:

$$z = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \cdots + \beta_k x_k \qquad (4.5)$$

β_0 : *intercept*

$\beta_{1,\ldots,} \beta_k$: *regression coefficients*

$x_{1,\ldots,} x_k$: *independent variables*

For the MON The Hague 2006 the outcome variable was light rail use. For each respondent the participation in the tram or metro was listed. There were only a few respondents (35) that used light rail compared with the group (1031) that did not use light rail. The respondents were weighted to make the groups more equal. In research question b several variables that influence public transport use were mentioned. These variables were added as independent variables in the analyses. Furthermore, general personal and household characteristics were added, such as age and number of persons in the household. For transport characteristics the number of cars and bicycles in the household were added and the possession of a student public transport card. The list with the independent variables can be found in Table 4.2.

Table 4.2 also shows the variables in the logit models based on the survey. There were two logit models developed. The output variable is whether or not being a frequent public transport user. In the survey only the frequent public transport users were questioned whether they use the light rail facilities in their district. These results were only available for a small group, and thus another outcome variable is used. A frequent public transport user was defined as using public transport at least once a week. The first model took into account comparable characteristics as the MON The Hague 2006 regression. In the second model the preferences of the respondents were also added. These are the questions in which the residents were asked to value the importance of transport modes, and to value, which transport characteristics were important for people considering to move to a certain area. In the survey the groups were more equal, 43 public transport users and 83 others.

Some respondents were excluded from the analyses because of missing variables. In all models no additional accessibility parameters of the districts were added. These parameters were only available on district level. Therefore, only a categorical district variable is added. Other accessibility parameters would have a high correlation with the district variable and each other.

Type	MON The Hague 2006	Survey	
Dependent	Using tram	Frequent public transport user	
Independent	Sex	Sex	
	# persons in household	# persons in household	
	Education level	Education level	
	Social characteristics	Job	
	Age	Age	
		Type of house	
		Ownership house	
	# cars in household	# cars in household	
	# bicycles in household	# bicycles in household	
	Possession student PT card	Possession PT subscription	
	Adult with no driving licence	Trip frequency to The Hague	
	Adult not being main car user	Value transport modes	**(Model 2)**
		Value transport characteristics	**(Model 2)**

Table 4.2: Variables in the logistic regression

5 Results

In the previous chapter the methods of analysis were discussed. The results of these analyses are covered in this chapter. The sections follow the research questions from section 3.3. In each section the results are discussed and presented in graphs and tables. In the last section of each section the research question is answered.

5.1 Public transport in Vinex locations

This section contains the results of the comparison between the developments of public transport in the study areas and large-scale Vinex locations of the Netherlands. This comparison gives insight in how representative the case study areas were for the Vinex locations in the Netherlands. Furthermore, the development of public transport in the study areas could be reviewed. For all Vinex locations the area served by public transport was calculated, for the methods see section 4.2. This calculation was done for all different types of public transport stops, from intercity train stations to busses with a frequency lower than once an hour, in the years 2003, 2005 and 2008.

The results showed that there were differences between the implementation of public transport in the case study areas in The Hague compared with the Vinex locations in the Netherlands. The results are presented in Figure 5.1. In 2003 more than 30 percent of the surface area of the Vinex locations was not served by public transport, in the case study areas this was only 15 percent. In the following years this trend remained visible. In 2005 less than 10 percent was not served in The Hague compared to 25 percent in the Netherlands. In 2008 public transport was further developed with 16 percent and 5 percent (the Netherlands vs. The Hague) of the surface area not served.

Public transport service level can be divided in two groups, low-quality public transport and quality public transport. Quality public transport contains all rail based public transport and busses with a frequency higher than 4 busses per hour. Low-quality public transport contains all bus stops with a frequency lower than 4 busses per hour. The three case study areas were, if served, only served by quality public transport. In the Vinex locations in the Netherlands a small part of the surface area was only served by low-quality public transport, 8 percent in 2003 and 5 percent in 2008. Therefore there was a large difference in service level between the study areas in The Hague and the Netherlands. During the years this difference became smaller. In 2003, 85 percent of the surface area of the locations in The Hague was served by quality public transport and 61 percent in the Netherlands. In 2005, 91 percent in of the surface area of The Hague and 69 percent in the Netherlands were served. In 2008, 94 percent of the Vinex locations in The Hague were served by quality public transport and 79 percent in the Netherlands

The trend for rail bases public transport is slightly different. In The Hague the surface area served by rail based public transport started with 42 percent in 2003, declines slightly in 2005 to 40 percent and in 2008 raises to 61 percent with almost all planned tram and metro lines realised. For the Vinex locations in the Netherlands rail based public transport increased from 29 percent to 47 percent in 2008. Between 2005 and 2008 several new local train stations were opened to serve the residents. In The Hague light rail played a major role, serving 16 to 28 percent of the area. For the rest of the Netherlands, this trend is different; around 4 per cent of the surface area of the Vinex locations is serviced by light rail transport in 2008.

The figures also show the development in public transport through the years in Wateringse Veld, Ypenburg and Leidschenveen. Throughout the years most of the districts' surface areas were served by quality public transport. The least- and most-served district was Wateringse Veld with 75 percent in 2003 and 98 percent in 2008. In 2003 both Wateringse

Veld and Ypenburg light rail facilities. In Wateringse Veld, a tram line and frequent bus service were set up in 1997. The other two districts, Leidschenveen and Ypenburg, frequent bus services were also obtained in 1997. The tram line in Ypenburg was realised in 2002 In 2003 Voorburg station was still an intercity train station, this was altered in 2007. By this time between the districts Ypenburg and Leidschenveen, Ypenburg station was opened. This makes on one hand both districts better served by local trains, but on the other hand the districts were not served anymore by intercity trains. In 2007 Wateringse Veld and Leidschenveen light rails facilities were completed. Line 16 covering the north of Wateringse Veld was opened and in Leidschenveen the metro station was completed.

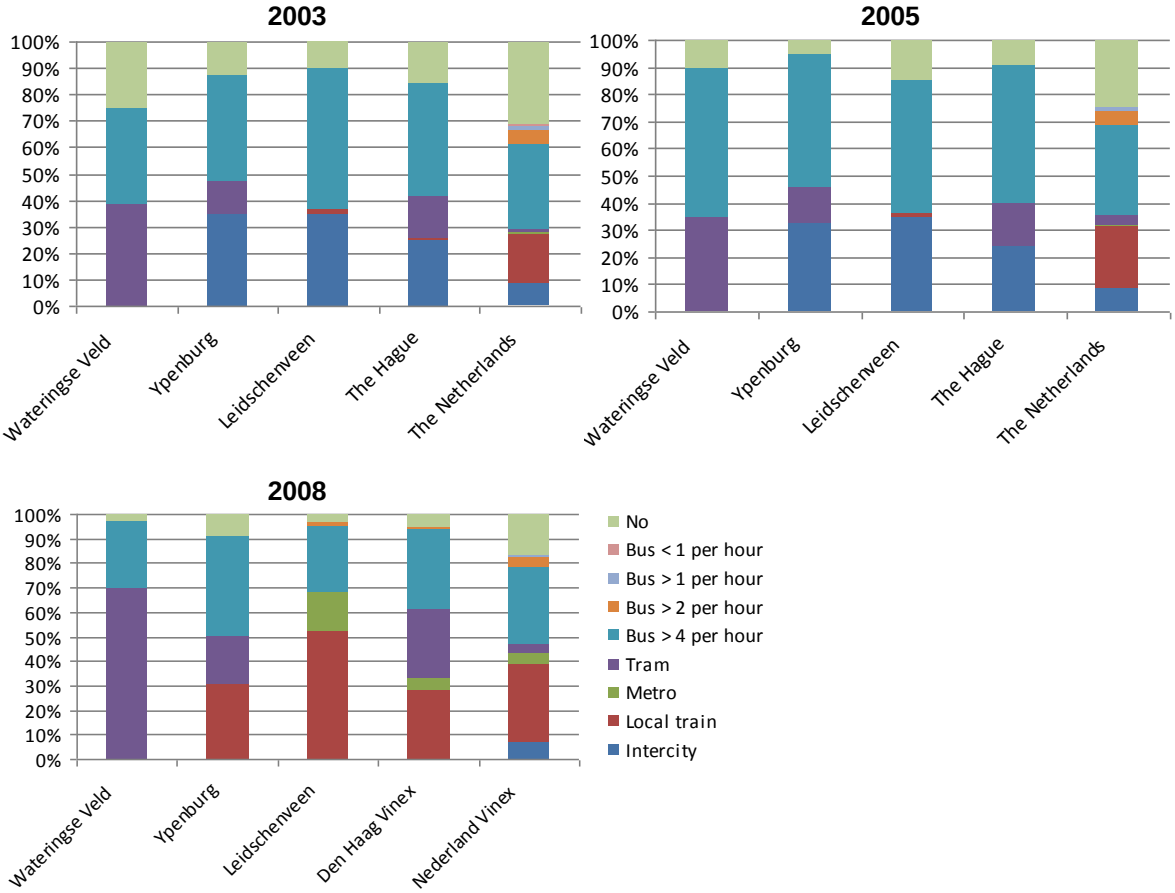


Figure 5.1: Service area Public Transport on Vinex locations for 2008 (PT stops)

Conclusion

The development of public transport in other Vinex locations in the Netherlands has followed a different pattern than in the case study areas. This showed that Vinex locations in the Netherlands were later and less well-connected to any form of quality public transport. In one of the case study areas, in Wateringse Veld, a tram line and frequent bus service were set up in 1997. The other two districts, Leidschenveen and Ypenburg, frequent bus services were also obtained in 1997. The tram line in Ypenburg was realised in 2002, and the metro station in Leidschenveen was completed in 2007.

In the Vinex locations in the Netherlands, the development has been slower. In 2008, 10 to 14 years (Boeijenga and Mensink 2008) after the development of Vinex locations, one fifth of the area of these locations had not yet been provided with public transport services. To the Vinex locations in The Hague, light rail has become an important public transport mode, and, by 2008, all three of the case study areas were provided with one or more light rail lines. For the rest of the Netherlands, this trend is different; around 4 per cent of the area of the Vinex locations is serviced by light rail transport. This low percentage is due to the fact that only the country's main cities have such light rail systems.

5.2 Study areas

In this part of the analyses the study areas are compared in order to reflect the use of public transport. Starting with those characteristics that would influence the use of public transport the most. This was done with the MON of The Hague from 2006, for all persons that have at least one trip. The data set was limited as for Wateringse Veld only the respondents were known that made a trip. For that reason, the same selection was made for Ypenburg and Leidschenveen. Furthermore, the districts were compared on other characteritics, using the survey conducted for this study as well. With these analyses results of the survey are reviewed.

5.2.1 Characteristics influencing public transport use

Starting with the characteristics that are known to influence the public transport use, these are the

- Adults without an driving licence;
- Adults that are not main user of the car owned in the household;
- Students, in possession of a student public transport card.

In the MON The Hague 2006 these characteristics could be analysed for the respondents from the Vinex districts in The Hague. Table 5.1 shows the results grouped for public transport users and non-public transport users. The last column presents the results of the Pearson's Chi-Square test. These shows if there was a significant association (see Appendix V: Analyses for public transport).

The numbers show that there was indeed a difference between the two groups. The results from the Chi-Square test showed that there are several associations between the use of public transport and the characteristics. Only no association was found between the use of public transport and the number of students. This was probably caused by the number of primary and secondary school student presented in the group of students. People with a driving licence were less likely to be a public transport user, just as the persons that were the main user of a car. Student that own a public transport card were more likely to be a public transport user.

Furthermore, there was a difference in the number of cars in the household. The group public transport users had an average number of 1.3 cars per household and the non-public transport users 1.5. These numbers show that car ownership was higher among non-public transport users. In the Netherlands and The Hague the car ownership per mobile household was on average 1.2 and 1.0, respectively. Thus the numbers of car ownership in the case study areas, public transport user or not, was higher than the average car ownership per household in the Netherlands and The Hague.

Category	**PT User**	**Non-PT user**	**Pearson's χ^2**
# respondents	**106**	**1476**	
Student	27 %	20 %	0.089
Not student	73 %	80 %	
Student PT card	15 %	1 %	**0.000**
No student PT card	85 %	99 %	
Main car user	36 %	50 %	**0.000**
Not main car user	49 %	18 %	
< 18 year	15 %	31 %	(excluded)
Driving license	66 %	63 %	**0.000**
No driving license	19 %	6 %	
< 18 year	15 %	31 %	(excluded)
Cars per household	1.3	1.5	

Table 5.1: Characteristics population grouped in public and not public transport users (MON The Hague 2006, Vinex districts)

To see if there was a difference between the districts that could explain the use of public transport the results in Table 5.2 are grouped per district. Wateringse Veld had the highest number of students and also the highest number in student public transport card possession, 5 percent against Ypenburg 2 and Leidschenveen 1. The driving license and car ownership gives another image. As for these categories Wateringse Veld had the highest number of main car users and lowest percentage of persons above 18 without a driving license. Wateringse Veld and Ypenburg had the highest number of cars per household; this was probably connected with the high number of main car users. The analysis thus showed that the various characteristics related to public transport use were pointing in different directions. Therefore, it is likely that these characteristics even each other out, and that the resulting effect is only small.

Category	Wateringse Veld	Ypenburg	Leidschenveen
# residents	**219**	**704**	**659**
Student	29 %	21 %	21 %
Not student	71 %	79 %	79 %
Student PT card	5 %	2 %	1 %
No student PT card	95 %	98 %	99 %
Main car user	46 %	41 %	44 %
Not main car user	20 %	27 %	23 %
< 18 year	34 %	32 %	33 %
Driving license	58 %	58 %	56 %
No driving license	8 %	10 %	11 %
< 18 year	34 %	32 %	33 %
Cars per household	1.5	1.5	1.4

Table 5.2: Characteristics population districts in percentage (MON The Hague 2006)

5.2.2 Characteristics of the study areas

Other characteristics of the study areas are discussed in this section. This made it possible to compare the study areas to obtain a better view of the districts. Discussed are spatial characteristics and demographic aspects.

5.2.2.1 Spatial characteristics

The three case study areas are part of the Fourth Spatial Planning Document (MVROM 1990). The construction of the districts started in 1996 for Wateringse Veld and Ypenburg. In Leidschenveen the construction started two years later. Leidschenveen is the smallest district measuring around 300 hectares; Wateringse Veld is slightly bigger with 340 hectares. Ypenburg outranks both districts with a surface area of 450 hectare; these numbers are excluding the surface area of the water bodies. In 2008 the number of houses in Wateringse Veld was 5300. Leidschenveen had slightly more houses, around 5900. Ypenburg being the largest district had 8700 houses.

Table 5.3 gives an overview of the planned spatial characteristics. The planned density of houses is similar for the three districts with 24 to 26 houses per hectare. With this the districts had an average density compared with the Vinex districts in the Netherlands (Boeijenga and Mensink 2008). In all three districts the high densities were planned near the light rail stations. Shopping facilities were also located near light rail stations. Hence, the districts have a potential for high public transport use rates, see also section 2.3. In Wateringse Veld and Ypenburg the high density neighbourhoods were developed in the early stages of the projects. In Leidschenveen the high density area was only recently constructed.

		Unit	Wateringse Veld	Ypenburg	Leidschenveen
Density	average	houses/ha	26	24	26
	highest	houses/ha	61	68	52
	lowest	houses/ha	28	11	31
Houses	Apartment	%	31	21	28
	House	%	69	71	72

Table 5.3: Spatial planning Vinex districts (Boeijenga and Mensink 2008)

The development of the density numbers per district is shown in Figure 5.2. All districts are still developing, therefore, these are not final numbers. Both Ypenburg and Wateringse Veld were reaching the 20 houses per hectare in 2008; Leidschenveen was behind with 15 houses per hectare. Compared with the municipality of The Hague the density was low. For the density in persons per hectare the figures are similar; only here the districts are closer to the average of The Hague. This was probably the cause by the young families living in the Vinex districts, therefore, the houses were occupied with more persons per house.

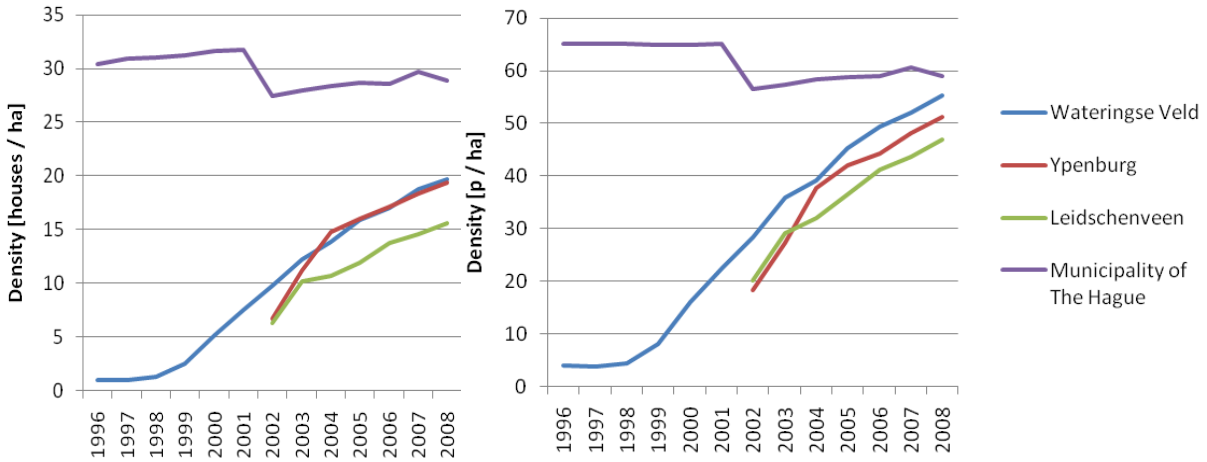


Figure 5.2: Density in houses and persons per hectare (District Monitor The Hague)

In 2008 the number of owner occupied houses was between 62 and 71 percent according to the District Monitor of The Hague. In Ypenburg the largest number of houses was rented. The results are, in Table 5.4, compared with the survey, to see how representative the survey was. As explained in section 4.3 no weight factors were calculated for the survey because the population of the survey was a subset of the total population. Only houses in the neighbourhood of the tram stations were selected. The District Monitor showed that Leidschenveen in 2008 had the lowest number of rental houses. Ypenburg had the most equal ratio between rental and owner occupied house. The difference between the District Monitor and the survey is that in Wateringse Veld fewer residents of rented houses were questioned. These respondents were most difficult to reach. However, only the south of Wateringse Veld was questioned, where the percentage of rented houses is less. In the District Monitor both parts of Wateringse Veld were presented and, therefore, the ratio could become quite different.

		Wateringse Veld	Ypenburg	Leidschenveen
District Monitor (2008)	Owner occupied	62 %	54 %	71 %
	Rented	38 %	46 %	29 %
Survey (2010)	Owner occupied	73 %	53 %	65 %
	Rented	27 %	47 %	35 %

Table 5.4: Ownership of houses

Moreover, the ratio between apartments and houses was reviewed. Table 5.3 shows the plans for the districts. The numbers found in the District Monitor for 2008 were quite

comparable. For Wateringse Veld and Ypenburg the sample of the survey had the same ratio as the District Monitor. For Leidschenveen these results were quite different. This can be explained because only recently the apartments around the Leidschenveen metro station were realised. Therefore, these are not part of the data in the District Monitor in 2008. Furthermore, only the residents within 500 meter of the metro station were questioned. In this buffer houses and apartments are both well presented and, therefore, the ratio found in the survey is plausible.

		Wateringse Veld	Ypenburg	Leidschenveen
District Monitor (2008)	Apartment	27 %	20 %	16 %
	House	73 %	80 %	84 %
Survey (2010)	Apartment	28 %	20%	46%
	House	72 %	80%	54%

Table 5.5: Type of house

5.2.2.2 Demography

In addition to the spatial characteristics, the demographic developments in the districts are reviewed. The number of residents in Ypenburg reached almost 24,000 in 2009. Wateringse Veld and Leidschenveen had comparable numbers with 18,000 and 17,000, respectively. The ethnic composition of the districts was comparable. The ratio of native residents in the districts dropped from 71 percent in 2002 to 66 percent in 2008.

Over the years the composition in age of the districts changed in Wateringse Veld (Figure 5.3). In the beginning of the development more than one third of the population was 65 or older. During the years this number decreased to 7 percent in 2008. For the other two districts information is available for the years 2002 – 2008. Therefore, the potentially extreme results from the first years were not available. As the population of the district is only small in the beginning, more extreme results can occur in this period. For Ypenburg and Leidschenveen the percentage of elderly in 2008 was 3 and 4 percent, respectively, both substantial lower than in Wateringse Veld.

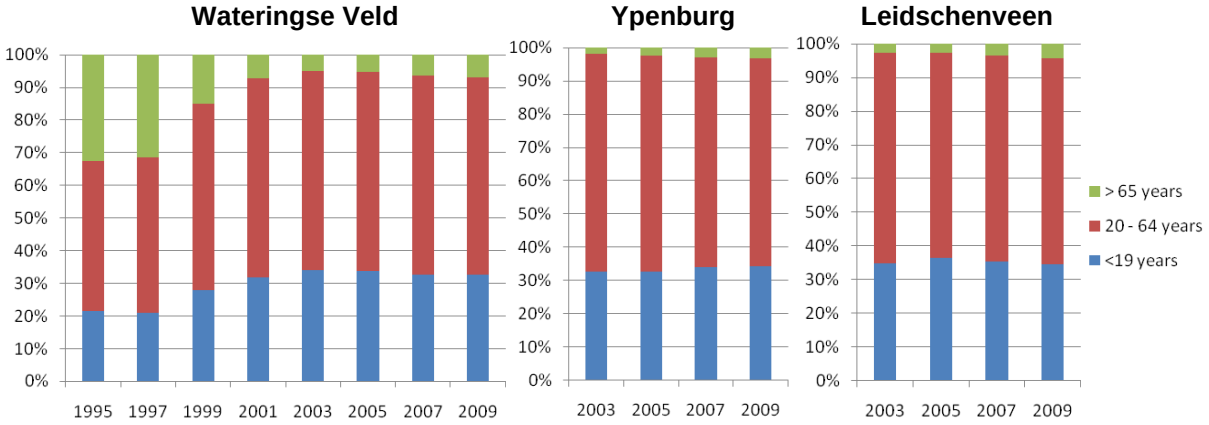


Figure 5.3: Age in three classes (District Monitor The Hague)

The number of persons per household was in Wateringse Veld and Ypenburg the same in 2008 according to the District Monitor (Table 5.6). Leidschenveen had slightly more persons per household; this is probably caused by the late construction of the large apartment complexes. Because of the construction of these in 2009, the number of person per household will decrease. These numbers were also found in the survey, conducted in April 2010. In both Wateringse Veld and Ypenburg the numbers of 2008 were lower than found in the survey 2010. This could be caused by the non-response of the survey, families with children tend to be more at home around dinner time and, therefore, had a higher chance to be respondent in the survey.

	Wateringse Veld	Ypenburg	Leidschenveen
District Monitor (2008)	2.7	2.7	2.9
Survey (2010)	3.1	3.0	2.8

Table 5.6: # of persons per household

Moreover, the balance between male and female were compared. Table 5.7 shows the results for the Districts Monitor 2008 and the survey conducted in April 2010. The numbers showed that in the districts the sexes were equally distributed. In the survey the results were slightly different. Especially, in Wateringse Veld the difference was 9 percent. This meant that more women filled in the survey; this can lead to a different value for public transport. As certain groups of women are more often using public transport, see the previous section 5.2.1.

		Wateringse Veld	Ypenburg	Leidschenveen
District Monitor (2008)	Male	51 %	50 %	50 %
	Female	49 %	50 %	50 %
Survey (2010)	Male	42 %	53%	50 %
	Female	58 %	47%	50 %

Table 5.7: Sex ratio

Table 5.8 shows the distribution between three income classes for the Vinex districts. The District Monitor showed that the incomes were distributed similar in the three districts. In Leidschenveen in 2006 the group of low income was the smallest. These results can differ greatly with the situation nowadays (2010) as the districts are realised in parts. In the survey many respondents did not want to answer the question on income. Therefore, the results are not representative. Comparing the results with the Districts Monitor, especially persons with a low income were missing.

		Wateringse Veld	Ypenburg	Leidschenveen
District Monitor (2006)	Low	21 %	22 %	16 %
	Medium	46 %	42 %	51 %
	High	33 %	36 %	33 %
Survey (2010)	No answer	42 %	26 %	38 %
	Low	4 %	12 %	2 %
	Medium	32 %	34 %	26 %
	High	22 %	28 %	34 %

Table 5.8: Income in three groups

5.2.3 Conclusion

In this section the characteristics of the three case study areas were compared. Furthermore, the effect of these characteristics on the public transport use in the areas was analysed.

Starting with those characteristics that would influence the use of public transport the most, the districts were found to differ greatly. Certain people are more likely to use public transport, mostly because of limitations regarding car use. In Wateringse Veld, the number of people without a driving license is the lowest, and the area also has the highest number of people that are the main user of a car; it therefore scores high in non-public transport use. However, Wateringse Veld also has the largest number of students that own a student public transport card. The analysis thus showed that the various characteristics related to public transport use were pointing in different directions. Therefore, it is likely that these characteristics even each other out, and that the resulting effect is only small.

For other characteristics, such as demography and spatial planning, the districts are comparable. The main difference between Wateringse Veld and the other two case study areas is that 7 per cent of the population in Wateringse Veld is elderly, while for the other two areas this is between 3 and 4 per cent, which could have influenced mobility figures.

The survey and the District Monitor had different results for various characteristics. These results could be explained by the date of the data set or the different population. Nonetheless, some results showed that a group, the female, was questioned more. In the survey a subset of the population in the districts is used, therefore, it is not possible to correct for this.

5.3 Accessibility

Accessibility is analysed to review the competitiveness of public transport in the three districts. Two indicators were selected for this analysis, service area and travel time to main destinations. The 15 and 30 minute service areas were determined for three transport modes. The results are discussed in the first section. For the main destinations the travel time ratio was calculated, to observe the competitiveness of public transport. These results are described in section 5.3.2.

5.3.1 Service areas

For three transport modes, car, bicycle and light rail, the service area was calculated. Within these service areas the number of residents and facilities are calculated. For the detailed results see Appendix VI: Accessibility. First, the results of access to residents are discussed and, second, the results for facilities are captured.

5.3.1.1 Access to residents

The access to residents by car increased slightly over the years (Figure 5.4). From Leidschenveen the most residents could be reached within 15 minutes. During peak hours the results were the same for Leidschenveen and Wateringse Veld. In Ypenburg during peak hour the access to residents dropped below 300,000. For the 30 minute boundary the results for Leidschenveen and Ypenburg were similar. In Wateringse Veld the number was almost 200,000 residents lower, in both peak and off peak periods.

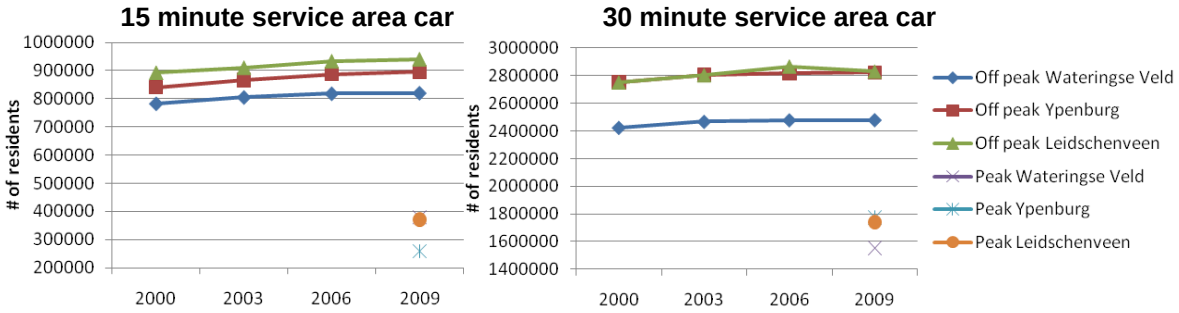


Figure 5.4: Residents in service area (Navteq & resident density)

In Figure 5.5 the same results for bicycle and light rail (referred to as PT) are presented. For bicycle the access to residents showed a different result compared with the car. Wateringse Veld had access to the most residents. The numbers for Leidschenveen and Ypenburg were much lower, but increasing over time. The increase was caused by the development of the districts themselves. Wateringse Veld is situated in a more developed area and, therefore, the numbers during the construction of the district do not change that much. For the 30 minute service area for bicycle the slope of the diagram is less steep. This is cause by the surrounding areas. From Leidschenveen the access to residents by bicycle was the lowest and more than two times as low as in Wateringse Veld.

For light rail the difference between the districts is much smaller. Wateringse Veld, with an early realisation, had the best access to residents in the 15 minute boundary. Leidschenveen, in 2009, had almost the same numbers, even though this district was served with more public transport lines. The tram lines in Wateringse Veld drive to a denser area,

and thus reach more residents. For the 30 minute boundary the results for all districts were comparable.

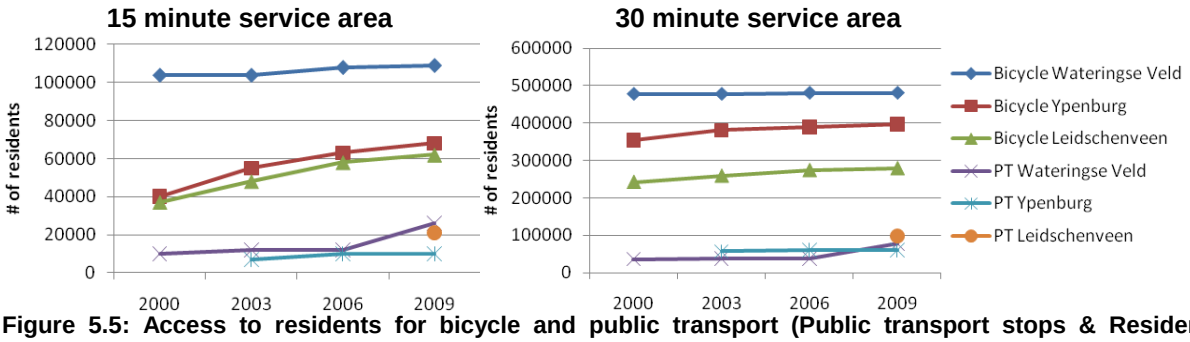


Figure 5.5: Access to residents for bicycle and public transport (Public transport stops & Resident density)

There is a large difference between the results for public transport and bicycle. This is caused by the calculation method. For bicycle a buffer around the centroids in the district was used. Therefore, it gave access to the residents in the direct neighbourhood of the case study areas. For public transport the area in the district was not used because people will not use public transport to travel inside the district. For public transport only a buffer around the light rail stations that could be reached within the time boundary were used. This sums up to a smaller area and thus to less residents, see Figure 5.6.

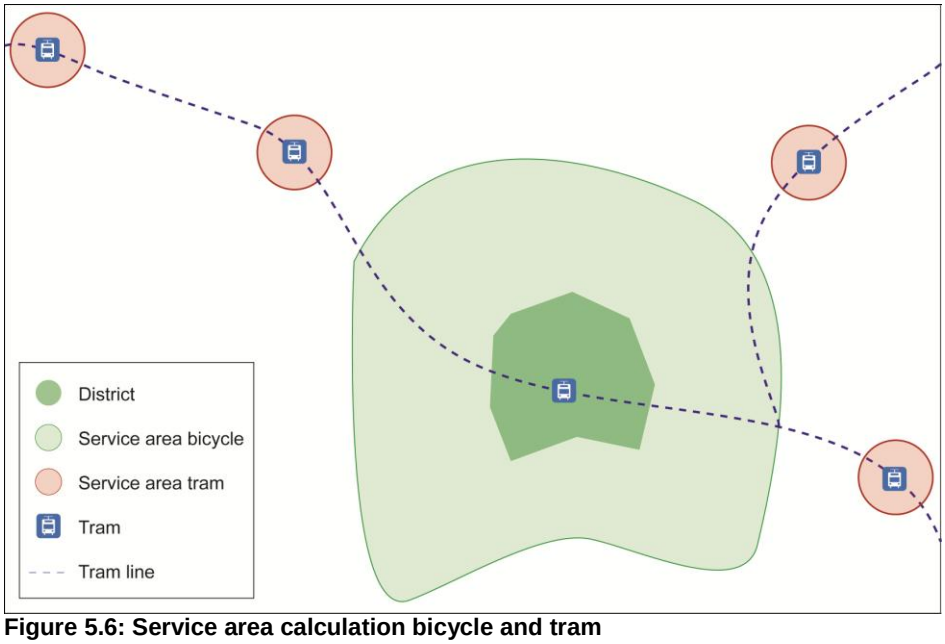


Figure 5.6: Service area calculation bicycle and tram

5.3.1.2 Access to facilities

Next to the number of residents within the service area, the number of jobs and facilities were calculated as well. The results are presented in this section.

The number of jobs within the service area for cars increased slowly over time. For 2006 there was a small decrease, see Figure 5.7. One of the explanations for this is the decrease of jobs counted in the city centre of Delft. In Ypenburg and Leidschenveen most jobs could be reached within 15 minutes. During the peak period Leidschenveen had access to the most jobs, also for the 30 minute boundary. Only Wateringse Veld had in all occasions a noteworthy lower number of jobs within reach.

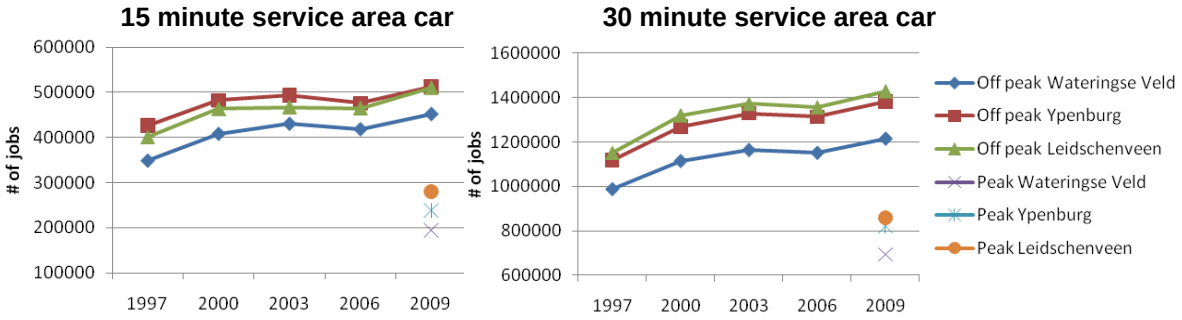


Figure 5.7: Jobs in service area (Navteq & LISA)

For the service area of bicycle and light rail the numbers are different. Figure 5.8 shows these results. For both time periods Wateringse Veld had access to the most jobs, and Leidschenveen had the lowest score. The decrease for the 30 minute service area of Ypenburg is a remarkable result; again the city centre of Delft could partly explain this.

For light rail Ypenburg and Leidschenveen had only data for a part of the period, as these facilities were completed on a later moment. The results of Wateringse Veld and Ypenburg were comparable, as expected, as both tram lines travel in the same direction. Leidschenveen had access to more jobs, having connections to more locations outside the area, and a faster connection to The Hague's central station.

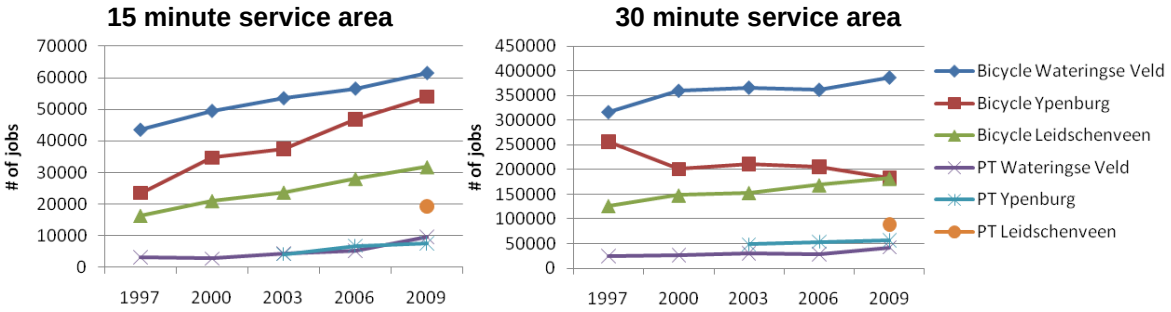
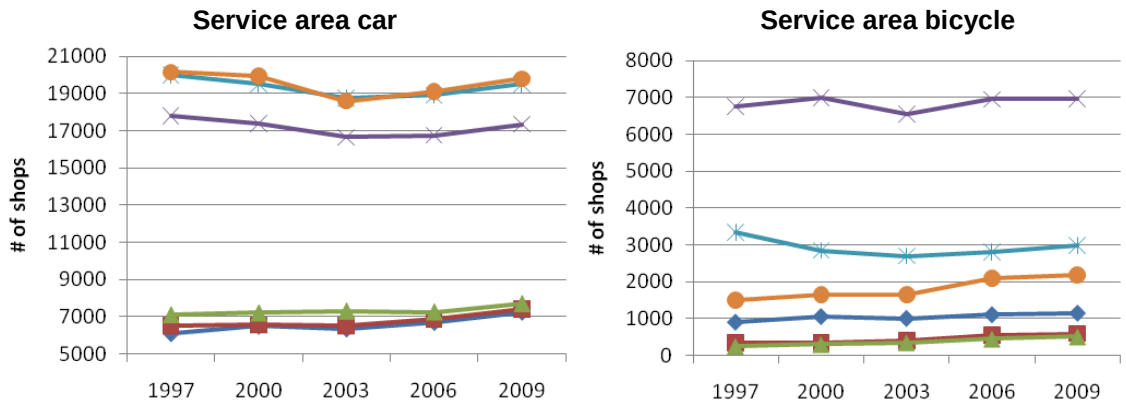


Figure 5.8: Jobs in service area of bicycle and public transport (Public transport stops & LISA)

For access to shops the results are visualised in Figure 5.9. The graphs are grouped per transport mode. Again for car transport, Ypenburg and Leidschenveen had access to more shops than Wateringse Veld, especially within the 30 minute boundary. For bicycle Wateringse Veld had the most shops within reach. This can be explained by the shopping centre of Rijswijk, which is within reach. For public transport the same trend as for the jobs is visible. Leidschenveen, having connections in more directions, had access to more shops. Tram line 16 in the north of Wateringse Veld increased is completed in 2007 and, therefore, the graphs show an increase. For the 15 minute boundary the result are quite the same for all districts.



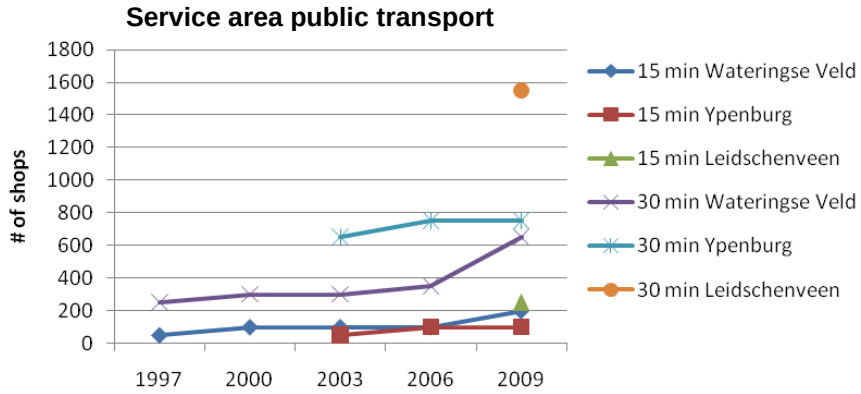


Figure 5.9: Shops in service area (Public transport stops, Navteq & LISA)

Finally, the access to schools, both primary and secondary, is analysed. The results are presented in Appendix VI: Accessibility. For the car in the results did not show a major development. For bicycle during the years 1997 – 2009 the number of schools increased. This can be explained as the districts themselves and their neighbourhoods developed and more schools were opened. Only in the 30 minute service area for Ypenburg again the numbers dropped. For public transport the access to schools increased over the years.

The average results are presented in Table 5.9. Again, Leidschenveen was more accessible by car than the other two districts in the 30 minute service area. Wateringse Veld had most school accessible for cyclists. The numbers for public transport in 2009 are comparable. Probably schools are not often located within the 300 meter boundary around a light rail station.

		Wateringse Veld		Ypenburg		Leidschenveen	
		Total	**Secondary**	**Total**	**Secondary**	**Total**	**Secondary**
Car off peak	15 min	440	130	480	130	430	130
	30 min	1400	330	1600	360	1900	650
Bicycle	15 min	100	35	35	10	30	10
	30 min	480	60	240	60	200	45
Public Transport	15 min	5	2	5	1	15	10
	30 min	20	5	35	10	45	15

Table 5.9: Number of schools (Public transport stops, Navteq & LISA)

Reviewing the service area it becomes clear that Leidschenveen had for both public transport and car mobility the best results. Wateringse Veld especially had access to many residents and facilities by bicycle. Ypenburg scored in the middle for all three transport modes. These results make it more likely that people of Leidschenveen tend to travel by car and public transport. For Wateringse Veld transport by bicycle is more attractive than in the other two districts.

5.3.2 Destinations

Next to the service area of the district, the competitiveness of the light rail services was calculated for the main destinations of the districts. For this the districts of the municipality of The Hague and the towns of the rest of the Netherlands were used. In Table 5.10 the top ten destinations are given. In all districts most trips were inside the district, up to 48 percent in Leidschenveen. The second destination was, in all three cases, a town in the neighbourhood of the district. The city centre of The Hague was in fourth position. The survey showed that 21% of the respondents travel to the city centre of The Hague at least once a week.

	Wateringse Veld	%	Ypenburg	%	Leidschenveen	%
1	Wateringse Veld	34.0	Ypenburg	27.5	Leidschenveen	48.0
2	Rijswijk	11.5	Nootdorp	33.1	Leidschendam	9.3
3	Wateringen	7.7	Delft	6.2	Zoetemeer	6.4
4	Centre The Hague	7.7	Centre The Hague	4.3	Centre The Hague	4.9
5	Laak	4.4	Rijswijk	3.4	Voorburg	4.5
6	Delft	3.8	Laak	3.0	Haagse Hout	3.4
7	Rotterdam	3.3	Pijnacker	2.4	Rijswijk	3.2
8	Excamp	2.2	Zoetermeer	2	Ypenburg	2.6
9	Loosduinen	2.1	Rotterdam	1.7	WV & Wateringen	2.5
10	Voorburg	2	Voorburg	1.7	Laak	2.0
11	Leidschendam	1.6	Leidschendam	1.1	Rotterdam	1.5
	Total	**80.3**	**Total**	**86.4**	**Total**	**88.3**

Table 5.10: Main destinations of the districts (MON The Hague 2006)

For the destinations the competitiveness of light rail was calculated for 2010. This was only done for the destinations outside the districts. For the trips inside the districts it was not possible to estimate the travel times. Light rail services are considered to be competitive if it has a travel time ratio lower than two, see also section 2.1.2. For all links the travel time ratios were calculated. The results give an indication whether or not public transport is competitive on this link. Table 5.11 shows the travel time ratio, and Appendix IV: Development road network contains the detailed travel times for car, bicycle and public transport. Ypenburg had the lowest amount of competitive public transport links. Only to the city centre of The Hague and to the Laak quarter light rail could compete with car travel times, during peak hours. Wateringse Veld had four competitive links. These are equally distributed in the top ten. Leidschenveen had the highest number of competitive links. These are the links with a direct connection from Leidschenveen station and therefore could lead to frequent light rail use. Ypenburg has the most links for which the travel time ratio was not calculated. In case the egress time was too long, or when there were more than 2 transfers the travel time was not calculated as it is considered to be less competitive.

Wateringse Veld	TT ratio	Ypenburg	TT ratio	Leidschenveen	TT ratio
Rijswijk	**1.6**	Nootdorp	2.2	Leidschendam	2.5
Wateringen	-	Delft	2.1	Zoetemeer	**1.7**
Centre The Hague	**1.7**	Centre The Hague	**1.7**	Centre The Hague	**1.3**
Laak	2.4	Rijswijk	-	Voorburg	2.5
Delft	2.6	Laak	**1.9**	Haagse Hout	**1.1**
Rotterdam	**1.6**	Pijnacker	2.8	Rijswijk	2.4
Excamp	3.6	Zoetermeer	-	Ypenburg	-
Loosduinen	3.1	Rotterdam	-	WV & Wateringen	2.8
Voorburg	**1.4**	Voorburg	2.5	Laak	**1.9**
Leidschendam	3	Leidschendam	2.5	Rotterdam	**1.3**

Table 5.11: Travel time ratio of car peak hour and public transport (Navteq & National Accessibility Map)

Next to the travel time ratio comparing car peak hour and light rail, the travel time ratio of bicycle and light rail is interesting as well. The results are presented in Table 5.12. It becomes clear that in the case study areas light rail is competitive. Only in Wateringse Veld there was one destination with a travel time ratio more than 2. In Leidschenveen there were several links for which public transport was even quicker than the bicycle. The results showed that light rail in the case study areas is competitive with the bicycle. However, for most trips are the origin and destination are within the district (see Table 5.10), and for these trips bicycle is more attractive.

Wateringse Veld	TT ratio	Ypenburg	TT ratio	Leidschenveen	TT ratio
Rijswijk	**1.1**	Nootdorp	**1.4**	Leidschendam	**0.6**
Wateringen	-	Delft	**1.6**	Zoetemeer	**0.6**
Centre The Hague	**1.2**	Centre The Hague	**0.9**	Centre The Hague	**0.6**
Laak	**1.4**	Rijswijk	-	Voorburg	**1.6**
Delft	**1.1**	Laak	**1.1**	Haagse Hout	**0.6**
Rotterdam	**0.5**	Pijnacker	**1.6**	Rijswijk	**0.8**
Excamp	3.2	Zoetermeer	-	Ypenburg	-
Loosduinen	**2.0**	Rotterdam	-	WV & Wateringen	**0.9**
Voorburg	**0.6**	Voorburg	**1.2**	Laak	**1.3**
Leidschendam	**1.0**	Leidschendam	**1.2**	Rotterdam	**0.4**

Table 5.12: Travel time ratio for bicycle and public transport (Navteq & National Accessibility Map)

5.3.3 Conclusion

Even though the districts are located within the same municipality, there are many differences in accessibility. Leidschenveen has, using transportation by car, access to the most residents and facilities. With regards to access to other residents, the results for public transport were comparable. In the areas of facilities, jobs, shops and schools, Leidschenveen scored the best. Wateringse Veld has the most facilities accessible to cyclists. When looking at the travel time ratio, Leidschenveen again scored highest. From the results, a frequent use of public transport was expected in Leidschenveen for 2009. The results for Ypenburg and Wateringse Veld were expected to be comparable.

5.4 Self-selection

Self-selection plays an important role in travel behaviour research. The causality between living environment and travel behaviour can work in two directions. The question is whether public transport users choose to live in neighbourhoods that are well connected by public transport, or are people influenced by their environment and do they use public transport because it is available. Therefore, the preferences of the residents in the case study areas were analysed. Self-selection was analysed with two different data sources, for the description of the analyses see section 4.5. The first section discusses the primary data set of this research, a survey conducted in the study areas. In the second section another survey is analysed, the Dutch research in housing (WoON).

5.4.1 Survey

To analyse self-selection different groups of residents were compared. Their value for public transport was analysed. First, the general outcome of the survey is analysed. Next the frequent public transport users, using public transport at least once a week, are compared with the non-frequent public transport users. These analyses are used to see if frequent public transport users value public transport different than non-frequent users. Furthermore, the three study areas are compared.

While reading the statistical analyses, one has to keep in mind that the sample size of the survey was limited, due to time constraints. Therefore, no solid conclusions could be drawn based on the survey alone. Still, it gives insight in the influence of self-selection on the results.

5.4.1.1 Results of the survey

To analyse self-selection two methods were used in the survey. The respondents were asked to value the motivation to move to the area and, furthermore, they were asked to value several transport modes. They could divide 10 points between the aspects. The respondents valued the type of house and price, mean 3.4 and 2.1, respectively, as the most important aspects to move to the area. Transport is the least important with a mean of 0.9, and it has also the lowest standard deviation, see Table 5.13. This shows that the transport facilities in a neighbourhood are not the key concern if people are considering to move to a certain area.

Self-selection can still influence the travel behaviour of residents, but the respondents are, in most cases, not conscious choosing the neighbourhood that satisfies their travel behaviour.

	Mean	Std. Deviation
Price	2.1	1.67
Type of house	3.4	1.80
Neighbourhood	1.7	1.55
Location	1.7	1.66
Transport	0.9	1.14

Table 5.13: Value the motivation for choosing to move into this area (Question 3: survey, all districts)

The respondents were also asked to value transport aspects. Only the respondents that valued transport with one or higher in the previous question were analysed because only these considered the transport aspects. The results for 73 respondents are presented in Table 5.14. From these results it becomes clear that a location near the highway is most important, but the standard deviation is the highest, so the respondents do not agree on this. The parking facilities and public transport facilities are second. The respondents found the existence of bicycle lanes the least-important aspect. The car ownership in all districts was high compared with The Hague, see the results from section 5.2. This could explain the importance of a location near the highway. The parking facilities are scarce, therefore, people in the districts were generally not satisfied, and their value for parking facilities drops. The low points for bicycle lanes are explained by, that in the Netherlands bicycling facilities are in general well organised. Therefore, people do not search for a location with good bicycle lanes, but assume these facilities are arranged. Public transport is of average importance, thus some respondents assess public transport faculties when considering a move to an area.

	Mean	Std. Deviation
Near highway	3.7	1.97
Parking facilities	2.2	1.61
Existence of bicycle lanes	1.3	1.13
Public transport facilities	2.6	1.60

Table 5.14: Value the transport aspects for choosing to move into this area (Question 4: survey, all districts)

Keeping the previous results in mind it is not surprising that the car is the most-important transport mode for the respondents. In line with the previous results the standard deviation is the highest for the car, see Table 5.15. Tram and bicycle share the second place. For bicycles this can be explained by the Dutchmen's preference for cycling. To be able to tell more about the self-selection influence in these matters the results were analysed for different groups, and this will be discussed in the next sections.

	Mean	Std. Deviation
Car	4.8	2.35
Bicycle	1.9	1.49
Bus	0.8	1.08
Light rail	1.9	1.61
Train	0.6	0.93

Table 5.15: Value the importance of transport modes (Question 6: survey, all districts)

5.4.1.2 Comparison of frequent public transport users with non-frequent users

With the three survey questions from the previous section the analyses for self-selection continue. The results for transport and public transport facilities (train, tram and bus) were used. Two different groups were distinguished: frequent and non-frequent public transport users. Frequent public transport users were defined as using public transport at least once a

week. The groups were used to see if there is a difference in the score of transportation, public transport facilities and the public transport modes, tram, bus and train.

Table 5.16 presents the mean and standard deviation for the frequent and non-frequent users. The results show that there is a difference in valuation of public transport related aspects. The frequent public transport users on average valued all aspects higher than the group non-frequent users. The frequent users have in most occasions a higher standard deviation; this is probably due to the smaller sample size of this group.

		Mean		Std. Deviation	
Question	**(# respondents)**	**Frequent**	**Non-frequent**	**Frequent**	**Non-frequent**
3	Transport	1.0 (50)	0.8 (97)	1.11	1.16
4	Public Transport facilities	3.3 (28)	2.1 (45)	1.72	1.35
6	Bus	1.4 (52)	0.5 (98)	1.43	1.09
	Light rail	3.0 (52)	1.3 (98)	1.78	1.15
	Train	0.7 (52)	0.5 (98)	1.09	0.83

Table 5.16: Value of public transport related aspects of frequent and non-frequent public transport users (survey, all districts)

The box plots of the values show (see Appendix VII: Self-selection) that there are some outliers for the value of transport and train. These are not excluded from the analysis because it were values that residents give to transport and train. Excluding these values the analyses would not present the opinion of the residents.

The means from Table 5.16 are tested to see if the differences are significant. Therefore, first, the Kolmogorov-Smirnov test and the Shapiro-Wilk test were used to test if the results were normal distributed. In case of more than 50 respondents the Kolmogorov-Smirnov test was used in other cases the Shapiro Wilk was used (Innes s.d.). Only the score for public transport facilities of the group frequent public transport users is normal distributed, most results are positively skewed and, therefore, not normally distributed (see Appendix VII: Self-selection). This is caused by the scale of the survey. The lowest value was zero, and it was not possible for the respondents to give negative scores.

To test if the groups are significantly different nonparametric tests needed to be used, in this case the Mann-Whitney U test. The results in Table 5.17 show that for three of the five values there was a significant difference between both groups. Frequent public transport user value public transport facilities, bus and light rail, higher than non-frequent users. These results are used to observe the difference in value between the three districts.

	Significance value (2-tailed)
Transport	0.215
Public Transport facilities	**0.002**
Bus	**0.000**
Light rail	**0.000**
Train	0.456

Table 5.17: Results Mann-Whitney U test

5.4.1.3 Difference between districts

To discuss the effect of self-selection in the case study areas these are in this section compared to see if they value transport related aspects different. From the previous section it is known that frequent public transport users value public transport, bus and tram higher than non-frequent users. Because the sample size was limited, the analysis was done with basic statistics.

Table 5.18 shows the mean and standard deviation for the three aspects. Public transport facilities are valued high in all districts. In Leidschenveen scored public transport the highest,

but the standard deviation was the highest in this district as well. For the other aspect the results are comparable.

		Mean			Std. Deviation		
Q	**(# respondents)**	**Watering -se Veld**	**Ypenburg**	**Leidschen-veen**	**Watering -se Veld**	**Ypenburg**	**Leidschen-veen**
4	Public Transport facilities	2.6 (11)	2.7 (12)	3.3 (16)	1.44	1.72	1.81
6	Bus	1.0 (50)	0.7 (50)	0.7 (50)	1.16	0.85	1.20
	Light rail	1.9 (50)	1.7 (50)	2.0 (50)	1.48	1.58	1.77

Table 5.18: Value of transport aspects for the Vinex districts of The Hague (survey)

To give more insight, in the distribution of the values, histograms are presented in Figure 5.10. The value for public transport was, in general, higher in Leidschenveen in comparison with the other districts. Wateringse Veld had the most respondents that valued public transport facilities with zero, and also had the least respondents that valued transport with more than zero points, only 11 respondents.

For the public transport modes bus and light rail the values were fairly the same for all districts. However, between these modes there is quite a difference. For bus the frequency declines as the value becomes higher while for tram the peak is at value two. All districts were at the moment of the survey well connected by light rail; this probably explains the high value that residents give to the transport mode. The lower status of bus transport is visualised in these diagrams.

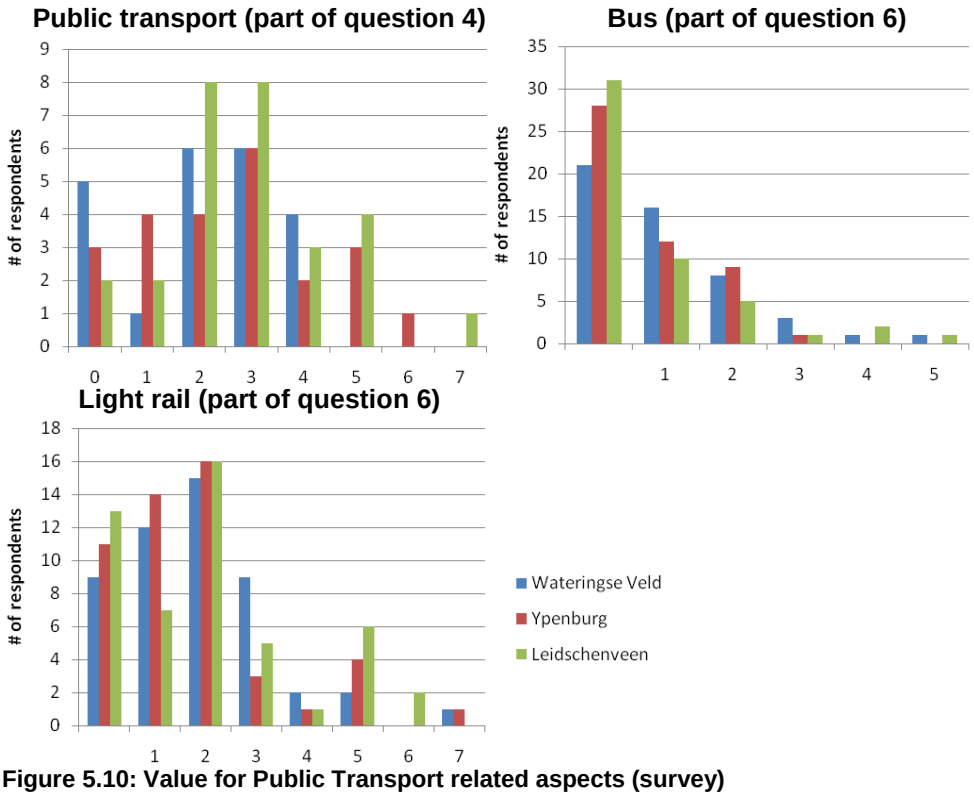


Figure 5.10: Value for Public Transport related aspects (survey)

5.4.1.4 Change of travel behaviour

The frequent public transport users were also asked how often they used public transport in their previous living environment, and when they started to use public transport at least once a week. The sample size for these questions was very small, 49 respondents. Therefore, this group is not divided in districts. In this group 33 percent started using public transport frequently before they moved into the case study area, 47 percent on the moment they

arrived in the area and 20 percent on a later moment. All districts were represented. This means that most public transport users in the area were non-frequent public transport users before they move to the area.

The respondents were, furthermore, asked if they started to use the public transport more since they moved to the area. 33 percent answers this question with no, 7 percent with neutral and the major group uses public transport more. This shows that if self-selection has an impact on the results, it is only accountable for a part of the group.

5.4.2 Dutch research in housing (WoON)

The Dutch research in housing, referred to as WoON, was also used to analyse the effect of self-selection. The two years available, 2006 and 2009, were used. In 2006 Wateringse Veld and Ypenburg were served by tram line, in Leidschenveen frequent busses were available. In 2009 all three districts were well served by light rail service, see section 5.1. WoON is a survey, which maps housing preferences and conditions. The sample size for the Vinex locations was at least 152 respondents per districts, see Table 5.19. As WoON is a national survey the weight factors cannot be used for analyses on district level.

	2006		**2009**	
	#	**%**	**#**	**%**
Wateringse Veld	175	22,5	380	42,5
Ypenburg	433	55,7	363	40,6
Leidschenveen	169	21,8	152	17,0

Table 5.19: Sample size WoON

For analysing the effect of self-selection on public transport use, three questions were interesting in the WoON:

- Do you use the public transport in the neighbourhood?
- How important are public transport facilities?
- Are you satisfied with the public transport in the neighbourhood?

From the public transport users 80 percent was satisfied with the public transport facilities in the neighbourhood. The non-public transport users were for 70 percent satisfied with the public transport. Figure 5.11 shows that public transport users are, in general, more satisfied with the facilities; even though they are potentially more aware of the failures in the system. Furthermore, the figure shows that the satisfaction with public transport increased between 2006 and 2009. This can be explained by the completion of the light rail facilities in Leidschenveen and Wateringse Veld in 2007, which gave the districts a frequenter and quicker connection by public transport. Satisfied respondents tend to use public transport more often, but the direction of the causality is still unclear. Are the residents satisfied because they are aware of the possibilities of the public transport in the neighbourhood? Or are they satisfied with the facilities and, therefore, using public transport?

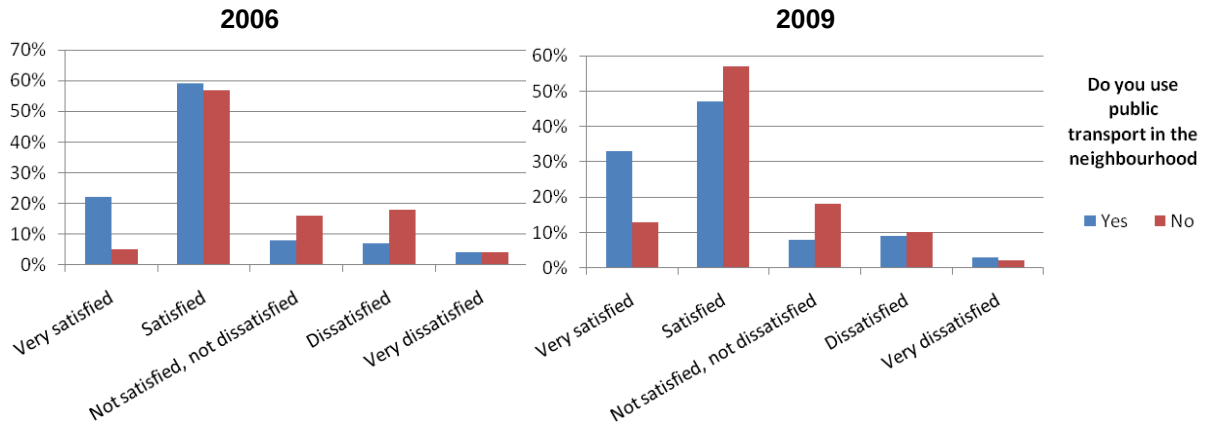


Figure 5.11: Are you satisfied with the public transport in the neighbourhood? (WoON, Vinex Districts The Hague)

Figure 5.12 shows the results for the same question only this time grouped per district. There are little differences between the diagrams. In Wateringse Veld respondents were more satisfied in 2009, probably because the completion of tram line 16 in 2007 covering the north of the districts. Combining this information with the knowledge of the previous section the more satisfied users relate to more public transport users. For Wateringse Veld this was not the case as the number of users decline with 10 percent. The figures for Ypenburg stayed quite the same over the years. Respondents in Wateringse Veld were to be more satisfied in both years, and there were more public transport users in Wateringse Veld. In Leidschenveen respondents are more satisfied in 2009 than in 2006, this correlates with the fact that in Leidschenveen the number of users did not decline between 2006 and 2009.

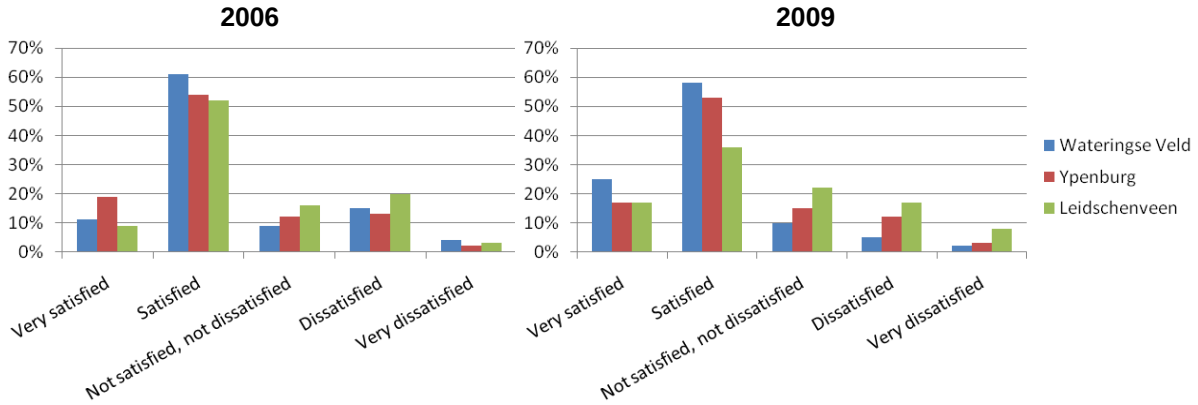


Figure 5.12: Are you satisfied with the public transport in the neighbourhood? (WoON, Vinex Districts The Hague)

Public transport facilities are important for the respondents in WoON. Figure 5.13 shows that only a small part of the respondent found public transport facilities unimportant or totally unimportant. In both years around 20 percent of the non-public transport users found the facilities unimportant. Between the years there had not been a change in opinion of the residents on importance of public transport facilities. Most respondents, user and non-user of public transport, found public transport important. From the public transport users a larger part found public transport facilities very important. This is logical as public transport is used by these respondents.

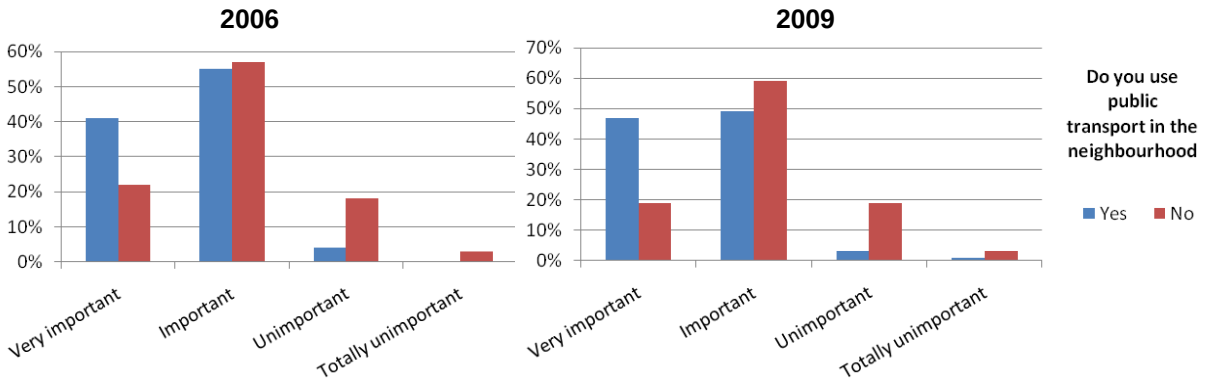


Figure 5.13: How important are public transport facilities? (WoON, Vinex Districts The Hague)

Figure 5.14 shows the importance of public transport facilities grouped by district. From this figure it becomes clear that public transport facilities are equally important for the respondents from the districts. The number of people that find public transport not important slightly increased in 2009. From these diagrams it becomes clear that people that find public transport important are located in all districts.

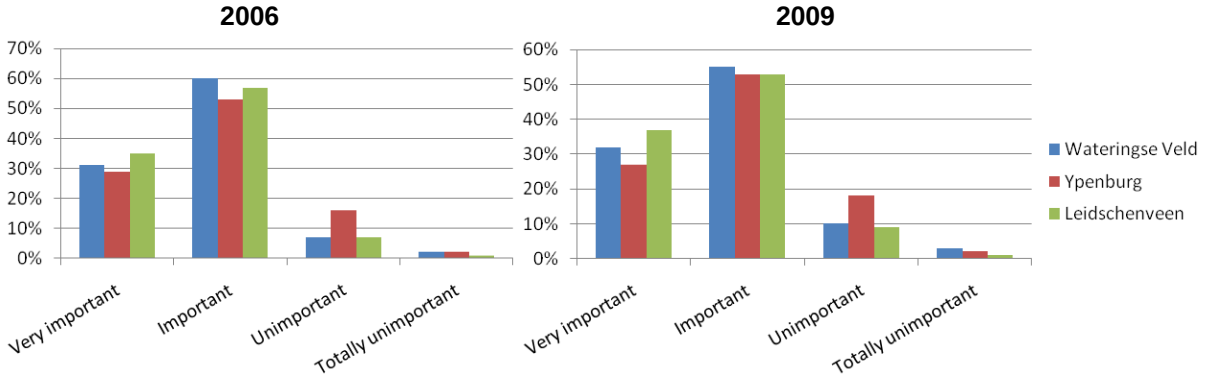


Figure 5.14: How important are public transport facilities? (WoON, Vinex Districts The Hague)

5.4.3 Conclusion

Self-selection plays an important role in travel behaviour research. The causality between living environment and travel behaviour can work in two directions. On one hand the living environment could influence the travel behaviour by providing the right circumstances for public transport use. On the other hand the travel preferences of people can influence the migration choices. This means that they move into a district that meets their travel needs.

The research question by these results was:
Does self-selection affect the use of public transport in the case study areas?
The preferences of the residents in the case study areas were analysed. The results from the survey showed that, for public transport users, public transport facilities are important. Some people consider public transport an important aspect in their choice of moving to a certain area. A survey among 150 residents in the case study areas showed that the number of people who felt this way was only small; the respondents who did value this aspect appeared to live scattered over the three areas. Moreover, transport facilities seemed the least-important aspect for people considering a move to a certain area.

Subsequently, there appeared to be a relation between the level of satisfaction about the public transport facilities in the neighbourhood and the use of public transport. The amount of people satisfied with the public transport, was the highest in Wateringse Veld, the area with the earliest connection; also this area had the largest amount of public transport users among its residents, according to the survey. However, the differences between the case

study areas were only small and, therefore, not likely to have influenced the outcome of this research to any great extent.

5.5 Migration

Research question e analyses the effect of migration patterns on the local use of public transport. The migration patterns influences the group of people that had no public transport facilities available to them during their first years in the district. In the districts with late implementation of light rail facilities a part of the residents moved to the area when the light rail facilities were not finished (yet). Therefore, the residents are more likely to develop a car-oriented travel pattern. The speed of the migration patterns determines the size of the group of people that had no public transport facilities available to them during their first years in the district. Over the years, group with no public transport facilities in the beginning, will become increasingly smaller. The speed of this process is determined by the migration speed.

The migration patterns in the municipality of The Hague were analysed using the District Monitor of The Hague. The District Monitor provided information on the migration mobility; this is ratio between the number of migrants that leave the district and the total number of residents. Combining this data with data from Statistics Netherlands the migration mobility could be compared with other districts in The Hague, the municipality of The Hague, the Province of South Holland, Western the Netherlands and the Netherlands. The other districts in The Hague are districts with a population size comparable with the case study areas. Figure 5.15 shows the migration mobility from the start of the development of the districts in 1995. For Ypenburg and Leidschenveen this data was only available starting in 2002 when the districts became part of the municipality of The Hague.

The diagram clearly shows that the migration mobility in Leidschenveen, Wateringse Veld and Ypenburg are low compared with the other areas. The municipality of The Hague had high migration mobility rates compared with the rest of the Netherlands. Starting in the nineties the migration mobility was around 20 percent and declining to 16 percent in 2008. For the Netherlands it was around 12 percent and for the region West Netherlands and the province South Holland the numbers are similar. The migration mobility in the Vinex districts of The Hague was in most years lower than the Dutch average.

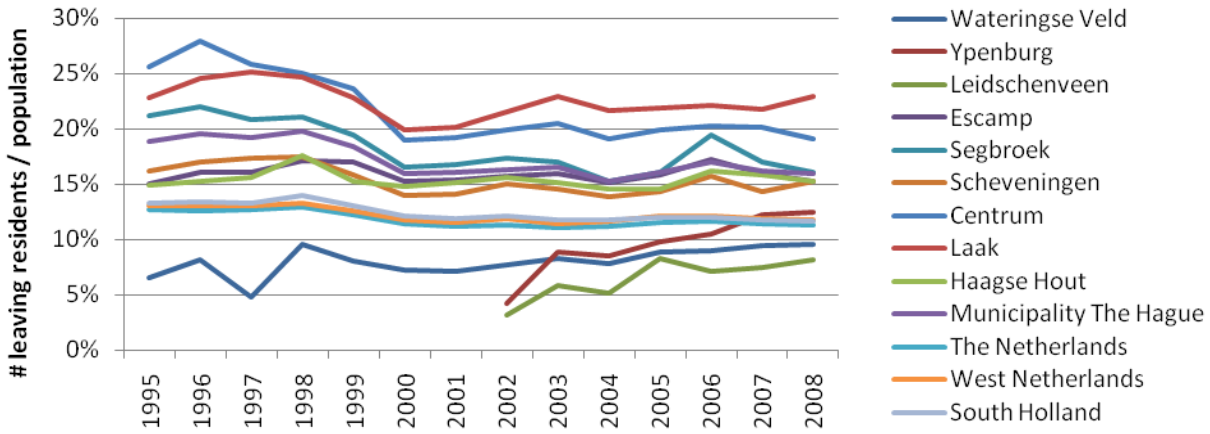


Figure 5.15: Migration mobility (District Monitor The Hague)

Another method to give insight in the migration patterns is the Dutch research in housing (WoON). This data set provided information on the construction year of the house and the year of settlement. These were used to determine whether or not the residents were first residents. In Figure 5.16 the percentage of respondents that were first residents is grouped by the construction year of the house. In 2006 the major part of the respondent were first residents, only 12 percent were not first residents. In 2009 this increased to 26 percent, with a major increase of non-first residents in the older houses. From this diagram it becomes

clear that most residents stay in the districts for a long period. Many residents live in the district longer than 10 years, which is higher than the average 7 years in the rest of the Netherlands. This underlines the low migration mobility found in the previous paragraph.

Figure 5.16: Percentage of first residents in the Vinex locations in The Hague grouped by year of construction (WoON, Vinex Districts The Hague)

Conclusion

In this section the migration patterns of the districts in The Hague were analysed. The migration patterns could influence the number of people that had no public transport facilities available to them during their first years in the district. The group of residents that did not had the light rail facilities in the beginning will become smaller during the years, when residents move to other areas. Therefore, the migration patterns were reviewed in research question e: *Do migration patterns influence the use of public transport?*

When comparing the migration patterns in the Vinex locations of The Hague with those in the Netherlands and the municipality of The Hague, it became clear that the migration patterns were slow. Over the years, group with no public transport facilities in the beginning, will become increasingly smaller, therefore, the effect of early public transport will slowly fade out with the years.

5.6 Use of public transport

In the last sub research question the effect of the time of implementation of light rail facilities on public transport use is analysed. First, the use of public transport in the districts is analysed with different indicators. Second, the relation between the variables is analysed with regression analyses.

5.6.1 Use of public transport

The use of public transport is determined with four indicators. First, the MON The Hague 2006 is used to determine the modal split for number of trips and distance. This gives an indication of the ratio between light rail use and other modalities in the area. In the second section the results from the survey are analysed. The third section discusses the counts. The last section discusses compares the results for the different indicators.

5.6.1.1 Modal split

Figure 5.17 shows the modal split for the number of trips in the three districts. This was calculated for the trips that start or end in one of the districts and which were made by the residents of the district. In 2006 the modal split for light rail was two times higher in Wateringse Veld as in Ypenburg and Leidschenveen. In Ypenburg the relative number of trips with the tram is lower than in Wateringse Veld. Leidschenveen was not yet connected to the metro line and, therefore, this result was expected.

A remarkable result is the high bicycle use in Ypenburg, as the results in 5.3.1 show that Ypenburg had lower access to residents and facilities for bicycle than Wateringse Veld. This shows that accessibility is not the only factor influencing the choice of a transport mode. There are many other factors that influence the mode choice of residents.

Nevertheless, the results from research question b for service areas, section 5.3.1, explain the high modal split for bicycle in the Netherlands. Travelling by bicycle one can reach the destinations in the direct neighbourhood, while with public transport one can only travel to public transport stops.

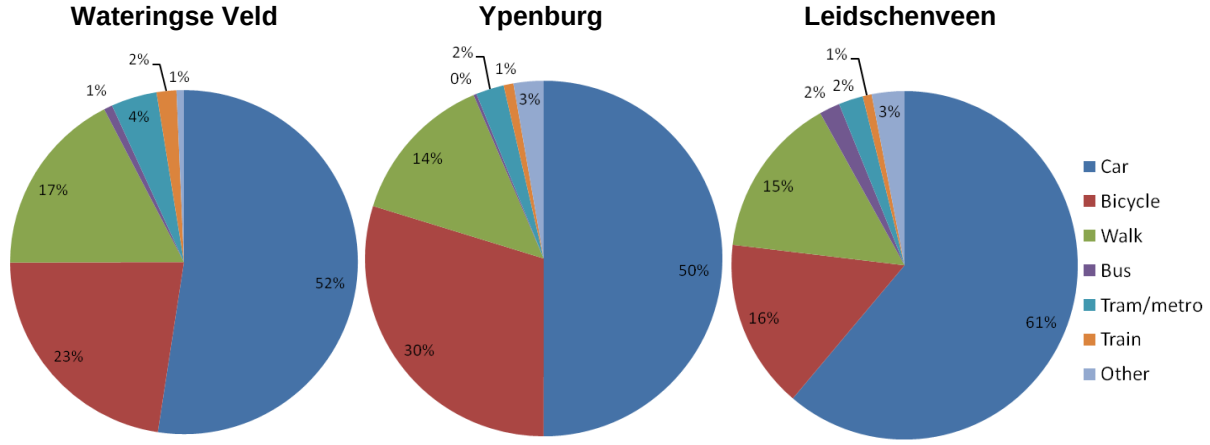


Figure 5.17: Modal split in trips in percentage (MON The Hague 2006)

Furthermore, for all trips of the residents the modal split in distance were calculated. These results give another figure, see Figure 5.18. Cars are also used for longer distances and, therefore, the relative car use in distance is higher that the number of movements. Again, in Wateringse Veld public transport is used the most. Tram has a modal split of 4 percent and train even 7 percent.

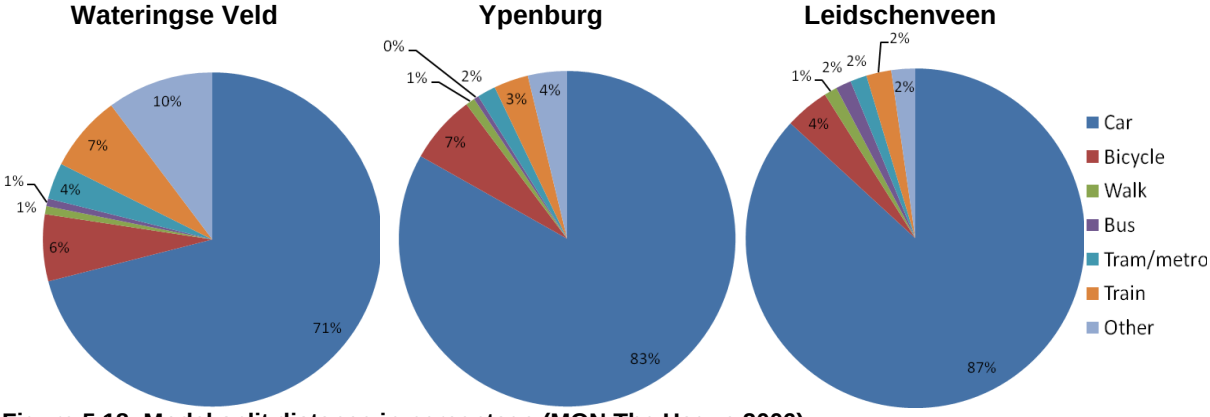


Figure 5.18: Modal split distance in percentage (MON The Hague 2006)

5.6.1.2 Frequency of public transport use

In the survey the respondents were asked about their travel behaviour in two questions. The first asked which transport modes were used in the household at least once a week. There were three options given, and the respondent had the possibility to add other transport modes. In the second questions the respondents were asked how often they use public transport.

Table 5.20 shows the results for the different transport modes. It shows that the car was used in most households at least once a week. Overall only 5 percent of the household did not use the car once a week. The results for bicycle showed the same result as the modal

split in the previous section. Again Ypenburg had the highest bicycle use rates, in 76 percent of the household the bicycle was used at least once a week. For public transport the results can not be compared with the results of the MON The Hague 2006 for Leidschenveen. The survey was conducted at the moment the metro station in Leidschenveen was completed, which was not the case in 2006. For Wateringse Veld and Ypenburg the results are the same as the modal splits. In Wateringse Veld more households use public transport at least once a week. Important to keep in mind is that this does not explain the number of trips and number of persons that use the public transport mode in the household.

		Wateringse Veld	Ypenburg	Leidschenveen	Total
Car	Yes	94 %	94 %	98 %	95 %
	No	6 %	6 %	2 %	5 %
Bicycle	Yes	62 %	76 %	52 %	63 %
	No	38 %	24 %	48 %	37 %
Public Transport	Yes	44 %	34 %	52 %	43 %
	No	56 %	66 %	48 %	57 %

Table 5.20: Which transport mode is used at least once a week in the household? (survey)

In the survey the respondents were also asked how often they use public transport. The results are presented in Figure 2.1. The results again show that the most persons using public transport at least once a week are living Leidschenveen. The table shows, moreover, that only a small portion of the respondents, 9 percent, uses public transport at least once a week. Respondents tend to use public transport several times a week or less that once a week. The survey did not asked for which type of trips public transport is used. One could expect that public transport is used several times a week mainly by commuters and students. The non-frequent public transport users are probably using public transport for leisure related trips.

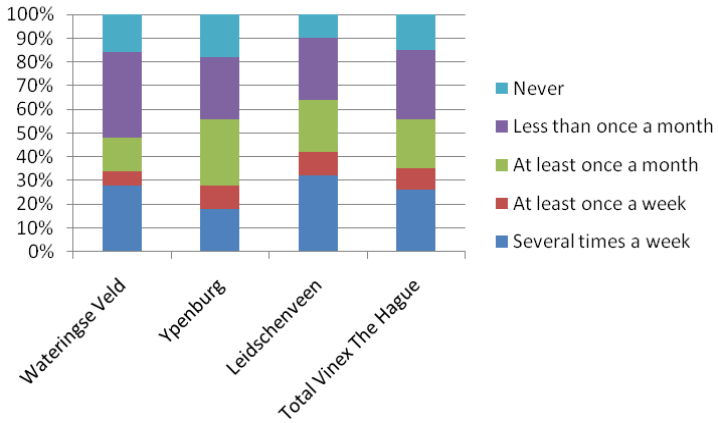


Figure 5.19: Use of public transport of the respondents (survey)

5.6.1.3 Counts

However, the counts from the light rail stations, counting the number of people getting on and off the tram or metro, show another result. In Figure 5.20 the results for the counts are presented. Especially Leidschenveen jumps out with 2155 people getting on or off the tram or metro at a light rail station per 1000 residents. Also Ypenburg had for all years a higher number of people getting on of off the tram or metro per 1000 residents than Wateringse Veld. However, it were not only residents from the case study areas that are counted in this indicator. Therefore a correction factor was calculated.

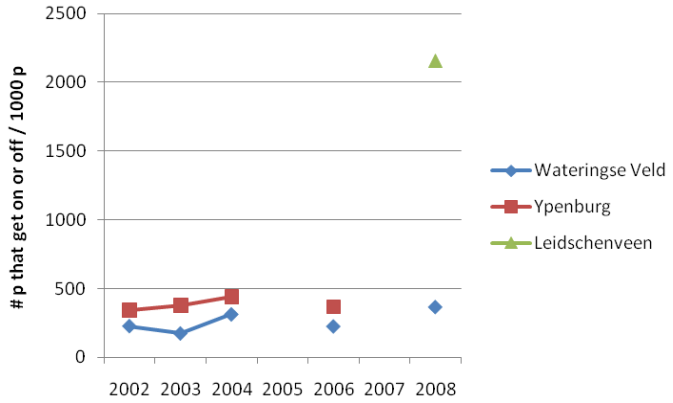


Figure 5.20: Get on and off for an average working day, not corrected (tram counts)

Only the residents of the case study areas could be influenced by the timing of the implementation of light rail facilities. To account only for the residents a correction factor was calculated. With the MON The Hague 2006 the ratio between the number of residents and non-residents that travel to the districts by tram or metro for an average working day were calculated. The numbers are presented in Table 5.21. It shows that Ypenburg attracted more non-residential persons by tram than Wateringse Veld. This partly explains the higher counts in Ypenburg than in Wateringse Veld.

	Wateringse Veld	Ypenburg	Leidschenveen
Ratio residents/non-residents	80.5%	62.7%	100%

Table 5.21: Ratio of tram users for an average working day (MON The Hague 2006)

Figure 5.21 shows the relative number of people getting on or off the tram or metro within the district, corrected for non-residential tram users. From this figure it becomes clear that still in Ypenburg relatively more people were getting on and off the tram on an average working day. Especially in 2003 the difference between Wateringse Veld and Ypenburg was large, respectively 140 versus 237 persons per day. In the other years the difference varied between 24 and 48. The national MON 2006 was used to calculate the number of people, not residents of the municipality of the Hague, that travel to the Vinex districts in The Hague on a average working day. In this survey no additional travellers were found and, therefore, the concluded is that mainly people from The Hague travel to the case study areas.

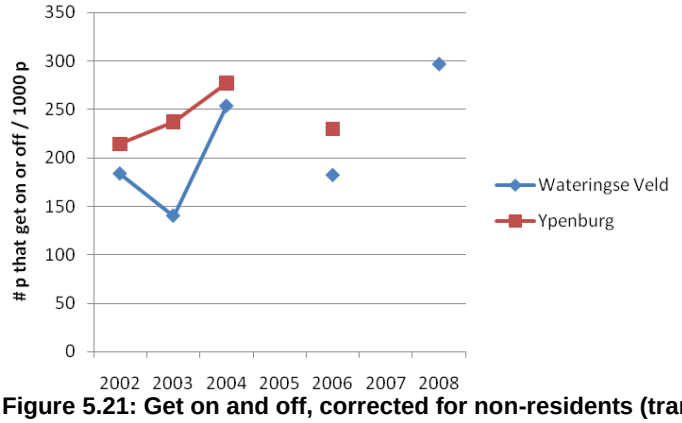


Figure 5.21: Get on and off, corrected for non-residents (tram counts)

For Leidschenveen only the tram counts for 2008 were available. These numbers differ greatly from the counts from Ypenburg and Wateringse Veld, with 2155 people getting on or off the metro station per 1000 residents. This difference can be explained by several factors. First of all, it was not possible to correct for the number of non-residential users of the light rail facilities as the station was opened in 2007 and the MON is from 2006. In the neighbourhood of the metro station a large institute, Statistics Netherlands is located.

Probably many employees travel by public transport from outside Leidschenveen to the district. The results from section 5.3 expected a frequent use of public transport in Leidschenveen as the district scored well on the accessibility indicators. The other difference is the head time in Leidschenveen, which is much shorter than in the other areas. As Savelberg (2007) makes clear the head time elasticities in the Netherlands are not yet studied. Wardman (2004) found in a study in Great Britain for rail based transport head time elasticity between -0.08 and -0.27. Using these elasticities, the corrected for head time public transport use in Leidschenveen is between 605 and 1695 people that get on or off at the metro station. This is still substantial higher than the number for Wateringse Veld. 296. Furthermore, Leidschenveen has more connections. In Wateringse Veld and Ypenburg there was one tram line, in Leidschenveen there are three different lines. These are also connecting the residents with towns in the neighbourhood instead of only the city centre of The Hague.

5.6.1.4 Differences between the indicators

The results from the MON The Hague 2006 and the survey compared with the counts from the tram stations tell a different story. The MON The Hague 2006 gave a clear view of a higher modal split for light rail, both in distance as in the number of trips, for Wateringse Veld than Ypenburg. This validates the thought that an earlier impletation of public transport in new housing developments would lead to higher use of the public transport facilties. However, the counts from the trams stations for four years, including 2006, gave a higher number of people that use the light rail facilities in Ypenburg. To explain this difference several factors have to be analysed.

First, with the MON The Hague 2006 number of trips per 1000 persons were calculated to have results in the same unit as the counts. The results show a higher use of tram per 1000 residents in Wateringse Veld, compared with Ypenburg (Table 5.22). A limitation of the data set is that for Wateringse Veld only the respondents that made a trip are known. Therefore, the same selection is made in Ypenburg. Table 5.22 shows thus the number of tram trips per 1000 travelling residents on a workday. These results show the same results as the modal split in the previous section. In Wateringse Veld the number of trips per 1000 residents is higher than in Ypenburg. Therefore, this did not help to explain the differences between the indicators.

District	Respondents	Trips by tram	Trips / 1000 respondents
Wateringse Veld	176	22	125
Ypenburg	471	40	84

Table 5.22: Number of tram trip per with start of end in the district 1000 travelling persons on a workday (MON The Hague 2006)

There are two factors left that could explain the difference found between the modal split and the counts. The number of non-travelling persons could be higher in Wateringse Veld and, therefore, the relative number of trips is lower than in Ypenburg. However, the amount of residents that are travelling is lower as well. In this study there is no data available on the non-traveling residents. Therefore, an estimation is made on the characteristics of the districts, see also section 5.2. Wateringse Veld had an higher rate of elderly, therefore, there is a chance that in Wateringse Veld, compared to the other districts, has a higher number of people that are not traveling. This can explain a part of the difference between the modal split and the counts.

Next to the percentage non-travelling residents, the number of trips per resident influences the counts as well. The modal split is a relative measure comparing the number of trips or distance of one transport mode with other modes. If in one district the residents tend to make more trips the modal split can be lower than in another district, while the absolute numbre of persons that getting on or off the tram or metro in the districts is higher. Therefore, it is

interesting to review the average number of trips per (travelling) person. Table 5.23 shows that the number of trips per person in Wateringse Veld is lower than in Ypenburg. This influences the number of light rail trips of the districts and, therefore, the differences between the districts becomes smaller.

		Trips	
	# Respondents	**Mean trips**	**Std. Deviation**
Wateringse Veld	176	3.4	1.8
Ypenburg	472	3.6	2.1
Leidschenveen	426	3.8	1.9

Table 5.23: Average number of trips per respondent on a workday (MON The Hague 2006)

5.6.2 The effect of timing

In this section the results from the logistic regression analyses are described. For the MON The Hague 2006 and the survey 2010 three logit models were made. These models make it possible to analyse the contribution of the variables in explaining the outcome variable. In the models personal characteristics, transport characteristics and spatial characteristics were added. The logit models are described in Appendix VIII: Regression analyses, together with the co-linearity assessment. First, the results of the MON The Hague 2006 are discussed. Secondly, results from the survey are described.

A logistics regression analysis is executed to explain the differences in use of light rail in the Vinex districts. The respondents from the three Vinex districts in the MON The Hague 2006 were used. To analyse the effect of timing a district variable was added. This variable shows if there is a significant difference between the districts, taking other characteristics into account. Table 5.24 shows the results for the district variable, the other independent variables in the analysis and assessment of the model. The latter shows that the model is significant with a low R^2. This means that the model has some problems in explaining the variation of the outcome variable.

The results for the district variable show that there was a significant difference between the districts for light rail use, if personal, household and transport characteristics are taken into account. In the analysis Wateringse Veld is the base case, and the other districts are compared with the light rail use of the residents of Wateringse Veld. In both Ypenburg (e^{β} = 0.36) and Leidschenveen (e^{β} = 0.30) the use of light rail is lower than in Wateringse Veld.

				95% C.I. for e^{β}		
		β (S.E.)	**Sig.**	**Lower**	**e^{β}**	**Upper**
District	Wateringse Veld		**0.000**			
	Ypenburg	-1.03 (.14)	**0.000**	.27	.36	.47
	Leidschenveen	-1.19 (.14)	**0.000**	.23	.30	.40

Included variables	Sex	# cars in household
	# persons in household	# bicycles in household
	Education level	Possession student PT car
	Social characteristics	Adult with no driving licence
	Age	Adult not being main car user

Note R^2 = .28 (Hosmer & Lemeshow). .32 (Cox & Snell). .43 (Nagelkerke).
Model χ^2 = 1038.721. p<.001

Table 5.24: Results for Vinex districts logit model (MON The Hague 2006, Vinex districts)

Subsequently, the data of the survey is analysed. Two logit models were developed. The outcome variable in these models is whether or not being a frequent public transport user. In the first logit model a categorical district variable and personal, household and transport

characteristics were added. In the second model the preferences of the respondents were added as well.

The results for the first model are presented in Table 5.25. In this model the different districts were not significant in explaining the outcome variable. Therefore, considering the survey conducted in 2010 there is no difference between the districts taking into account social and other characteristics. This logit model is significant as well. Comparing the modal with the previous results the R^2 is higher, which indicates a better prediction of the outcome variable.

				95% C.I. for e^{β}		
		β (S.E.)	**Sig.**	**Lower**	**e^{β}**	**Upper**
District	Wateringse Veld		.191			
	Ypenburg	-1.46 (0.802)	.069	.048	.232	1,119
	Leidschenveen	-.572 (0.736)	.437	.133	.564	2,385

Included variables	Sex	# cars in household
	# persons in household	# bicycles in household
	Education level	Possession PT subscription
	Job	Trip frequency to The Hague
	Age	
	Type of house	
	Ownership house	

Note R^2 = .44 (Hosmer & Lemeshow). .43 (Cox & Snell). .59 (Nagelkerke).
Model χ^2 = 72.039. p<.001

Table 5.25: Logit model with personal, household and transport characteristics (survey, Vinex The Hague)

In the second model, next to these characteristics, the preferences of the respondents were added. From the survey question three and six were used. In these questions, the respondents were asked to value the importance of transport modes and to value transport aspects for considering a move to a certain area.

Table 5.26 shows the results for the districts, the value for transport modes and transport facilities. It shows that only value for bus, tram and public transport are significant. All are positively related to frequent public transport use. Important to acknowledge is that the standard errors for β and 95 percent confidence interval for e^{β} are large. The sign of the beta for the three variables remains positive within the confidence interval.

The regression coefficient for the districts is not significant. In the survey, the number of frequent transport users was distributed quite even over the districts, with Leidschenveen having the largest amount (see Figure 5.19).

Including the preferences of the residents results in a model with a higher R^2, and the model is, thus, better in explaining the variation of the output variable. This shows that the preferences of persons are an important indicator of their travel behaviour.

				95% C.I. for e^{β}		
		β (S.E.)	**Sig.**	**Lower**	**e^{β}**	**Upper**
District	Wateringse Veld		0.325			
	Ypenburg	-2.06 (1.396)	0.141	.008	.128	1.975
	Leidschenveen	-0.77 (1.506)	0.610	.024	.464	8.883
Value (Importance)	Car	0.014 (0.926)	0.988	0.165	1.014	6.24
	Bicycle	-0.010 (0.995)	0.992	0.141	0.99	6.962
	Bus	2.858 (1.182)	**0.016**	1.719	17.419	176.53
	Tram	2.165 (1.052)	**0.040**	1.108	8.712	68.51
	Train	0.187 (0.965)	0.846	0.182	1.205	7.986
Value (moving into the area)	Near highway	-0.178 (0.418)	0.669	0.369	0.837	1.897
	Parking facilities	-0.731 (0.578)	0.205	0.155	0.481	1.493
	Bicycle lanes	-0.192 (0.554)	0.730	0.279	0.826	2.447
	Public transport facilities	1.488 (0.689)	**0.031**	1.147	4.427	17.09

Included variables	Sex	# cars in household
	# persons in household	# bicycles in household
	Education level	Possession PT subscription
	Job	Value transport modes
	Age	Value transport characteristics
	Type of house	Trip frequency to The Hague
	Ownership house	

Note R^2 = .44 (Hosmer & Lemeshow). .43 (Cox & Snell). .59 (Nagelkerke).
Model χ^2 = 72.039. p<.001

Table 5.26: Logit model with personal, household, transport characteristics and the personal preferences (survey, Vinex The Hague)

The results from the three logit models show differences. The district variable was significant in one model, but not in the other two. In the MON The Hague 2006 the district variable was significant, next to various other variables (for the results for the other variables see Appendix VIII: Regression analyses). In the two logit models based on the survey the district variable was not significant.

There are a few differences between the data sets that could explain these differences. First, in the MON The Hague 2006 all age groups are presented, while in the survey only adults were questioned. In the survey the students are not present either. Second, the data sets are from different years, the MON was from 2006 when Ypenburg had a tram line and the metro station in Leidschenveen was not completed. The results for the survey are from April 2010, when all districts are connected to light rail facilities. Last, the outcome variable is different for the data sources.

Therefore, it is concluded that, taking into account personal, household and transport characteristics, there was a significant difference in public transport use between the districts (2006). At this time there are comparable light rail services in Wateringse Veld and Ypenburg; in Leidschenveen there are no light rail facilities available. When having public transport facilities in all districts (which was the case in 2010), transport use in the districts did not differ significantly. Therefore, the time of implementation could have had an influence, but only temporary.

5.6.3 Conclusion

In this last section the use of public transport and the effect of timing were analysed. The use of public transport was analysed according to different parameters.

These results are used to answer the research question:
What is the effect of the time of implementation of light rail services on the use of public transport?
To answer this question many factors need to be taken into account. Therefore, in the previous sections influences, such as spatial characteristics, migration patterns and self-selection were analysed. Looking at the modal split in the areas, for both number of trips and distance, Wateringse Veld clearly had the highest modal split for public transport. However, the counts at the light rail stations show another result. From the day that the tram lines in both Leidschenveen and Ypenburg were realised, a higher number of people were counted getting on and off the light rail trams, than in Wateringse Veld. Also when the results are corrected for head time and for the number of non-residents travelling to and from these areas. In April 2010 Leidschenveen has the highest share of frequent public transport users.

Looking at the variables that explain the amount of light rail use in the case study areas, in 2006, the areas themselves play a significant role. Although another data source of April 2010 showed the districts to not be significantly different. Therefore, timing could have an influence on public transport use, albeit temporarily.

6 Conclusions and recommendations

In this chapter, the final conclusions of this study are presented. First, the answers to all the research questions are discussed, concluding with the answer to the main research question. Furthermore, the limitations of this study are reviewed. In the discussion, the methods are discussed from a wide perspective. And, finally, the recommendations are presented, both to policymakers and for further research.

6.1 Conclusions

This section contains the conclusion of this study. The objective of this research was:
The objective of this study is to analyse the effect of the time of implementation of light rail transport in new housing areas on local use of public transport.

This section first discusses the research questions as formulated in Section 3.3, and concludes with the answer to the main question.

The first research question was formulated as follows:

a. *How is public transport set up for Vinex locations, in general, and what are the differences with its development in the case study areas?*

To answer this question, the case studies were analysed in a larger perspective. In the analysis, the development of public transport in all Vinex locations in the Netherlands was compared with that in the case study areas in The Hague.
The development of public transport in other Vinex locations in the Netherlands has followed a different pattern than in the case study areas. In the latter public transport services came into operation at various times.

In one of the case study areas, in Wateringse Veld, a tram line and frequent bus service were set up in 1997. The other two districts, Leidschenveen and Ypenburg, frequent bus services were also obtained in 1997. The tram line in Ypenburg was realised in 2002, and the metro station in Leidschenveen was completed in 2007. In the rest of the Netherlands, the development has been slower. In 2008, 10 to 14 years after the start of construction of Vinex locations, one fifth of the area of these locations had not yet been provided with public transport services. To the Vinex locations in The Hague, light rail has become an important public transport mode, and, by 2008, all three of the case study areas were provided with one or more light rail lines. For the rest of the Netherlands, this trend is different; around 4 per cent of the area of the Vinex locations is serviced by light rail transport. This low percentage is due to the fact that only the country's main cities have such light rail systems.

The second research question was:

b. *What are the characteristics of the case study areas and do these influence the use of public transport?*

To answer this question, the characteristics of the three case study areas were compared. Furthermore, the effect of these characteristics on the public transport use in the areas was analysed.
Starting with those characteristics that would influence the use of public transport the most, the districts were found to differ greatly. Certain people are more likely to use public transport, mostly because of limitations regarding car use. In Wateringse Veld, the number of people without a driving license is the lowest, and the area also has the highest number of people that are the main user of a car; it therefore scores high in non-public transport use. However, Wateringse Veld also has the largest number of students that own a student public transport card. The analysis thus showed that the various characteristics related to public

transport use were pointing in different directions. Therefore, it is likely that these characteristics even each other out, and that the resulting effect is only small.

For other characteristics, such as demography and spatial planning, the districts are comparable. The main difference between Wateringse Veld and the other two case study areas is that 7 per cent of the population in Wateringse Veld is elderly, while for the other two areas this is between 3 and 4 per cent, which could have influenced mobility figures.

Also the level of accessibility per different transport mode could also influence the use of public transport. This led to the formulation of the following research question:

c. Does the level of accessibility of the areas influence the use of public transport?

The amount of jobs, shops and schools within the service area show big differences between the districts. Wateringse Veld has most jobs and facilities accessible to cyclists, while Leidschenveen was most accessible for cars. The public transport services of Wateringse Veld and Ypenburg are comparable, both leading in the direction of The Hague's central station. Leidschenveen has a much wider level of public transport, having connections to more locations outside the area, and a faster connection to The Hague's central station. With respect to schools, the differences are smaller, especially for public transport. One of the reasons for this could be that none of the schools were located within 300 metres of a light rail stop. Reviewing the main destinations of the residents, in 2006, it became clear that in Leidschenveen public transport is most competitive (in 2010).

Another aspect that could influence the results from this study is that of self-selection. This led to the following research question:

d. Does self-selection affect the use of public transport in the case study areas?

Some people consider public transport an important aspect in their choice of moving to a certain area. A survey among 150 residents in the case study areas showed that the number of people who felt this way was only small; the respondents who did value this aspect appeared to live scattered over the three areas. Furthermore, there appeared to be a relation between the level of satisfaction about the public transport facilities in the neighbourhood and the use of public transport. The amount of people satisfied with the public transport, was the highest in Wateringse Veld, the area with the earliest connection; also this area had the largest amount of public transport users among its residents, according to the survey. However, the differences between the case study areas were only small and, therefore, not likely to have influenced the outcome of the survey to any great extent.

The migration patterns could influence the number of people that had no public transport facilities available to them during their first years in the district. Therefore, this was reviewed in research question e:

e. Do migration patterns influence the use of public transport?

When comparing the migration patterns in the Vinex locations of The Hague with those in the Netherlands, and the entire municipality of The Hague, it became clear that the migration patterns were slow. Over the years, group with no public transport facilities in the beginning, will become increasingly smaller, therefore, the effect of early public transport will slowly fade out with the years.

Finally, the focus is on the public transport use in the case study areas.

f. What is the effect of the time of implementation of light rail services on the use of public transport?

The result for this research question pointed in two directions. Looking at the modal split in the areas, for both number of trips and distance, Wateringse Veld clearly had the highest modal split for public transport. However, the counts from the light rail stations, counting the number of people getting on and off the tram or metro, show another result. From the day that the tram lines in both Leidschenveen and Ypenburg were realised, a higher number of people were counted getting on and off the light rail trams, than in Wateringse Veld. Also

when the results are corrected for head time and for the number of non-residents travelling to and from these areas.

Looking at the variables that explain the amount of light rail use in the case study areas, in 2006, the areas themselves play a significant role. Although another data source of April 2010 showed the districts to not be significantly different. Therefore, timing could have an influence on public transport use, albeit temporarily.

To answer the main research question, the information from the answers to all these questions needed to be combined. The main question was:
To which extent does time of implementation of light rail transport in new housing areas affect the local use of public transport?
Based on the analyses in which the three cases are compared, it is concluded that timing of public transport does have a small effect on its use.

In 2006, Wateringse Veld had the highest modal split for light rail. However, the counts from the light rail stations, counting the number of people getting on and off the light rail trams, show another result. Wateringse Veld had a lower use of the transport facilities than in Ypenburg and Leidschenveen. Also the number of people that frequently used public transport in Leidschenveen, in April 2010, was higher than in Wateringse Veld.

In this study, a small effect of the timing of the implementation of light rail facilities could be observed. In 2006, in Wateringse Veld, more people used light rail services than in the other two areas, when accounted for personal characteristics. For 2010, however, the results were different. In these analyses, there was no significant difference between the three areas. Therefore, it is concluded that timing could have an influence, albeit temporarily.

6.2 Limitations

There were several limitations to this research. In the first two paragraphs the limitations of the chosen case study areas are described. The last paragraph describes the most-important limitation of the survey.

The difference in quality between the public transport connections of Leidschenveen and the other two areas, made the conclusion harder to draw. Leidschenveen has connections to more destinations outside the area and also a smaller head time. Therefore, the results could not easily be compared.

Another limitation were the quality levels of the public transport services in the case study areas. From the time of development of the three areas, all were serviced by quality bus services. Therefore, most of the early residents did have access to public transport if they so desired. This could make the possible effect of the realisation of light rail at a later stage smaller. From talking to survey respondents, it became clear that residents in Leidschenveen did feel the disadvantage of late realisation of their light rail service. According to some residents, they bought a second car during this period, which they would not have done if there had been good public transport.

The sample size of the primary data set for this research was only limited. The time and resources were limited and, therefore, no solid conclusions could be drawn, based on the survey alone. The survey would have provided more information on residents' preferences if conducted in larger sample or under a larger population.

6.3 Discussion

In the previous section, the limitations of this study were presented. This section discusses the methods from a wide perspective, with the conceptual model (Figure 3.3) in mind.

First of all, this study was a case study. The analyses were done for a select group of Vinex locations in the Netherlands. The results could be different for other locations.

As mentioned in section 3.6, the used method has the advantage that it provided information on all factors presented in the conceptual model. The main disadvantage is that not all information is combined in one analysis and, therefore, some interactions are only estimated.

In this study, most analyses were quantitative, calculating percentages, statistical tests and drawing diagrams. With regression analyses the relationship between several factors was analysed. However, not all results from the different research questions were linked together on a quantitative base. Some effects on public transport use were estimated qualitatively. Therefore, for example, effect of accessibility on public transport could only be estimated and not calculated.

In addition to more quantitative analyses, extra information could be gained by conducting one large-scale analysis instead of several small analyses. For example, a land-use transportation interaction model could be used to predict public transport use in the areas, when public transport would be implemented in all areas at the same time. These results could then be compared with the results in reality. If there were to be a major difference, this could mean that timing has an effect on the use of public transport. This method will also make it easier to look at different districts from different parts of the country.

Moreover, the survey could provide more information if has a larger scale, addressing more factors from the conceptual model. Additional questions in the survey are questions on the reasons of people for using public transport, and whether their household situation had changed after they first moved into the district. Furthermore if the survey combines travel characteristics, for example, using a travel diary, with self-selection methods and travel preferences, it is possible to extract the relationship between the time of implementation of light rail services and the use of public transport.

6.4 Recommendations

This research is conducted using three case studies, and was the first of its kind. Therefore, further research is recommended. Below, in the first section, the options for further research are described. The second section contains recommendations for policymakers.

6.4.1 Further research

There are several options for further research. This section names some of these options.

First of all, it would be important to do this research with a larger number of cases; this would make conclusions more likely to be true. Selecting the cases, for this type of research, is an important aspect. The case study areas need to have a comparable level of public transport service, to deliver comparable results (see also the limitations in Section 6.2).

Another option is combining more types of public transport in the research and comparing the differences of timing for these types. In doing so, a comparison could be made to see whether first implementing quality bus services and later replacing this by light rail services, would have the same effect as implementing light rail services from the start.

Furthermore, the sample size of the survey conducted to study the aspect of self-selection, was only limited. Therefore, a survey with a large sample size is recommended, so that more solid conclusions could be drawn on the effect of self-selection on the use of public transport.

In this research, only one aspect of migration was analysed, namely, the speed of migration patterns, comparing this to that in other areas in the Netherlands. Other options would be to review the attractiveness of an area, before and after the realisation of quality public transport facilities. This could be done by using several indicators, such as housing prices and number of new residents. In these analyses, many factors would need to be considered, such as development in housing prices in the rest of the Netherlands, and migration speeds, which all would require a large data set of information.

In the analyses of the modal split and tram counts at the stations showed different results for the differences between the case study areas. Several suggestions are also provided in Subsection 5.6.1.4, but these could not fully explain these differences. Therefore, it would be interesting to do research into these differences.

6.4.2 Policy recommendations

Next to scientific recommendations, this section also discusses some policy recommendations. From this study it became clear that there are many aspects that influence the use of public transport. One of them is the timing of the realisation of transport services. The effect found in this study was small and related to the modal split for the various types of public transport.

When considering the realisation of new public transport facilities in new housing areas, it is important to realise that there are several factors that influence the use of public transport. Furthermore, as resources are not unlimited in public transport projects, the importance of early implementation would need to be weighed against other aspects, such as connections, frequency and quality of the public transport facilities. This research showed that an early realisation of public transport did not make a large difference. Therefore, policymakers need to take this into account when considering such early realisation. The frequent use of public transport in Leidschenveen indicates that other aspects of public transport facilities may play a more important role.

In the case study Vinex locations in The Hague were well-connected to frequent bus services before the light rail service was realised. A bus service is a good option to provide public transport for early residents, making the larger investments for light rail at a later stage, when the population of these new districts has become larger.

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Appendices

Appendix I: The Survey

This section discusses the survey used for this research. The first section contains the process of making the survey. The second section discusses the conduction of the survey. In the last sections the outcome of the survey is analysed to answer several research questions.

The making of the survey

The survey was made in several steps. The first step was analysing the purpose of the survey, so the information which should result from the survey. In the research there are two research question which use information from the survey, namely self-selection (d) and migration (e). Next to the questions relating to these subjects, general questions were asked. This makes it possible to assess the survey in comparison to the population.

The next step was transferring the needed information in methods of questioning. For migration this step was fairly easy, because the respondents could easily be asked when they moved into the house. For self-selection this process was more complicated. Self-selection cannot be questioned in a simple manner, therefore, two methods were used. The first method asked the respondents to value different aspects of the reason to move into the area where they are currently living. Five main aspects of migration reasons where asked to value: price, type of house, neighbourhood, location and transport. The respondents could divide 10 points between the five aspects. By this the importance of the aspects becomes clear. Also the respondents were asked to value transport aspects, namely location near the highway, parking facilities, existence of bicycle lanes and public transport facilities. For the second method the respondents were questioned to value different transport modes. This makes it possible to analyse if all public transport 'lovers' live in one district. The respondents were also asked how often they use the different transport modes, and if they use public transport more often now they live in their current neighbourhood compared to earlier neighbourhoods where they were living.

The methods from the previous section were formulated in questions and the several versions of the survey were tested. To test the survey several people were used, some were acquainted with the research and others not. Therefore, it was possible to change the questions if something was not clear or misunderstood. A total of seven persons were used for testing the survey.

Then the survey was finished by changing the lay-out and putting the questions in the right order. The first two questions are simple, so the residents are convinced to start with the survey. The general questions, such as age and gender were put last, on advice of one of the experts at the PBL, Kees Vringer, because this makes the survey more attractive to fill in for the respondent.

The last step was making an accompanying letter. This letter was made in cooperation with the secretary, Wilma de Jong. The letter is in the lay-out of the PBL. The research objective in the letter is slightly different from the research. It is stated that the research focuses on the mobility behaviour of residents of new housing development. Public transport is deliberately not mentioned in the letter. By this the respondent is not focussed on public transport and, therefore, the change is higher that he/she fills in the survey open-minded.

The survey for each neighbourhood was slightly different because different public transport facilities were available with different timing. The people that moved into the district before the tramlines were realised are also questioned if their mobility behaviour has changed since the realisation of the public transport.

Accompanying letter

Onderwerp
Onderzoek naar mobiliteit van nieuwbouwbewoners

Beste meneer/mevrouw,

Datum
17 maart 2010

Tel
(030) 274 3626

Bijlagen
1

Voor u ligt een onderzoek naar het mobiliteitsgedrag in nieuwbouwwijken. Het doel is om de mobiliteit van nieuwbouwbewoners in kaart te brengen. De resultaten worden gebruikt om in toekomstige nieuwbouwwijken rekening te houden met de wensen van de bewoners. Het onderzoek wordt uitgevoerd in opdracht van het Planbureau voor de Leefomgeving en is het afsluitende deel van de opleiding Civiele Techniek aan de Universiteit Twente.

Deze enquête maakt onderdeel uit van het onderzoek en de resultaten van de enquête worden in de eindfase gepresenteerd. Het invullen neemt ongeveer 5 minuten van uw tijd in beslag. De resultaten zullen anoniem worden verwerkt en uw bijdrage is éénmalig.

Ik kom binnenkort langs om de ingevulde enquête op te halen.

Heeft u opmerkingen of vragen dan kan u ze sturen naar elske.olthof@pbl.nl of contact opnemen met mijn begeleider, de heer H. Nijland, tel. 030 274 3626.

Alvast bedankt voor het invullen van de enquête.

Met vriendelijke groeten,

Elske Olthof

Surveys

Wateringse Veld

Deze enquête is voor een onderzoek naar de mobiliteit van bewoners van nieuwbouwwijken. Ik wil u graag bij voorbaat bedanken voor het invullen van deze enquête. Kunt u bij de meerkeuze vragen het antwoord omcirkelen wat het meest van toepassing is.

1. Hoe vaak gaat u naar het centrum van Den Haag?
    a. Meerdere keren per week
    b. Minstens 1 keer per week
    c. Minstens 1 keer per maand
    d. Minder dan 1 keer per maand
    e. Nooit

2. Voor welke activiteiten gaat u naar het centrum van Den Haag? U mag meerdere antwoorden omcirkelen.
    a. Werken of School
    b. Shoppen
    c. Boodschappen
    d. Vrije tijd
    e. Vervoer

3. Kunt u beoordelen hoe belangrijk de volgende aspecten waren om in deze wijk te komen wonen? U heeft 10 punten te verdelen. Een voorbeeld van een antwoord is:

Prijs	5	punten	uw antwoord:	Prijs	…… punten
Type woning	3	punten		Type woning	…… punten
Buurt	1	punt		Buurt	…… punten
Ligging	0	punten		Ligging ten opzichte van plaats	…… punten
Transport	1	punten +		Transport	…… punten
Totaal	10	punten			

4. Kunt u de volgende transportaspecten op dezelfde manier beoordelen? Het gaat er om welk belang ze hadden bij uw keuze om in de wijk te komen wonen. U mag 10 punten verdelen.

Uw antwoord:	Ligging ten opzichte van de snelweg	…… punten
	Parkeervoorzieningen	…… punten
	Aanwezigheid fietspaden	…… punten
	Aanwezigheid openbaar vervoer	…… punten

5. Welke vervoersmiddelen worden in uw gezin minimaal 1 keer per week gebruikt?

Auto	Ja / Nee
Fiets	Ja / Nee
Openbaar vervoer	Ja / Nee
Anders, namelijk	……

6. Kunt u de volgende vervoersmiddelen een score geven van 1 tot 10 hoe belangrijk u ze vindt? U mag 10 punten verdelen.

Uw antwoord:	Auto	…… punten
	Fiets	…… punten
	Bus	…… punten
	Tram	…… punten
	Trein	…… punten

7. Hoe vaak maakt u gebruik van het openbaar vervoer?
    a. Meerdere keren per week — ga door naar vraag **8**
    b. Minstens 1 keer per week — ga door naar vraag **8**
    c. Minstens 1 keer per maand — ga door naar vraag **12**
    d. Minder dan 1 keer per maand — ga door naar vraag **12**
    e. Nooit — ga door naar vraag **12**

8. Sinds wanneer maakt u minimaal 1 keer per week gebruik van het openbaar vervoer? Jaartal ……

9. Rijdt u wel eens in tram 16 en/of 17?
    a. Meerdere keren per week
    b. Minstens 1 keer per week
    c. Minstens 1 keer per maand
    d. Minder dan 1 keer per maand
    e. Nooit

10. Bent u sinds u hier bent komen wonen meer gebruik gaan maken van het openbaar vervoer?
    Ja / Neutraal / Nee

11. Hoe vaak ging u in uw vorige woonplaats met het openbaar vervoer?
    a. Meerdere keren per week — ga door naar vraag **14**
    b. Minstens 1 keer per week — ga door naar vraag **14**
    c. Minstens 1 keer per maand — ga door naar vraag **14**
    d. Minder dan 1 keer per maand — ga door naar vraag **14**
    e. Nooit — ga door naar vraag **14**

12. Heeft u sinds u hier bent komen wonen overwogen om gebruik te gaan maken van het openbaar vervoer?
    Ja / Enigszins / Nee

13. Wat is de reden dat u niet geregeld gebruik bent gaan maken van het openbaar vervoer?
    a. Geld
    b. Tijd
    c. Voorkeur auto
    d. Anders, namelijk ……

14. In wat voor een woning woont u? Graag in beide kolommen één antwoord omcirkelen
    a. Appartement — a. Huur
    b. Rijtjeshuis — b. Koop
    c. Twee onder één kap
    d. Vrijstaand

15. Sinds wanneer woont u op dit adres? Jaartal ……

16. Woonde u daarvoor ook al in deze wijk?
    a. Ja, de oude postcode was ……
    b. Nee

17. Hoeveel autos heeft uw huishouden? Aantal ……

18. Hoeveel werkende fietsen zijn er in uw huishouden? Aantal ……

19. Bezit u of iemand in uw gezin een openbaar vervoer abonnement? Zo, ja welk type?
    a. Ja: Regio Haaglanden / Trein / Algemeen
    b. Nee

20. Wat is uw leeftijd? …… jaar

21. Geslacht M / V

22. Hoeveel personen heeft uw gezin? Aantal ……

23. Hoeveel uur per week heeft u een betaalde baan?
    a. 35 uur of meer
    b. 12 tot 35 uur
    c. minder dan 12 uur
    d. Niet
    e. Geen antwoord/wil niet zeggen

24. Indien van toepassing, hoeveel uur/dagen per week heeft uw partner een betaalde baan?
    a. 35 uur of meer
    b. 12 tot 35 uur
    c. minder dan 12 uur
    d. Niet
    e. Geen antwoord/wil niet zeggen

25. Wat is uw hoogst afgerond opleiding?
    a. Basisschool
    b. Middelbare school
    c. Mbo
    d. Hbo
    e. Universitair
    f. Geen antwoord/wil niet zeggen

26. In welke categorie valt het netto jaarinkomen van uw gezin?
    a. Minder dan €23.000
    b. Tussen €23.000 en €43.000
    c. Meer dan €43.000
    d. Geen antwoord/wil niet zeggen

Bedankt voor het invullen van deze enquête.

Ypenburg

Deze enquête is voor een onderzoek naar de mobiliteit van bewoners van nieuwbouwwijken. Ik wil u graag bij voorbaat bedanken voor het invullen van deze enquête. Kunt u bij de meerkeuze vragen het antwoord omcirkelen wat het meest van toepassing is.

1. Hoe vaak gaat u naar het centrum van Den Haag?
    a. Meerdere keren per week
    b. Minstens 1 keer per week
    c. Minstens 1 keer per maand
    d. Minder dan 1 keer per maand
    e. Nooit

2. Voor welke activiteiten gaat u naar het centrum van Den Haag? U mag meerdere antwoorden omcirkelen.
    a. Werken of School
    b. Shoppen
    c. Boodschappen
    d. Vrije tijd
    e. Vervoer

3. Kunt u beoordelen hoe belangrijk de volgende aspecten waren om in deze wijk te komen wonen? U heeft 10 punten te verdelen. Een voorbeeld van een antwoord is:

Prijs	5 punten	uw antwoord:	Prijs	…… punten
Type woning	3 punten		Type woning	…… punten
Buurt	1 punt		Buurt	…… punten
Ligging	0 punten		Ligging ten opzichte van plaats	…… punten
Transport	1 punten +		Transport	…… punten
Totaal	10 punten			

4. Kunt u de volgende transportaspecten op dezelfde manier beoordelen? Het gaat er om welk belang ze hadden bij uw keuze om in de wijk te komen wonen. U mag 10 punten verdelen.

Uw antwoord:	Ligging ten opzichte van de snelweg	…… punten
	Parkeervoorzieningen	…… punten
	Aanwezigheid fietspaden	…… punten
	Aanwezigheid openbaar vervoer	…… punten

5. Sinds wanneer woont u op dit adres? Jaartal …… **na 2006 ga naar vraag 8 anders ga door met vraag 6**

6. Wist u dat tramlijn 15 aangelegd zou worden toen u hier kwam wonen?
    a. Ja **ga door naar vraag 7**
    b. Nee **ga door naar vraag 8**

7. Zo ja, heeft dit invloed gehad op de keuze om hier te komen wonen?
    a. Ja, daardoor was de wijk aantrekkelijker
    b. Ja, daardoor was de wijk minder aantrekkelijk
    c. Nee

8. Welke vervoersmiddelen worden in uw gezin minimaal 1 keer per week gebruikt?

Auto	Ja / Nee
Fiets	Ja / Nee
Openbaar vervoer	Ja / Nee

Anders, namelijk ……

9. Kunt u de volgende vervoersmiddelen een score geven van 1 tot 10 hoe belangrijk u ze vindt? U mag 10 punten verdelen.

Uw antwoord:	Auto	…… punten
	Fiets	…… punten
	Bus	…… punten
	Tram	…… punten
	Trein	…… punten

10. Hoe vaak maakt u gebruik van het openbaar vervoer?
    a. Meerdere keren per week — ga door naar vraag **10**
    b. Minstens 1 keer per week — ga door naar vraag **10**
    c. Minstens 1 keer per maand — ga door naar vraag **16**
    d. Minder dan 1 keer per maand — ga door naar vraag **16**
    e. Nooit — ga door naar vraag **16**
11. Sinds wanneer maakt u minimaal 1 keer per week gebruik van het openbaar vervoer? Jaartal ……
12. Rijdt u wel eens in tram 15?
    a. Meerdere keren per week
    b. Minstens 1 keer per week
    c. Minstens 1 keer per maand
    d. Minder dan 1 keer per maand
    e. Nooit
13. Ging u voordat tram 15 in 2002 ging rijden wel eens met het openbaar vervoer?
    a. Meerdere keren per week
    b. Minstens 1 keer per week
    c. Minstens 1 keer per maand
    d. Minder dan 1 keer per maand
    e. Nooit
14. Maakt u sinds het gaan rijden van tram 15 vaker gebruik van het openbaar vervoer? Ja / Nee
15. Hoe vaak ging u in uw vorige woonplaats met het openbaar vervoer?
    a. Meerdere keren per week
    b. Minstens 1 keer per week
    c. Minstens 1 keer per maand
    d. Minder dan 1 keer per maand
    e. Nooit
16. Bent u sinds u hier bent komen wonen meer gebruik gaan maken van het openbaar vervoer?
    Ja / Neutraal / Nee — ga door naar vraag **18**
17. Heeft u sinds het gaan rijden van lijn 15 overwogen om gebruik te gaan maken van het openbaar vervoer?
    Ja / Enigszins / Nee
18. Wat is de reden dat u niet geregeld gebruik bent gaan maken van het openbaar vervoer?
    a. Geld
    b. Tijd
    c. Voorkeur auto
    d. Anders, namelijk ……
19. In wat voor een woning woont u? Graag in beide kolommen één antwoord omcirkelen

a. Appartement	a. Huur
b. Rijtjeshuis	b. Koop
c. Twee onder één kap	
d. Vrijstaand	

20. Woonde u daarvoor ook al in deze wijk?
    a. Ja, de oude postcode was ……
    b. Nee
21. Hoeveel autos heeft uw huishouden? Aantal ……
22. Hoeveel werkende fietsen zijn er in uw huishouden? Aantal ……
23. Bezit u of iemand in uw gezin een openbaar vervoer abonnement? Zo, ja welk type?
    a. Ja: Regio Haaglanden / Trein / Algemeen
    b. Nee
24. Wat is uw leeftijd? …… jaar
25. Geslacht M / V
    a.
26. Hoeveel personen heeft uw gezin? …… volwassenen
    …… kinderen
27. Hoeveel uur per week heeft u een betaalde baan?
    a. 35 uur of meer
    b. 12 tot 35 uur
    c. minder dan 12 uur
    d. Niet
    e. Geen antwoord/wil niet zeggen
28. Indien van toepassing, hoeveel uur/dagen per week heeft uw partner een betaalde baan?
    a. 35 uur of meer
    b. 12 tot 35 uur
    c. minder dan 12 uur
    d. Niet
    e. Geen antwoord/wil niet zeggen
29. Wat is uw hoogst afgerond opleiding?
    a. Basisschool
    b. Middelbare school
    c. Mbo
    d. Hbo
    e. Universitair
    f. Geen antwoord/wil niet zeggen
30. In welke categorie valt het netto jaarinkomen van uw gezin?
    a. Minder dan €23.000
    b. Tussen €23.000 en €43.000
    c. Meer dan €43.000
    d. Geen antwoord/wil niet zeggen

Bedankt voor het invullen van deze enquête.

Leidschenveen

Deze enquête is voor een onderzoek naar de mobiliteit van bewoners van nieuwbouwwijken. Ik wil u graag bij voorbaat bedanken voor het invullen van deze enquête. Kunt u bij de meerkeuze vragen het antwoord omcirkelen wat het meest van toepassing is.

1. Hoe vaak gaat u naar het centrum van Den Haag?
    a. Meerdere keren per week
    b. Minstens 1 keer per week
    c. Minstens 1 keer per maand
    d. Minder dan 1 keer per maand
    e. Nooit

2. Voor welke activiteiten gaat u naar het centrum van Den Haag? U mag meerdere antwoorden omcirkelen.
    a. Werken of School
    b. Shoppen
    c. Boodschappen
    d. Vrije tijd
    e. Vervoer

3. Kunt u beoordelen hoe belangrijk de volgende aspecten waren om in deze wijk te komen wonen? U heeft 10 punten te verdelen. Een voorbeeld van een antwoord is:

Prijs	5	punten	uw antwoord:	Prijs	…… punten
Type woning	3	punten		Type woning	…… punten
Buurt	1	punt		Buurt	…… punten
Ligging	0	punten		Ligging ten opzichte van plaats	…… punten
Transport	1	punten +		Transport	…… punten
Totaal	10	punten			

4. Kunt u de volgende transportaspecten op dezelfde manier beoordelen? Het gaat er om welk belang ze hadden bij uw keuze om in de wijk te komen wonen. U mag 10 punten verdelen.

Uw antwoord:	Ligging ten opzichte van de snelweg	…… punten
	Parkeervoorzieningen	…… punten
	Aanwezigheid fietspaden	…… punten
	Aanwezigheid openbaar vervoer	…… punten

5. Sinds wanneer woont u op dit adres? Jaartal …… **na 2006 ga naar vraag 8 anders ga door met vraag 6**

6. Wist u dat de Randstadrail aangelegd zou worden toen u hier kwam wonen?
    a. Ja **ga door naar vraag 7**
    b. Nee **ga door naar vraag 8**

7. Zo ja, heeft dit invloed gehad op de keuze om hier te komen wonen?
    a. Ja, daardoor was de wijk aantrekkelijker
    b. Ja, daardoor was de wijk minder aantrekkelijk
    c. Nee

8. Welke vervoersmiddelen worden in uw gezin minimaal 1 keer per week gebruikt?

Auto	Ja / Nee
Fiets	Ja / Nee
Openbaar vervoer	Ja / Nee

    Anders, namelijk ……

9. Kunt u de volgende vervoersmiddelen een score geven van 1 tot 10 hoe belangrijk u ze vindt? U mag 10 punten verdelen.

Uw antwoord:	Auto	…… punten
	Fiets	…… punten
	Bus	…… punten
	Tram	…… punten
	Trein	…… punten

10. Hoe vaak maakt u gebruik van het openbaar vervoer?
    a. Meerdere keren per week **ga door naar vraag 11**
    b. Minstens 1 keer per week **ga door naar vraag 11**
    c. Minstens 1 keer per maand **ga door naar vraag 17**
    d. Minder dan 1 keer per maand **ga door naar vraag 17**
    e. Nooit **ga door naar vraag 17**

11. Sinds wanneer maakt u minimaal 1 keer per week gebruik van het openbaar vervoer? Jaartal ……

12. Rijdt u wel eens in Randstadrail of Erasmuslijn?
    a. Meerdere keren per week
    b. Minstens 1 keer per week
    c. Minstens 1 keer per maand
    d. Minder dan 1 keer per maand
    e. Nooit

13. Ging u voordat Randstadrail in 2006 ging rijden wel eens met het openbaar vervoer?
    a. Meerdere keren per week
    b. Minstens 1 keer per week
    c. Minstens 1 keer per maand
    d. Minder dan 1 keer per maand
    e. Nooit

14. Maakt u sinds het gaan rijden van de Randstadrail vaker gebruik van het openbaar vervoer? Ja / Nee

15. Hoe vaak ging u in uw vorige woonplaats met het openbaar vervoer?
    a. Meerdere keren per week
    b. Minstens 1 keer per week
    c. Minstens 1 keer per maand
    d. Minder dan 1 keer per maand
    e. Nooit

16. Bent u sinds u hier bent komen wonen meer gebruik gaan maken van het openbaar vervoer?
    Ja / Neutraal / Nee **ga door naar vraag 19**

17. Heeft u sinds het gaan rijden van de Randstadrail overwogen om gebruik te gaan maken van het openbaar vervoer?
    Ja / Enigszins / Nee

18. Wat is de reden dat u niet geregeld gebruik bent gaan maken van het openbaar vervoer?
    a. Geld
    b. Tijd
    c. Voorkeur auto
    d. Anders, namelijk ……

19. In wat voor een woning woont u? Graag in beide kolommen één antwoord omcirkelen

a. Appartement	a. Huur
b. Rijtjeshuis	b. Koop
c. Twee onder één kap	
d. Vrijstaand	

20. Woonde u daarvoor ook al in deze wijk?
    a. Ja, de oude postcode was ……
    b. Nee

21. Hoeveel autos heeft uw huishouden? Aantal ……

22. Hoeveel werkende fietsen zijn er in uw huishouden? Aantal ……

23. Bezit u of iemand in uw gezin een openbaar vervoer abonnement? Zo, ja welk type?
    a. Ja: Regio Haaglanden / Trein / Algemeen
    b. Nee

24. Wat is uw leeftijd? …… jaar

25. Geslacht M / V
    b.

26. Hoeveel personen heeft uw gezin? …… volwassenen
    …… kinderen

27. Hoeveel uur per week heeft u een betaalde baan?
    a. 35 uur of meer
    b. 12 tot 35 uur
    c. minder dan 12 uur
    d. Niet
    e. Geen antwoord/wil niet zeggen

28. Indien van toepassing, hoeveel uur/dagen per week heeft uw partner een betaalde baan?
    a. 35 uur of meer
    b. 12 tot 35 uur
    c. minder dan 12 uur
    d. Niet
    e. Geen antwoord/wil niet zeggen

29. Wat is uw hoogst afgerond opleiding?
    a. Basisschool
    b. Middelbare school
    c. Mbo
    d. Hbo
    e. Universitair
    f. Geen antwoord/wil niet zeggen

30. In welke categorie valt het netto jaarinkomen van uw gezin?
    a. Minder dan €23.000
    b. Tussen €23.000 en €43.000
    c. Meer dan €43.000
    d. Geen antwoord/wil niet zeggen

Bedankt voor het invullen van deze enquête.

Appendix II: Results from the survey

This appendix contains the results of the survey that are not used in the main part of this master thesis. In this appendix the results are grouped for the different districts, and also the total is presented. For some questions the number of respondents was too small to use the information in the main part. Some other questions were used to get a complete survey. Otherwise the respondents would expect the goal of the survey and, therefore, answer the questions bearing the goal in mind.

		Wateringse Veld		Ypenburg		Leidschenveen		Total	
		%	#	%	#	%	#	%	#
Commute or school	Yes	14	7	20	10	35	17	23	34
	No	86	43	80	10	65	32	77	115
Shopping	Yes	60	30	76	38	65	32	67	100
	No	40	20	24	12	35	17	33	49
Grocery shopping	Yes	8	4	10	5	8	4	9	13
	No	92	46	90	45	92	45	91	136
Leisure	Yes	36	18	46	23	37	18	40	59
	No	64	32	54	27	63	31	60	90
Transport	Yes	6	3	20	10	12	6	13	19
	No	94	47	80	40	88	43	87	130

Table II.1: For which activities are you travelling to the city centre of The Hague? (survey)

	Wateringse Veld		Ypenburg		Leidschenveen		Total	
	%	#	%	#	%	#	%	#
Several times a week	71	12	53	8	59	13	61	33
At least once a week	18	3	40	6	18	4	24	13
At least once a month	6	1	7	1	14	3	9	5
Less than once a month	6	1	0	0	9	2	3	6
Never	0	0	0	0	0	0	0	0

Table II.2: How often do you use the tram in your district? (respondents that use public transport at least once a week, survey)

	Wateringse Veld		Ypenburg		Leidschenveen		Total	
	%	#	%	#	%	#	%	#
Yes	32	11	28	10	35	9	31	30
Slightly	18	6	19	7	8	2	16	15
No	50	17	53	19	58	15	53	51

Table II.3: Did you consider using public transport more often? (respondents that use public transport less than once a week, survey)

		Wateringse Veld		Ypenburg		Leidschenveen		Total	
		%	#	%	#	%	#	%	#
Money	Yes	3	1	14	5	7	2	8	8
	No	97	33	86	30	93	26	92	87
Time	Yes	29	10	29	10	15	4	25	24
	No	71	24	71	25	85	22	75	71
Preference car	Yes	59	20	37	22	42	15	60	57
	No	41	14	63	13	58	11	40	38

Table II.4: What is the motivation to not use public transport frequently? (respondents that use public transport less than once a week, survey)

	Wateringse Veld		Ypenburg		Leidschenveen		Total	
	%	#	%	#	%	#	%	#
Yes	6	3	10	5	4	2	7	10
No	94	47	90	45	96	48	93	140

Table II.5: Was your previous home also located in this district?

Category	Wateringse Veld	Ypenburg	Leidschenveen	Total
Cars per household	1.6	1.4	1.3	1.4
Bicycles per household	2.3	2.6	2.2	2.4
Public transport season ticket	36 %	26 %	44 %	35 %

Table II.6: Transport characteristics (survey)

	Wateringse Veld		Ypenburg		Leidschenveen		Total	
	Av.	St. Dev.	Av.	St. Dev.	Av.	St. Dev.	Av.	St. Dev.
Average age	46	13.4	45	11.8	44	13.6	45	12.9

Table II.7: Respondents age (survey)

	Wateringse Veld		Ypenburg		Leidschenveen		Total	
	%	#	%	#	%	#	%	#
No answer	6	3	4	2	8	4	6	9
> 35 hour	46	23	48	24	56	28	50	75
12 to 35 hour	26	13	30	15	16	8	24	36
< 12 hour	2	1	2	1	0	0	1	2
No	20	10	16	8	20	10	18	28

Table II.8: Respondents # of working hours per week (survey)

	Wateringse Veld		Ypenburg		Leidschenveen		Total	
	%	#	%	#	%	#	%	#
No answer	11	5	5	2	7	3	8	10
> 35 hour	50	22	51	21	46	21	49	64
12 to 35 hour	29	13	27	11	28	13	28	37
No	11	5	17	7	20	9	16	21

Table II.9: Respondents partner # of working hours per week (survey)

	Wateringse Veld		Ypenburg		Leidschenveen		Total	
	%	#	%	#	%	#	%	#
No answer	6	3	0	0	8	4	5	7
Primary school	10	6	2	1	0	0	4	6
Secondary School	20	10	10	5	16	8	15	23
MBO	34	17	22	11	36	18	31	46
HBO	18	9	50	25	32	16	33	50
University	12	6	16	8	8	4	12	18

Table II.10: Education level respondents (survey)

	Ypenburg		Leidschenveen		Total	
	%	#	%	#	%	#
Yes	100	1	70	14	71	15
No	0	0	30	6	29	6

Table II.11: Did you know that the tram line was going to be realised? (respondents that moved into the district before the realisation of the tram line, survey)

	Ypenburg		Leidschenveen		Total	
	%	#	%	#	%	#
Yes, more attractive	100	1	67	10	69	11
No	0	0	33	5	31	5

Table II.12: Was the district more attractive because of the tram line? (respondents that knew that the tram line was going to be realised, survey)

	Ypenburg		Leidschenveen		Total	
	%	#	%	#	%	#
Yes	0	0	50	10	45	10
No	100	2	50	10	55	12

Table II.13: Are you using public transport more often since the realisation of the tram line? (respondents that moved into the district before the realisation of the tram line, survey)

Appendix III: Post-it analysis

Chi-square test: expected and observed counts.

In this analysis only the surveys which were not filled in at the door are used.

Test if there is a relationship between the post-it on the letters and the participation in the survey
H_0: no association exists between the post-it and participation
H_1: an association exists between the post-it and participation
The significance level α = 0.05
Degrees of freedom df= (2-1)*(2-1) = 1
Critical value (X^2)*=3.84
(X^2) = 0.276 (Table III.)
$(X^2) < (X^2)$*
H_0 is not rejected
There exist no association between the presence of a post-it on the accompanying letter and the participation in the survey.

			Post-it		
			No	Yes	Total
Participation in survey	No	Count	23	27	50
		Expected Count	24.6	25.4	50.0
	Yes	Count	61	60	121
		Expected Count	59.4	61.6	121.0
Total		Count	84	87	171
		Expected Count	84.0	87.0	171.0

Table III.1: Crosstab post-it and participation (SPSS)

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.276[a]	1	.600		
Continuity Correction[b]	.127	1	.721		
Likelihood Ratio	.276	1	.599		
Fisher's Exact Test				.618	.361
Linear-by-Linear Association	.274	1	.601		
N of Valid Cases	171				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 24.56.
b. Computed only for a 2x2 table

Table III.2: Chi-Square test post-it and participation (SPSS)

Appendix IV: Development road network

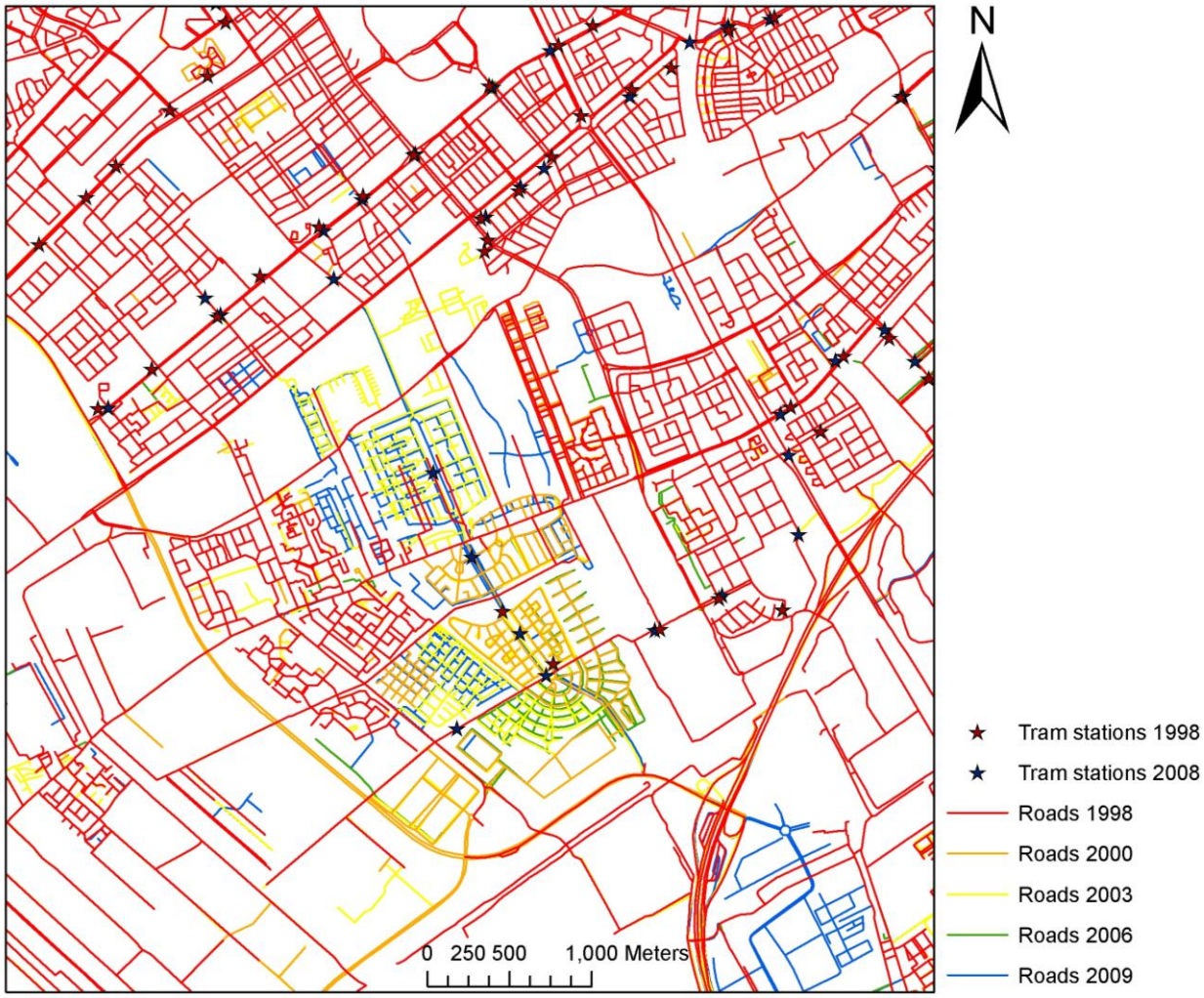

Figure IV.1: Development of the road network in Wateringse Veld

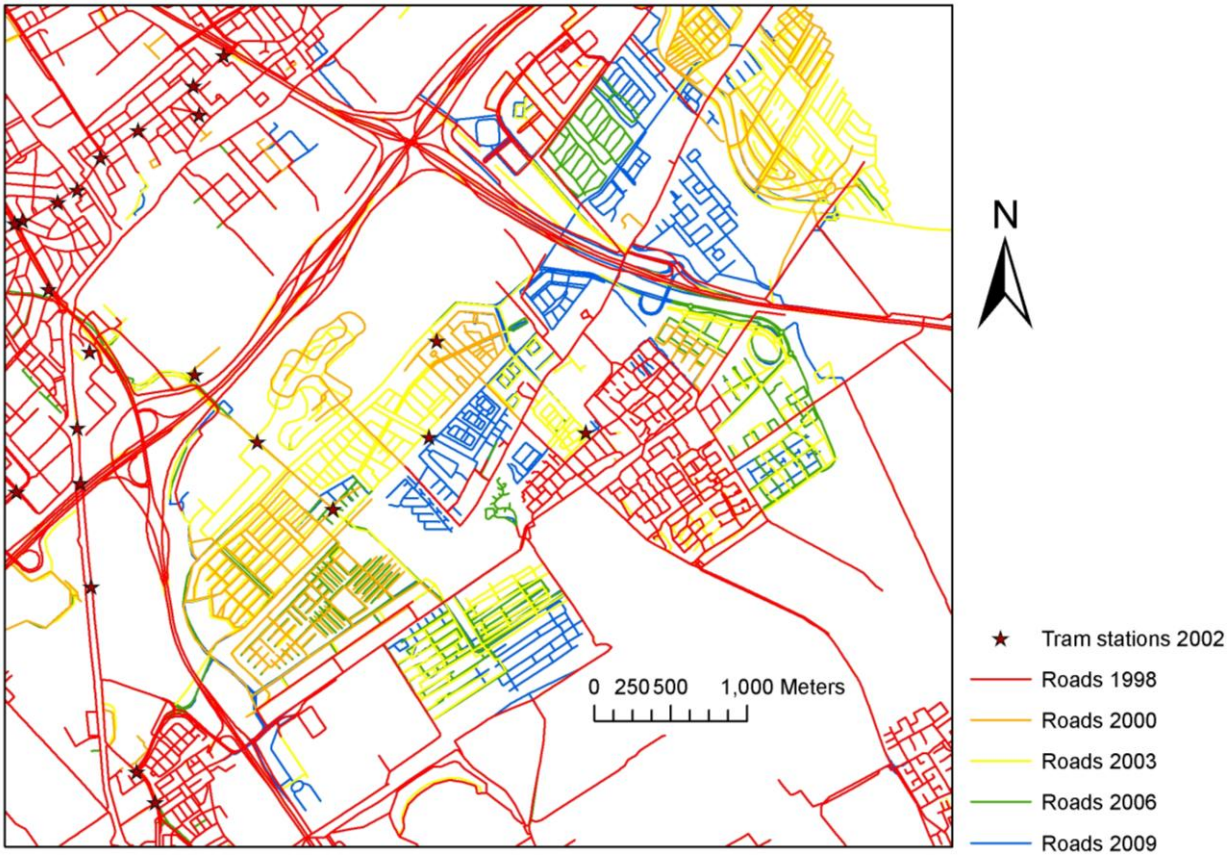

Figure IV.2: Development of the road network in Ypenburg

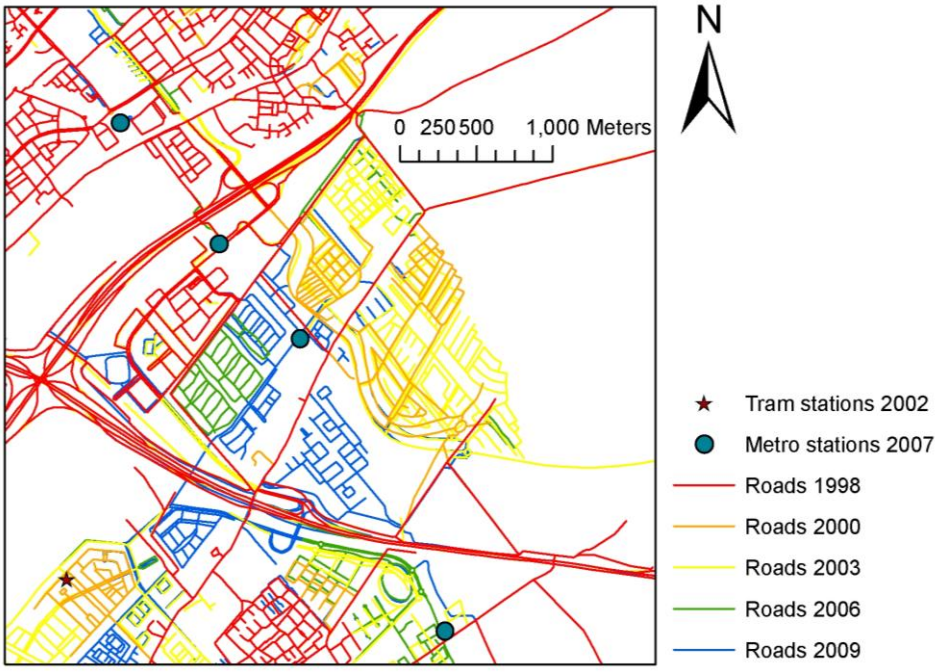

Figure IV.3: Development of the road network in Leidschenveen

Appendix V: Analyses for public transport

This appendix contains the cross tab analyses for public transport characteristics. The characteristics are driving license, main car users, students public transport card and students. The Chi-Square analyses in SPSS are used to analyse if there is an association between the use of public transport and these characteristics. If there is an association the yellow cell from the table indicates 0.05 or lower, is all other cases there is no significant relationship.

Driving licence

			Driving license			
			< 18 years	Yes	No	Total
Use of public transport	No	Count	460	929	87	1476
		Expected Count	444.4	931.7	99.9	1476.0
		% within Use of public transport	31.2%	62.9%	5.9%	100.0%
	Yes	Count	16	69	20	105
		Expected Count	31.6	66.3	7.1	105.0
		% within Use of public transport	15.2%	65.7%	19.0%	100.0%
Total		Count	476	998	107	1581
		Expected Count	476.0	998.0	107.0	1581.0
		% within Use of public transport	30.1%	63.1%	6.8%	100.0%

Table V.1: Crosstab for driving licence (MON The Hague 2006)

			Driving license		
			Yes	No	Total
Use of public transport	No	Count	929	87	1016
		Expected Count	917.6	98.4	1016.0
	Yes	Count	69	20	89
		Expected Count	80.4	8.6	89.0
Total		Count	998	107	1105
		Expected Count	998.0	107.0	1105.0

Table V.2: Crosstab for driving licence (MON The Hague 2006)

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	18.102[a]	1	**.000**		
Continuity Correction[b]	16.546	1	.000		
Likelihood Ratio	14.116	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	18.085	1	.000		
N of Valid Cases	1105				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.62.
b. Computed only for a 2x2 table

Table V.3: Pearson's Chi-Square test for driving licence (MON The Hague 2006)

Student public transport car

			Student PT Card		
			Yes	No	Total
Use of public transport	No	Count	18	1458	1476
		Expected Count	31.7	1444.3	1476.0
		% within Use of public transport	1.2%	98.8%	100.0%
	Yes	Count	16	90	106
		Expected Count	2.3	103.7	106.0
		% within Use of public transport	15.1%	84.9%	100.0%
Total		Count	34	1548	1582
		Expected Count	34.0	1548.0	1582.0
		% within Use of public transport	2.1%	97.9%	100.0%

Table V.4: Crosstab for student public transport card (MON The Hague 2006)

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	90.532[a]	1	**.000**		
Continuity Correction[b]	84.055	1	.000		
Likelihood Ratio	44.008	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	90.475	1	.000		
N of Valid Cases	1582				

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 2.28.
b. Computed only for a 2x2 table

Table V.5: Pearson's Chi-Square test for student public transport card (MON The Hague 2006)

Main car user

			Main car user			
			< 18 year	Yes	No	Total
Use of public transport	No	Count	460	744	272	1476
		Expected Count	444.1	729.6	302.3	1476.0
		% within Use of public transport	31.2%	50.4%	18.4%	100.0%
	Yes	Count	16	38	52	106
		Expected Count	31.9	52.4	21.7	106.0
		% within Use of public transport	15.1%	35.8%	49.1%	100.0%
Total		Count	476	782	324	1582
		Expected Count	476.0	782.0	324.0	1582.0
		% within Use of public transport	30.1%	49.4%	20.5%	100.0%

Table V.6: Crosstab for main car user (MON The Hague 2006)

			Main car user		
			Yes	No	Total
Use of public transport	No	Count	744	272	1016
		Expected Count	718.4	297.6	1016.0
	Yes	Count	38	52	90
		Expected Count	63.6	26.4	90.0
Total		Count	782	324	1106
		Expected Count	782.0	324.0	1106.0

Table V.7: Crosstab for main car user (MON The Hague 2006)

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	38.374[a]	1	**.000**		
Continuity Correction[b]	36.891	1	.000		
Likelihood Ratio	34.631	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	38.339	1	.000		
N of Valid Cases	1106				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 26.37.
b. Computed only for a 2x2 table

Table V.8: Pearson's Chi-Square test for main car user (MON The Hague 2006)

Students

			Student		
			Yes	No	Total
Use of public transport	No	Count	289	1187	1476
		Expected Count	295.8	1180.2	1476.0
		% within Use of public transport	19.6%	80.4%	100.0%
	Yes	Count	28	78	106
		Expected Count	21.2	84.8	106.0
		% within Use of public transport	26.4%	73.6%	100.0%
Total		Count	317	1265	1582
		Expected Count	317.0	1265.0	1582.0
		% within Use of public transport	20.0%	80.0%	100.0%

Table V.9: Crosstab for students (MON The Hague 2006)

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.884[a]	1	**.089**		
Continuity Correction[b]	2.473	1	.116		
Likelihood Ratio	2.702	1	.100		
Fisher's Exact Test				.102	.061
Linear-by-Linear Association	2.882	1	.090		
N of Valid Cases	1582				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 21.24.
b. Computed only for a 2x2 table

Table V.10: Pearson's Chi-Square test students (MON The Hague 2006)

Appendix VI: Accessibility

Service Area

Residents

		2000	2003	2006	2009
Car off peak	15 min	783000	805000	818000	820000
	30 min	2425000	2468000	2479000	2480000
Car peak	15 min				379000
	30 min				1552000
Bicycle	15 min	104000	104000	108000	109000
	30 min	478000	478000	481000	481000
Public Transport	15 min	10000	12000	12000	26000
	30 min	36000	37000	37000	78000

Table VI.1: Number of residents within the service area for Wateringse Veld (Navteq & resident density)

		2000	2003	2006	2009
Car off peak	15 min	841000	867000	888000	895000
	30 min	2750000	2804000	2820000	2823000
Car peak	15 min				259000
	30 min				1776000
Bicycle	15 min	40000	55000	63000	68000
	30 min	354000	381000	390000	397000
Public Transport	15 min		7000	10000	10000
	30 min		57000	60000	60000

Table VI.2: Number of residents within the service area for Ypenburg (Navteq & resident density)

		2000	2003	2006	2009
Car off peak	15 min	893000	911000	934000	941000
	30 min	2753000	2806000	2869000	2832000
Car peak	15 min				371000
	30 min				1742000
Bicycle	15 min	37000	48000	58000	62000
	30 min	242000	259000	274000	279000
Public Transport	15 min				21000
	30 min				98000

Table VI.3: Number of residents within the service area for Leidschenveen (Navteq & resident density)

Jobs

		1997	2000	2003	2006	2009
Car off peak	15 min	348600	407900	430200	418200	451800
	30 min	989800	1115000	1164300	1151400	1214600
Car peak	15 min					194400
	30 min					693000
Bicycle	15 min	43700	49600	53600	56600	6150
	30 min	316500	359200	365500	361300	385800
Public Transport	15 min	3200	2800	4300	5300	9700
	30 min	24400	26600	30700	28800	42400

Table VI.4: Number of jobs within the service area for Wateringse Veld (Navteq & LISA)

		1997	2000	2003	2006	2009
Car off peak	15 min	426700	482200	494100	476000	512000
	30 min	1117600	1268700	1329300	1313400	1382800
Car peak	15 min					238000
	30 min					822200
Bicycle	15 min	23500	34700	37400	46800	54000
	30 min	256400	200700	210700	205500	1823000
Public Transport	15 min			4200	6800	7600
	30 min			48432	53400	56300

Table VI.5: Number of jobs within the service area for Ypenburg (Navteq & LISA)

		1997	2000	2003	2006	2009
Car off peak	15 min	400900	463400	467300	465200	510600
	30 min	1150200	1319700	1371800	1356300	1429100
Car peak	15 min					280300
	30 min					858800
Bicycle	15 min	16300	21000	23700	28100	31794
	30 min	126600	148000	153100	168800	182023
Public Transport	15 min					19300
	30 min					89100

Table VI.6: Number of jobs within the service area for Leidschenveen (Navteq & LISA)

Shops

		1997	2000	2003	2006	2009
Car off peak	15 min	6100	6500	6350	6700	7250
	30 min	17800	17400	16650	16750	17350
Bicycle	15 min	900	1050	1000	1100	1140
	30 min	6750	7000	6550	6950	6860
Public Transport	15 min	50	100	100	100	200
	30 min	250	300	300	350	650

Table VI.7: Number of shops within the service area for Wateringse Veld (Navteq & LISA)

		1997	2000	2003	2006	2009
Car off peak	15 min	6500	6550	6500	6850	7400
	30 min	20000	19500	18750	18900	19500
Bicycle	15 min	350	350	400	550	590
	30 min	3350	2850	2700	2800	2480
Public Transport	15 min			50	100	100
	30 min			650	750	750

Table VI.8: Number of shops within the service area for Ypenburg (Navteq & LISA)

		1997	2000	2003	2006	2009
Car off peak	15 min	7100	7200	7300	7250	7700
	30 min	20150	19950	18600	19100	19800
Bicycle	15 min	250	300	350	450	510
	30 min	1500	1650	1650	2100	2190
Public Transport	15 min					250
	30 min					1550

Table VI.9: Number of shops within the service area for Leidschenveen (Navteq & LISA)

Schools

Total number of schools (number of secondary schools)

		1997	2000	2003	2006	2009
Car off peak	15 min	410 (120)	440 (130)	440 (120)	460 (130)	440 (130)
	30 min	1390 (330)	1440 (340)	1400 (310)	1440 (330)	1420 (330)
Bicycle	15 min	100 (35)	100 (35)	95 (30)	100 (35)	130 (30)
	30 min	450 (140)	480 (135)	465 (115)	480 (120)	595 (110)
Public Transport	15 min	2 (1)	3 (1)	3 (1)	4 (1)	10 (4)
	30 min	13 (4)	15 (3)	15 (3)	17 (3)	39 (11)

Table VI.10: Number of schools within the service area for Wateringse Veld (Navteq & LISA)

		1997	2000	2003	2006	2009
Car off peak	15 min	450 (130)	480 (130)	470 (120)	500 (130)	490 (130)
	30 min	1590 (360)	1640 (360)	1600 (340)	1690 (400)	1610 (350)
Bicycle	15 min	22 (5)	35 (5)	35 (5)	50 (10)	70 (10)
	30 min	305 (95)	240 (65)	230 (60)	240 (60)	250 (45)
Public Transport	15 min			5 (0)	6 (1)	6 (1)
	30 min			38 (11)	35 (7)	33 (6)

Table VI.12: Number of schools within the service area for Ypenburg (Navteq & LISA)

		1997	2000	2003	2006	2009
Car off peak	15 min	350 (130)	480 (130)	480 (120)	480 (120)	430 (140)
	30 min	1870 (650)	1950 (670)	1910 (650)	1940 (670)	1910 (960)
Bicycle	15 min	25 (5)	30 (5)	35 (10)	45 (15)	70 (15)
	30 min	150 (45)	170 (45)	165 (40)	200 (55)	255 (50)
Public Transport	15 min					17 (8)
	30 min					43 (16)

Table VI.13: Number of schools within the service area for Leidschenveen (Navteq & LISA)

Destinations

		Car		Bicycle		PT (min)	
	%	Off peak	Peak	Distance (km)	Time (min)	Access	Vehicle
Centrum	7.7	10	23	6.3	31.7	7	32
Rijswijk	11.5	9	13	3.7	18.5	14	6
Delft	3.8	12	15	7.4	36.9	17	22
Voorburg	2	13	20	9.0	44.8	13	14
Leidschendam	1.6	15	20	11.6	58.0	8	52
Rotterdam	3.3	19	30	21.5	107.4	7	43
SD Laak	4.4	14	20	7.0	35.2	16	32
SD loosduinen	2.1	7	23	7.1	35.3	10	60
SD excamp	2.2	11	15	3.4	17.1	15	39
Wateringen	7.7	7	5	1.9	9.7	Not an option	

Table VI.14: Travel time to main destination for Wateringse Veld

	%	Car		Bicycle		PT (min)	
		Off peak	Peak	Distance (km)	Time (min)	Access	Vehicle
Centrum	4.3	11	20	7.2	36.0	10	23
Delft	6.2	10	15	4.0	19.9	9	23
Nootdorp	33.1	7	10	3.1	15.6	17	5
Pijnacker	2.4	8	20	7.2	36.1	12	44
SD Laak	3.0	11	15	5.3	26.3	17	11
Leidschendam	1.1	12	20	8.2	40.8	8	41
Rijswijk	3.4	9	15	5.0	25.0	Not an option	
Zoetermeer	2	17	20	10.5	52.5	15	>60
Rotterdam	1.7	15	30	18.6	92.8	Not an option	
Voorburg	1.7	9	15	5.9	29.7	12	25

Table VI.15: Travel time to main destination for Ypenburg

	%	Car		Bicycle		PT (min)	
		Off peak	Peak	Distance (km)	Time (min)	Access	Vehicle
Leidschendam	9.3	8	10	8.6	43	18	14
Zoetemeer	6.4	16	15	8.4	42	19	15
Rijswijk	3.2	9	15	9.2	46	14	25
Centrum	4.9	14	22.5	9.2	46	11	18
SD Haagse Hout	3.4	10	20	7.4	37	10	11
Voorburg	4.5	7	12.5	3.9	20	19	20
Ypenburg	2.6	14	15	4.7	23		>60
Wateringse Veld & Wateringen	2.5	16	20	11.9	59	22	45
SD Laak	2.0	10	20	5.7	29	19	26
Rotterdam	1.5	16	30	21.0	105	25	28

Table VI.16: Travel time to main destination for Leidschenveen

Appendix VII: Self-selection

Survey

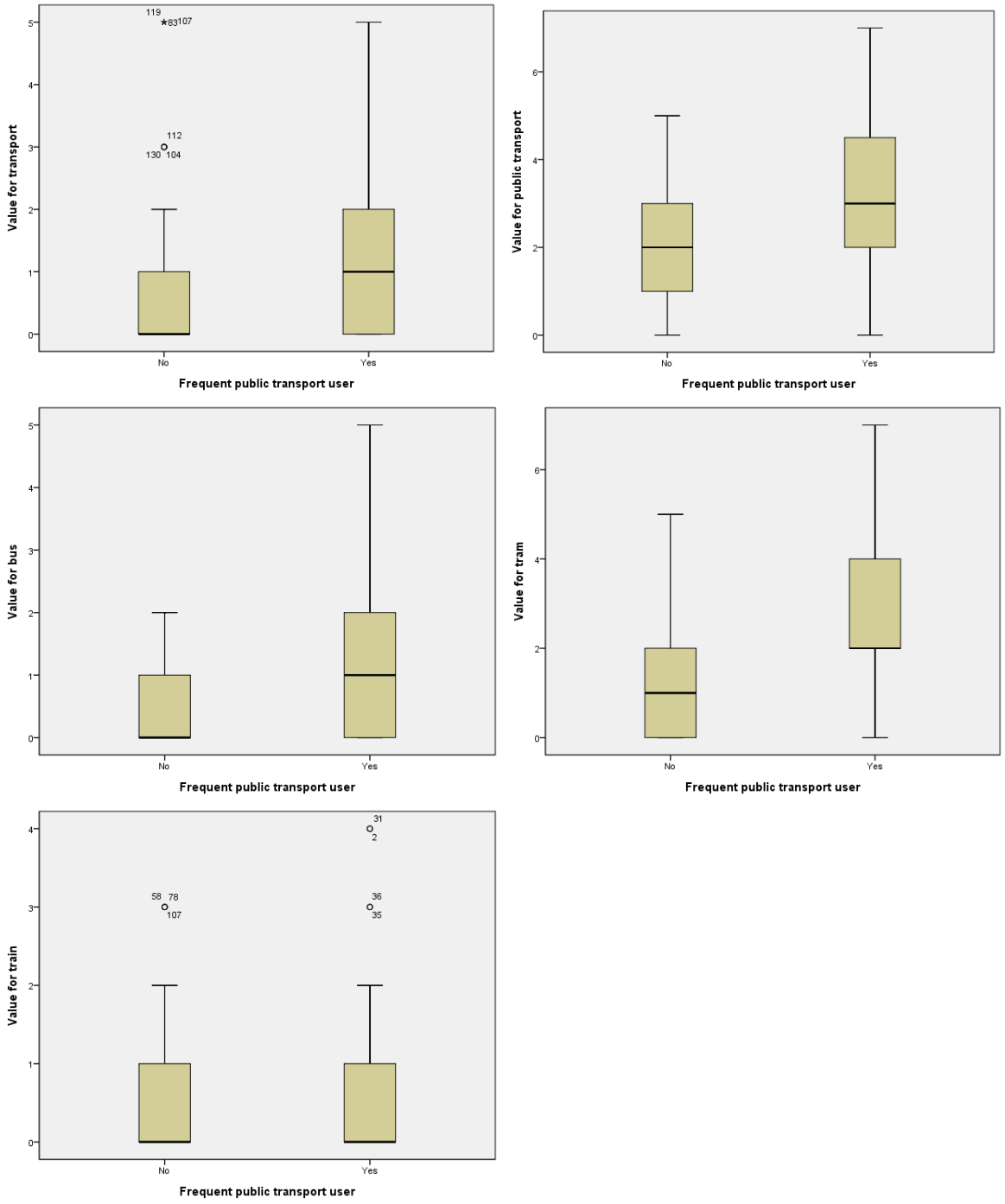

Figure VII.1: Box plots for public transport related aspects (survey)

	Frequent PT user	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Value for Transport	0	.299	97	**.000**	.723	97	.000
	1	.257	50	**.000**	.800	50	.000
Value for Public Transport	0	.156	45	.008	.930	45	**.010**
	1	.148	28	.118	.947	28	.169
Value for Bus	0	.375	97	**.000**	.697	97	.000
	1	.207	50	**.000**	.842	50	.000
Value for Tram	0	.197	97	**.000**	.854	97	.000
	1	.215	50	**.000**	.918	50	.002
Value for Train	0	.394	97	**.000**	.662	97	.000
	1	.359	50	**.000**	.688	50	.000

a. Lilliefors Significance Correction

Table VII.1: Tests for normality for public transport related aspects (survey)

	Value for Transport	Value for Public Transport	Value for Bus	Value for Tram	Value for Train
Mann-Whitney U	2145.000	368.000	1690.000	1092.500	2387.000
Wilcoxon W	6898.000	1403.000	6541.000	5943.500	7238.000
Z	-1.240	-3.036	-3.722	-5.910	-.745
Asymp. Sig. (2-tailed)	.215	**.002**	**.000**	**.000**	.456

a. Grouping Variable: Frequent public transport user

Table VII.2: Non parametric tests for public transport related aspects (survey)

Appendix VIII: Regression analyses

MON The Hague 2006

					95% C.I. for e^{β}		
		B	**S.E.**	**Sig.**	**Lower**	**e^{β}**	**Upper**
Constant		.918	.347	**.008**		2.505	
# persons in hh		.032	.067	.637	.906	1.032	1.176
Age	<18	1.336	.329	**.000**	1.994	3.802	7.250
	18-35			**.000**			
	35-50	-.743	.154	**.000**	.352	.476	.644
	50-65	.215	.178	.227	.875	1.239	1.756
	>64	-1.177	.413	**.004**	.137	.308	.692
Sex	Female	.223	.102	**.029**	1.023	1.250	1.527
District	Wateringse Veld			**.000**			
	Ypenburg	-1.029	.141	**.000**	.271	.357	.471
	Leidschenveen	-1.192	.142	**.000**	.230	.303	.401
# cars in hh		-.936	.097	**.000**	.324	.392	.475
# bicycles in hh		-.508	.051	**.000**	.544	.602	.666
Possession student PT card		2.698	.406	**.000**	6.697	14.848	32.923
Adult	No driving licence	1.693	.231	**.000**	3.457	5.437	8.551
	Not main car user	.933	.152	**.000**	1.886	2.542	3.428
Social	Unemployed			**.000**			
	Part time	2.288	.292	**.000**	5.563	9.854	17.456
	Full time	3.068	.281	**.000**	12.394	21.507	37.322
	Student	1.139	.203	**.000**	2.100	3.124	4.648
Education (adult)	Low	-.720	.151	**.000**	.362	.487	.654
	High	-.486	.141	**.001**	.466	.615	.811

Note R^2 = .28 (Hosmer & Lemeshow). .32 (Cox & Snell). .43 (Nagelkerke).
Model χ^2 = 1038.721. p<.001

Table VIII.1: Logit model for light rail use (MON The Hague 2006)

Model	**Tolerance**	**VIF**
Age	.707	1.414
# persons in hh	.472	2.119
District	.857	1.167
Sex	.942	1.062
# cars in hh	.765	1.307
# bicycles in hh	.565	1.768
Possession student PT card	.599	1.670
No driving licence (adult)	.645	1.551
Not main car user (adult)	.526	1.902
Social	.771	1.297
Education (adult)	.742	1.348

Table VIII.2: Co-linearity analyses for logit model for light rail use (MON The Hague 2006)

The Pearson's correlation test shows that several variables are related. There are two strong relationships, higher than 0.5 or lower than -0.5. These are the number of persons in the household related to the number of bicycles, with a Pearson's correlation coefficient of 0.633 (sig .000). This is a logical relation, as with an increase of the number of persons in the household in most Dutch households the number of bicycles increases. Next to these variables, not having a driving licence is related to not being the main car user, with a Pearson's correlation coefficient of 0.554 (sig .000).

Survey

					95% C.I. for e^{β}		
		B	**S.E.**	**Sig.**	**Lower**	**e^{β}**	**Upper**
Constant		2.736	2.303	.235		15.424	
# persons in hh		.298	.350	.395	.678	1.347	2.677
Age		-.031	.032	.338	.910	.970	1,033
Sex	Female	.156	.681	.819	.308	1.169	4,436
District	Wateringse Veld			.191			
	Ypenburg	-1.460	.802	.069	.048	.232	1,119
	Leidschenveen	-.572	.736	.437	.133	.564	2,385
Owner occupied home		-1.247	.825	.131	.057	.287	1.449
Type of house	Apartment			.072			
	Terrace	.480	.837	.566	.314	1.616	8,332
	Semi detached	3.141	1.782	.078	.704	23.127	759,895
	Detached	4.394	1.957	**.025**	1.750	80.977	3747,67
# cars in hh		-2.644	.669	**.000**	.019	.071	.264
# bicycles in hh		.045	.205	.828	.699	1.046	1.563
Possession PT card		2.405	.619	**.000**	3.295	11.075	37.229
Job	Full time			.308			
	Part time	.725	.726	.318	.498	2.065	8,571
	Unemployed	-.895	1.161	.441	.042	.409	3,974
Education	Low			.756			
	Mid	.646	.910	.478	.321	1.908	11,351
	High	.620	.912	.496	.311	1.859	11,110
Seldom to centre The Hague		-.701	.649	.279	.139	.496	1.768

Note R^2 = .44 (Hosmer & Lemeshow). .43 (Cox & Snell). .59 (Nagelkerke).
Model χ^2 = 72.039. p<.001

Table VIII.3: Logit model for being a frequent public transport user (survey)

					95% C.I. for e^{β}		
		B	**S.E.**	**Sig.**	**Lower**	**e^{β}**	**Upper**
Constant		7.786	9.68	0.421		2406.8	
# persons in hh		0.141	0.658	0.83	0.318	1.152	4.18
Age		-0.265	0.102	**0.009**	0.628	0.767	0.936
Sex	Female	-1.089	1.647	0.509	0.013	0.337	8.496
District	Wateringse Veld			0.325			
	Ypenburg	-2.055	1.396	0.141	0.008	0.128	1.975
	Leidschenveen	-0.768	1.506	0.610	0.024	0.464	8.883
Owner occupied home		2.083	1.574	0.186	0.367	8.029	175.50
Type of house	Apartment			0.211			
	Terrace	1.146	1.456	0.431	0.181	3.145	54.616
	Semi detached	6.008	3.18	0.059	0.799	406.617	206917
	Detached	16.297	14.126	0.249	0	$1.2*10^{7}$	$1.3*10^{19}$
# cars in hh		-5.613	2.132	**0.008**	0	0.004	0.238
# bicycles in hh		0.809	0.511	0.113	0.825	2.246	6.115
Possession PT card		2.813	1.329	**0.034**	1.23	16.653	225.49
Job	Full time			0.313			
	Part time	0.615	1.591	0.699	0.082	1.85	41.86
	Unemployed	3.479	2.297	0.130	0.359	32.418	2924.34
Education	Low			0.229			
	Mid	-3.616	2.148	0.092	0	0.027	1.812
	High	-3.051	2.022	0.131	0.001	0.047	2.488
Seldom to centre	The Hague	-2.082	1.384	0.132	0.008	0.125	1.877
Value (Importance)	Car	0.014	0.927	0.988	0.165	1.014	6.24
	Bicycle	-0.01	0.995	0.992	0.141	0.99	6.962
	Bus	2.858	1.182	**0.016**	1.719	17.419	176.53
	Tram	2.165	1.052	**0.040**	1.108	8.712	68.51
	Train	0.187	0.965	0.846	0.182	1.205	7.986
Value (moving into the area)	Near highway	-0.178	0.418	0.669	0.369	0.837	1.897
	Parking facilities	-0.731	0.578	0.205	0.155	0.481	1.493
	Bicycle lanes	-0.192	0.554	0.730	0.279	0.826	2.447
	Public transport facilities	1.488	0.689	**0.031**	1.147	4.427	17.09

Note R^2 = .72 (Hosmer & Lemeshow). .60 (Cox & Snell). .83 (Nagelkerke).
Model χ^2 = 117.515. p<.001

Table VIII.4: Logit model for being a frequent public transport user including preferences (survey)

Model	Tolerance	VIF
# persons in hh	.460	2.175
Age	.512	1.952
Sex	.765	1.307
District	.778	1.285
Owner occupied home	.618	1.619
Type of house	.555	1.801
# cars in hh	.627	1.596
# bicycles in hh	.571	1.750
Possession PT card	.646	1.548
Job	.501	1.994
Education	.636	1.573
Seldom to centre The Hague	.675	1.482
Car	**.052**	**19.340**
Bicycle	.118	8.486
Bus	.197	5.084
Tram	.122	8.195
Train	.283	3.540
Near highway	.593	1.686
Parking facilities	.733	1.365
Bicycle lanes	.583	1.715
Public transport facilities	.480	2.084

Table VIII.5: Co-linearity analyses for being a frequent public transport user (survey)

The Pearson's correlation test shows that several variables are related. There are three strong relationship, higher than 0.5 or lower than -0.5. These are the number of persons in the household related to the type of house, with a Pearson's correlation coefficient of 0.536 (sig .000). Next to these variables, job is related to age, with a Pearson's correlation coefficient of 0.513 (sig .000). Last is the score of tram related to the score for car, with a Pearson's correlation coefficient of 0.518 (sig .000)