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Self-driving bus to improve accessibility of rural areas in the Netherlands

Peoplemover as a first- and last mile solution

Pieter Bos

Key Terms

Accessibility

Public Transport

Rural Areas

Automated Vehicles

Peoplemover

Colophon

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Preface

This thesis is the completion of my master's degree program in Environment & Society Studies, with a specialization in local environmental change and sustainable cities. During the year, all stages of research are passed, starting with the development of a research plan and ending with the description of the final results. The major part of the research is conducted at my internship at CROW in Ede. The research explains the role self-driving busses, so called peoplemovers, could play in strengthening public transport in rural areas and hereby increasing the accessibility of those regions. Before the content of the research will be described in the following summary, I would like to thank a few people.

First of all, my supervisor Hillie Talens from CROW who has been really important to my research. She was always of great help, came with good specific advice, connected me to her large network in the field and brought me to a number of interesting congresses related to my research topic.

Secondly, Duncan Liefferink deserves an honorable mention as my supervisor from the Radboud University. Although he is not familiar with the topic of transport planning and quantitative research, he still was able to make a large contribution by providing clear feedback to my writings.

Thirdly, the company of Panteia was of great help to my research. Jasper Tanis and Bert Schepers sent my survey to 4000 members of the public transport panel of Panteia, which resulted in a large response. Without the panel I would have never been able to achieve the large number of over 400 completed questionnaires. Furthermore, they helped me with executing the statistical analysis of the survey.
Additionally, OVKK and Netwerk Duurzame Dorpen also contributed to the data collection by posting my survey on their social media and newsletters. This is really appreciated .

Erik Kroes was really important for the methodological part of this research. He made me familiar with the interesting but complex field of stated preference research, which has been used as the research method of this thesis.

In the development of the peoplemover concept, Frans Hamstra was of great help. During the couple of talks we had, he introduced me to the peoplemover concept. The basic ideas of the peoplemover as described in this thesis belong to him.

Finally, I want to thank my family and friends that supported me during this research project. I could always rely on them for the necessary support, distraction and a beer or two.

I hope I did not forget to mention anyone. Enjoy reading my thesis!

Pieter Bos.

Summary

Rural areas in the Netherlands are coping with urban decline, an aging population and departing amenities. This has led to a decreased use of public transport in these areas (KiM, 2010). The lower demand for public transport in these regions has made bus lines in remote areas less and less profitable. Bus companies are therefore forced to quite driving on these regional bus lines. The disappearance of the regional bus lines results in a new grid of stretched, direct bus lines, connecting only the larger villages and towns. This new grid of stretched bus lines has led to an increased first- and last mile problem. The first- and last mile is the distance people have to overcome towards the nearest public transport hub. The average first- and last mile has increased in rural areas during the last years and is expected to further increase in the near future.
New initiatives are necessary to bridge this increased first- and last mile, and the emerging field of automated buses could provide a promising solution. These buses do not require a driver, which means saving the majority of the costs for driving a bus. In this thesis, the concept of the 'peoplemover' is proposed. The peoplemover is a self-driving bus that connects the remote locations with the stretched, main bus network. This bus is able to drive with a speed of 20-40 km/h, on a separate or private lane and has a capacity of maximum twelve people. The potential of a peoplemover-like concept is commonly recognized and pilots are already conducted in for example Appelscha and Ede-Wageningen. It is however, never submitted to the public transport users, which attributes of this self-driving bus solution they see as most important and how large the demand can be expected to be in the future. Therefore, this research has answered the following main research question:

'To which attributes should the peoplemover comply according to public transport users in the Netherlands, and how large is the demand for this first- and last mile solution?'

Through a stated preference experiment, the following attributes are submitted to more than 400 public transport users: Frequency, travel time, level of comfort and availability of Wi-Fi and the possible attendance of a steward. In this stated-preference experiment, the respondents gave ratings to 16 peoplemovers, each having different attributes. Based on these ratings the importance of each attributes could be derived.

The outcomes of the experiment showed that public transport users attach highest value to travel time and frequency, ant bothered less about the availability of Wi-Fi and the level of comfort. The travel fare and possible attendance of a steward showed average importance values. Hereby a direct route without intermediate stops and a frequency of every 30 minutes was especially appreciated. Some interesting differences showed up when distinctions where made on personal characteristics. For example, lower educated and elderly respondents attached more value to the attendance of a steward and the importance of frequency increases as the distance to the nearest transport stop increases. In addition, people with previous experience with automated vehicle prefer vehicles departing on demand, whereas the other respondents preferred a frequency of every 30 minutes.

When it comes to the future demand for a peoplemover solution, the results where rather positive. 13% of the respondents was definitely willing to use the people mover, and 40% was not opposed of using the proposed first- and last mile solution. Again, differences turn out when looking at the personal characteristics.

The demand for a peoplemover increases if distance to the nearest bus stop increases and people currently using the car or bicycle for their first- and last mile show relatively high interest in using the concept. Additionally, the demand for a peoplemover is higher among respondents that already have previous experience with automated vehicles.

Some limitations to the research results have to be mentioned. Firstly, the sample was not representative for the entire population of public transport users in the Netherlands. Elderly and higher educated people where overrepresented. Because the differences for these personal characteristics are also elaborated in the discussion of the results, the impact of the misrepresentation can be interpreted. Furthermore, the results showed relatively high variance and poor validity. This can probably be explained by the fact that a number of 16 different peoplemovers presented in the survey was too high to clearly distinguish for the respondents. Respondents might have lost concentration at the end of the survey.

The research results can be used for further development of self-driving buses as a first- and last mile solution for rural areas in the Netherlands. For developers in practice, it is especially important to look at the target group of a specific peoplemover. The reason for this is that the results showed significant differences among the subgroups. A peoplemover connecting a touristic location would require different attributes than a peoplemover developed for commuters. Guidelines for suitable attributes for different subgroups can be found in this thesis.

Table of Content

Note with regard to the figures used in this thesis:

A number of figures presented in this master thesis are shown in Dutch. The explanation of the Dutch terminology used in these figures is visible in appendix 8.1. Here, several Dutch notions that occur regularly in this thesis are also translated. For figures where the Dutch terminology is already translated in the caption of the figure, this translation is not included in appendix 8.1.

1. Introduction

1.1 Problem statement

Public transport in rural areas in the Netherlands is under pressure. Population decline and the aging population have, among other things, led to a decreased demand for public transport in these areas (Kennisinstituut voor Mobiliteitsbeleid, 2010). In most places, the supply of public transport is kept relatively high so far, but this situation seems no longer maintainable as transport companies are making significant losses on these rural bus lines. For this reason, the province of Gelderland has even decided to stop with local bus services (Visscher, 2014). At this moment, at least 19 villages in Gelderland are no longer connected to the public transport network (Omroep Gelderland, 2014). According to Omroep Gelderland, these villages count for 13.200 inhabitants.

Figure 1.1: The prospective transport grid of Friesland with stretched bus and train lines.
Source: MuConsult (2010) as cited in Welzen, 2014, p.2

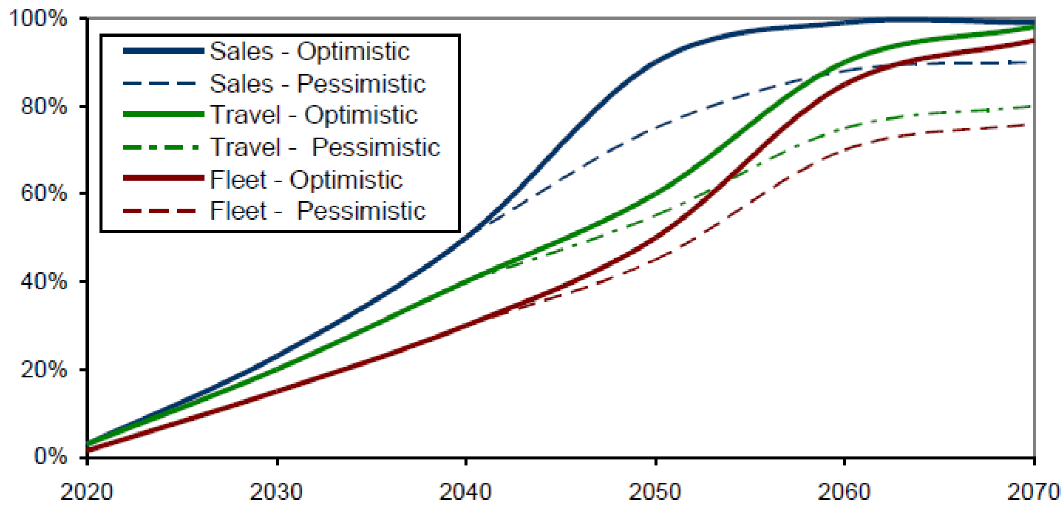
As a response to the decreasing demand for public transport in rural areas, governments and transport companies are 'stretching' their bus lines in order to improve profitability. The costs of paying a bus driver no longer weigh against the ever decreasing returns.

This means bus lines are more and more solely connecting the larger towns and villages by using the larger roads. Finally, this will result in a new grid wherein so called "blind spots" occur that are not provided with public transport. This future situation is shown for the province of Friesland in figure 1.1.

The new stretched pattern of public transport service lines will lead to an increased first- and last mile problem, which is already visible in the rural areas of today. The first mile can be defined as the distance people have to cover from or towards their home towards or from the nearest transport hub (Wang & Odoni, 2012). This first mile distance has increased over the last years. In areas with the lowest urbanity rates, the distance towards a transport hub with at least one bus every hour is 810 meter average, for urban areas this is only 162 meter (Harms, 2008, p.173). In the most rural areas 20,5% of the inhabitants has no access to public transport, in contrast to 0,5% in the most urban areas (CROW, 2015). This proves that transport modes for this first-and last mile are necessary for the viability of public transport in rural areas. Tom Welzen (2014) presented in his master thesis an useful overview of current initiatives within Europe for overcoming the first- and last mile in rural areas.

Dutch examples are e.g. the ‘Buurtbus’, ‘Regiotaxi’, ‘Omnibus’ and ‘Digitale Duim’ (Welzen, 2014, p.38). Furthermore, people are of course using bicycles and walking to overcome the first- and last mile.

Yet, a new development could bring innovative solutions for the increasing first- and last mile problem of rural areas in the Netherlands.
These new initiatives could come from the emerging field of automated, self-driving vehicles, including buses. Researchers consider self-driving vehicles as a realistic part of the transport future, and expect automated vehicles to be on public roads already by the year 2025, see figure 1.2 (Litman, 2015)



If autonomous vehicle implementation follows the patterns of other vehicle technologies it will take one to three decades to dominate vehicle sales, plus one or two more decades to dominate vehicle travel, and even at market saturation it is possible that a significant portion of vehicles and vehicle travel will continue to be self-driven, indicated by the dashed lines.

Figure 1.2: Automated vehicle sales, fleet and travel projections. When automated vehicles are actually dominating the vehicle fleet depends on which scenario becomes reality.
Source: Litman, 2015, p.13

The potential advantage of a self-driving buses in comparison to conventional buses, is that they do not require a driver, which saves the majority of the costs for operationalizing a bus line. By saving the costs of a driver, self-driving buses have the potential to cover the first mile and connecting the smaller villages with the main public transport network, on a frequent basis while still gaining profits.

In a declaration of intent (2016), the provinces of Friesland, Groningen, Drenthe and the municipality of Oostellingwerf recognized the potential of self-driving buses as a new public transport concept for covering the first-and last mile. Pilots are already executed in for example Appelscha and Ede-Wageningen.
As automated buses seem to be a promising solution, it is interesting to find out whether there is an actual demand for these automated buses as a first- and last mile solution, and to what characteristics these buses should comply according to the potential users. This is something that has not been done in previous research. In order to answer those questions, it is important to develop a concrete picture of how the concept of self-driving buses would look like in the future. For this reason, this thesis proposes the idea of the ‘peoplemover’.

The 'peoplemover' is a self-driving bus that drives on a separate or private lane, with a speed of 20-40 km/h. The concept of this peoplemover will be elaborated in detail in chapter 3.

Following on the problem statement described above, the research aim and questions of this research are as follows:

1.2 Research aim and questions

The aim of this research is to contribute to knowledge development about the potential role automated buses could play as a first-and last mile solution for public transport in rural areas in the Netherlands. Hereby will be looked at both the characteristics of the vehicle as the demand for this new public transport concept. In compliance with the research aim, the central research question of this master thesis is as follows:

To what characteristics should the self-driving bus as a first- and last mile solution for rural areas in the Netherlands comply, and what is the potential demand for this public transport concept?

In order to answer the main research question, the following three sub-questions will be addressed first:

- *What are the fixed and variable attributes of the proposed peoplemover concept?*

- *What is the opinion of public transport users in the Netherlands regarding the variable peoplemover attributes?*

- *How large is the estimated future demand for the proposed peoplemover?*

1.3 Research relevance

In the problem statement, some knowledge gaps and societal matters are already briefly pointed out. Here, the scientific and societal relevance of this research will be deepened out.

1.3.1 Scientific relevance

Previous research on automated vehicles (AV) is often focused on the technological equipment necessary for fully self-driving vehicles in the future. This research assumes that completely automated buses will indeed become reality in the future, and uses this assumption as a starting point for the description of the peoplemover in chapter 3. Most researchers agree that fully automated vehicles will be driving on public roads, although there is large debate on when this will actually happen (see figure 1.2).
Other numerous articles are about the impact of automated vehicles on transport systems of especially urban areas. For example, Kennisinstituut voor Mobiliteitsbeleid (KiM) described four scenarios for the urban environment of the future, depending on the level of vehicle automation and the willingness of people to share vehicles (KiM, 2015). The four scenarios and their impact on road capacity, other modes of transport and societal elements are visible in figure 1.3.

	Mobility as a service: any time, any place	Fully automated private luxury	Letting go on Highways	Multimodal and shared automation
Road capacity and car usage				
Capacity	+	+	0/+	0/+
Car usage	+	++	0/+	0
Other transport modes				
Public transport	--	--	0	0/+
Cycling	0/+	-	0	+
Automated freight transport	++	++	+	+
Societal impact				
Number of parking places	--	0	0	-
Spatial distribution	+	++	0	0/+
Social inclusion	++	+	0	0
Traffic safety	++	++	+	+
Environment and livability	+	0	0/-	0/+
Market share car manufacturers	-	+	0	--
Number of car manufacturers	--	0	0	--
Drivers (public transport & freight transport)	--	--	0	0

++ = Large increase
+ = Increase
0/+ = Minor increase
0 = No change
0/- = Minor decrease
- = Decrease
-- = Large decrease

Figure 1.3: The four scenarios of automated vehicles in urban areas and their impacts.
Obtained and adjusted from: KiM, 2015, p.36

The Boston Consultant Group (BCG) conducted in 2016 on behalf of the municipality of Amsterdam a study of the effects of automated vehicles on the city of Amsterdam. They concluded that approximately half of the travellers in Amsterdam was willing to switch to an automated vehicle if this would be available (BCG, 2016). Especially current public transport users would switch to an automated vehicle. Cyclists would largely stick to cycling (BCG, 2016). For rural areas, such figures are not yet known.
When we look at automated buses in particular, the notion of Automated Demand Responsive Transport appears often in the literature. This notion refers to a system of self-driving buses that depart only on call, and drive along a fixed route on mainly cycling lanes.

Helmy, Adjenughwure, Alafi, Bosdikou, & Denisiano (2016) from the TU Delft researched the demand for an automated demand responsive transport system between Delft-Zuid station and the TU Delft campus. The demand for this new transport mode appeared to be high and the concept appeared to be profitable. This study proved the potential for self-driving buses as a first-and last mile solution, but again, this research was conducted in an urban environment.

Recent literature about the first-and last mile problem is mainly about smartly combining existing transport concepts (CROW, 2014). The notion of 'mobility as a service' is important in this context.

Mobility as a service stands for the transition from transport modes towards mobility (MaaS, 2016). Consumers no longer pay for the train or the car, but simply pay to get from destination to destination, regardless of the transport mode that is used. The application calculates the most efficient or cheap journey, for which the consumer can pay online. Numerous mobility concepts are combined into one platform.
Mobility as Service is mentioned as a first-and last mile solution as it offers possibilities to efficiently combine for example 'doelgroepenvervoer' with public transport. Tom Welzen (2014) described in his thesis a very useful overview of the European first- and last mile initiatives. He distinguished the initiatives on a number of criteria, including travel time, flexibility, accessibility, costs, reliability and availability. For each group of users, different first-and last mile solutions appeared to be suitable (Welzen, 2014). His thesis proves that there is not just one first- and last mile solution, but that it is always about the local, personal context and about customization. The overview of first mile solutions of Welzen (2014) is visible in appendix 8.6. This research strives to find out whether or not self-driving buses could become complementary to these existing initiatives.

What is also striking in the previous literature, is that very little is submitted to the future users of automated vehicles, or in other words the consumers. The book of Marco Maréchal (2016) is one of the few studies that emphatically looked at the opinion of inhabitants of the Netherlands about automated vehicles. His book showed a lot of interesting results, such as the fact that the general public is fairly reluctant when it comes to using automated vehicles. People are also worried about the risk that ICT software in self-driving vehicles can be hacked (Maréchal, 2016). Furthermore, higher educated people appear to be more positive about automated vehicles than lower educated people (Maréchal, 2016).
This reluctant attitude although, is common to almost all innovations (Rogers, 1976). The well-known innovation theory of Rogers (1976) will be explained in more detail in the theoretical framework. Unfortunately, the book of Maréchal is mainly about private cars rather than public transport vehicles and is not specifically about rural areas.

What becomes clear about the literature review above is that so far little is known about the role automated buses could play in addressing the accessibility issues of rural areas by providing a first- and last mile solution, and that the potential users are only rarely involved. This thesis aims mainly to contribute to filling these two knowledge gaps in scientific literature. Public transport users of the Netherlands will be questioned about their opinion about different attributes self-driving buses could have, and the potential use of these buses will be estimated.
This research will deliver practically applicable knowledge. The thesis can be used for developing future self-driving bus concepts, referred to in this thesis as 'peoplemovers'.

1.3.2 Societal relevance

Accessibility is a rising problem for rural areas and large debate in society is going on about automated vehicles. Population figures are declining outside the cities, which makes public transport less and less profitable for bus companies operating in these areas. Rural areas are therefore relatively car dependent, which is on his turn is not contributing to a cleaner environment and creates congestion problems around cities. Most importantly, the societal relevance of this thesis lies in the fact that public transport derives further and further away from rural residents, with some of them depending on public transport for their mobility. A report of KiM and Centraal Planbureau (CPB) from 2009 describes the social function of public transport.

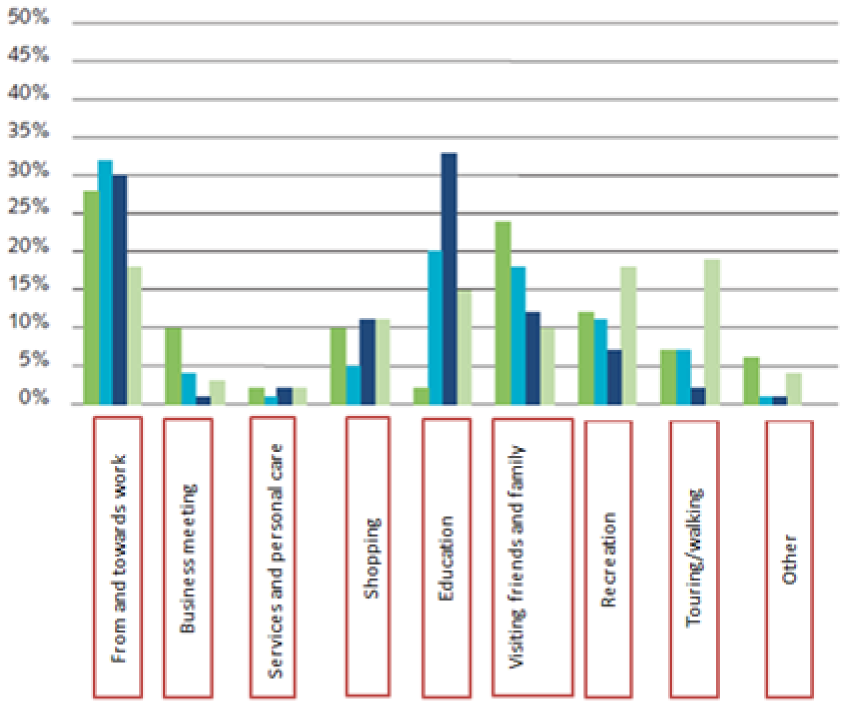


Figure 1.4: Reasons for travel with regard to different modes of transport.
Obtained and adjusted from: KiM & CPB, 2009, p.37

Green bar	=	Car
Light blue bar	=	Train
Dark blue bar	=	Bus/tram/metro
Grey bar	=	Other transport modes

When it comes to participating in activities, public transport is especially important for commuting to work and attending education, see figure 1.4. When it comes to attending education, the bus is most important. For future self-driving peoplemovers as a first-mile solution, students can thus be an important target group.

KiM and CPB (2009) explain that public transport is relatively important to specific groups of society. People without a driver's license depend to a large extent on public transport, or travel as a passenger in the car. The same can be noted about car ownership.

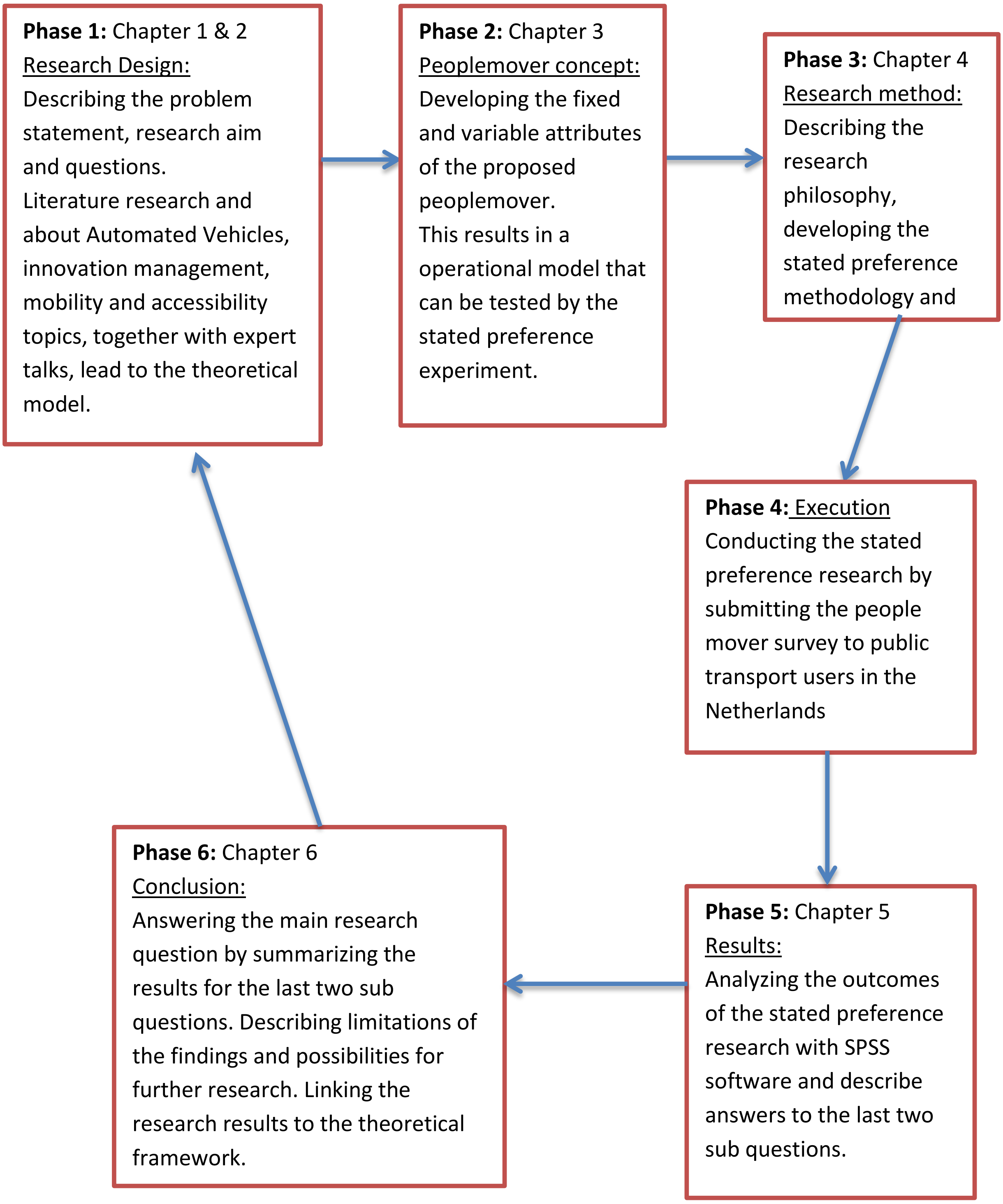
Jobless and lower income groups travel less kilometers in general and more often by public transport (KiM & CPB, 2009). Still, the majority of travel kilometers for these groups is covered by car.
What is often heard about public transport, is that it is an important “service” for elderly people. In fact, this is not the case. Elderly people travel the same share of their kilometers with public transport as other age groups (KiM & CPB, 2009). If people are no longer able to drive themselves, the majority prefers walking or traveling as a car passenger rather than choosing public transport. Also handicapped people do not use public transport more often than other people. The social function of public transport is thus not as large as commonly believed.

Despite the figures above, there are still inhabitants of rural areas that almost entirely depend on public transport for their mobility. For this group, the social function of public transport remains pertinent. This is consistent with the opinion of Karel Martens.
In his book ‘Transport Justice’, Karel Martens (2017) focuses on the inequality issues in our transport system. He states that affordable public transport for everybody is crucial in providing equal opportunities to every member of society. Accessibility should be a fundamental right of every citizen in the Netherlands (Martens, 2017). He claims that the focus in transport planning in the last decade has been too much on the performance of the transport system rather than on the people (failing) to use this system. This social function becomes even more important now amenities are pulling away from the smaller villages. Public transport is crucial in providing mobility and access to activities for people not able or allowed to drive a car (Martens, 2017).

The above shows that accessibility of the public transport system in rural areas is especially important for specific, more vulnerable groups of our society. Examining possibilities to overcome the growing first- and last mile problem, such as self-driving buses, therefore clearly contributes to a societal goal of a just transport system for everyone in society.
It also became clear that travel preferences depend on personal characteristics. This will be taken into account in the remainder of this thesis.

1.4 Research Model

In this paragraph is presented which steps this research will follow in order to answer the research questions. The figure below shows three different steps, starting with the research design and ending with the analysis of the conducted stated preference research. By drawing conclusions from the stated preference outcomes, the main research question can be answered. In the methodology chapter will be further explained what is exactly meant by this 'stated preference' research.



2. Theoretical Framework

In this chapter, the relevant theoretical concepts for this research will be discussed. Theories on the topics of innovation, consumer behavior, demographic trends in rural areas, public transport use in rural areas and the first- and last mile problem are described.

2.1 Innovation

Automated Vehicles are often mentioned as being one of the most important innovations of the 21st century. Crossan & Apaydin (2010) wrote an extensive literature review about what innovation actually entails, and came up with this comprehensive definition (p.1155):

'Innovation is production or adoption, assimilation, and exploitation of a value-added novelty in economic and social spheres; renewal and enlargement of products, services, and markets; development of new methods of production; and establishment of new management systems. It is both a process and an outcome.'

Automated Vehicles are innovative in many aspects of this definition. It can be considered as a renewal in vehicle production and transportation services, and the innovative process towards full automation of vehicles is likely to continue for decades to come. It will lead to new methods of vehicle production and it will add value to societal issues such as equal accessibility.
An important aspect of innovation is its implementation in society. This process is also referred to as *diffusion* by Everett M Rogers in his famous book *New Product Adoption and Diffusion* (1976). Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system (Hoffman, 2007, p.1). This social system, is a set of interrelated units that are engaged in joint problem solving to accomplish a common goal.
The members of a social systems can be classified on the basis of innovativeness (Hoffman, 2007). This division of society can be seen in figure 2.1.

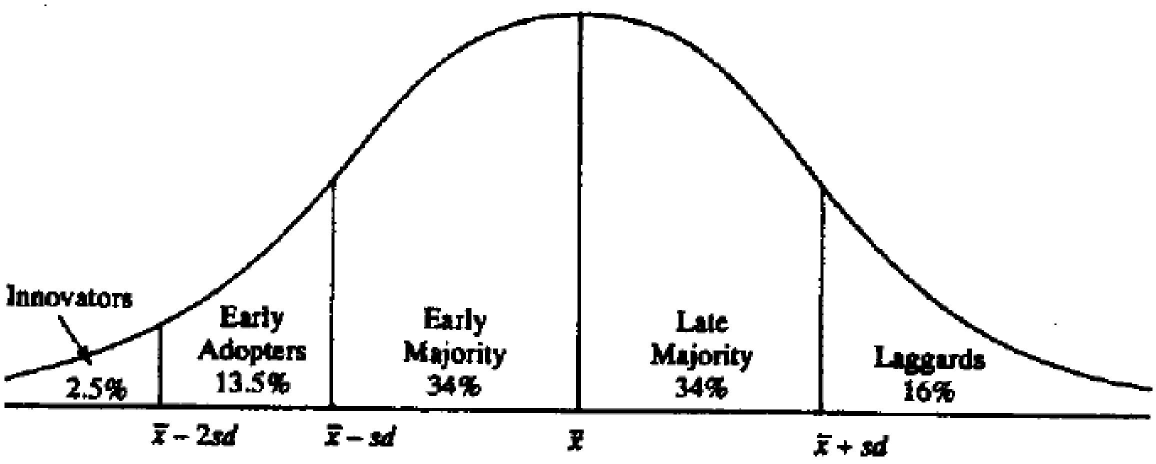


Figure 2.1: Classification of society on the basis of innovativeness.
Source: Hoffman, 2007, p.44

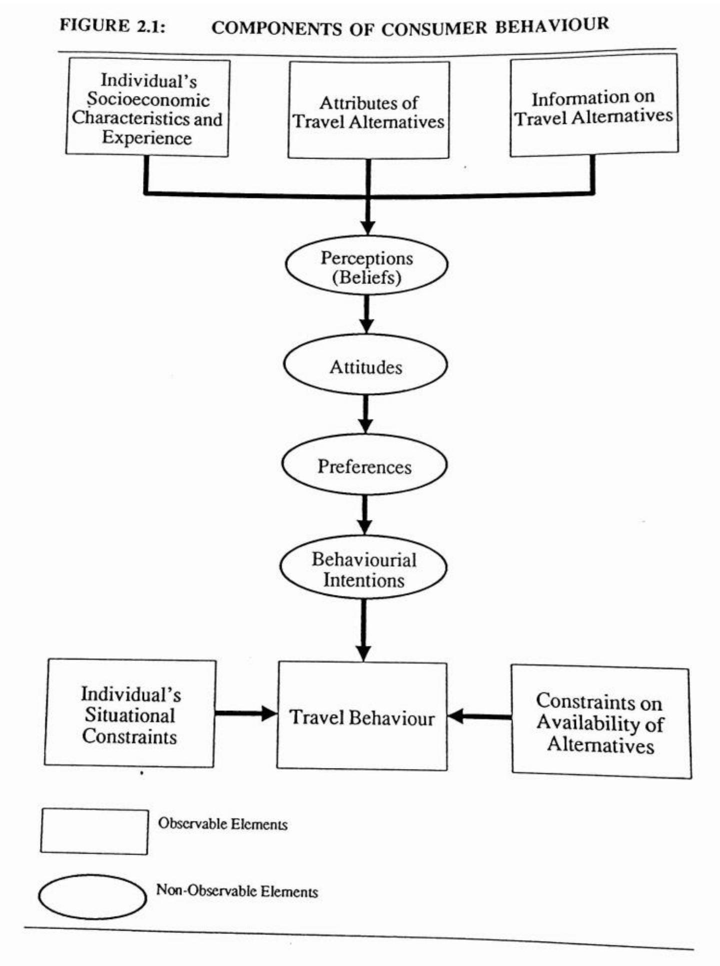
This figure shows that only 16% of society belongs to the innovators and early adopters. The rest of society has a more reserved attitude towards innovations. When it comes to automated vehicles, 42% of Dutch people expect risks of hacking the software in automated vehicles and 66% does not want self-driving cars around in cities (CROW, 2016).

The diffusion of innovation theory of Rogers declares the current worried opinion of people concerning automated vehicles, by explaining that a certain restrained attitude of society is common to almost all innovations (Rogers, 1976).

This theory is of special importance to this research because it can explain possible negative opinions found in the executional phase of this research.

2.2 Consumer behavior

The innovation theory of Rogers is closely related to consumer behavior theories. What causes consumers to make certain travel decisions? What factors are influencing this behavior? As there are loads of consumer behavior theories, this paragraph focuses on factors affecting behavioral decisions when it comes to travel. The components of consumer behavior in relation to travel are summarized by the model of Pearmain, Swanson, Kroes & Bradley (1991, p.20). Elements influencing travel behavior can be divided in elements external and internal to the consumer. External elements are for example attributes of the travel alternatives and situational constraints. Internal elements are the consumers' personal perceptions and preferences (Pearmain, Swanson, Kroes, & Bradley, 1991). External elements promote and constrain market behavior, whereas internal elements reflect consumers' understanding of their options and influence their decisions to pursue particular strategies (Pearmain, Swanson, Kroes & Bradley (1991, p.19). Furthermore, internal elements cannot be exactly measured. Those elements can only be estimated, for example by using stated preference methods as has been done for this research. Stated preference research provides data on both preferences as behavioral intentions (Pearmain et al., 1991).



The model of figure 2.2 is based on the classic economic theory that individuals derive 'utility' from the consumption of a particular product or transport service (Pearmain et al, 1991). According to a report of the Kennisinstituut voor Mobiliteitsbeleid (KiM) of 2011, transport decisions are not always rational decisions. This is illustrated by the component 'perceptions (beliefs)'. Actual improvements of the public transport system do not influence the travel decisions of individuals if the image of public transport is not changed accordingly (KiM, 2011). Positive image building is therefore crucial for successful public transport measures.

Figure 2.2: Components of consumers travel behavior
Source: Pearmain, Swanson, Kroes & Bradley, 1991, p.20.

For example, positive changes in public transport services are often only recognized by regular public transport users rather than car users (KiM, 2011). Furthermore, car users often continue choosing the car just because they are used to do so (KiM, 2011).

2.3 Accessibility of rural areas in the Netherlands

Another set of theories relevant for this research, are accessibility theories. But if we speak about the accessibility of rural areas in the Netherlands, the notion of 'rural' has to be defined. The peoplemover concept proposed in chapter 3 of this research is especially applicable to rural areas in the Netherlands, as the first-and last mile problem is most dominant in these areas.

Although some definitions of 'rurality' are based on subjective values and meaning attached to the characteristics of rural areas, this thesis uses a more measurable definition. Therefore, this research will follow the definition of Centraal Bureau Statistiek (CBS, 2015) This institute provides a lot of data for determining the research areas. 'Urbanity' of an area is defined by CBS as the concentration of human activities based on the average density of addresses within a certain area, the so called OAD measurement. An area is defined as 'not-urban' if the average OAD score is below 500, meaning the number of addresses inside 1km2 is below 500. Sociaal Cultureel Planbureau (SCP) includes for the notion 'rural' also the areas with a low urbanity rate which reaches until 1000 addresses/km2 (SCP, 2006). In this research is chosen to go along with this decision, because it is important not to exclude the villages from rural areas. Therefore, the working definition for 'rural' of this thesis is as follows:

A low concentration of human activities based on an average number of maximum 1000 addresses per km$^{2.}$

Figure 2.3: Rural areas in the Netherlands
Source: SCP, 2006, p.21

Figure 2.3 above shows the urbanity of all postal code areas in the Netherlands. This map shows that 72% of the surface of the Netherlands belongs to this definition of rural area, which includes 38% of the total population (SCP, 2006, p.21). As this source dates from 2006, it is likely the percentage of people living in rural areas is a little lower today.

Important to understand, is the difference between accessibility and mobility. This difference can be illustrated by the fact that travel speed is high in rural areas (high mobility), but the accessibility of jobs is low. The main explanation for this is logically distance, but there are more components determining the accessibility of a place. Therefore, accessibility can be seen as the final aim, and mobility just as a way to achieve it. Transportation occurs because of the need to participate in activities, and thus accessibility is the ease of participation in these activities. Linked to this explanation, several definitions of accessibility have been given in previous literature. These are all given in the article of Geurs & van Wee (2004, p. 128).

The potential of opportunities for interaction (Hansen, 1959).
The ease with any land-use activity can be reached from a location using a particular transport system (Dalvi & Martin, 1976).
The freedom of individuals to decide whether or not to participate in different activities (Burns, 1979).
The benefits provided by a transportation/land-use system (Ben Akiva & Lerman, 1979).

In more modern definitions, the virtual or digital dimension is also referred to. This research disregards the virtual component of accessibility. There is also less focus on the land-use component, as the research strives to find out how accessibility could be improved within the existing land use system. Therefore, the following working definition for accessibility is formulated:

The extent to which transport systems enable (groups of) individuals to physically reach- and participate in activities or destinations at times they desire by means of a (combination of) transport mode(s).

Dijst, Geurs & van Wee (2002) state that accessibility can be basically viewed from two perspectives. The first perspective is the individual or household perspective. To what extent are individuals or households able to reach and participate in activities at times they desire?
The second perspective is the location of those activities. To what extent are activities (such as jobs) able to receive individuals or households from any place at times they desire?
Good accessibility occurs when both perspectives are matched.
This research will be conducted from the individual/household perspective. The reason for this is that the research aim of this research is to examine the possibilities of improving the accessibility of rural areas from the viewpoint of the inhabitants.

According to Geurs & van Wee (2004), there are four basic components determining the accessibility of a location or service:

1. The land use component. This component consists the amount, quality and spatial distribution of opportunities supplied at each destination, the demand for these opportunities at origin locations and the confrontation between supply and demand for these opportunities.
2. Transportation component. Here the transportation system is described. It consists the effort, costs and time people it takes for people to cover a distance using a certain transport system. Disutility occurs because of the confrontation between travel demands and travel supply. This thesis is mainly about improving this component of accessibility.
3. The temporal component. This component reflects temporal constrains. Constraints occur when the time available for individuals to participate in activities does not match with the availability of those availabilities due to for example opening hours or road blockages.
4. The individual component. The needs, abilities and opportunities of people. Needs depend on factors like age and income. Abilities refer to for example physical restrictions of people. Opportunities are about factors like educational level, income and travel budget. These personal characteristics will be questioned in the survey. The peoplemover concept has the ability to improve the individual component of accessibility for the more vulnerable groups of society. Firstly, because the absence of a driver makes a ticket potentially cheaper allowing access for poorer users. Secondly, because the peoplemover will be accessible for disabled people as will be described later on.

These components are mutually related. This becomes visible in the model of Geurs & van Wee (2004) about the relationships between the different components of accessibility, visible in figure 2.4:

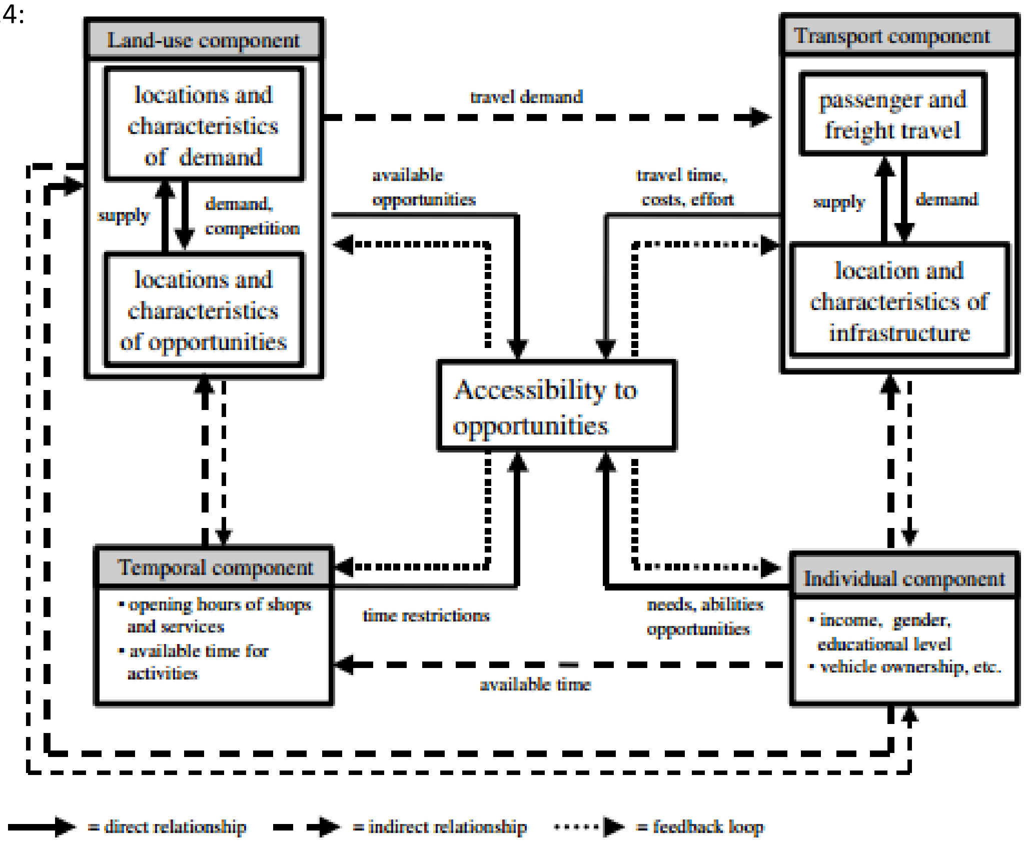


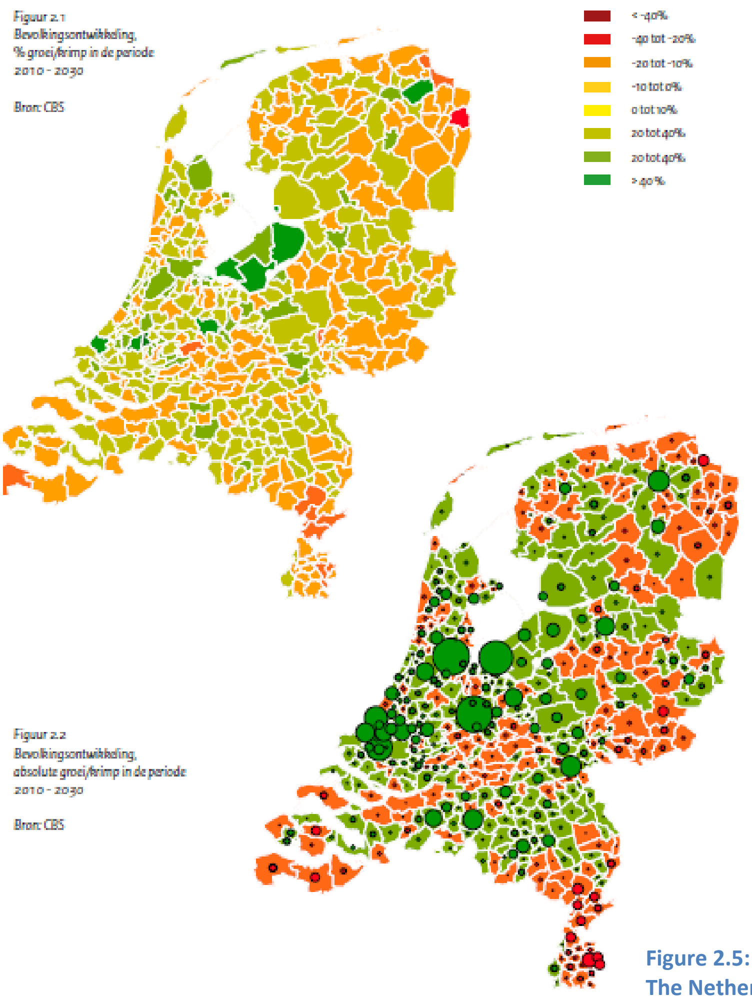
Figure 2.4: The components of accessibility and their mutual relations.
Source: Geurs & van Wee, 2004, p.129

This thesis focuses on the relationship between transport component and the individual component of accessibility. The land-use and temporal component are not taken into account for this thesis. This is coherent with the decision to look from the individual or household perspective of accessibility.

What can be said in general, is that rural areas in the Netherlands are rather car dependent, which means the use of public transport, cycling or walking is lower in rural areas than in urban areas. Planbureau voor de Leefomgeving (PBL) (2014) describes the following rule of thumb: the higher the level of urbanity, the better the multi-modal access. The other way around, the lower the level of urbanity, the lower the level of multi-modal access. Rural areas have less access to the transport network in general, and are more car-dependent. This car-dependency is likely to increase, as we will see in the remainder of this paragraph.

2.3.1 Demographic Trends

Rural areas in the Netherlands are dealing with a number of stubborn accessibility problems which are hard to tackle. Population decline is one of the main causes. The impact of population decline on mobility planning is described in a report of the Kennisinstituut voor Mobiliteitsbeleid (2010). The impacts on freight- and flight transport is left out, because this thesis focuses on the automated transport of people on the scale of rural areas in the Netherlands. The population growth/decline figures are visible in figure 2.5, for the period until 2030 in both absolute and relative numbers.



These maps show that further growth will occur in the urban areas, mainly in the West and middle of the Netherlands. Population decline will occur mainly in the rural areas, on the edge of the country. Places with already low density rates, will become even more sparsely populated. A declining population will further aggravate the already existing accessibility problems of rural areas.

Another important demographic trend which will impact accessibility, is the aging population in rural areas. Aging plays an important role in population decline, because of the fact that a high percentage of elderly people logically leads to a higher death rate.

Figure 2.5: Population growth and decline in The Netherlands, 2010-2030. Green color means growth, red color means decline.
Source: KiM, 2010, p.16

The relatively aged populations of rural areas in the Netherlands are caused by a combination of selective departure of young-adults and low inflow of youngsters (CBS & PBL, 2016). Furthermore, smaller municipalities are aging faster than the larger municipalities.
By the year 2000 there were no differences in the degree of aging between cities and rural areas.

In 2030, about 25% of the inhabitants of rural areas is above 65 years of age in comparison to 15% of the people living in cities (CBS & PBL, 2016). An aging society, especially in rural areas will have significant impacts on travel behavior and mobility (Planburau voor de Leefomgeving, 2013). From the year 2010, the baby boom generation is retiring. This results that their travel pattern changes from daily home to job trips towards irregular leisure trips at different times of the day (PBL, 2013). Therefore, the aging society has an inhibitory effect on the increasing mobility and congestion because of their more dispersed travel pattern.
On the other hand, the elderly people of the future will be more prosperous, more vital, more active and more mobile than previous generations (PBL, 2013). They are expected to travel more frequently and over larger distances than current elderly, also caused by the fact that a higher percentage will have a driving license (PBL, 2013). A last important point of attention, is that an increased number of elderly on the road is expected to lead to an increased number of incidents, unless alterations are made to the infrastructure or automated vehicles provide a way out.

2.3.2 Displacement of amenities in rural areas

The continuing population decline has revived the debate on the diminishing level of amenities in rural areas. An often heard argument is that population decline results in a loss of amenities in rural areas, due to diminishing service areas for those amenities. The truth is that this is not the case so far, but rural areas could be on a tipping point. At this moment, the availability of amenities in shrinking villages is not lower than in villages elsewhere (Vermeij, 2012). But there are some negative signs. First, a small decline in supply of GPs, physiotherapists, grocery stores and pubs is clearly visible (Vermeij, 2012). Secondly, schools in villages are leaving. This could result in the departure of more young families, which could end up in a negative vicious circle (Vermeij, 2012).

What can be said in general, is that in urban areas travel speed, or in other words mobility, is relatively low but jobs and services are close which makes them accessible. In rural areas, travel speed is higher but jobs and services are so remote that they are less accessible. This general rule is illustrate in figure 2.6, where the accessibility of jobs in the Netherlands is shown.

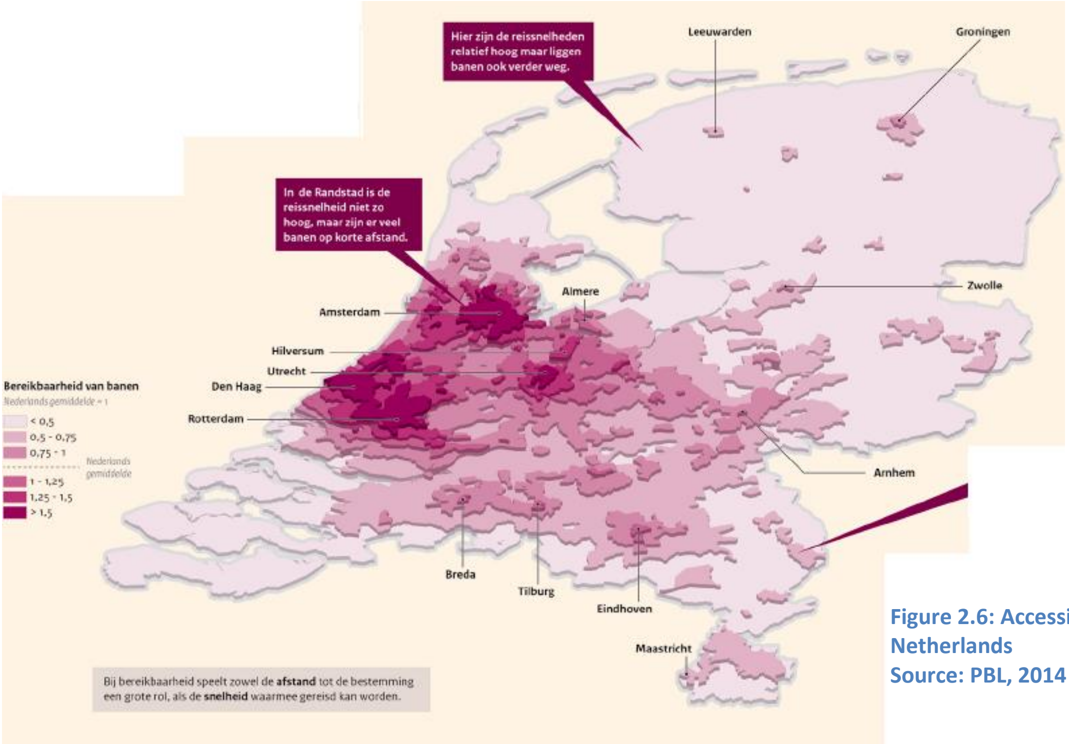


Figure 2.6: Accessibility of jobs in the Netherlands
Source: PBL, 2014

The largest problems with a decreasing level of amenities occur for the people not owning a car.
In urban areas, not owning a car is present in all sectors of society. In rural areas, people with low income, women and elderly are overrepresented in this statistic (Vermeij, 2012). Therefore, in rural areas the departure of amenities leads to the marginalization of certain groups in society. Not owning a car is not a deliberate decision in rural areas.
In his book ‘Transport Justice’, author Martens dives into this topic of social injustice caused by the transport system (Martens, 2017). In his observation, the focus of transport planning and policies have been on performance of the transport system and not on the persons actually using or failing to use it (Martens, 2017). In his opinion, many aspects in Dutch society are more or less equally divided, such as income. He asks himself why this is not the case for transport planning.
Possibly, the people mover concept could help solving the inequality issues.

2.3.3 Car Use

Population decline in North-East Groningen, de Achterhoek, Zeeuws-Vlaanderen and Southern Limburg results in a decrease of the growth in car use (KiM, 2010). The rise in the number of retirees in rural areas will have a similar effect (KiM, 2010).
If all circumstances would remain constant, the declining population in rural areas would lead to a decline in car mobility. However, other trends are causing an expected increase in car use. Higher female employment, changing lifestyles and increased welfare are examples of these trends.

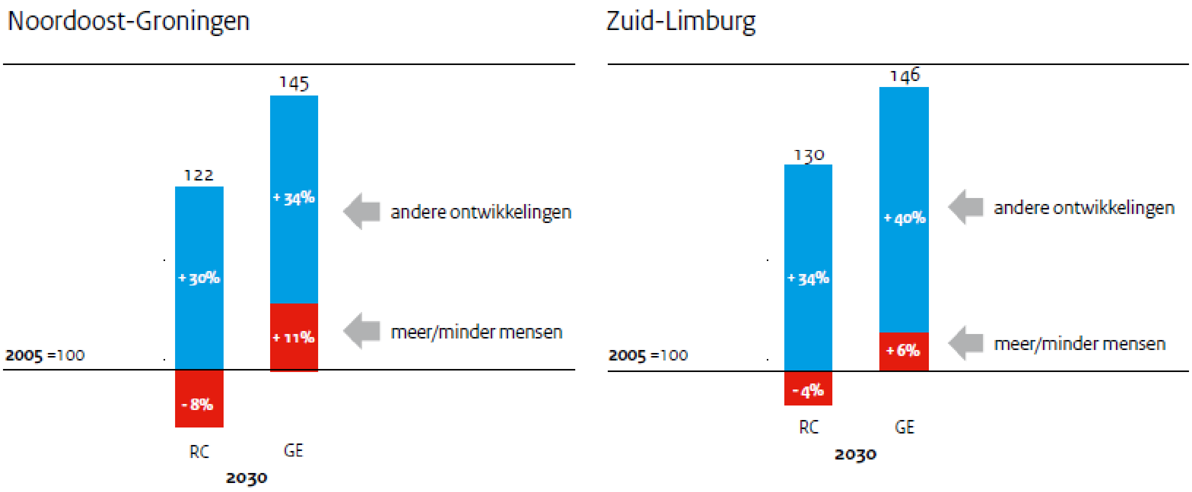


Figure 2.7: Car use by the year 2030 in shrinking regions in the Netherlands, with the effect of increasing and decreasing in red (for different scenarios) and the effect of other trends in blue.
Source: KiM, 2010, p.23

Figure 2.7 proves that car use is expected to rise in rural areas, both in the scenario of population decline and in the (more unlikely) scenario of population increase. Important to mention, is that this increase in car use is even larger in urban areas.

2.3.4 Public Transport in rural areas

Unless the declining population in rural areas, the supply of public transport did not decrease in those places since the year 2000 (KiM, 2010). Regular bus lines are often converted to transport on demand, in order to maintain profitability of those lines as much as possible (KiM, 2010). Especially smaller villages with 7.500 inhabitants or less became more and more reliable on regional taxis when it comes to public transport (KiM, 2010). Over the last couple of years, some of the 'old-fashion' bus lines have been restored because of high exploitation costs of regional taxis (KiM, 2010).
In contrast to the supply, the demand for public transport has decreased in rural areas during the last decade. This results in extremely low occupancy rates of buses. As example, an average of 6 passengers per kilometer in Limburg (KiM, 2010). This downwards trend is expected to continue, as contemporary public transport ends in a vicious circle. Lower public transport demand leads eventually to a lower supply, which leads to even lower demands etcetera (Brake & Nelson, 2007). Brake & Nelson (2007) explain that most households own a car because public transport is poorly accessible or unreliable. The peoplemover improves public transport service supply, and therefore potentially breaks through the negative vicious circle.

A report called 'Bereikbaarheid verbeeld' from PBL (2014) made accessibility in the Netherlands visible by presenting clear figures and facts. A first important fact, is that trips outside the cities are mostly made by train or car. When traveling by train, the kilometers travelled inside the train pass quickly. Traveling from home to the departing station and from the station to the final destination takes relatively more time and struggle (PBL, 2014). Figure 2.8 underlines this fact.

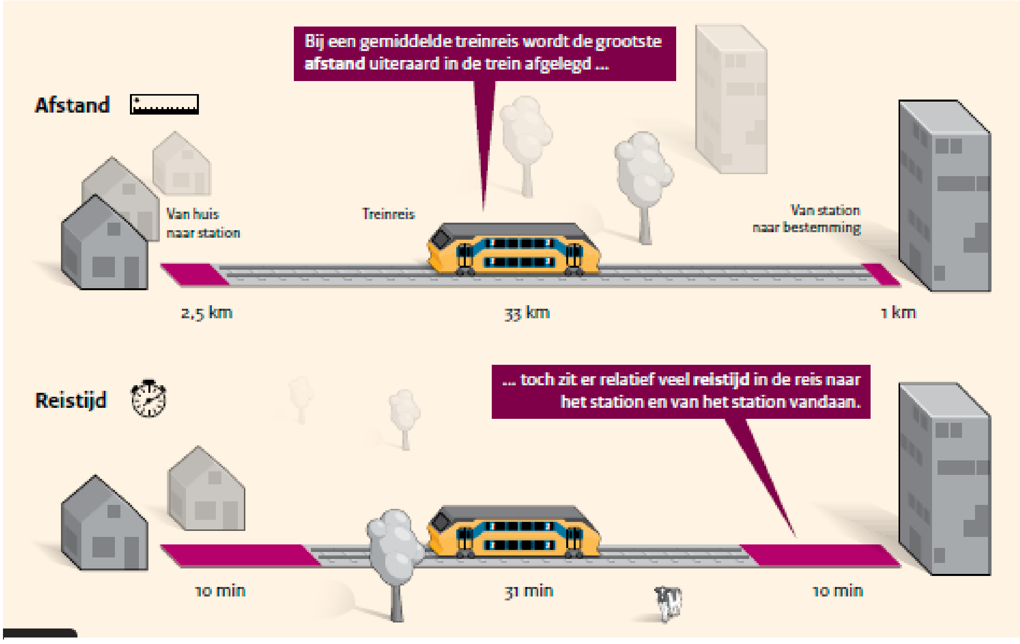


Figure 2.8: Traveling towards and from the train station takes relatively more time
Source: PBL, 2014, p.21

A similar principle applies to cars. Cars quickly drive the most kilometers outside the build environment, but inside urban areas traveling takes relatively much time. Cars are also the most used means of transport in rural areas. Jobs and services are too remote for travelling by foot or bicycle, and people are therefore forced to use the car as using public transport is often time consuming in these areas (PBL, 2014).

2.3.5 First- and last mile problem

As already seen a little in the previous paragraph, the first-and last mile towards the nearest public transport hub is a large and increasing problem that makes public transport less and less attractive. The first-and last mile problem is already described in the introduction chapter, but it is important to attach a clear working definition to this phenomenon.

The first mile can be defined in different ways. Some papers state this first mile is the distance from home towards the nearest bus stop, regardless the frequency and direction these buses are heading (Wang & Odoni, 2012). This definition is locally oriented, without looking at the regional context of where the buses from that stop are connected to. This research looks at a more regional scope, meaning that the first mile is the distance towards the nearest station or hub with buses going in multiple directions on a more frequent basis (Cheng, Nguyen, & Lau, 2012) .Therefore, this thesis uses the following working definition for the first- and last mile:

The distance from the residence towards the nearest transport hub from where it is possible to travel further towards multiple directions and destinations.

Thereafter, a transport hub in this thesis is defined as:

A public transport stop where passengers are able to transfer to at least one other transport mode with multiple directions on a daily basis.

At this moment, the solutions offered for the first- and last mile in rural areas are highly fragmented and differ for each country.

Graduate Tom Welzen (2014) made an analysis of the first- and last mile initiatives on the European scale. For the Netherlands he mentions the buurtbus, regiotaxi, omnibus and digitale duim as initiatives that are already implemented. The last mile can also be traveled by car/motor, scooter, cycling and walking.

Transport policy makers, especially in rural areas, are always coping with two conflicting criteria: speed and proximity (CVS, 2010). A higher proximity of public transport stops means regularly a lower travel speed and vice versa. This can be explained by the fact that in residential areas buses have to travel slower and in a detour, whereas more remote direct buses travel with a higher speed on regional roads.

In the Netherlands, the acceptable first- and last mile distance is determined by the type of public transport stop. Different types of stops have a different 'influence area'. This influence area is the area that is considered to be 'served' by a certain type of transport stop. The influence area of a public transport stop is determined by the maximum distance travelers are willing to overcome towards the nearest transport hub. This depends on the travel speed and time a certain public transport mode is offering. For the more direct, high speed bus and train lines people are willing to cover a larger first- and last mile. The influence area of these stops is thus larger (van der Blij, Veger, & Slebos, 2010).

- The influence area of a normal bus or tram stop is 400 to 500 meter.
- For metro stops the influence are is 700 to 1000 meter
- For small train stations the influence are is about 2000 meter
- People are willing to travel up to 5000 meter towards the major train stations

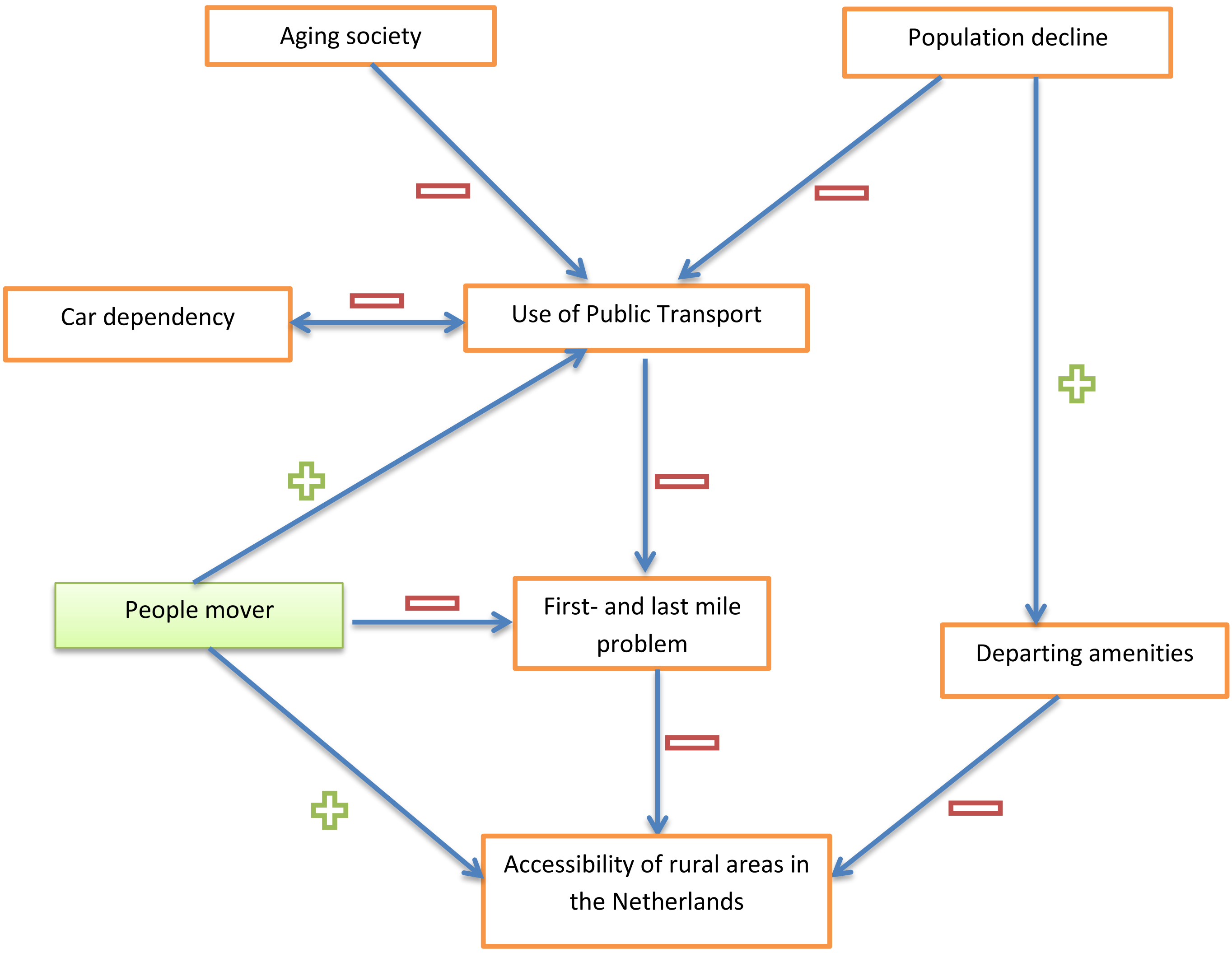
For high-quality public transport and direct, fast bus lines people are willing to cover a longer first mile than for normal bus stops. For these bus stops, an influence area of 1000-1300 meter is considered feasible (van der Blij, Veger, & Slebos, 2010).
The difference in influence areas that depend on the type of transport stop, can also be explained by the value of time theory by Wardman (2004). This theory expresses the different parts of the trip in the associated costs. These costs depend and variate on their turn on two issues: 'user type variation' and 'travel mode variation' (Wardman, 2004, p.364). The user type variation has to do with income differences. The marginal utility of money is different for each traveler, which directly influences the value of time of a journey. The 'travel mode variation' differs depending on the travel mode that is selected. When it comes to using public transport (PT), traveling is expensive during waiting and walking towards the nearest PT stop (Wardman, 2004). In contrast to for example driving a car, the in-vehicle travel time can be spend useful when using public transport. Therefore, the time spend in this part of the trip is considered to have a lower value or costs. Privately owned automated cars have the potential to have the same in vehicle value of time as contemporary public transport, because travelers no longer have to spend their time on driving the vehicle. According to Litman (2010), scientists did not yet agree on whether or not the self-driving car will become a competitor for public transport, or just as a support to public transport. The automated vehicle proposed in this thesis is clearly in favor of the latter.

2.4 Theoretical model

The theoretical model below shows the main elements of the theoretical chapter discussed above, and their interrelationships. We have seen that population decline and aging in rural areas leads to a decreased use of public transport. This lower use of public transport results in the so called vicious circle of car-dependency. The lower use of public transport means less services are provided, making public transport less attractive, resulting in higher car-dependency. An increased car dependency results in an even lower use of public transport in return. Population decline leads to amenities leaving these areas. The fact amenities are departing in rural areas means those amenities become more remote, directly resulting in lower accessibility as well.

The decreased use of public transport in rural areas forces bus companies and governments to stretch bus lines, which leads to an increased first-and last mile problem. This increased first-and last mile problem influences the accessibility of rural areas in a negative way.

The idea of the people mover is ought to result in a higher use of public transport by decreasing the first-and last mile problem. Hereby the peoplemover contributes to the accessibility of inhabitants of rural areas in the Netherlands. This influence of the people mover is researched in the thesis, as well as the preferred attributes this vehicle should have.



Note that the theoretical model presented above is meant to summarize the theoretical framework and the interrelations between the different sets of theories. This model described the role the peoplemover could possible fulfil in the future. This theoretical model will not be directly tested during the executional phase of this research.
What will be tested in this research, is what attributes of the peoplemover are most important to people with different personal characteristics and what the potential use is for the proposed concept.
The operational model as drawn in chapter 3 is the one that will be tested in the executional phase of this research, where a stated preference experiment will be conducted.

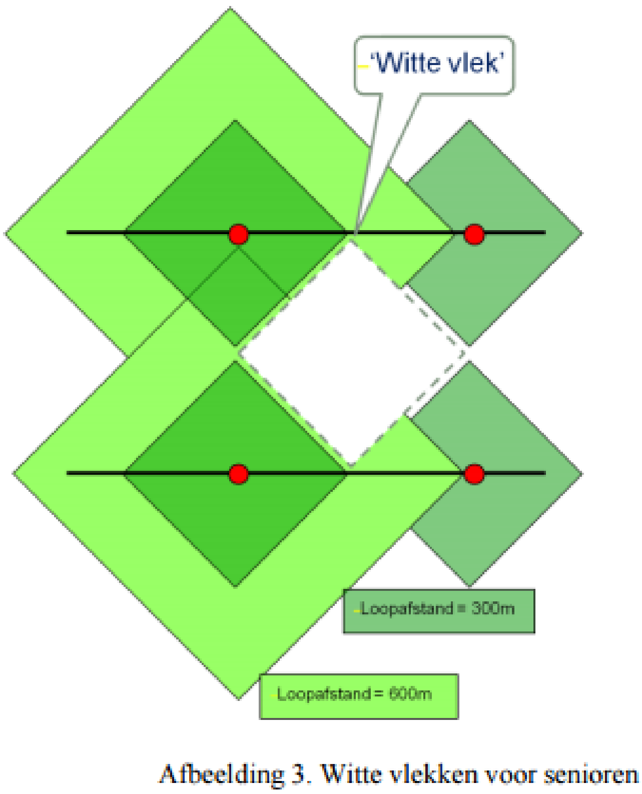
3. The Peoplemover

What are the fixed and variable attributes of the proposed peoplemover?

In the theoretical model is explained that the decreasing demand for public transport in rural areas is forcing bus companies to 'stretch' their bus lines into more direct routes between the larger towns. As a result, the average distance towards the nearest bus stop is increasing in rural areas (Harms, 2008; Welzen, 2014). This is also referred to as an increasing first- and last mile problem in rural areas in the Netherlands.

However, according to van Nes (2002), this development means movement towards a more optimal organization of public transport. He argues that more direct bus lines over main roads is positive, because each bus would attract more passengers, is able to depart more frequently and can drive faster (van Nes, 2002). This would apply to both urban as rural areas. In urban areas, the maximum distance towards the nearest transport hub would be 600 meters (Van Nes. 2002). This is walkable for most people.

For rural areas, this restructuring of bus lines leads to first-mile distances that are insurmountable by foot, especially for specific groups of society like elderly. The stretching of bus lines results in so called 'blind spots' in rural areas. This are areas that fall outside the service areas of the nearest bus stops.



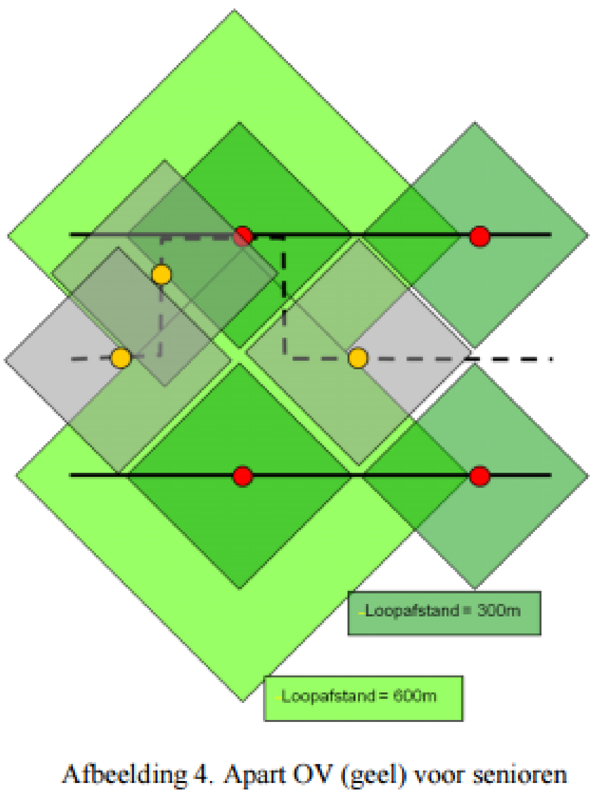


Figure 3.1: Blind spots in the new stretched pattern of bus lines, in this case specific to elderly. Red dots indicate the bus stops along the major bus line. Yellow dots on the right figure indicate stops for new first- and last mile solution. Source: Kors, 2015, p.4

For these ‘blind spots’, first-and last mile solutions are needed to connect the people living at these places with the main public transport network.

Fur this specific function, this thesis proposes the use of automated buses. In the remainder of this thesis, these automated buses as a first-and last mile solution are called ‘Peoplemovers’. Peoplemovers are ought to connect the smaller villages with stops at this major bus line. The concept of the people mover is visible in figure 3.2 below. The red dots indicate the larger villages and towns, which are connected with a stretched bus line in blue, executed by a regular bus. The smaller villages are indicated with green dots, and are linked to the major bus line by the new concept of peoplemovers, which are indicated with orange lines.

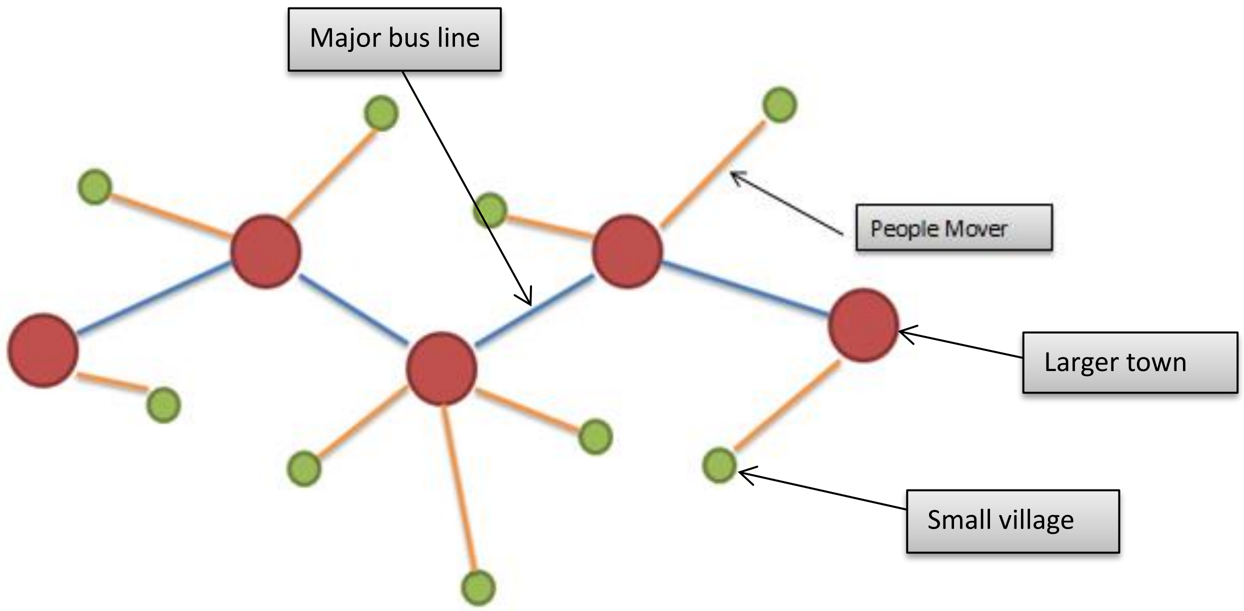


Figure 3.2: The concept of the people mover

This thesis strives to find out what the demands and preferences of the inhabitants are for a people mover. Below, the relevant characteristics of the people mover will be discussed. Firstly the fixed attributes will be described. These are the basic characteristics the people mover will have under all circumstances, entailing: level of automation, travel speed, accessibility of the vehicle and safety measures. Afterwards, the variable attributes will be discussed. These are the variables which are not fixed and whereon the survey respondents are able to state their preferences. Peoplemovers in the future can be realized according to these preferences, of course depending on the local context and target group.

3.1 Fixed Attributes

When it comes to the attributes of the proposed peoplemover, a distinction can be made between fixed and variable attributes. Fixed attributes can be seen as context attributes. These attributes are the basic features of the proposed peoplemover. It is important to describe these attributes as precise as possible, in order to present the respondents a clear picture of how the peoplemover would potentially look like. After these fixed attributes are explained, the respondent is able to give his or her opinion about the variable attributes. These variable attributes will be explained later on in this chapter. The fixed attributes are mainly developed with the help of Frans Hamstra. He works together with the provinces of Groningen and Drenthe and with the municipality of Oostellingwerf. Furthermore, he is owner of the innovative company Drietachtig.
Frans Hamstra can be considered as one of the pioneers in the field of self-driving buses as a first- and last mile solution. In a pair of conversations, the fixed attributes of the proposed peoplemover are discussed. These talks are supplemented with literature research.

3.1.1 Level of Automation

For answering the research question, it is important to know what is exactly meant with the notion of 'automated vehicles' and the self-driving peoplemover.
Firstly, the concept of 'Automated Vehicles' includes multiple types of vehicles. Roughly said, three types can be distinguished (BCG, 2016):

1. Self-driving cars. The driver is able to spend his or her time on doing other things then driving. Front seats could possibly be turned around to create a "living room feeling".
2. Self-driving taxis. This are the same vehicles as self-driving cars, but ridership is exploited by commercial providers rather than individual drivers. Taxi companies provide a platform for renting vehicles for a certain trip, and sharing a vehicle or ride becomes much easier.
3. Self-driving buses. These buses could drive on-demand, with multiple passengers and possibly from door to door. This expected type of self-driving vehicles will probably provide a new form of transport.

An impression of the three predicted types of self-driving vehicles in the future is shown in figure 3.3 below:

Figure 3.3: The three types of Automated Vehicles. The self-driving car on the left, the taxi in the middle and the bus on the right. Source: BCG, 2016, p.3

For the peoplemover, the self-driving buses are considered most feasible as it will be a form of public transport. Different type of buses could be used as a peoplemover. In this thesis, the vehicle produced by Easymile is selected. This vehicle is also used for the pilots in Ede-Wageningen and Appelscha, and is named EZ10.

Specifications

Capacity: 12 persons (6 seating and 6 standing)
Cruising speed: 20 km/h
Maximum speed: 40 km/k
Propulsion engine: Electric asynchronous
Autonomy: up to 14 hours of operations.
Battery: Lithium-ion (LiFeP04)
Battery Charger: 230V 16A
Air-Conditioning: Yes
Length: 3.928 m
Width: 1.986 m
Height: 2.750 m
Wheelbase: 2.800 m
Payload: 1700 kg
Fully loaded: 2750 kg

Figure 3.4: Impression of the proposed people mover vehicle, the EZ10 model of Easymile and its specifications. Source: Easymile, 2017. Obtained from: http://easymile.com/mobility-solution/

Most important for this research, is that the vehicle drives with a speed of 20-40 km/h and can has a capacity of twelve persons with six of them standing (Easymile, 2017). If the demand appears to be high as a result of this research, larger vehicles could be considered in the future.

Secondly, it is important to realize that the above types of AV assume a level of high automation. At this moment, technological development has not yet reached the level of full automation.
The Society of Automated Engineers (SAE) (2014) has provided an international standard for levels of automation of vehicles, ranging from no-automation to full-automation. The different levels and a description of their differences is visible in figure 3.5.

For the concept of the people mover, only vehicles of automation level 5 are considered as an option. The absence of driver's costs is what makes the people mover profitable in comparison to traditional buses, and therefore lower levels of automation could not be considered as an improvement. The people mover will be equipped with cameras on both the inside and the outside. These cameras can be viewed from a remote control centre, which has an overview of all the people movers in a region. In a case of emergency, the remote control centre can send emergency services. Additionally, the remote control centre could also play a role in the detection of ticket fraud.

SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/ Deceleration	*Monitoring* of Driving Environment	Fallback Performance of *Dynamic Driving Task*	System Capability *(Driving Modes)*
***Human driver* monitors the driving environment**						
0	**No Automation**	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	**Driver Assistance**	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes
2	**Partial Automation**	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/ deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes
***Automated driving system* ("system") monitors the driving environment**						
3	**Conditional Automation**	the *driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes
4	**High Automation**	the *driving mode*-specific performance by an automated driving system of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	**System**	Some driving modes
5	**Full Automation**	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	**All driving modes**

Figure 3.5: The 5 levels of vehicle automation.
Source: SAE, 2014, p.2

The idea of the remote control center is closely related to the concept of 'connected mobility'. By using ICT applications in cars and buses, information between vehicles can be exchanged. For example, if several vehicles are connected, vehicles can drive in platoons close to each other on higher speeds. This increases safety, traffic flow efficiency and decreases fuel use. Also information about congestion and parking places can be provided in the vehicle.

Figure 3.6: Connected mobility, Exchanging information by using ICT applications
Source: IAV, 2015

3.1.2 Travel speed
The travel speed is the second fixed variable. The peoplemover is ought to drive with a speed in between 20 and 40 km/h. This means the peoplemover will be faster than the bicycle in most occasions, but slower than the car. The peoplemover will drive on a separate lane, or as the only user on an existing lane. Therefore there will be no problematic interactions with other road users, and the vehicle will not be delayed by congestion problems.
The total travel time will be determined by a combination of this fixed variable of the travel speed and the varying variable of possible intermediate stops between departing and final stop.

3.1.3: Accessibility of the vehicle
In order to maximize the benefits of the peoplemover in comparison to other transport modes, the peoplemover will be accessible for most people not able to drive a car. There will be a wheelchair facility, as well as easy access for blind, deaf or elderly people.

3.1.4 Safety of the vehicle
The absence of a driver could result in passengers feeling unsafe. The safety of the peoplemover will be as much as possible guaranteed by cameras on the inside and outside of the vehicle. These camera images are visible in a remote control center, from where emergency services can be reached out and ticket fraud can be determined.
Additionally, the automated bus will be equipped with an emergency brake.

Now we have defined the fixed peoplemover attributes, the variable attributes will be described in more detail.

3.2 Variable attributes
The variable attributes are the attributes whereon the respondents have been given the opportunity to express their preferences about. The following attributes are considered to be relevant.

3.2.1 Waiting time and frequency
Waiting time and departure frequency is another relevant element of the people mover that has to be taken into consideration.
A first possibility is that the people mover would drive 'on demand' where travelers order the vehicle up front for a certain departure time. Mageean & Nelson (p. 255) define demand responsive transport as:

'*transport ''on demand'' from passengers using fleets of vehicles scheduled to pick up and drop off people in accordance with their needs. DRT is an intermediate form of transport, somewhere between bus and taxi which covers a wide range of transport services ranging from less formal community transport through to area-wide service networks.'* (Mageean & Nelson, 2003, p.255).

If the vehicles would drive on demand, a so called Automated Demand Responsive Transport System (ADRTS) would be created. Helmy, Adjenughwure, Alafi, Bosdikou & Denisiano (2016) conducted a survey to estimate the demand for a first-and last mile automated shuttle between the Delft-Zuid train station and the campus of the Delft University.

Although the results showed an interesting high demand, they are only applicable for the specific urban context of Delft-Zuid towards the campus and serve a specific target group, namely people working or studying at the university. Furthermore, the proposed vehicle would drive at low speed on the public road among other road user and is therefore not fully comparable with the people mover as proposed in the thesis. Lastly, using a survey method with a relatively low response resulted in a high level of uncertainty about the results (Helmy, Adjenughwure, Alafi, Bosdikou, & Denisiano, 2016). Driving on demand can be seen as the cheapest and most efficient option, but requires some more effort from the passengers.

The second possibility is that the people mover would drive according to a fixed schedule. With a fixed schedule, a people mover departing every 30 minutes, 60 minutes or even less are considered as realistic. During peak hours, the vehicles could possibly drive more often. Driving more regularly means more vehicles are needed which leads to higher operational costs.

3.2.2 Level of comfort

The fourth element that could vary for the peoplemover is the level of comfort in the vehicle. First of all, it is important to mention that automated vehicles are referred to a higher value of time as passengers have the possibility to spend their time in the vehicle 'useful' instead of having to drive by themselves (TU Delft, 2015). Of course this advantage is already present in current public transport, but an increased level of comfort could result in further 'travel time enrichment' (TU Delft, 2015). Although Groot, Warffemius, Koopmans, & Annema (2011) state that the level of comfort is difficult to operationalize, we try to provide some indicators here and divide two different levels.

A first important indicator for comfort is the level of crowdedness, or 'passenger load'. The passenger load is linked to the in-vehicle travel time. The level of comfort decreases if the travel time increases, and decreases much faster if the public transport vehicle is crowded (Centre for Transport Studies Stockholm, 2015). This relationship is even stronger if a passenger has no seating place.

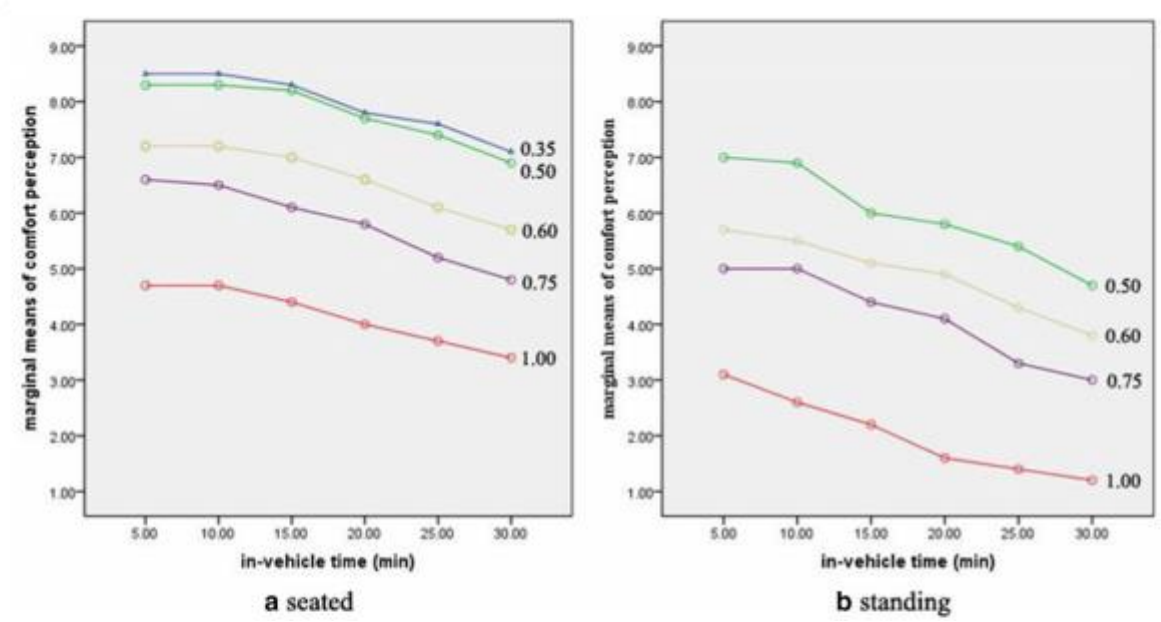


Figure 3.7: Travel comfort in relation to seating place and in-vehicle time
Source: Sheng, Feng, Li & Hu (2016, p.5)

Figure 3.7 above shows that the level of perceived comfort decreases if the travel time increases, both for seating and standing passengers. The experienced level of comfort is always lower for standing passengers, and also decreases faster if in-vehicle time increases (Sheng et al. 2016). Additionaly, the effect of passenger load on experienced comfort is larger than the effect of travel time on comfort. The influence of in-vehicle time increases rapidly after 15 minutes.
Therefore, the availability of a seating place is the used indicator for expressing comfort.

3.2.3 Price

Some of the above mentioned elements of the people mover have an influence of the associated travel fare. For example, a high frequency and comfort would normally result in a higher fare. On the other hand, subsidies by governmental agencies potentially have an even larger influence on the fare. Therefore, it is realistic to submit different fares to the respondents independent of the other attribute levels. In this thesis, the travel fare is expressed in comparison with current public transport costs. In the Landelijk Tarieven Kader 2017 (DOVA, 2017) is determined that the price for using public transport in the Netherlands can be divided into a basic amount and a price per kilometer. The basic amount is 0,89 euro (DOVA, 2017). The price per kilometer is around 0,15 euro. In this research, three possible fares are submitted to the respondents: 50%, 100% and 150% of the price of contemporary public transport. (DOVA, 2017)

3.2.4 Intermediate stops and travel time

As mentioned before, the travel time of the peoplemover is determined by a combination of the fixed travel speed of 20-40 km/h and the possibility of intermediate stops.
The number and flexibility of stops in between departing and final stop can vary and have a strong influence of the in-vehicle travel time. The travel time is expressed in this research in comparison to the travel time by bicycle.
With flexible stops, passengers have the possibility to stop at every point of the route. Therefore, flexible stops is ought to cause the strongest delay, as the vehicle is likely to stop more often. The use of flexible stops is associated with a travel time of 1,5 times the travel time by bicycle.
Driving directly is obviously the quickest option. The peoplemover can drive with a constant speed from beginning to end. This option is thus associated with a travel time of 0.5 times the travel time by bicycle.
Organizing fixed stops along the route is the last option. The vehicle will stop less than with flexible stops, but logically more often than with no stops. The option with fixed stops is therefore associated with the same travel time as using the bicycle.

3.2.5 Presence of a steward

Presence of a steward is another attribute that could vary. Because people might feel less comfortable when a bus driver is no longer there, the presence of a steward instead is a possibility for maintaining the order and assisting and welcoming passengers. If a steward is present, this obviously diminishes the cost savings significantly.

3.2.6 Availability of Wi-Fi

The last attribute that could vary, is the possible availability of Wi-Fi. In comparison to the car, public transport provides the possibility to use your time more usefully. The availability of a free Wi-Fi service allows people for example to work, but logically brings some extra costs as well. Is the availability of Wi-Fi influencing the in-vehicle value of time to such extent that people value it as being important?

3.3 Relevant personal characteristics

On the top left of figure 2.2 is displayed the element of 'individual's socioeconomic characteristics and experience'. These personal characteristics and experience influence the preferences and behavioral intentions which are measured in the stated preference research phase of this thesis. Therefore, they are relevant to question in the survey. The following personal characteristics are found to be relevant when it comes to travel decisions:

1. **Age**
   Every stage of life has a different mobility pattern, which is likely to change in the future (Planbureau voor de Leefomgeving, 2014). Children until the age of 15 have low mobility rates, and travel mostly as a passenger in the car of their parents (PBL, 2014, p.15). For traveling to secondary school, the bicycle is popular (PBL, 2014). This mobility increases rapidly reaching peak mobility around the age of 30. Students in the Netherlands can use public transport mostly for free and therefore use this transport mode the most (PBL, 2014, p.15). At the age people are working, the car is by far the most used mode of transport (PBL, 2014, p.15). After retiring, the car passenger seat becomes more frequently used again.
   All of the above shows that age and the associated stage of life has strong influence on the travel decisions people make.

2. **Urbanity of place of residence**
   The concept of the peoplemover is developed for rural areas in the Netherlands. It is therefore interesting to see whether or not people living in rural areas have other preferences for the peoplemover attributes than people living in urban areas, and if rural residents are more likely to use the peoplemover. This personal characteristic is closely related to the distance of respondent towards the nearest bus stop. Therefore, this distance is also questioned in the survey.

3. **Level of education**
   The level of education is another variable that influences people's travel decision. A higher level of education is associated with a higher level of income and more car-ownership (PBL, 2013). Also, higher educated people are often more open for, and positive about, innovations such as automated vehicles (Maréchal, 2016).

4. **Car ownership and driver license**
   Having a car and a driver's license obviously allows people to be more flexible in their travel decisions. Car users are possibly less positive about (new) forms of public transport, and therefore it is a relevant variable to question. The report of KiM (2009) showed that people having a car and/or driver's license are less likely to use public transport. It is thus interesting to find out whether or not they are also less likely to use the peoplemover.

5. **Public transport subscription or discount**
   People owning a public transport subscription or discount card are more likely to use public transport. Therefore, they are more aware of the current problems of public transport in rural areas and possibly better in assessing the different people movers.

6. **Frequency of public transport use**
   People that already use public transport on a frequent basis are also an important group of potential users of the peoplemover. Also, it is interesting to find out whether or not new public transport users can be attracted.

7. **Previous experience with automated vehicles**
   People that have previous experience with automated vehicles are probably more positive the proposed automated bus than people without this experience. Research from the pilot in Appelscha shows that people that took part are rather positive about the automated bus tested there. For example, the figure below shows that the majority of the participants of the Appelscha pilot expects automated transportation will replace public transport in the future.

Zeer eens: 1	**13**	26.5%
2	**21**	42.9%
3	**12**	24.5%
4	**2**	4.1%
Zeer oneens: 5	**1**	2%

Figure 3.8: Do you believe automated vehicles will replace public transport in the future?
Source: Gemeente Oostellingwerf, 2016, p.3

3.4: Operational model

The fixed and variable attributes of the peoplemover described above are converted into the operational model shown below in figure 3.9.

The theoretical model showed that the aim of the peoplemover is to contribute to bridging the first- and last mile in rural areas in the Netherlands, increase public transport use and improve accessibility. Content wise, this research investigated which attributes of this peoplemover are most important to public transport users, and what is the potential demand for a peoplemover. The operational model thus shows what is exactly measured in this research. The operational model is constructed of four elements: the personal characteristics of the respondents, the rating these respondents attach to the different peoplemovers, the importance of the variable peoplemover attributes according to those respondents and the potential demand for the peoplemover.

The potential demand for the peoplemover and the rating of the 16 different peoplemovers can be calculated directly from questions in the survey, based on a set of personal characteristics. By conducting stated preference analysis, the importance and partial utilities of the variable attributes of the peoplemover can be derived from the ratings respondents gave to the different peoplemovers. Once these importance values and partial utilities are calculated, this provides specific information about the potential demand for the peoplemover.

The four main components of these research and their interrelationships are shown in the following operational model.

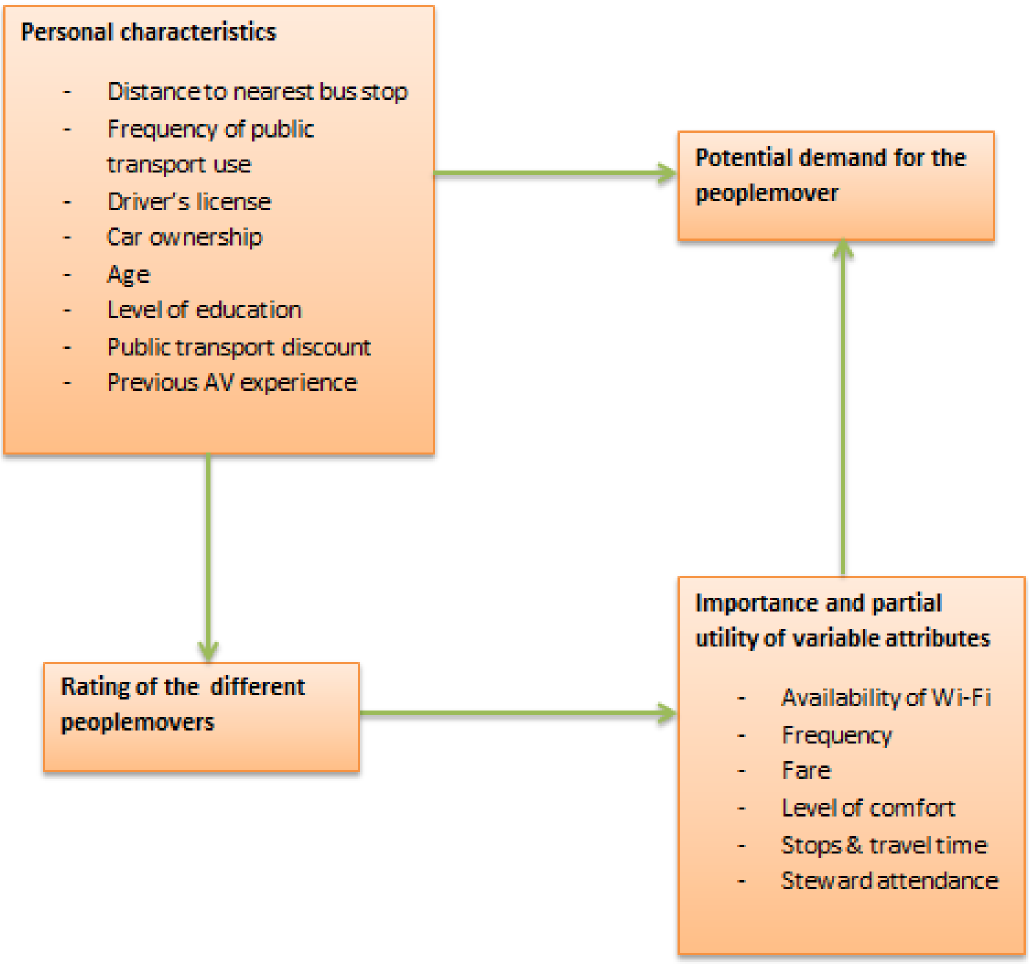


Figure 3.9: Operational model

3.5 Operationalization

The different attributes that are relevant for the people mover are operationalized in the following operationalization table. The attributes are operationalized by attaching measurement unites, the applied level of these unites and the variants that will be presented in the Stated Preference (SP) research. During the Stated Preference research, people can chose between different sets of attributes. This means that peoplemovers with different combinations of attributes will be presented to the respondents, on which they can base their ratings. In the methodology chapter this method will be further elaborated.

Independent Attribute	Measurement unit	Level	Variants in SP research
Steward attendance	The presence of a steward	Yes No	Yes No
Frequency	Maximum number of minutes between arriving at departing stop and actual departing time.	0-60	0 (on demand) 30 (every half hour) 60 (every hour)
Stops and in-vehicle travel time	Possibility and flexibility of stops between point of departure and final destination, influencing the travel time.	The possibility and type of intermediate stops in relation to the travel time compared to the bicycle	Direct (2 times faster than bicycle) Fixed (as fast as the bicycle) Flexible (1,5 times slower than the bicycle)
Comfort	Perceived level of comfort.	Passenger load	High Low
Wifi	Availability of in-vehicle Wifi-network	Yes No	Yes No
Price	Fare in comparison to current public transport	0.5-1.5 times the price of current public transport	0.5 1.0 1.5

The total number of combinations of attributes is 216. It is impossible to submit all of these 216 different combinations to the respondents. Therefore, a selection of all these combinations is made in the methodological phase of this research.

4. Methods

This chapter will describe the methodology used for answering the sub- and main research questions. Both research design and methods will be addressed. What can be said about the research in general, is that the research is application-oriented more than fundamental (Vennix, 2011). The aim is not to develop 'knowledge because of the knowledge', but to develop knowledge that is practically applicable for rural areas in the Netherlands.
Furthermore, the main research question is open-ended, which means that the research can be referred to as exploratory (Farthing, 2016). A risk of open-ended questions, is that by nature they do not provide much guidance on what the research ought to be describing (Farthing, 2016, p.77). This problem can be avoided, by clearly clarify the scope of the research and the definitions of the key terms. This has been done in the operationalization and theory paragraphs.
On the other hand, it is important to realize the research is not purely exploratory. Previous literature and theoretical frameworks form a solid basis on which the stated preference study is built.

This research is not bound to strictly follow a deductive or inductive approach, which is in line with the pragmatic research philosophy. The research design shows therefore elements of both. It is deductive in the sense that the theoretical model provides a base for the development of the peoplemover concept, as has been done in chapter 3. This concept will to some extent be tested by questioning whether or not people are willing to use the peoplemover. Furthermore, the relevant attributes are as well derived from previously developed theories.
The research design is inductive in the sense that new theoretical knowledge is gained by examining the variable attributes of the peoplemover. It will lead to new theoretical insights about the preferences of public transport users when it comes to the innovative concept of self-driving buses.

First, the philosophical assumptions will be described after which the research population and the stated preference approach will be explained.

4.1 Research Philosophy

Behind every scientific research there are certain philosophical believes and assumptions. Developing a philosophical perspective requires the researcher to make assumptions on both the nature of society and the nature of science (Burrell & Morgan, cited in Holden & Lynch, 2004). The philosophical perspective I brought to this research is that there is an objective truth out there, but that it is difficult to exactly measure this truth in social science. Furthermore, I believe research is always conducted in a certain context and cannot be entirely separated from that context. For example, the opinion of inhabitants of rural areas in the Netherlands about attributes of the people mover do not necessarily have to be the same as that of inhabitants of rural areas in Indonesia because of the different context, culture and background. That being said, it is time to have a look at the numerous philosophical movements that exist in research philosophy, each with their own assumptions and related research methods.

In research philosophy, several interpretive frameworks can be distinguished ranging from positivism on the one side to social constructionism on the other side. Each interpretive framework entails their own ontological, epistemological, axiological, and methodical beliefs.
Ontological beliefs are about the nature of reality and its characteristics (Creswell, 2014, p.20). Some philosophers and scientists believe that different people have different realities, based on different experiences. Therefore, researchers and the people researched have their own realities as well. Others believe there is just one objective and measurable truth out there. Again, others believe that there is in fact an objective truth out there, but that humans are incapable of objectively constructing this one truth. This discussion is also referred to as the 'dualism between reality within and outside the mind' (Creswell, 2014, p.20)
Epistemological beliefs are about how knowledge is known (Creswell, 2014, p.20). In qualitative research, knowledge is known through the subjective meanings of individuals (Creswell, 2014, p.20). In quantitative research, knowledge is known through the objectively considered observation of the researcher.
Axial beliefs are the values a researcher him-or herself brings to the inquiry. In qualitative research, it is conventional the researcher explains these values beforehand.

Positivism and social-constructionism can be seen as the two extremes in the field of research philosophy. Positivism is based on the believe that there is one objective reality 'out there', determined by causal relationships which can be found by conducting scientific research (Creswell, 2014, p.36). It is associated with deductive research methods.
In social-constructionism, multiple realities exist and are constructed through lived experiences and interactions with others (Creswell, 2014, p.36). Honoring individual values is important when it comes to axial beliefs (Creswell, 2014, p.36).
However, Holden & Lynch (2004) argue that these more extreme approaches can be delimiting. They state, that selecting an intermediate philosophical approach allows the researcher to match philosophy, methodology and the research problem (Holden & Lynch, 2004). This research is consistent with this argumentation, by selecting pragmatism as the philosophy for this research.

In pragmatism, reality is what is useful, is practical and works (Creswell, 2014, p.37). Pragmatism suits this research well, as it is practically oriented. This research strives to develop knowledge about the preferred attributes of- and demand for the proposed peoplemover. This knowledge is practical in the sense that it can be directly applied by transport agencies in the future. It is most important to find an answer to the problem statement, the methods by which this is achieved have of course to be in line with this question but are only of second importance. The final aim is more important than the means. Therefore, researchers are free of choice what methodology is most suitable for achieving the research aims. This suits well into this research, as the stated preference methodology is specially developed for making tradeoffs between various attributes of a product.

The research context is important in the philosophy of pragmatism. Therefore, the rural areas in the Netherlands and the present accessibility problems are described in detail in the theoretical framework. The results of this research therefore only apply to the specific context of rural areas in the Netherlands.

The epistemological belief in pragmatism is that reality is known by using different research tools, both deductive objective and inductive subjective (Creswell, 2014, p.37). More inductive tools are used during this research for the development of the fixed peoplemover attributes. These have been developed during the conversations with Frans Hamstra, in combinations with a literature research. The conversations with Frans Hamstra are not officially documented.
As an axial believe in pragmatism, the developed knowledge reflects both the values of the researcher and the values of the participants (Creswell, 2014, p.37). The values of the participants are clearly represented in their stated preference output. The values of myself as a researcher are visible in the interpretation of which results are most relevant and important.

4.2 Research population

The quantitative data for this thesis will be gathered by conducting a survey. In this survey, the majority of the questions include the stated preference experiment which will be explained later on in this chapter. Around this experiment, the personal characteristics will be questioned. Lastly, respondents will be asked whether they are willing to use the peoplemover in the future.
Before executing this survey, it is important to define the research population and target group. As the peoplemover will be a public transport service, the research population is the (potential) public transport user. Additionally, there is a second reason for selecting the public transport users as the target group for the conducted survey. As stated preference research is about imaginary future scenarios, it is important the respondent is as good as possible able to imagine these scenarios. Current public transport users are better in this task than non-public transport users, because they are more aware of the contemporary problems public transport is facing.
As van Hagen & Exel (2012) explain, it is difficult to define exactly the users of public transport. Two-thirds of the Dutch population uses public transport at least once a year (van Hagen & Exel, 2012). On an average day, almost 7% of the inhabitants of the Netherlands is using public transport. Therefore, the research population of this thesis is set at 1,2 million. This include people that use public transport on a daily, weekly, monthly or even yearly basis. The one-third of the inhabitants of the Netherlands never using public transport is also not likely to do so when the peoplemover is introduced. Most of these people are strongly attached to the car or not capable of using public transport due to for example financial or physical constraints (van Hagen & Exel, 2012).
When it comes to demographic figures and other personal characteristics of public transport users, these where difficult to obtain for bus passengers. For passengers using the NS trains, this data is available. Therefore, when it comes to demographic and personal characteristics, the characteristics of train passengers is used. These are visible below in figure 4.1.

1.1
Sociaal demografische verschillen treinreiziger versus Nederlander
NS

	Klant NS	Nederland	Afwijking
Geslacht			
man	48%	50%	-2%
vrouw	52%	50%	+2%
Leeftijd			
4-11 jaar	10%	10%	-1%
12-17 jaar	8%	8%	+1%
18-24 jaar	13%	9%	+4%
25-34 jaar	15%	13%	+2%
35-44 jaar	15%	16%	-1%
45-54 jaar	15%	15%	-1%
55-59 jaar	7%	7%	0%
60-64 jaar	5%	7%	-1%
65+	12%	16%	-3%
	100%	100%	
Opleidingsniveau (vanaf 12 jaar)			
hoger onderwijs	38%	31%	+7%
middelbaar onderwijs	42%	47%	-5%
lager onderwijs	10%	12%	-2%

Figure 4.1 Social-demographic differences between train passenger and Dutch population
Source: van Hagen & Exel, 2012, p.8

Regarding gender, with 52% slightly more women are found in the train compared to the entire Dutch population. As for age, it appears that young adults are strongly represented. This can be explained by the fact that students in the Netherlands can use public transport for free during most days of the week.
The fact that a relatively large number of students is using public transport results in a relatively highly educated research population. The subgroup of highly educated people is 7% larger than for the entire population of the Netherlands.
More details of the research population are unfortunately not available. The representativeness of the sample will thus be tested on the basis of gender, age and level of education.

Now the research population is defined, it is time to look in more detail into the stated preference methodology which is applied in this research.

4.3 Stated Preference

The review of literature and scientific theories in chapter 2, and the description of the peoplemover in chapter 3, has resulted in an operational model that will be tested by applying Stated Preference research.

4.3.1 The origins of stated preference

Stated Preference (SP) is a form of conjoint analysis. Conjoint analysis is a method that origins from the field of market research, as a tool to predict the future demand and preferences of consumers for a certain service or product and its attributes (Oppewal & Timmermans, 1993). Stated Preference is a type of conjoint analysis that is often used in the field of transport planning, to forecast the demand for future transport services (Sanko, 2001). Stated preference research is practically oriented, and beneficial for both transport operators and consumers. For both transport operators and consumers, there is a need to evaluate priorities among the different policy elements (Pearmain, Swanson, Kroes, & Bradley, 1991). Furthermore, there is a need to establish accurate forecasts of behavior in response to alternative policies (Pearmain, Swanson, Kroes, & Bradley, 1991). According to Hensher (1993, p.107) stated preference methods are widely used in research about travel behavior and practice to identify behavioral responses to choice situations which are not revealed in the market. The attribute levels offered by existing choices are modified to such an extent that the reliability of revealed preference models as predictors of response is brought into question (Hensher, 1993, p.107). In revealed preferences, the respondent is asked what he actually did. Revealed preference research is about actual and existing choice and preference decisions (Sanko, 2001). By using revealed preference, predictions for the future could also be made. A problem occurs in situations where a policy or product is completely new (Pearmain et al., 1991). For these situations, stated preference research is suitable. Stated preferences are given in an artificial future situation.

The researcher specifies a specific future situation, in which the respondent states his preferences among the different alternatives he or she gets provided (Sanko, 2001). As it is the researcher's mind that creates this future scenario, it is crucial to specify this scenario according to certain guidelines.

After discussing the disadvantages of stated preference research, the further design of the research method will be elaborated.

4.3.2. Disadvantages of stated preference

If carried out perfectly, stated preference perfectly predicts future revealed preference. There are some reasons this 100% "perfection" is difficult to achieve. Some biases are well-known (Sanko, 2001):

- Respondents try to justify their actual behavior. In other words, they tend so make widely accepted answer rather than their real opinion.
- Respondents try to control policies.
- What people state they would do in a certain situation can differ from what they actually would do.

Pearmain et al. (1991) emphasize this last constraint. They state there is a potential difference between statements of preferences and actual behavior.
Luckily, the tension of people to differ their stated preference from actual preferences disappears to a large extent when their preferences are being asked indirectly. In conjoint analysis, the preference for one attribute level is always linked to consequences for other attributes. For example, a respondent can choose for a cheaper fare, but the consequence is a lower frequency. Hereby, the attributes are not questioned directly but always in relation to other attributes.

According to McFadden (1987, p.277) the major challenges of stated preference research are:

'*(1) the design of laboratory techniques which elicit responses containing reliable information on market behavior, (2) the development of methods for translating experimental data into market forecasts and (3) convincing validation of the forecasts that result.'*

4.3.3. Stated Preference Design

Hensher (1993) describes six tasks in developing a stated preference design, that to a large extent overlap with the six stated preference phases as described by Sanko (2001). Additionally, the handbook of Pearmain et al. (1991) is used for developing the stated preference design.
Therefore, the steps in these papers are combined into six steps for development of the Stated Preference design of this masterthesis.

<u>Step 1 to 3:</u>
The steps include the identification of the set of attributes, selecting the measurement unit for each attribute and the specification of the number and magnitudes of attribute levels (Hensher, 1993). These steps are already undertaken during the operationalization of the theoretical framework, which has resulted in the operationalization scheme. The level of measurement is added to this scheme, visible in figure 4.2. For the attributes coded as linear less, a higher score on this attribute is ought to be less preferred, with a linear negative relationship between the rating of the peoplemover and the score on this attribute. The strength of this relationship, meaning the correlation coefficient, will be calculated by applying linear regression.
For the attributes coded as discrete, it is not possible to estimate in advance whether or not a certain attribute level will be valued as more positive or negative.

Attribute	Measurement unit	Level range	Attribute Levels	Level of Measurement
Presence of steward	Presence of steward	Yes or No	Yes (score 0) No (score 1)	Linear (less)
Frequency	Maximum number of minutes between arriving at departing stop and actual departing time.	0-60	0 (on demand) 30 (every half hour) 60 (every hour)	Discrete
Stops and in-vehicle travel time	Possibility and flexibility of stops between point of departure and final destination, influencing the travel time (measured in comparison to cycling)	The number of stops between start and destination, possibly flexible	0 (direct, 0,5) Fixed (1,0) Flexible (1,5)	Discrete
Comfort	Perceived level of comfort	Passenger load	High (score 0) Low (score 1)	Linear (less)
Wifi	Availability of in-vehicle Wifi-network	Yes No	Yes (score 0) No (score 1)	Linear (less)
Price	Fare in euros, in comparison to regular public transport fare	50-150%	50% (score 0) 100% (score 1) 150% (score 2)	Linear (less)

Figure 4.2: Operationalization scheme with the attached levels of measurement

The total number of possible combinations of attributes can be found by multiplying the levels in SP research. 2 x 3 x 3 x 2 x 2 x 3 = 216. This number is too high to submit to the target group. Therefore, the number of combinations of attributes has to be reduced. This reduction process is part of step 4.

Step 4: Statistical Design

In the statistical design, the attribute levels are combined into an experiment (Hensher, 1993). Several sets of combinations of attributes are described, which can be compared by the respondent. These combinations of attributes are also called ‘profile’ or ‘treatment’ in the literature (Hensher, 1993). The notion ‘profile’ will be used for the remainder of this thesis.

Profiles can be ranked or unranked. Unranked profiles are more abstract, with an attribute mix that is not defined for a particular mode of transport (Hensher, 1993). Ranked alternatives are mode-specific. The profiles used in this stated preference experiment are ranked in the sense that all profiles are defined for the people mover. Profiles are generated by using statistical design theory, which combines the attribute levels. A ‘full factorial design’, describes all possible alternatives. As calculated above, this would lead to 216 profiles. In a ‘fractional factorial’ design, this number of profiles is reduced to researchable numbers. This fractional factorial design is obviously necessary for this research, but it is important to realize that this comes with the loss of some statistical efficiency (Hensher, 1993). The researcher has to assume that certain interaction effects among the different attributes are not statistically significant.

This is a reasonable, but non-testable assumption (Hensher, 1993, p.115).

The benefit of a fractional factorial design is that a large number of attributes and levels can be examined, with usage of only one experimental design (Pearmain, Swanson, Kroes, & Bradley, 1991).

These authors state that normally a number of 9 to 16 alternative profiles is acceptable.

The experimental design of the stated preference experiment in this thesis is ‘orthogonal’.

This means that the attributes presented to the respondents are varied independently from one another (Pearmain et al., 1991, p.29). The advantage of an orthogonal design is that the importance of the individual attributes can be analyzed more easily, because multi-collinearity between these attributes is prevented (Pearmain et al., 1991, p.29).

There exist different types of fractional factorial designs, depending on the presence of interactions between different attribute levels. In a two way interaction, the individual's response alters with changes in the combinations of two attributes (Pearmain et al., 1991, p.34). For example, a positive two way interaction results in the fact that the combined effect of both attributes being at a good level is greater than the individual effects (Pearmain et al., 1991, p.34). For the feasibility of this research, there are no two-way interaction effects considered to be present. This has been taken into account when selecting the attributes. All attributes and their levels can occur independently of each other. It is important to realize that main effects explain 80% of the response variance, with two-way interactions between attribute levels explaining only 3%-6% (Pearmain et al, 1991, p.37). With this, relatively basic, research design, the vast majority of the information can be obtained.

The attributes and attribute levels of figure 4.3 are converted into an SPSS data file. This file is visible below:

	Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure	Role
1	Steward	Numeric	8	2	Aanwezigheid ...	{1,00, Ja}...	None	10	Right	Unknown	Input
2	Frequentie	Numeric	8	2	Frequentie	{1,00, On d...	None	12	Right	Unknown	Input
3	Reistijd	Numeric	8	2	Haltes en reistijd	{1,00, Direct...	None	10	Right	Unknown	Input
4	Comfort	Numeric	8	2	Comfort	{1,00, Hoog}...	None	10	Right	Unknown	Input
5	Wifi	Numeric	8	2	Aanwezigheid ...	{1,00, Ja}...	None	10	Right	Unknown	Input
6	Ritprijs	Numeric	8	2	Ritprijs in vergel...	{1,00, 50%}...	None	10	Right	Unknown	Input
7	STATUS_	Numeric	8	0		{0, Design}...	None	10	Right	Unknown	Input
8	CARD_	Numeric	8	0		None	None	10	Right	Unknown	Input

Figure 4.3: The data for the fractional factorial design

The used SPSS software does not allow to include interactions between attribute levels. For feasibility reasons is therefore chosen for a so called 'resolution 4 plan'. This is a type of fractional factorial design that allows the estimation of main effects only (Pearmain et al, 1991, p.37). All interactions are therefore assumed to be negligible (Pearmain et al, 1991, p.37). The stated preference design of this thesis is therefore referred to as a resolution level 4 design, with the smallest possibilities to discriminate interaction effects (Pearmain et al, 1991, p.35).
The risk of this design is that 'confounding interaction effects' might not be detected. If interaction effects between attribute levels of different attributes are significant, their effects in a fractional factorial design will be loaded onto the individual main effects (Pearmain et al, 1991, p.35). This would lead to false results.

The orthogonal fractional factorial design is designed by using SPSS statistical software. This resulted in 16 peoplemover profiles by which the main effect can be analyzed after the data is obtained. These profiles are visible in the figure below:

Varianten van de peoplemover

	Card ID	Aanwezigheid Steward	Frequentie	Haltes en reistijd	Comfort	Aanwezigheid Wi-Fi	Ritprijs in vergelijking met huidig OV
1	1	Nee	Ieder uur	Vaste haltes (1,0)	Laag	Nee	50%
2	2	Nee	On demand	Flexibele haltes (1,5)	Laag	Nee	50%
3	3	Nee	Ieder uur	Direct (0,5)	Hoog	Nee	150%
4	4	Ja	On demand	Direct (0,5)	Hoog	Ja	50%
5	5	Nee	Elk half uur	Direct (0,5)	Laag	Ja	50%
6	6	Ja	Elk half uur	Vaste haltes (1,0)	Hoog	Nee	50%
7	7	Ja	On demand	Flexibele haltes (1,5)	Hoog	Nee	50%
8	8	Nee	On demand	Direct (0,5)	Laag	Ja	50%
9	9	Ja	Ieder uur	Direct (0,5)	Hoog	Ja	50%
10	10	Nee	Elk half uur	Flexibele haltes (1,5)	Hoog	Ja	150%
11	11	Nee	On demand	Vaste haltes (1,0)	Hoog	Ja	100%
12	12	Ja	Elk half uur	Direct (0,5)	Laag	Nee	100%
13	13	Ja	On demand	Direct (0,5)	Laag	Nee	150%
14	14	Nee	On demand	Direct (0,5)	Hoog	Nee	100%
15	15	Ja	Ieder uur	Flexibele haltes (1,5)	Laag	Ja	100%
16	16	Ja	On demand	Vaste haltes (1,0)	Laag	Ja	150%

Figure 4.4: The orthogonal design showing the different profiles which are presented to the respondents.

<u>Step 5: Translation of the statistical design</u>

In this step the statistical design is translated into a set of questions and show cards for execution in the data collection phase.

The aim of this research is not to estimate future travel demands of the people mover. The aim of this research is to identify the preferred attributes and their levels of the peoplemover for different respondent subgroups. This influences the type of response that is required, the so called response dimension (Hensher, 1993). Response strategies in stated preference can be generally divided in two groups: preference and choice response.

In a preference response, the respondent indicates his or her preferences among a set of combinations of attributes (Hensher, 1993, p.109). This is a judgmental task, where the respondent can show his preferences on a ranking or rating scale.

The choose response is also referred to as a first-preference response task. Here, no information is sought about the alternatives which are not chosen. The individual is asked to choose just one of the presented profiles (Hensher, 1993, p.109). Stated choice experiments are feasible for predicting future market shares or travel demand (Hensher, 1993). The disadvantage of stated choice experiments is that no information is provided about the alternatives which are not chosen.

The interest of this thesis is not to define future travel demands, but centers on the attitude of respondents towards the peoplemover attributes. For this aim, rating or ranking response strategies are most suitable. In a ranking experiment, the respondent orders the presented peoplemover profiles based on his or her preferences. In this strategy, all profiles are presented at ones and the respondent is asked to order them (Pearmain et al, 1991). The disadvantage of ranking response, is that only information is provided about the order of preferences and not about the degree of preferences.

Ratings therefore present the richest response data because information on both order and degree of preference is generated (Hensher, 1993, p.111). Because of the research aim, richness of information provided by rating response and the relatively high number of profiles, the ratings response strategy is found most suitable for this thesis. Pearmain et al (1991, p.26) refer to this approach of measuring utility as 'functional measurement'. The given marks by the respondents can be transformed into plausible probabilities of choice. For example, a score of mark is transformed into a 0.1 probability. By doing so, a multiple linear regression model can be constructed (Pearmain et al, 1991). The SPSS software, as explained later on, automatically performs this transformation. The respondent will be asked to rate all 16 profiles individually on a 10 point scale.

Some critics about preference response strategies is that they are unrealistic or artificial. In the real world individuals are only able to select one option, and do not bother about the appreciation of the alternatives (Hensher, 1993).

The questions, or show cards, that will be presented in the stated preference experiment are also visible in figure 4.3. Each card-ID will be a different how card in the survey.

The separate show cards can be found in appendix 8.2.

Before proceeding to the actual executional phase, the questionnaire is piloted first by colleagues of CROW and friends and family. Hereby, the suitability of the experimental design as well as the clarity of the questions was confirmed, with a few minor changes. The largest complains where about the high number of sixteen peoplemovers that have to be rated. Respondents sometimes get confused or bored by so many different peoplemovers.

Unfortunately, this could not be solved because the number of 16 different combinations of attributes was the absolute minimum to come to generalizable results. For this reason, also no holdout cases are included in the design. Including holdout cases is a tool to verify the ratings attached to the other peoplemovers. With test respondents already complaining about the high number of different peoplemovers, it has been chosen not to include holdout cases.

For each profile the respondents were asked to provide a rating, ranging from 0 to 10, by swiping a toolbar. An example question is presented below.

Peoplemover nr.	**1**
Aanwezigheid Steward	Nee
Frequentie	Ieder uur
Haltes & Reistijd	Vaste Haltes (Net zo snel als de fiets)
Comfort	Laag
Aanwezigheid Wi-Fi	Nee
Ritprijs in vergelijking met huidig OV	50%

Welk cijfer zou u deze peoplemover geven?

Erg slecht Gemiddeld Goed

1 2 3 4 5 6 7 8 9 10

Figure 4.5: Example question

Data collection

The data for this research is collected by conducting a survey that includes the stated preference experiment. This survey has been held among a sample of the research population.
According to Pearmain et al. (1991, p.60). Sampling is concerned with two basic questions: who to interview and how many interviews?
The target respondents are already defined to some extent before. The survey is prepared for public transport users in the Netherlands. The reason for this is that they are probably more aware of the constraints of current public transport and therefore better able to estimate the effects of the different people mover attributes. Respondents mostly using other transport modes are also interesting in the sense that they can be questioned whether they are willing to transfer to public transport if their favorite peoplemover would be realized. This are the so called potential public transport users. This question is included in the final stage of the survey.
The experimental unit of this research is thus a public transport user in the Netherlands.
The research population are public transport users in the Netherlands.

The following variables of these experimental unites are found to be relevant for this research and are included in the survey:

- Gender
- Age
- Car ownership
- Level of education
- Possession of a driving license
- Possession of a public transport subscription
- Current level of public transport use
- Previous use of automated vehicle
- Distance to nearest bus stop
- Current transport towards nearest bus stop
- Urbanity of municipality of residence

When it comes to the sampling size, two types of variation in responses show up. The first type of variation occurs within each interview. Sufficient data has to be gathered within each interview. As described above, the number of 16 different peoplemover profiles in the survey is the minimum number for making valid statements about the total of 216 different peoplemover profiles. Therefore, the respondents have to rate each of the 16 presented peoplemovers.
The second type of variation with regard to sample size occurs between individuals, and is related to the representativeness of the sample for the whole population. A representative sample shows characteristics which are typical for those of the entire relevant population (McClave, Benson, Sincich, & Knypstra, 2011).
The respondents in the sample are not randomly selected. Various methods to reach a sufficient number of respondents are used. Most importantly, a panel of public transport users of research company Panteia is deployed. This panel is founded several years ago and contains about 10.000 panelist, which are mainly frequent public transport users interested in improving public transport services. Of these 10.000 panelists, an invitation to participate in the survey is send to 3.000 panel members. As the panel has not been supplemented by new members, the average age of the panelist is relatively high. This is partly compensated by the other survey collection methods. Whether the sample is still relatively aged will become clear in the external validity analysis, described in paragraph 4.4. The other collection methods contributed for about 60 surveys together. Those are explained below:

- A message on Linked-in. Linked-in connections are able to respond to the survey by clicking on the provided link. Whether the respondents belong to the target group is ensured by the introduction questions: 'How urban do you use public transport?'
- A message on my personal Facebook page. Friends and friends of friends are able to respond by clicking on the provided link. Based on the same principles as the message on Linked-in. The difference between Linked-in and Facebook is that the connections on Linked-in are often from the field of sustainable urban development or transportation. The respondents of Facebook are just friends from all kind of expertise.
- Netwerk Duurzame Dorpen (NDD). NDD is a nationwide network of Dutch villages with provincial support centers, working towards a sustainable future. Experts, partners, municipalities and thematic groups are collaborating to foster sustainable innovation and knowledge development.
  NDD was approached for this survey because they are also active in the field of innovative transportation, by looking for new transportation forms for rural areas in the Netherlands. NDD have posted the survey on their website, newsletter, Facebook and Twitter.
- Overijsselse Vereniging Kleine Kernen (OVKK). More than 130 local interest groups, village administrations, and many other parties have collectively joined the association of villages in the province of Overijssel. Together they strive for a sustainable and lively countryside, including the improvement of public transport services. The OVKK, like the NDD, have posted the survey on their website, newsletter, Facebook and Twitter.

Step 6: Selection of an appropriate estimation procedure – Data analysis

Multiple linear regression is most common and suitable for analyzing rating response. Utility is commonly constructed by a linear model, where the combination of attributes is additive (Pearmain et al., 1991). The partial utilities for each attribute level in a certain combination of attributes can be summed, together with the model constant, to obtain the utility of a certain profile.
The utility of a certain set of attributes can therefore be estimated by the following formula:

$U_i = a_0 + a_1X_1 + a_2X_2 ....a_nX_n$ with:

U_i = utility of option i
$X_i ....X_n$ = product attributes
$a_1....a_n$ = model coefficients
a_0 = model constant

The model coefficients can be seen as attribute weights. A_0 is the 'starting point', representing the basic bias towards or against the product.

The partial utilities which are necessary for determining the utility of each peoplemover are calculated by linear regression, using the conjoint modus of SPSS software.
With the SPSS syntax option, the ratings of the respondent for each peoplemover are linked to the orthogonal design. Hereby, the ratings for the peoplemovers are attached to the attributes behind those peoplemovers. The syntax used for making this 'link' is visible in the figure below:

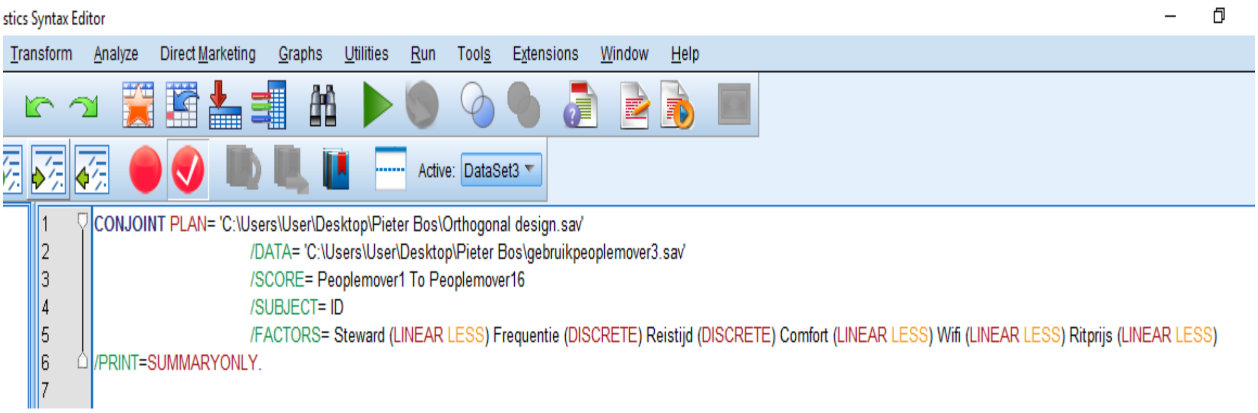


Figure 4.6: The syntax used for linking the data to the orthogonal plan, with which the conjoint analysis is executed.

The file behind the 'conjoint plan' contains the orthogonal design. This is the fractional factorial design in which the attributes of each peoplemover profile are described. The 'data' file contains of the data as obtained from the respondents. 'Score' describes that the answers given by the respondents have to be interpreted as ratings, and 'peoplemover1 to peoplemover16' means that the stated preference experiment only includes these questions. The 'subject' describes the attached ID number to each respondent.

Behind ‘factors’ is described on which level of measurement the variables are defined, with which the software has to deal. For steward, score 1 means ‘yes’ and score 2 means ‘no’. Therefore, a higher score means a lower preferred situation. Therefore, this variable is described as linear less. The same applies to Comfort, Wi-Fi and Travel fare. A higher score on those variables means a lower preferred situation. For the variables Frequency’ and Travel Time, it is not clear beforehand which score is preferred. Therefore, these variables are described as ‘discrete’. The selection of one attribute level is not expected to be more preferred than another attribute level of this attribute. The software is able to analyze the importance of each attribute when it comes to the preferences of respondent, as well as the partial utilities for each attribute level.
The importance values show which attribute is found most important by the respondents. This value is calculated by the extent to which a certain attribute influenced the rating people attached to the peoplemovers. In total, the sum of importance values for all attributes is always 100. Therefore, the importance values have to be interpreted as relative rather than absolute numbers. The importance values are always related to the importance values of the other attributes, as the sum of all attributes is always 100.
The second value that will be often discussed in the result chapter is the utility estimate. The utility estimates present the partial utilities for each attribute level within each attribute. This value is not about the importance respondents attach to an attribute, but about the preference and appreciation people attach to the individual attribute levels of each attribute. So although a certain attribute might not be important to someone, it still becomes visible how this person rates the individual attribute levels within this attribute.
As explained before, travel fare, comfort, availability of Wi-Fi and steward attendance are defined as being linear attributes. For these attributes, the partial utilities are calculated by the coefficients of the linear regression that is conducted by the SPSS software. It shows the correlation between the rating of the peoplemover and the specific attribute levels.
Travel time and frequency are defined as being ‘discrete’ attributes. This means the partial utilities can, in contrast to those of the linear attributes, have both positive and negative values. What is important to know is that for discrete attributes, the sum of the partial utilities is always zero. This means the partial utility for these attribute levels are relative rather than absolute figures. They show the partial utility of a certain attribute in relation to the utility of the other attribute levels within that attribute.

The result of these analysis will be presented in chapter 5.

4.4 Internal validity, external validity & reliability

In this paragraph the validity and reliability of the research will be discussed. In the results chapter, the research results will be discussed in the light of the validity limitations as will be described below.

4.4.1 Reliability

The reliability of the research is the extent to which it is possible to do the same research again with the same outcomes (Vennix, 2011). In stated preference research, reliability is thus is the ability to reproduce the measured preferences. Pearmain et al. (1991, p.80) claim that research shows a good level of reliability for the most common stated preference methods. These authors state that correlations between the preferences given by the same people at different times mostly have values around 0.9 on a scale from 0.0 to 1.0.

Reliability is about the possibility of repetition of the research (Vennix, 2011). Can the research be conducted in the same way again and will this deliver the same results? In a perfect reliable research, the results are independent of the researcher and the used measurement tool (Vennix, 2011, p.186). For this reason, all steps that are undertaken during the research are documented. The literature research and operationalization is described in detail in the first chapters. This chapter describes the methods, and the outcomes are visible in the next chapter. Furthermore, all the data can be obtained with permission of the Radboud University, Panteia and the author. Additionally, the applied questionnaire and a number of relevant tables is visible in appendix 8.5. This extensive documentation makes it hypothetically possible to conduct exactly the same research by following exactly the same research steps and check if the same results are found.

4.4.2 Internal Validity

The internal validity of stated preference is about the descriptive quality of the model (Pearmain et al., 1991). A research is of sufficient internal validity if the 'measuring instrument' is actually measuring what it should measure (Vennix, 2011). For this research, the developed set of attributes must be a good reflection of the relevant attributes for a vehicle like the peoplemover. By conducting an extensive literature research and structured operationalization this is assured in chapter 3.

It is important to notice that stated preference measures the preferences of respondents in a non-existing future situation. Therefore, the internal validity cannot be measured directly. A tool to estimate the internal validity, is to compare coefficients obtained from RP data and SP data from the same sample and in the same context (Pearmain et al., 1991, p.80). Research conducted in this field show good results for most cases. For this research, revealed preference data is unfortunately not available. By conducting the structured operationalization of the relevant peoplemover attributes, the internal validity is assured in the research design as much as possible.

For conducting an analysis like stated preference, which is based on linear regression techniques, the data should comply with three assumptions for parametric data (Foster, Barkus & Yavorsky, 2006). These three assumptions are (Foster, Barkus & Yavorsky, 2006, p.5):

- Compliance with a normal distribution.
  For this research, the ratings of the peoplemover should be normally distributed.
- The dependent variable has to be measured on a ratio or interval scale.
  For this research, the dependent variable is the rating of the peoplemover.
- The scores on the dependent variable show homogeneity of variance between groups of participants

These three assumptions for parametric data will be tested in the remainder of this paragraph.

Compliance with a normal distribution
To determine whether the peoplemover comply to normal distributions, it is important to know the standard deviations.

All the peoplemovers show relatively high standard deviation statistics in between the value of 2,4 and 2,8. This means that although the results have a central tendency towards different means for each peoplemover, the 95% confidence interval covers the entire range from 0 to 10. When it comes to the variance of the rating of each peoplemover, it can be concluded with 95% certainty that the mean value lies in between 0 and 10. The means of each peoplemover have therefore no statistical value, as the possible rating range only from 0 to 10. If a lower standard deviation is demanded, a larger sample is required. The standard deviation table is visible in appendix 8.3. The variance in research results can be displayed visually attractive by box-plots, which also present possible outliers. Boxplots divide the data in quartiles with each quartile containing 25% of the recorded data (McClave, Benson, Sincich, & Knypstra, 2011). The second quartile, at 50% of the data records, logically is the fiftieth percentile. The box contains the second and third quartile, which is the middle 50% of the responses. The inner fences are at 1,5 interquartile range (IQR) (McClave et al., 2011). Responses outside the inner fences are possible outliers. For peoplemovers 4 until 9 there are possible outliers. The reason there are only possible outliers for these peoplemovers is that these peoplemovers have higher mean scores than the other peoplemovers. Therefore, there is ‘space’ for possible outliers at the bottom of the boxplots. For normal, hill-shaped distributions the possible outliers outside the inner fences consist of less than 5% of the observations for this variable.

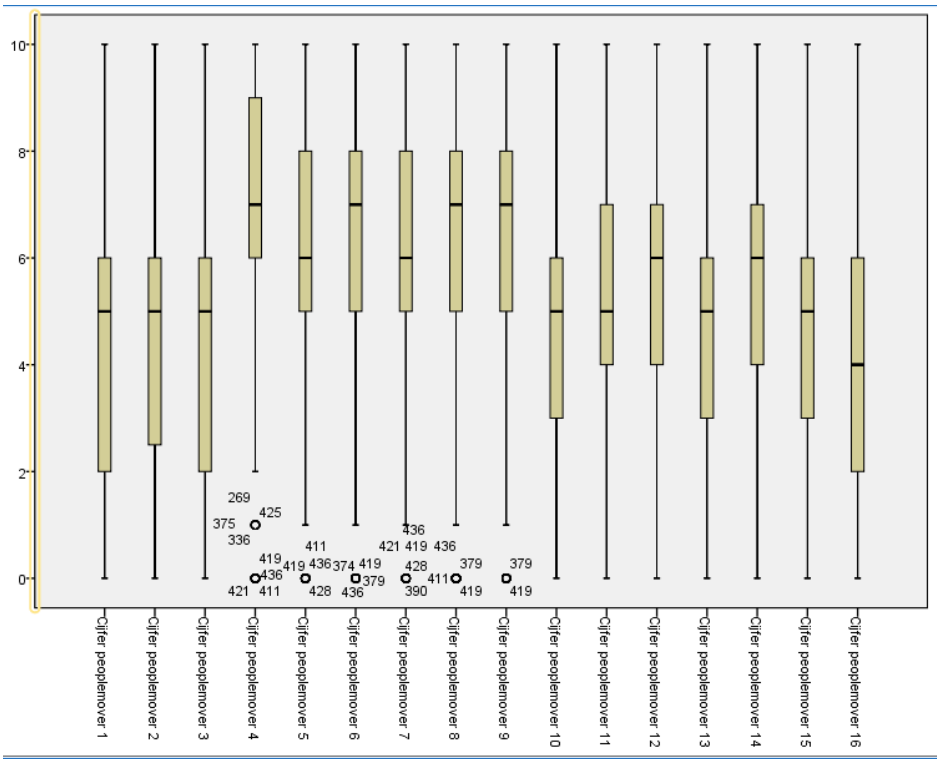


Figure 4.7: Boxplots for the peoplemovers.

The number of outliers for each peoplemover is visible in the table in the validity appendix 8.3.

As is visible in figure 4.7, peoplemover 4 consists 31 extremes, equal to 8,1% of the observations. This suggests that the distribution of the observations for this variable does not comply with the definition of normality (Foster, Barkus & Yavorsky, 2006).

Whether the peoplemovers indeed do not comply with the definition of normality, can be determined by checking the values for skewness and Kurtosis. For each peoplemover, these values are visible in the table presented in appendix 8.3. If the peoplemover rating would be normally distributed, the values for kurtosis and skewness would be around zero. What becomes clear, is that for each peoplemover at least one of these two values is high. Skewness deals with the position of the peak in the distribution, whether or not the peak is in the center (Foster, Barkus & Yavorsky, 2006). Positive values for skewness mean an accumulation of scores on the left side of the distribution, or in other words a right-skewed distribution (Foster, Barkus & Yavorsky, 2006, p.5). Negative values logically mean an accumulation of scores on the right side of the distribution, or in other words a left-skewed distribution (Foster, Barkus, & Yavorsky, 2006).
Kurtosis deals with the height of the tails of the curve, whether or not the distribution is too flat. For example, peoplemover 1 has relatively low skewness, but relatively high kurtosis. For peoplemover 6 it is the other way around. This distribution has a relatively low kurtosis but a relatively high skewness.

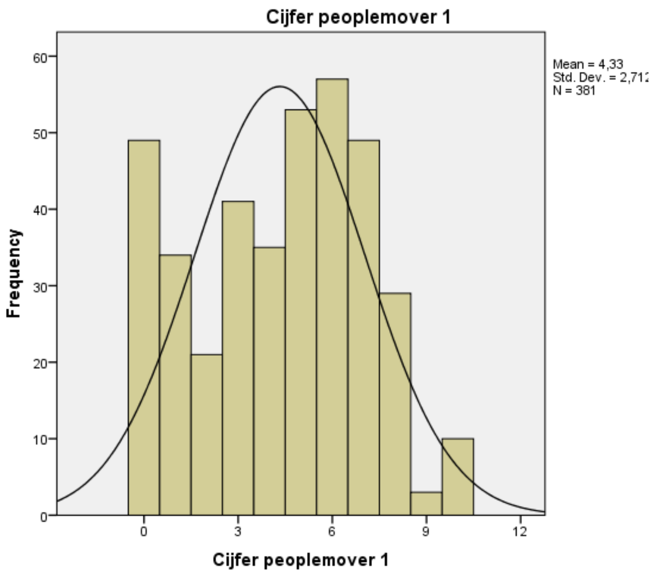


Figure 4.8: Peoplemover 1 distribution with high skewness but low kurtosis

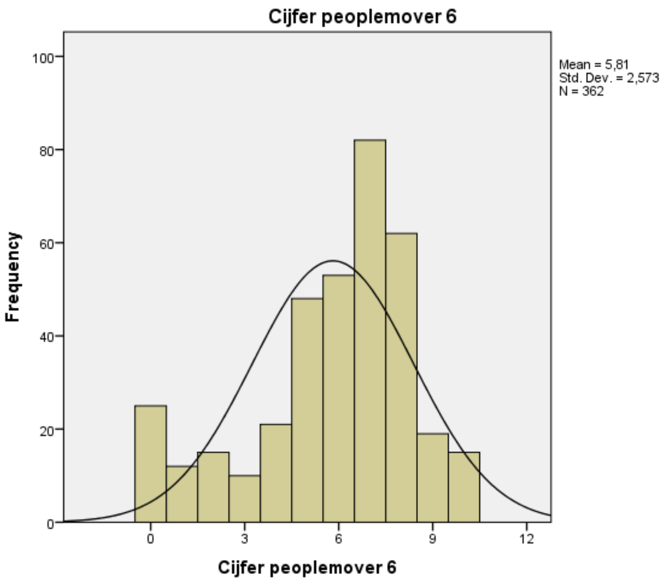


Figure 4.9: Peoplemover 6 with low skewness but high kurtosis.

It can to be concluded that the assumption of normality is not been fully met by the research sample. Whether the assumption of normal distribution is met for the entire population where this sample is drawn from is unfortunately not known.

Measurement of the dependent variable on interval or ratio scale

The second assumption for parametric data according to Foster, Barkus & Yavorsky (2006) is whether or not the dependent variable is measured on either interval or ratio scale. The ratings of the peoplemover or on ratio or at least interval scale. The dependent variables of the different peoplemovers are at least interval scale because there is a clear zero point (rating 0) and the differences between the score at one point of the scale is the same as the differences on another point of the scale. The dependent variable is arguably of ratio scale, as it can be said that a mark of for example 8 is twice as 'good' as a mark of 4.

What can be concluded for sure is that this research does comply with the second assumption for parametric data.

Homogeneity of variance between groups of participants

The third assumption for parametric data requires that the scores on the dependent variable show homogeneity of variance between groups of participants (Foster, Barkus & Yavorsky, 2006, p.5). This can be tested by executing the so called Levene's test for homogeneity. These test shows that for the different values of education, the variance is homogeneous for almost every peoplemover. This table is visible in appendix 8.3 as well.

However, for the values of age the variance is not homogeneous for almost every peoplemover. This means most of the peoplemovers are heterogeneous when it comes to variance between groups of participants.

Therefore, we have to conclude that this assumption for parametric data has not been completely met as well. Two out of the three assumptions for parametric data of Foster, Barkus & Yavorsky (2006) are thus not as would be preferred.

The influence of this conclusion about the three assumptions for parametric data on the research results, will be discussed in chapter 5.

4.4.3 External validity

External validity in stated preference is about the ability to predict actual behavior using the designed model. In the article of Green & Srinivasan (1978), various studies are presented in which the estimated aggregate market shares are sufficiently close to the actual shares (Pearmain et al, 1991, p.81). The external validity of a research is determined by the representativeness of the survey results for the entire population (Vennix, 2011). A sample is representative if the characteristics of the research population are sufficiently similar to the characteristics of the sample. When it comes to representativity, a sufficient sample size is important. The necessary sample size depends on the research population size and the level of variance of the data that is considered acceptable. During this research, great effort has been made in obtaining as much respondents as possible. Given the available amount of time and resources for this master thesis project, the number of respondents reached is satisfactory. In total, 440 people have responded to the questionnaire. The number of respondents (N) decreased during the questionnaire. Whereas peoplemover 1 has a N of 381, peoplemover 16 has only N 344. At the end, 320 people completed the entire questionnaire, which is equivalent to 78% of the people that participate.

Despite of the high number of respondents, the research still showed high levels of variance, as is discussed before.

The sample characteristics are compared to the population characteristics as visible in figure 4.1. This can be verified by executing so called chi-square tests.

What can be said first about age is that there are no respondents below 18 years of age. So although children are 18% of the public transport users, these are not included in this research. Furthermore, the categories of age and education that are questioned in the survey have to be adjusted into the same categories as are used in the description of the research population, shown in figure 4.1. The transformation of the categories for education is visible in figure 5.4. 'Basisonderwijs' and 'VMBO' are transformed into 'Primary education'. 'Havo', 'Vwo' and 'MBO' are transformed into 'Secondary education'. 'HBO' and 'University' are transformed into 'Higher education'.

```
RECODE opleiding (1=1) (3=2) (4=2) (2=1) (5=2) (6=3) (7=3) INTO opleidingnew.
VARIABLE LABELS  opleidingnew 'Opleiding'.
EXECUTE.
DESCRIPTIVES VARIABLES=opleidingnew
  /STATISTICS=MEAN STDDEV MIN MAX.
```

Figure 4.10: Transformation of the education variable into new variable values.

The table below shows the adjusted categories for the research population and the differences with the research sample in percentages.

Characteristic	Category	Research population	Sample	Difference research population and sample
Gender	Male	48%	55%	7%
	Female	52%	45%	7%
Age	4-18	18%	0%	18%
	18-25	14%	6%	8%
	25-40	22%	14%	8%
	40-65	34%	54%	11%
	65+	12%	26%	14%
Education	Higher education	42%	68%	26%
	Secondary education	47%	27%	20%
	Primary education	11%	5%	6%

Whether or not the differences between the research population and research sample cause the sample to be not representative, can be verified by Chi-Square tests. These tests, for the variables gender, age and education, are visible in the appendix 8.3.

What becomes clear is that all Chi-Square tests show a significance level below 0,05. This means the observed frequencies differ significantly from the expected frequencies. When it comes to gender, the proportion of men is too high. Regarding education, the sample is too highly educated leaving primary and secondary education under-represented. Finally, the sample is overage.

The groups of 40-65 and 65+ are overrepresented.
Therefore, it can be concluded that the sample is not representative for the research population when it comes to gender, age and education level. The research results can thus not be generalized for all the public transport users in the Netherlands.

On the other hand, the sample contains well-informed frequent public transport users. Although the results are not representative for the entire population of public transport users, it still provides useful information and clear indications. The fact that the sample indeed contains frequent public transport users, is supported by figure 5.7. 64% of the respondents is using public transport at least once a week. With 32% using public transport every day. This is almost 5 times more than the 7% that is using public transport every day for the entire Netherlands.

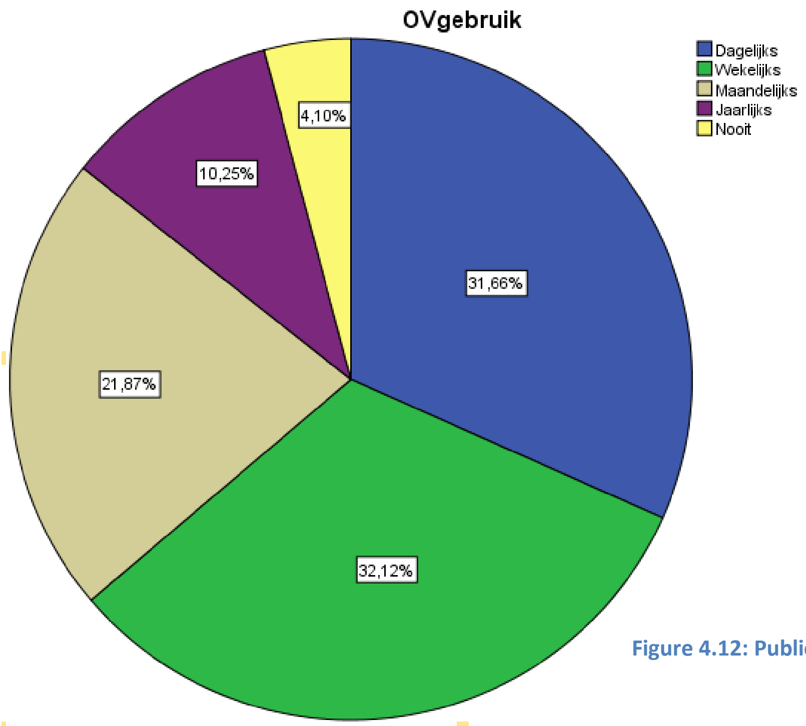


Figure 4.12: Public transport use.

4.5 Non-response

Non-response can have various negative effects on the validity of the research. As we have seen above, certain groups are underrepresented in the sample.

For the people reached out by the Netwerk Duurzame Dorpen, Overijsselse Vereniging Kleine Kernen (OVKK), personal Facebook page and personal LinkedIn page it is difficult to define the exact non-response. The reason for this is that it is not exactly known how many people are actually reached by these survey collection methods. What can be assumed, is that the non-response is very high for these data collection methods. The total number of surveys that was obtained by these collection methods was around 60, with a high share of students included. By the combined effort of NDD, OVKK, Linked-in and Facebook approaches, at least 600 people have to be reached. Assuming this number is about right, it would mean a non-response rate of 90%.

The remainder of the response was obtained by the OV-panel of Panteia. For this group of respondents, the non-response can be defined more clearly. The survey was send to a total number of 3000 panelists. This resulted in a number of about 380 new completed questionnaires. This is a response rate of approximately 12%, and thus a non-response rate of 88%.
There can be distinguished several reasons for this relatively low response rate.
First of all, the OV-panel is not frequently used during the last years. It is therefore possible that a number of panelists was not aware the panel is still active. Furthermore, panelists have possibly changed their contact details. Additionally, no reminders have been send to the respondents what could have caused people to miss the message.

A more general reason for the high non-response rate is possibly the non-attractive design of the survey. It is possible a number of people first checked what the survey was about, and did not feel like rating a large number of 16 peoplemovers.
Lastly, it is possible people are not attracted to the topic of self-driving buses. They might qualify it as an unrealistic innovation for which they are not willing to spend their time on.

There are two important negative implications of this high non-response rate. Firstly, elderly and highly educated people are overrepresented. Young, lower educated people are clearly underrepresented. By attaching different weights to the ratings of different response groups the problem of over- or underrepresentation can sometimes be compensated. However, the representation is distributed in such a way that this solution would not have made much of an impact. Therefore, the decision has been made to accept the fact that the sample is not representative but still contains useful information.

4.6 Research ethics

According to Farthing (2016, p.179), research ethics '*is about the basis, the values, on which decisions are made about the courses of action to adopt in any piece of research*'. Research ethics is about moral decisions, about right and wrong while conducting research.
Ethical issues occur in two aspects of the research design: the framing of the research and the practice of research (Farthing, 2016, p.179).
The framing of research concerns narrowing down research questions.
While narrowing research questions, decisions are partly made based on personal values or political opinions. This research started with the broad idea to find out what the possible contributions of automated vehicles could be to the accessibility of rural areas in the Netherlands. Afterwards, the research has been scoped towards public transport and the increasing first- and last mile problem.
It is important to realize that the selection and framing of this topic already reflects a personal value. To some extent, it is a personal opinion that the increasing first- and last mile in rural areas is a 'problem' that has to be solved. It can be said that my personal, political opinion is to some extent in line with the book of Karel Martens (2017) about transport justice. I agree to his opinion that accessibility should be provided for every citizen in the Netherlands, and that public transport is an important tool to achieve this. This proves that research is not value free in the absolute sense.

The second aspect of the research design where ethical issues often occur, is during the generation of data (Farthing, 2016, p.179). This has been done in compliance with the six rules of the ESRC Framework for Research Ethics 2012:

- Participants are fully informed about the purpose, methods and intended use of the research.
- The confidentiality of information supplied must be respected.
- The anonymity of participants are respected.
- Harm to participants is avoided.
- The independence of the research is clearly stated.
- Participation was voluntarily.

Most of the participants of this research are member of the public transport panel of research company Panteia. The confidentiality of information and the anonymity provided by these respondents, is confirmed again by signing a privacy agreement with Panteia. Of course, the ethical rules are used for every participant of this research.

5. Research results

What is the opinion of public transport users in the Netherlands with regard to the variable peoplemover attributes?

In this chapter, the research results will be discussed. First, descriptive statistics of the survey outcomes will be described. Afterwards, the results of the stated preference experiment will be given. Here, the general outcomes for the entire sample will be discussed first. Afterwards, distinctions will be made for several subgroups of this sample regarding to age, level of education, urbanity rate, distance to nearest bus stop, current public transport use and more. At the end of this chapter, the implications of the limited external and internal validity for the research results will be discussed.

5.1 Descriptive statistics

The pie charts of figure 5.1 and 5.2 show that the sample was relatively aged and highly educated. This can be directly explained by the fact that most of the respondents come from the panel of Panteia, which is already described in the last chapter. 68% of the respondents has completed higher education. Only 5% % is primary educated, leaving 27% secondary educated. Nationally, 12% is primary educated, 47% secondary educated and 31% higher educated (van Hagen & Exel, 2012).

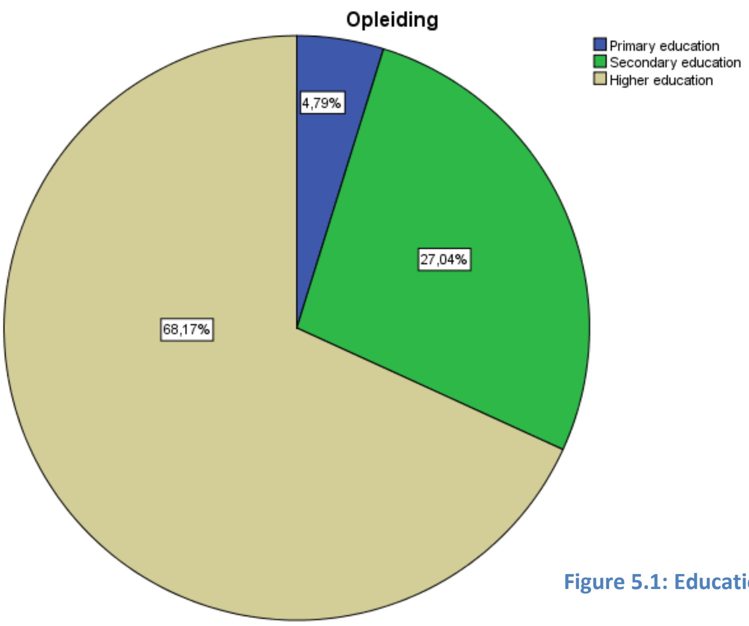


Figure 5.1: Education level of research sample

Crosstabs show that education does not seem to have much influence on public transport use. What it does influence, is car ownership. The higher educated people probably have a higher income as well. What can be concluded for sure, is that car ownership increases with higher education levels. Of the highly educated people, 67% is owning a car. In comparison, of the respondents with primary education, car ownership is 47%.

When it comes to age, the largest group consist of respondents between 40-65. A large share of 26% belongs to the 65+. The young people are not so much represented, with only 6% of youngsters. The implications of these representativity issues for the research results will be discussed later on.

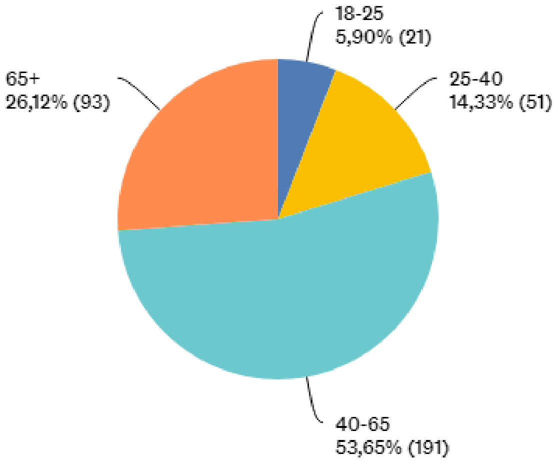


Figure 5.2: Age of the research sample

Regarding gender, it can be noted that 55% is male and 45% female. Most of the respondents live in what they see as strongly urbanized areas. 13,73% live in the most rural areas of the Netherlands, which are the areas the peoplemover concept is proposed for.

Furthermore, almost 80% has access to the nearest bus stop within 500 meters. For those people, the bus stop is within the described influence area. 8% of the respondents have to travel further than 1000 meters.

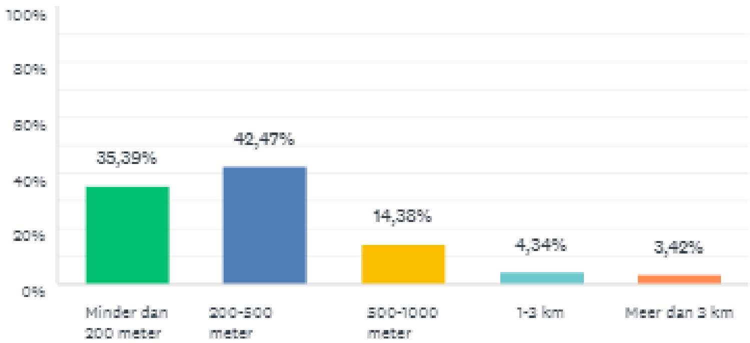


Figure 5.3: Distance to nearest bus stop

Especially for them, a first- and last mile solution like the peoplemover can be suitable and useful. At this moment, also because of their relatively short distance towards the nearest transport hub, most people (75%) use walking to cover their first mile. 7% use their bicycles to get to their nearest transport hub. The figures found for cycling are lower than in previous research conducted by (CVS, 2010, p.8).

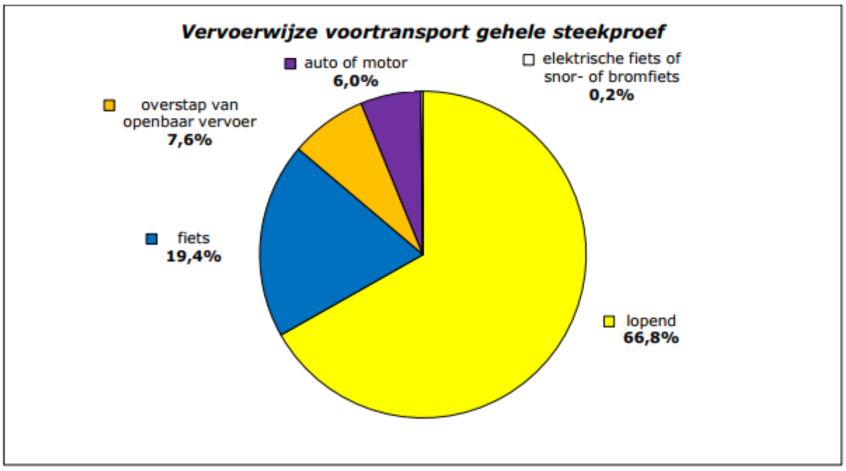


Figure 5.4: Mode of transport from home towards nearest bus stop. In the research of CVS (2010), cycling had a larger share than was found in this research.
Source: van der Blij, Veger & Slebos , p.8

Most of the respondents are frequent public transport users. 85% uses public transport at least every month. 10,25% use PT only once a year, and 4,1% never uses public transport. Therefore, the sample complies to the formulated target group of the research, which was public transport users in the Netherlands.

For this public transport use people have only sparsely previous experience with automated vehicles. Only 11% state to have previously used an automated vehicle, which is still quite a high number taking into account the low number of pilots that has been performed so far.

Interestingly enough, people do not seem to use public transport less often if the distance to the nearest transport hub increases. For example, of the 7 respondents that live more than 3.000 meter away from the nearest bus stop, 46% uses public transport every day. For comparison; people living less than 500 meters away, only 32% is using public transport every day. For this sample, distance does not seem to have much of an impact on public transport use. People living more remote from the nearest bus stop use public transport even more.
This may be explained by the fact that the panel of Panteia is composed of people that are interested in public transport and to a large extent support the use of it. Therefore, they might be willing to use public transport no matter the first-mile distance that has to be covered.

In contrast to distance, car ownership is influencing the use of public transport. 55% of the car owners is using public transport every week in comparison to 64% of the non-public car owners.
The way people cover their first mile does change if distance increases. This is presented in the table below:

Transport towards bus stop →	**By foot**	**Bicycle**	**Car**	**Other**	**I never use the bus**
Distance to bus stop					
Less than 200 meter	86%	0%	1%	4%	9%
200-500	81%	6%	0%	4%	9%
500-1000	60%	17,5%	3%	5%	14%
1-3km	10%	47%	5%	5%	32%
>3km	33%	20%	33%	0%	13%

Figure 5.5: Distance towards nearest bus stop in relation to the mode of transport towards this bus stop.

For the people within 500 meters of a public transport stop, more than 80% cover their first mile by foot. For the people traveling between 1 and 3 kilometer, by far largest share is for bicycles. For distances above three kilometer, the transport mode is splintered. People are traveling by car, bicycle and, surprisingly, by foot. It has to be mentioned that the number of cases was low for this category.

The first mile mode of transport is also influenced by age. From the group 18-25 year old, 96% is traveling by foot towards their nearest transport stop. For the other age groups, this figure lies in between 70 and 80%. However, young people are also more frequently living in urban areas and are thus covering shorter distances towards the bus stop.
The results and figures below show that the researched personal characteristics indeed influence travel decisions. This makes it likely that the preferences regarding the different attributes of the peoplemover will differ among the subgroups. After the discussion of the results for the entire research sample, we will see if these differences among the subgroups are indeed found.

5.2 Stated Preference entire sample

Now the descriptive statistics of the research sample are discussed, it is time to look at the outcomes for the stated preference experiment that is conducted. In this paragraph, these outcomes will be discussed for the entire sample.
Hereby will be looked at mainly two values: the importance values and utility estimates. The meanings of these values is explained in the methodology chapter.
In figure 5.5, the importance summary for the entire sample for each attribute is given. The y-axis of the bar chart consist of the average importance values of all respondents. These values are bundled together into the figure below.

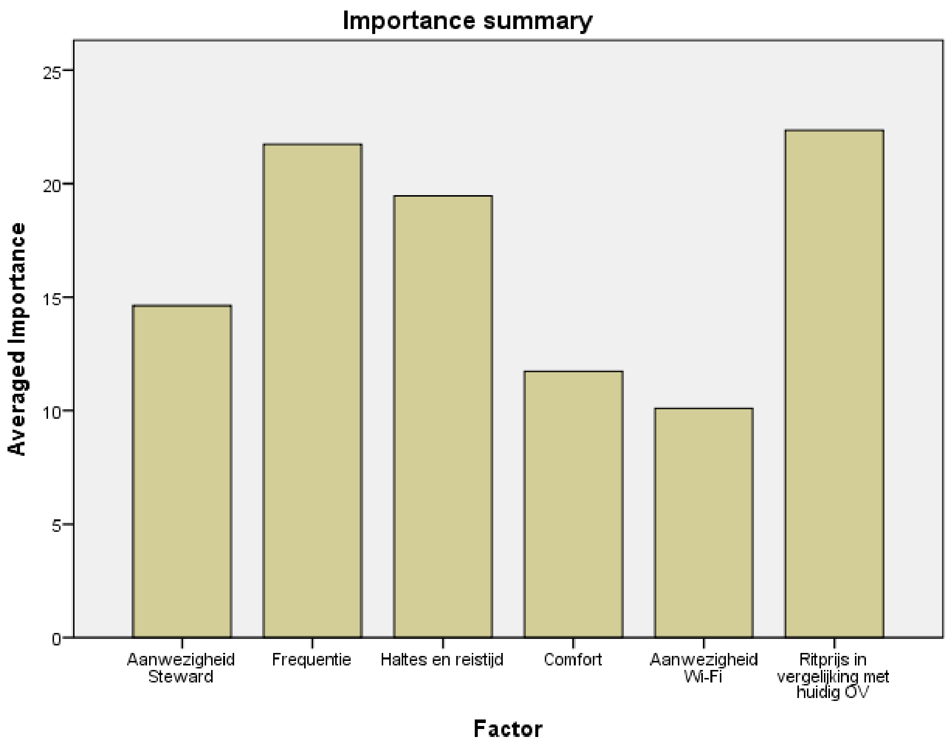


Figure 5.6: Bar chart of the importance values for the entire sample.

This shows that people attached the most value on fare and frequency. Travel time is the third most important attribute. The attendance of a steward, comfort and availability of Wi-Fi are found to be the least important. The figure below shows the partial utility for each attribute level within each attribute. The higher the partial utility figure, the more positive the respondents where about this attribute level. The lower the partial utility figure, the more negative the respondent was about the attribute level. These partial utilities for each attribute will be discussed in more detail later on. First the other relevant output tables will be explained.

Attribute	Attribute level	Utility Estimate
Frequency	On demand	0.072
	Every 30 minutes	0.310
	Every hour	-0.381
Travel Time	Direct (0.5)	0.473
	Fixed stops (1,0)	-0.218
	Flexible stops (1,5)	-0.256
Steward	Yes	-0.477
	No	-0.955
Comfort	High	-0.537
	Low	-1.075
Wi-Fi	Yes	0.321
	No	-0.642
Travel Fare	50%	-0.717
	100%	-1.434
	150%	-2.150

Figure: 5.6: Partial utilities for entire sample

Attribute	Importance V
Travel Fare	22,351
Frequency	21,733
Travel time	19,455
Steward	14,624
Comfort	11,741
Wi-Fi	10,096

Figure 5.7: Importance values for entire sample.

On figure 5.7, the numbers behind the bar chart above are provided. It shows that the difference in importance between fare, frequency and travel time is relatively small. These three attributes are found by far the most important. Fare is found twice as important as comfort and Wi-Fi, which are the two attributes that are found the least important by the respondent. The importance value of the attendance of a steward is in between the lower valued attributes and the higher valued attributes.

Attribute	Regression Coefficients
Steward	-0.477
Comfort	-0.537
Wi-Fi	-0.321
Travel Fare	-0.717

Figure 5.8: Coefficients table

The coefficients table shows the linear regression coefficients for those factors specified as LINEAR. For the attributes frequency and travel time, no linear relation was supposed.

This is confirmed by the reversal tables, visible below. A 'reversal' is a so called contradictory outcome. It occurs when a respondents assesses a higher rating to a peoplemover with a less preferable attribute level. For example, an individual gives a higher rating to a peoplemover without Wi-Fi than to exactly the same peoplemover with Wi-Fi included. Although reversals preferably occur as less as possible, it indicates that respondents are clearly less interested in a particular attribute. Reversals occurred by far most frequently for the attributes Wifi, steward attendance and comfort. The importance values table shows that exactly these three attributes are seen as least important by the respondents.
The relatively high number of reversals for 'travel fare' is, however, remarkably, because this attribute is rated as most important.

Number of reversals	Number of subjects
1	111
2	56
3	21

Figure 5.9: This table displays the number of subjects that have given number of reversals

Attribute	Number of reversals
Wi-Fi	97
Steward	92
Comfort	53
Travel Fare	44
Travel time	0
Frequency	0

Figure 5.10: Number of reversals

5.2.1 Partial Utilities

Frequency
This attribute was not coded as discrete which means the partial utilities could have both positive and negative values. The sum of the values is zero.
A travel frequency of once an hour was by far the least appreciated. The peoplemover is developed to cover a relatively short distance towards the nearest transport hub. It is therefore understandable that respondents are not willing to wait a long time for this short journey.

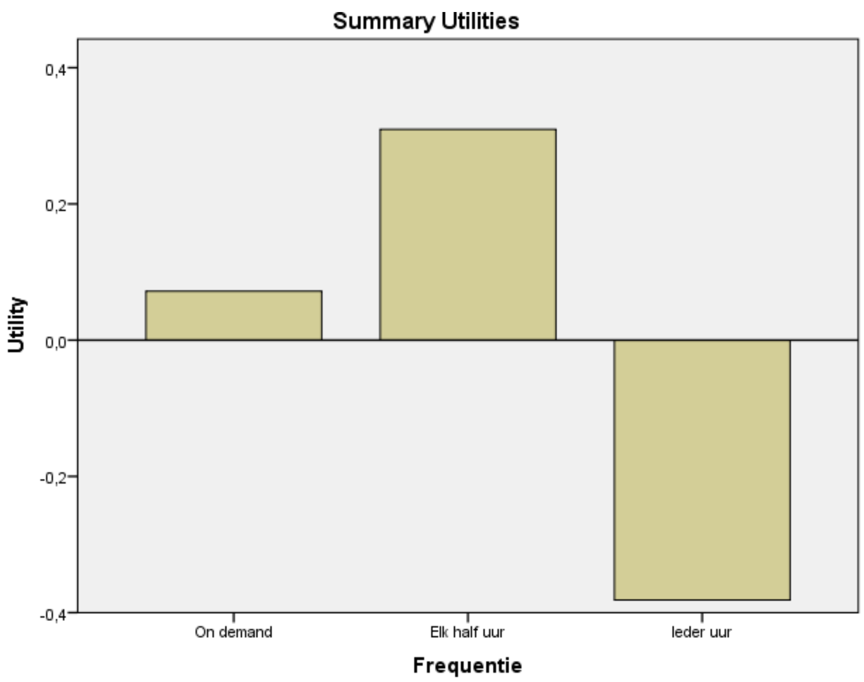


Figure 5.11: Partial Utility bar chart for the frequency attribute

Interestingly, on demand is rated lower than a frequency of every half hour. Possibly, people are not willing to pre-order a vehicle for such a short journey. It is also possible that this will change over time, as people will get more used to the concept of 'mobility as a service' where ordering a trip on your phone is rather easy. If an 'on demand frequency' is really not considered feasible by the potential users, this can have strong implications for the Automated Demand Responsive Transport Systems (ADRTS) that are currently being developed and frequently discussed in literature (Winter, 2015; Helmy et al., 2016). In the proposals of ADRTS's, such as the automated shuttle between Delft-Zuid and the Delft University Campus, departing only on demand is taken as a starting point from where the possible role for automated vehicles is further researched. Based on the results of this research, it can be argued that it would be feasible to conduct a prior study on whether or not departing 'on demand' is the best option. The results of this study show that an on demand frequency is not the most desired option for a peoplemover, regardless of age, gender, education and so on. However, an on demand system is considered to be more flexible and therefore most cost-efficient. This could be a reason to still choose for such a system.
For the peoplemover proposed in this research, a frequency of every half hour is appreciated the most. Departing only every 60 minutes is by far the least favorable attribute level.

Travel time and intermediate stops

Like frequency, travel time and intermediate stops is not coded as a linear attribute. This means the partial utilities could have both positive and negative values, with the sum of the values again being zero. When it comes to travel time and intermediate stops, the respondents were forced to decide what was more important to them: a short travel time, or the availability of intermediate, possible flexible, stops. The decision that the respondents made, is visible in the figure below:

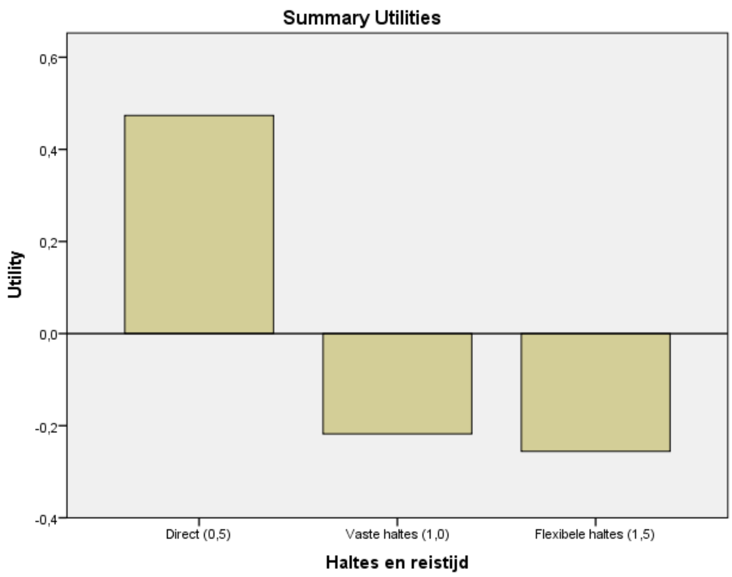


Figure 5.12: Partial Utility bar chart for the travel time attribute

The respondents clearly chose for travel time instead of intermediate fixed or flexible stops. With a positive partial utility of 0,473, traveling direct from the departing stop towards the final stops was by far the most favored attribute level. Fixed and flexible intermediate stops are both considered as being not feasible. A likely explanation is that the route the peoplemover will cover in the future, the first mile, is a relatively short distance of three kilometers maximum. Fixed or flexible intermediate stops would both lead to travel times comparable or slower than by bicycle, which would make the peoplemover a less attractive alternative.

Fare

In contrast to travel time and frequency, the travel fare is clearly a linear variable. The higher the fare, the more negative respondents were expected to rate the peoplemover. As visible in the figure below, this expectation came true. What has to be taken into account, is that 44 reversals where noted for this attribute. This means, respondents rated similar peoplemover with a higher fare more positive than those with a lower fare.

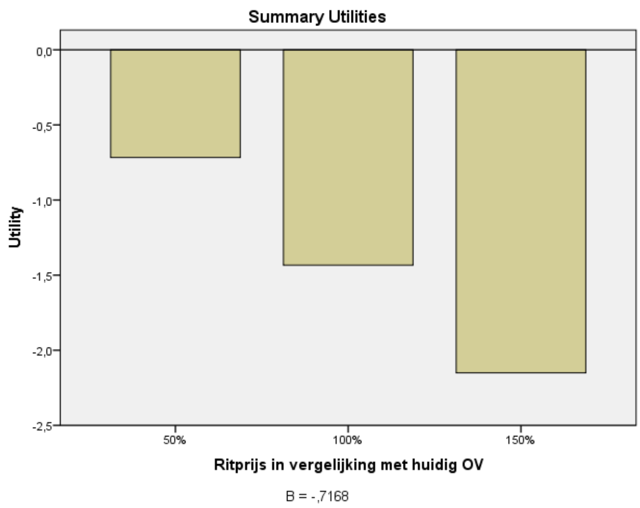


Figure 5.13: Partial Utility bar chart for the travel fare attribute

As visible in the importance value, with a value of 22,351, the research sample considered fare as the most important attribute when it comes to rating the different peoplemovers. Fare logically also appeared to be the attribute with the strongest negative correlation, resulting from the linear regression analysis. The correlation coefficient for fare is -0,717.
For future peoplemover applications it is thus important to evaluate the fare that will be charged. As for most people there are alternatives for the peoplemover to cover the first mile, a fare higher than that of regular public transport is likely to prevent people using the peoplemover.

Level of comfort
The attribute 'level of comfort' is also treated as a linear variable. A high level of comfort was linked to code 1, a low level to code 2. Therefore, the linear correlation between the rating of a peoplemover and the level of comfort was expected to be negative. As visible in the figure below, this expectation is true.

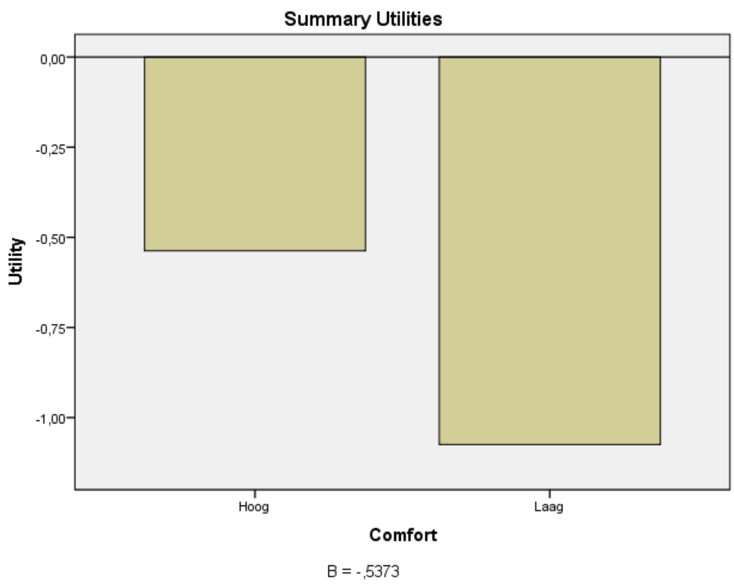


Figure 5.14: Partial Utility bar chart for the comfort attribute

There is a negative correlation between the rating of the peoplemovers and the level of comfort. A lower level of comfort leads to a lower valuation of the peoplemover. In comparison to the correlation coefficient of the fare, the negative correlation between the level of comfort and the peoplemover ratings is less strong. The correlation coefficient for the level of comfort is -0.537. This weaker correlation is also visible in the importance value table, where the level of comfort has a value of only 11,741. This value is the second lowest, just above the availability of Wi-Fi.
This proves that respondents do not bother too much about the provided level of comfort, which is defined as the availability of a seat. For the small time and distance the peoplemover will cover, people are probably willing to stand as well.

Steward attendance

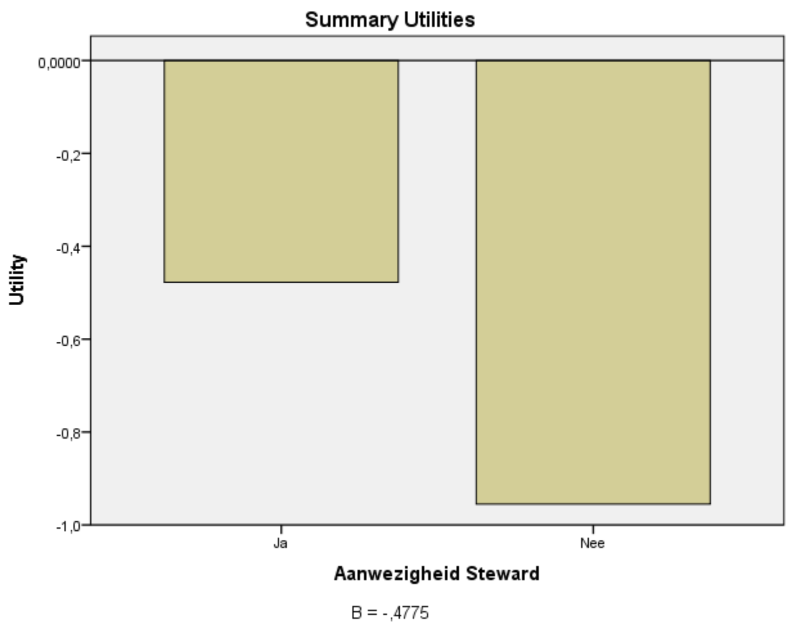


Figure 5.15: Partial Utility bar chart for the steward attendance attribute

Like the level of comfort, the attendance of a steward can also be described by a negative linear correlation. The presence of a steward has a positive contribution to the utility of a peoplemover, but for most respondents it is not the most important attribute. The high number of reversals for this attribute also shows the attendance of a steward was not the most important attribute for people while rating the different peoplemovers. This is also proven by the importance table, with an only average importance value. This might prove that most respondents have a relative high confidence in the technique of self-driving buses.
Although the attendance of a steward might not be that important to the entire sample, and thus the general public, but for specific subgroups it might be more important. This will be discussed in the next paragraph of this thesis, where distinctions between subgroups are made.

Availability of Wi-Fi
The last variable for which the partial utilities have to be discussed is the availability of Wi-Fi. This variable was considered as being linear, because the availability of Wi-Fi can be considered as more preferred than no availability.

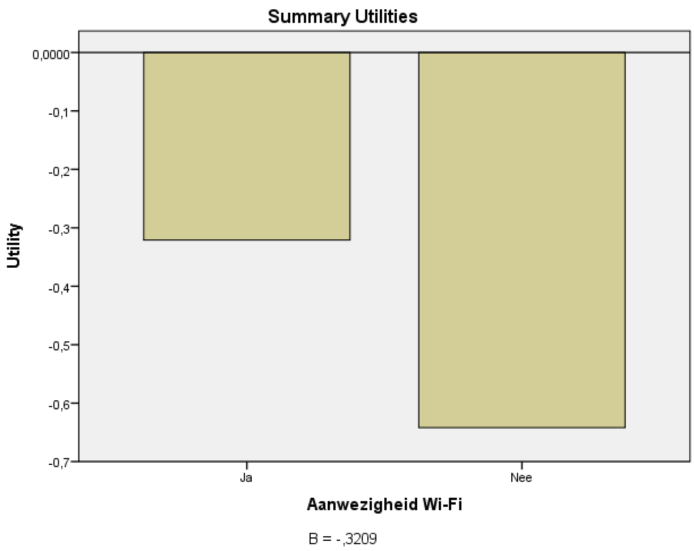


Figure 5.16: Partial Utility bar chart for the availability of Wi-Fi attribute

This expectation was only partly true. Although the availability of Wi-Fi had a positive impact on the rating of the peoplemovers, the correlation appeared to be weak. The correlation coefficient was only -0,321, which is the lowest coefficient of all attributes. Therefore, we can conclude that the availability of Wi-Fi is the least relevant attribute when it comes to developing a people mover. The explanation for this outcome is obvious. As the travel time in the peoplemover will be short, it is not suitable to use Wi-Fi for working purposes like in the train.

Now the research results are discussed for the entire sample, it is time to look at the results for the different subgroups. The influence of age, education, level of urbanity, car ownership and public transport use on the preferred attributes and partial utilities will be examined and described. For readability reasons, only the most striking results are picked out.

5.3 Results for the subgroups

5.3.1 Age

Age is the first personal characteristic that is questioned in the survey and that shows some interesting results. The table below shows the importance values for the youngest and oldest subgroups of age that included enough cases.

Age	Frequency	Travel time	Steward	Comfort	Wi-Fi	Travel-Fare
18-25	17,5	26,4	9,2	10,8	9,7	26,3
65+	20,7	15,9	18,2	13,6	10,3	21,3

Importance values for the subgroups of 18-25 and 65+ years of age

For the subgroup of 18-25 year old, it becomes clear that they value travel time and fare as most important. The partial utility analysis makes clear that a fast, direct route and a low price is key for them. When it comes to the subgroup of elderly people, it is important to realize that most of them are retired and also have the possibility of using a discount public transport card. In contrast to the younger adults, travel time appears to be less an issue for them. What is striking, is that the elderly people value the attendance of a steward twice as important as the younger adults. For young people steward attendance is the least important attribute, whereas for people above 65 years of age it is the third most important.

Furthermore, it was expected that young adults would attach greater importance to Wi-Fi than the more aged people. Afterwards, we can conclude this was a wrong assumption. Possibly, younger adults find Wi-Fi less important than thought or just not important for such a short journey.

5.3.2 Driver license and car ownership

In contrast to age, the ownership of a driver license and/or a car does not have influence on the importance people attach to the different peoplemover attributes. People with a car and a driver license have similar importance values as the people not having a driver license and or a car. Additionally, also the partial utilities of both subgroups show similar figures. It can thus be concluded that these personal characteristics do not directly influence the rating of certain attributes and their levels. What it possibly does influence, is the use of public transport in general and the peoplemover in the future. Whether this is the case, will be elaborated later on in this chapter.

5.3.3 Gender

Regarding gender, only small differences can be noted. For men, frequency is the most important attribute whereas for women travel fare is most important. Furthermore, males slightly attach more value to the availability of Wi-Fi, in contrast to women who slightly stronger appreciate the attendance of a steward. When it comes to travel time and comfort, their opinions are similar and logically also in line with the entire research sample.

5.3.4 Level of education

When it comes to education, some interesting results are evident. The importance values for each attribute and for each questioned level of educated are summarized in the table below.

Education level	**Steward attendance**	**Frequency**	**Comfort**	**Travel time**	**Travel fare**	**Wi-Fi**
VMBO	22,3	21,5	15,7	14,9	14,5	10,9
HAVO	20,1	19,9	8,6	16,4	23,4	11,5
VWO/Gymnasium	8,6	19,8	12,8	21,2	31,5	5,8
MBO	16,0	20,1	12,7	17,6	23,1	10,5
HBO	15,3	22,3	11,8	18,2	22,8	9,6
University	11,3	22,5	11,2	23,1	21,2	10,5

Importance values for the different levels of education.

This table shows that there are significant differences between the importance values when it comes to education. The trend appears that lower educated people tend to higher value the importance of the attendance of a steward. We have seen that for the entire population, the value importance for steward attendance is only 14,6. For the respondents with VMBO education, this value is as high as 22,3. The higher education people (VWO/gymnasium and University), this value is 8,6 respectively 11,3. Education thus has a strong influence on the valuation of the attendance of a steward. For the other attributes, valuations are generally more similar amongst the different education levels. However, a few striking results appear. People that have finished a VWO/gymnasium education have an extremely high importance valuation for (a low) travel fare, and an extreme low valuation for the availability of Wi-Fi. VMBO educated people seem to bother less about the travel fare.

It should be noted that for some subgroups the number of cases is relatively low. For VWO/gymnasium, only 12 respondents are included. This makes the results described above less reliable, although the trends are clear.

5.3.5 Urbanity

The influence of the urbanity rate on the valuation of the peoplemover attributes is another interesting variable to look at. The respondents were asked to what extent they would describe their municipality of residence as being urban or not. Hereby, the levels of urbanity of the Centraal Bureau Statistiek (CBS) as described in the theoretical framework are used as a guideline.

What is striking about the results regarding level of urbanity, is their similarity. The importance valuation for the different peoplemover attributes is extremely similar for all levels of urbanity. This is against expectation, because the peoplemover was proposed for the most rural areas in particular. For example, one would expect that people living in the most rural areas would highly value the importance of frequency. Apparently, frequency is crucial for all urbanity levels. What can be concluded is that the preferred characteristics a peoplemover does not depend on urbanity rate. Looking at personal characteristics of the target group like age and education appears to be more important than location.

5.3.6 Public Transport use

Now we have seen the valuation of peoplemover attributes does not depend on the level of urbanity, it is interesting to look at the question whether it depends of the frequency of public transport use. Do people that use public transport more often value other attributes as important as the people using public transport less often?

Again, for most attributes, no large differences appear. Frequent public transport users attach similar importance values to the different attributes as people using public transport only yearly. What is striking, is that people using public transport only once a month attach high value to the travel fare. A low fare has to clearly convince these users to use the people mover.
In contrast to the importance values, the partial utilities do show some differences for the 'current public transport use' variable. The partial utilities for the frequency attribute are described in the table below.

Frequency of departure	**Daily PT use**	**Weekly PT use**	**Monthly PT use**	**Yearly PT use**
On demand	0,210	0,036	-0,074	0,119
Every 30 minutes	0,361	0,337	0,248	0,224
Every hour	-0,571	-0,373	-0,175	-0,343

Partial Utility estimates for the attribute levels of frequency with regard to contemporary public transport use.

Obvious for all public transport users, a frequency of every 30 minutes is favorite and every hour is least preferred. It was expected that people using public transport only once a year would value an on demand frequency higher than the people using public transport more often. What is striking, is that the daily public transport users appreciate an on demand frequency more than people using PT less frequent. This is again interesting information when future peoplemovers are created for a specific target group, like commuters or just tourists.

5.3.7 Distance to nearest bus stop

Another interesting variable to consider is the distance people have to overcome from their home towards the nearest bus stop. Do respondents living further away from a bus stop prefer other attributes and attribute levels than people living more close to a bus stop? The table below shows the different importance values for each distance level that was questioned.

Distance to nearest busstop	Frequency	Travel time
Less than 200 meter	18,9	24,3
200-500 meter	20,0	20,7
500-1000 meter	22,3	18,8
1-3 kilometer	24,0	18,7
More than 3 kilometer	25,2	18,2

Importance values for the attributes frequency and travel time with regard to the distance towards the nearest bus stop.

Two striking trends appear from the table above. Firstly, the importance value of frequency increases as the distance towards the stop of departure increases as well. The people that have to overcome a large first-mile to use public transport today, they demand a high frequency of the peoplemover in the future.
The second trend is that if the first-mile distance increases, the importance of travel time drops. Possibly, public transport users living in these more remote areas experience a long journey time not such a problem, as long as the public transport vehicle is departing on a frequent basis which keeps them on the move. This can be explained by the different values of time, as described by Wardman (2004). According to this author, the value of time depends on whether or not the time spend can be used useful. Traveling time that cannot be spend useful is therefore associated with higher costs, or value (Wardman, 2004). Travel time that can be spend useful has thus a lower value.
Following this theory, waiting time has a higher value than the in vehicle travel time. Therefore, the respondents living more remote bother less about the travel time than about frequency.

5.3.8 Previous use of automated vehicle

The last variable that will evaluated in this paragraph is the difference in appreciation of the peoplemover attributes when it comes to previous use of an automated vehicle, comparable to the peoplemover.

Previous use of automated vehicle	Frequency	Travel time	Steward	Comfort	Wi-Fi	Travel Fare
Yes	23,5	16,7	12,0	11,9	9,7	26,2
No	21,5	19,8	15,0	11,7	10,1	21,9

The influence of previous automated Vehicle experience on the importance values for all attributes

The importance table above shows for most of the attributes only minor differences. What can be concluded is that respondents with previous automated vehicle experience, valuate the attendance of a steward lower. It is likely that they gained greater trust in automated vehicles after their previous experience. Additionally, people with previous AV experience have a higher valuation for the travel fare.

When we look at the partial utilities table for frequency, another interesting results shows up.

Previous AV use	On demand	Every 30 minutes	Every hour
Yes	0,250	0,196	-0,446
No	0,049	0,324	-0,373

Importance table for the frequency attribute with regard to previous AV experience.

First of all, both subgroups strongly dislike the frequency of every hour. A difference occurs within the other two attribute levels. People with previous AV experience prefer an on-demand frequency, whereas people without this previous experience prefer the more regular 30 minutes frequency.

5.4 Potential use of the peoplemover

How large is the potential demand for the peoplemover?

Now all the different attributes are discussed for both the entire sample and the different subgroups, it is interesting to make a cautious forecast about the potential use of a peoplemover. Are people actually willing to use the proposed public transport solution?
When it comes to the complete sample, around 40% answered 'yes' or 'maybe' on the question '*are you willing to use the peoplemover in the future?*

Firstly, almost 13% state they are surely willing to use a peoplemover vehicle in the future. Including 'maybe', more than 40% is not opposed of using a peoplemover.

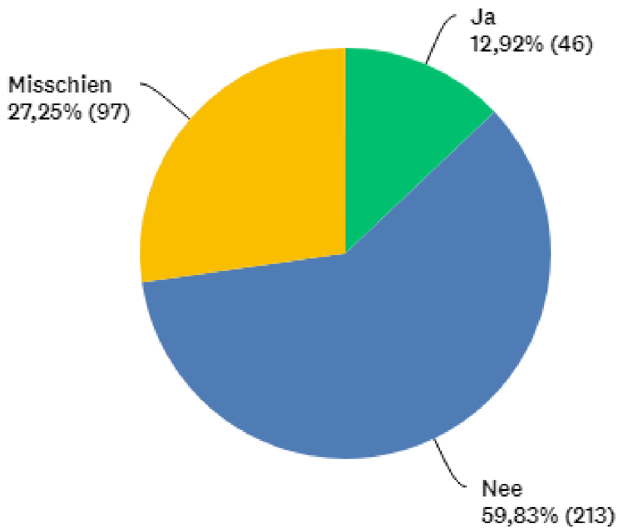


Figure 5.17: Potential use of the peoplemover for the entire research sample

This shows the peoplemover has large potential to contribute to the accessibility of rural areas in the future. But this potential might not be the same among the subgroups. Therefore, a selection of the most interesting subgroups is described below.

5.4.1 Level of Urbanity

Urbanity level	**Yes** (I will use the peoplemover in the future)	**No** (I will not use the peoplemover in the future)	**Maybe** (I will use the peoplemover in the future)	**Total**
Rural	16,0%	54,0%	30,0%	100%
Semi-rural	6,3%	65,6%	28,1%	100%
Sub-urban	11,1%	57,4%	31,5%	100%
Urban	14,0%	62.2%	23,8%	100%

Potential peoplemover use sorted by urbanity level

When we look at the level of urbanity, it becomes clear that the inhabitants of rural areas are most positive about using the peoplemover in the future. 16% would definitely use the peoplemover, and 46% is not opposing the use of it.

As the peoplemover concept was developed as a first-mile solution for rural areas, the figures above show the concepts complies with the target group.

Respondents living in semi-rural areas appear to be most unwelcome towards using the peoplemover.

5.4.2 Distance to nearest bus stop and age

The level of urbanity is in this thesis often related to the distance that has to be covered towards the nearest bus stop. What is staggering from the following table, is that after people have to cover more than one kilometer, the demand for the peoplemover solution strongly increases. 26,7 percent is definitely willing to use a future peoplemover for a distance of more than three kilometers, and 50% is not opposed of using the peoplemover for a distance between one and three kilometers.

Distance to nearest bus stop	Yes	No	Maybe	Total
Less than 200 meter	12,2%	61,8%	26%	100%
200-500 meter	12,4%	62,1%	25,5%	100%
500-1000 meter	8,3%	52,1%	39,6%	100%
1-3 km	25%	50%	25%	100%
More than 3 km	26,7%	53,3%	20,0%	100%

Potential use of the peoplemover sorted by distance to nearest bus stop

These figures prove that the peoplemover is most suitable for covering distances of more than 1 kilometer at least. For shorter distances, people prefer other modes of transport such as walking and cycling. For disabled or elderly people, a peoplemover distance shorter than 1 kilometer could still be suitable. Therefore, it is interesting to have a look at the relationship between age and potential peoplemover use. Surprisingly enough, the elderly people of 65 years or older in fact show the lowest demand for a future peoplemover. The group of 40-65 year old is most interested in potentially using the peoplemover.
Unfortunately, the age group of below 18 was not included in the sample. This group does not own a driver's license, and is therefore a potential user of the peoplemover.
This brings us to the next variable, namely 'car ownership'.

5.4.3 Current public transport use & transport towards nearest bus stop

The output shows that people who are currently using public transport the most are also the people willing to use the peoplemover in the future mostly. Surprisingly, the weekly public transport users appear to have the lowest interest in using the peoplemover with only 8,8% selecting definitely yes. What can be concluded for sure is that the peoplemover is not necessarily only attractive for daily users or just yearly users.

For the potential use of the peoplemover, it is also interesting to distinguish between the transport modes people are currently using for their first-mile towards the nearest transport stop. For the subgroups with enough cases, meaning 'walking', 'cycling', 'car' and 'never', the expected future peoplemover use is given in the table that follows.

Current mode of transport towards nearest bus stop	**Yes**	**No**	**Maybe**	**Total**
Walking	37 (13,7%)	166 (61,5%)	67 (24,8%)	270 (100%)
Cycling	5 (19,2%)	11 (42,3%)	10 (38,5%)	26 (100%)
Car	3 (37,5%)	2 (25%)	3 (37,5%)	8 (100%)
Never	1 (2,7%)	25 (67.6%)	11 (29,7%)	37 (100%)

The relationship between the mode of transport towards the nearest bus stop and the willingness to use the peoplemover in the future.

The table above shows both absolute and relative numbers. What showes up is that the peoplemover is likely to mainly attrackt people that are currently walking, simply because most people are walking the first mile towards their nearest busstop. Relatively seen, the peoplemover attracts the most cars. 37,5% of the people currently using the car towards the nearest bus stop will definitely switch towards the peoplemover, and another 37,5% will maybe do so.

5.4.4 Car Ownership

How does the potential use of the peoplemover relate to the possession of a car? The answer is visible in the table below.

Car ownership	Yes	No	Maybe	Total
Yes	14,0%	64,4%	21,6%	100%
No	11,5%	50,8%	37,7%	100%

Potential peoplemover use sorted by car ownership

It is clear that car ownership influences the willingness to use the peoplemover in the future. Although the percentage of people definitely willing to use the peoplemover is surprisingly a little higher for people owning a car, the percentage of people not opposing the use in the future is significantly higher for people not owning a car. 49,2% is potentially willing to use a future peoplemover for the respondents without an own car, whereas this is 35,6% for the people that do own a car.

The fact that even a relatively high number of respondents owning a car is willing to use a peoplemover in the future is promising. However, it should be noted that the fact people own a car does not mean they are necessarily using it on a regular matter instead of public transport. Furthermore, the respondents' panel consists mostly of public transport users which could mean they are more positive about new public transport solution. It is therefore difficult to estimate how many car users would transfer to the peoplemover and public transport for the complete trip.

5.4.5 Previous AV experience and education

Previous AV experience	Yes	No	Maybe	Total
Yes	20,9%	58,1%	20,9%	100%
No	11,8%	60,1%	28,1%	100%

Public transport users with previous automated vehicle experience show a higher demand for the peoplemover.

As the table above shows, respondents with previous experience with an automated vehicle appear to be more certain about their peoplemover use in the future. 20,9% of the people with AV experience is definite of using the peoplemover, in comparison to only 11,8% of the people without this experience.
These figures show that using an automated bus seems to convince of more use in the future.

Education is another variable for which future use of the peoplemover can be distinguished. For education, a clear rule of thumb can be described as follows: the higher the level of education, the more respondents are convinced of using the peoplemover in the future.

5.4.6 Potential increase in public transport use

Use Peoplemover (instead of current transport towards nearest bus stop)	**Yes** (I would use PT more often)	**No** (I would not use PT more often)	**Maybe** (I would use PT more often)	Total
Yes	27 (58,7%)	11 (23,9%)	8 (17,4%)	46 (100%)
No	28 (13,1%)	152 (71,4%)	33 (15,5%)	213 (100%)
Maybe	14 (14,4%)	31 (32,0%)	52 (53,6%)	97 (100%)
Total	69 (19,4%)	194 (54%)	93 (26,1%)	356 (100%)

The potential impact of the peoplemover on public transport use

The table above shows the potential increase of public transport use as a result of the introduction of the peoplemover. From the people that are willing to use the peoplemover, 58,7% says they would also use public transport more often if this peoplemover would indeed be realized. In total, 19,4% of the entire sample states to increase their public transport use if the peoplemover is realized. Oddly, 13,1% of the people that is not willing to use the peoplemover in the future, would still increase their public transport use if the peoplemover would be realized.

Furthermore, from all current public transport user groups, 16% to 23% states they would increase their public transport use if the peoplemover would be realized. This includes the daily, weekly, monthly and yearly PT users. From the people that are currently not using public transport, 42% is not opposed of using public transport in the future if the peoplemover would be introduced. Al of this proves that the introduction of the peoplemover would clearly lead to an increase of public transport use, although the magnitude of this increase depends on the context and target group.

5.5 Validity of the results

In the methodological chapter, the internal and external validity of the obtained research data is explained. Regarding internal validity, the data did not show full compliance to the assumptions for parametric data, as described by Foster, Barkus & Yavorsky (2006). Therefore, the research results as described above have to be interpreted carefully. It cannot be concluded with absolute certainty that the outcomes are indeed the true importance values and partial utilities of public transport users in the Netherlands. It can also not be concluded that the results are necessarily invalid but the poor internal validity is an important limitation of this research.

Additionally, two other matters should be mentioned with regard to the validity of the results. Firstly, it is important to realize that for feasibility reasons, this research only focused on one way interactions. This means that only the impact of the individual attribute levels on the rating of the different peoplemovers is calculated. The combined influence of two or more attribute levels is not researched. In other words, only the main effects are found. According to Pearmain et al. (1991) explain 80% of the variance. The other 20% of the variance is due to two or three-way interactions, and randomness.
Secondly, it is important to realize that the sample was not representative for the entire population of PT users in the Netherlands. Especially younger and lower educated people are underrepresented in the research sample. Attaching weight values to the under- or overrepresented subgroups in the sample is a possible solution. In the discussion of the results per subgroups, the different stated preferences of each subgroup became clear. By looking at those figures can be derived in what way the results of the entire research sample are misleading. Therefore, attaching weight values to the different subgroups to compensate the miss-representation was not considered to be necessary.
In the figures of the entire sample, especially the importance of steward attendance is underestimated and the importance of travel time is slightly overestimated.

6 Conclusion

In this research is investigated which attributes of a self-driving bus are most important to public transport users in the Netherlands and to what extent there is demand for self-driving buses as a first and last mile solution for rural areas in the Netherlands. The following main research question has been answered:

To what characteristics should the self-driving bus as a first- and last mile solution for rural areas in the Netherlands comply, and what is the potential demand for this public transport concept?

This question has been answered by firstly describing the concept of the 'peoplemover' as a first-and last mile solution. Afterwards this peoplemover concept is submitted to potential users, by conducting a survey among panelists of research company Panteia. This panel consists to a large extent of frequent public transport users. Part of this survey was a stated preference experiment, in which respondents were instructed to rate 16 peoplemovers, each with different attributes. The stated preference analysis produced importance values for each attribute and partial utility estimates for each attribute level. These values revealed which attributes and attribute levels are preferred by different types of respondents. As has been demonstrated, a low travel fare, a direct route without intermediate stops and a frequency of every 30 minutes are most important to the respondents. The level of comfort and availability if Wi-Wi is least important.
Lower educated and elderly people attach above average value to the attendance of a steward.
Regarding the potential demand for the peoplemover, 40% of the respondents is not opposed of using the new public transport concept in the future.
The further away people live from the nearest bus stop, the higher the demand for the peoplemover.
High potential demand for the peoplemover is also revealed for higher educated people and cyclists.
The introduction of peoplemovers in the public transport system of rural areas is also likely to increase the use of public transport. Among the respondents surely willing to use the peoplemover in the future, 58,7% will increase their public transport use because of the introduction of the peoplemover.

Most importantly, this research concludes that although there are some similarities, the preferences and potential demand differ among the subgroups. For future developers of the peoplemover, like bus companies and municipalities, it is of great importance to look at the local context and the intended target group. Once the local context and intended target group is defined, this research offers information on which attributes of the self-driving bus are preferred by the defined target consumer group. For example, if a peoplemover would be developed as a service for elderly people, the attendance of a steward should be seriously considered as an option. For young, higher educated people this would not be necessary.
The research results can also be used to make a first estimation of the potential demand for a future peoplemover in a specific context for a certain target group.

6.1 Connecting the results to the theoretical framework

In the theoretical framework, a number of relevant theories have been elaborated. The theories presented in the theoretical framework give rise to discuss the results of this research again. Innovation theories where described in paragraph 2.1. Most importantly, the well-known theory of Rogers (1976) about the diffusion of innovated showed that for typical innovations are accepted in the first stages by approximately 15% of the population. These 15% contain of the so called 'innovators' and 'early adaptors' (Rogers, 1976). This 15% figure shows great similarity with the estimated potential demand for the peoplemover. About 13% of the respondents indicated to surely use the peoplemover in the future. In the light of the innovation theory of Rogers (1976), these respondents can be seen as early adaptors. Another 27% of the respondents indicated to 'maybe' use the peoplemover in the future. With regard to the theory of Rogers (1976), these respondents can be seen as the 'early majority'. In the model of Rogers, this group contains of 34% of the populations which is again rather close to the 27% revealed in this research.

The theoretical framework explained in paragraph 2.2 that the preferences of travelers for certain attributes are partly caused by individual's socioeconomic characteristics and experience (Pearmain et al, 1991). Therefore, the preferences of respondents for the peoplemover attributes are distinguished for various personal characteristics, such as age, level of education, distance to nearest bus stop and car ownership. This research proved the model of Pearmain et al. (1991), in the sense that the preferences for certain peoplemover attributes indeed differ among the subgroups. For example, elderly and lower educated people attach more importance to the attendance of a steward than other subgroups. Additionally, respondents not owning a car and living further away from the nearest bus stop show higher demand figures for the peoplemover.
Individuals experience also proved to influence the demand for the peoplemover. Respondents with previous experience with automated vehicles show significantly higher demand and attach lower value to the attendance of a steward.

In the remainder of the theoretical framework, developments regarding demographics, public transport use and the first- and last mile problem is described. The declining population in rural areas in the Netherlands results in a lower demand for public transport in those areas, which in return leads to an increased first- and last mile problem. The results of this research reveal that the peoplemover could indeed contribute to solving this first- and last mile problem. The peoplemover can thus become an important complementation to the already existing first- and last mile solutions as described by Welzen (2014). An overview of these already existing first- and last mile initiatives is visible in the appendix. Welzen described the first- and last mile initiatives on the following criteria: flexibility, travel time, accessibility, availability, costs and reliability. The proposed peoplemover concept is relatively poor when it comes to flexibility, as the vehicle has to drive on a fixed route and a separate or private lane. The travel time and costs appeared to be important to the respondents. A direct, fast route and low costs are preferred. The peoplemover scores well on accessibility, as the proposed vehicle is accessible for disabled and blind travelers. Whether the peoplemover is reliable can only be concluded in the future.

6.2 Research limitations

The outcome of this research has a number of limitations. It is already discussed that obtained data shows relatively poor internal and external validity. The reliability of this research is ensured by clear documentation of all research steps.

The selected stated preference research method is limited by the fact that only 16 different peoplemovers are questioned in the stated preference experiment. This number of 16 different peoplemovers was the absolute minimum to estimate the importance values and partial utilities for all the possible 216 combinations of attribute levels. As a result, only the main effects, containing 80% of the research variance, can be explained with this research design (Pearmain et al, 1991). Still, comparing 16 different self-driving buses was already a rather complicated task for the respondents. Multiple respondents reported in their feedback that they found it hard to understand the differences between all 16 peoplemovers. This could be an explanation for the relatively high variance in the research results and the relatively poor validity as a consequence.

Additionally, the preferences for only six attributes are tested in this research. It is arguable that there are more relevant attributes of self-driving buses that could be tested, but this thesis focused on the most important attributes based on literature research. If more attributes would have been submitted to the respondents, the survey would have become too complicated.

Furthermore, the respondents were presented a rather general picture of how the peoplemover would look like in the future. Estimation of whether they would use the vehicle in the future or not was made more difficult because of the generality of the outlined future scenario. Presenting a local case, with a specific picture of the peoplemover in their own living environment would have been easier for the research participants.

6.2 Recommendations for further research

The limitations of this research gives reason for a number of possibly interesting follow-up studies. If participants would be presented a clearer picture of the proposed peoplemover solution in their local context, the task of rating different combinations of attributes and estimating their willingness to use the peoplemover would probably become easier. Conducting a case study would be an interesting follow-up study for achieving this improvement. A case study research design was also considered to be an option for this research, but it appeared not to be achievable to collect a sufficient number of completed questionnaires within the given amount of time. In a future case study about the peoplemover, quantitative surveys could be combined with more qualitative interviews with inhabitants of rural areas in the Netherlands. The results of this research did not provide any information about the reason behind the revealed preferences, although some suggestions have been made. It could thus be interesting to conduct some in-depth interviews to find out why certain attributes are more important to them than others.

This research also did not provide information about the preferences of people below 18 years of age, because this group was not included in the sample. As this group are clear potential users, a future research may investigate what the preferences and demands are for this specific age group.

Another interesting could be conducted about the exact price public transport users are willing to pay for using the peoplemover. This research has proven that travel fare is one of the most important attributes for almost every subgroup, but does not provide information about the exact fare people are willing to pay. In a follow-up study this could be investigated

6.2 Personal reflection

Over the last five months I have worked hard to complete this master thesis. Overall, I look back at the research process with a satisfied feeling although there are some lessons learned as well.

The development of the research design took a lot of time. First, I changed my research topic from 'citizen participation in reducing flood risk in urban areas' towards 'the role automated vehicles could play in increasing accessibility of rural areas in the Netherlands'. A research proposal with this subject is approved for Advanced Research Methods course. When it came to executing this research proposal, the topic appeared to be too broad. A number of conversations with experts in the field of accessibility of rural areas and automated vehicles was necessary for narrowing down the research topic towards automated buses and the first- and last mile problem. These conversations took place at various automated vehicle congresses in the Netherlands, I was able to visit thanks to CROW. An additional meeting took place with Frans Hamstra to further develop the proposed peoplemover concept. I have learned a lot about transport planning at these congresses and also obtained a number of contacts in the field.
After all this work was done, the stated preference method was selected for the executional phase of the research. As I was not familiar with this approach, the application of the stated preference method to my specific research topic appeared to be quite complicated. With the help of especially Erik Kroes I have succeeded. Looking back at the selection of this research method, I have underestimated the complexity. This can be seen as the main reason this research took five month for completion, instead of the intended four months. In the future, I would look better into the difficulty of a certain research method beforehand.

At my internship at CROW I was able to make rapid progress and support was offered by several colleagues. I am also grateful for the possibilities CROW provided for attending congresses and other topic-related activities.

What can be said in general is that especially at the beginning I could have done better in meeting deadlines and appointments with my supervisor Duncan Liefferink. As the research progressed, I think I have improved myself on this point. I have always greatly appreciated the feedback of my supervisors at CROW and the Radboud University. A lesson learned is that I could have asked earlier for help sometimes.

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8. Appendices

8.1 Explanation of Dutch figures and terminology

Figure	Dutch term	Translation/Explanation
General terms	Bereikbaarheid	Accessibility
	Frequentie	Frequency
	Haltes & Reistijd	Stops & Travel time
	Witte vlek	‘Blind spot’ in public transport network
	Ritprijs	Travel fare
	Ieder uur	Every hour
	Ieder uur	Every hour
	Laag	Low
	Hoog	High
	Ja	Yes
	Nee	No
	Misschien	Maybe
	Ritprijs in vergelijking met huidig OV	Travel fare in comparison to contemporary public transport use.
	Aanwezigheid steward	Steward attendance
	Cijfer	Mark
	Aanwezigheid Wi-Fi	Availability of a Wi-Fi network
2.3	Niet-stedelijk	Strongly rural
	Weinig-stedelijk	Rural
	Matig stedelijk	Moderate urban
	Sterk stedelijk	Urban

	Zeer sterk stedelijk	Strongly urban
2.6	'In de Randstad is de reissnelheid niet zo hoog, maar zijn er veel banen op korte afstand.'	In the Randstad the travel speed is low but the number of jobs nearby is high
	'Hier zijn de reissnelheden relatief hoog maar liggen banen ook verder weg.'	Here, travel speed is relatively high but jobs are more remote and therefore less accessible
2.7	'Andere ontwikkelingen'	Other developments
	'Meer/minder mensen'	More/less people
2.8	'Bij een gemiddelde treinreis wordt de grootste afstand uiteraard in de trein afgelegd. Toch zit er relatief veel reistijd in de reis naar het station en van het station vandaan'	In an average train trip, the majority of the travelled distance is covered inside the train. Although, a relatively large part of the travel time is spend covering the first- and last mile.
3.8	Zeer eens	Strongly agree
	Zeer oneens	Strongly disagree
4.1	Geslacht	Gender
	Man	Male
	Vrouw	Female
	Jaar	Years of age
	Leeftijd	Age
	Opleidingsniveau	Level of education
	Hoger onderwijs	Higher education
	Middelbaar onderwijs	Secondary education
	Lager onderwijs	Primary education
4.5	'Welk cijfer zou u deze peoplemover geven?'	How would you rate this peoplemover?
4.12	Dagelijks	Daily
	Wekelijks	Weekly

Maandelijks	Monthly
Jaarlijks	Yearly
Nooit	Never

8.2 Stated Preference Show cards

Profile Number 1

Card ID	Aanwezigheid Steward	Frequentie	Haltes en reistijd	Comfort	Aanwezigheid Wi-Fi	Ritprijs in vergelijking met huidig OV
1	Nee	Ieder uur	Vaste haltes (1,0)	Laag	Nee	50%

Profile Number 2

Card ID	Aanwezigheid Steward	Frequentie	Haltes en reistijd	Comfort	Aanwezigheid Wi-Fi	Ritprijs in vergelijking met huidig OV
2	Nee	On demand	Flexibele haltes (1,5)	Laag	Nee	50%

Profile Number 3

Card ID	Aanwezigheid Steward	Frequentie	Haltes en reistijd	Comfort	Aanwezigheid Wi-Fi	Ritprijs in vergelijking met huidig OV
3	Nee	Ieder uur	Direct (0,5)	Hoog	Nee	150%

Profile Number 4

Card ID	Aanwezigheid Steward	Frequentie	Haltes en reistijd	Comfort	Aanwezigheid Wi-Fi	Ritprijs in vergelijking met huidig OV
4	Ja	On demand	Direct (0,5)	Hoog	Ja	50%

Profile Number 5

Card ID	Aanwezigheid Steward	Frequentie	Haltes en reistijd	Comfort	Aanwezigheid Wi-Fi	Ritprijs in vergelijking met huidig OV
5	Nee	Elk half uur	Direct (0,5)	Laag	Ja	50%

Profile Number 6

Card ID	Aanwezigheid Steward	Frequentie	Haltes en reistijd	Comfort	Aanwezigheid Wi-Fi	Ritprijs in vergelijking met huidig OV
6	Ja	Elk half uur	Vaste haltes (1,0)	Hoog	Nee	50%

Profile Number 7

Card ID	Aanwezigheid Steward	Frequentie	Haltes en reistijd	Comfort	Aanwezigheid Wi-Fi	Ritprijs in vergelijking met huidig OV
7	Ja	On demand	Flexibele haltes (1,5)	Hoog	Nee	50%

Profile Number 8

Card ID	Aanwezigheid Steward	Frequentie	Haltes en reistijd	Comfort	Aanwezigheid Wi-Fi	Ritprijs in vergelijking met huidig OV
8	Nee	On demand	Direct (0,5)	Laag	Ja	50%

Profile Number 9

Card ID	Aanwezigheid Steward	Frequentie	Haltes en reistijd	Comfort	Aanwezigheid Wi-Fi	Ritprijs in vergelijking met huidig OV
9	Ja	Ieder uur	Direct (0,5)	Hoog	Ja	50%

Profile Number 10

Card ID	Aanwezigheid Steward	Frequentie	Haltes en reistijd	Comfort	Aanwezigheid Wi-Fi	Ritprijs in vergelijking met huidig OV
10	Nee	Elk half uur	Flexibele haltes (1,5)	Hoog	Ja	150%

Profile Number 11

Card ID	Aanwezigheid Steward	Frequentie	Haltes en reistijd	Comfort	Aanwezigheid Wi-Fi	Ritprijs in vergelijking met huidig OV
11	Nee	On demand	Vaste haltes (1,0)	Hoog	Ja	100%

Profile Number 12

Card ID	Aanwezigheid Steward	Frequentie	Haltes en reistijd	Comfort	Aanwezigheid Wi-Fi	Ritprijs in vergelijking met huidig OV
12	Ja	Elk half uur	Direct (0,5)	Laag	Nee	100%

Profile Number 13

Card ID	Aanwezigheid Steward	Frequentie	Haltes en reistijd	Comfort	Aanwezigheid Wi-Fi	Ritprijs in vergelijking met huidig OV
13	Ja	On demand	Direct (0,5)	Laag	Nee	150%

Profile Number 14

Card ID	Aanwezigheid Steward	Frequentie	Haltes en reistijd	Comfort	Aanwezigheid Wi-Fi	Ritprijs in vergelijking met huidig OV
14	Nee	On demand	Direct (0,5)	Hoog	Nee	100%

Profile Number 15

Card ID	Aanwezigheid Steward	Frequentie	Haltes en reistijd	Comfort	Aanwezigheid Wi-Fi	Ritprijs in vergelijking met huidig OV
15	Ja	Ieder uur	Flexibele haltes (1,5)	Laag	Ja	100%

Profile Number 16

Card ID	Aanwezigheid Steward	Frequentie	Haltes en reistijd	Comfort	Aanwezigheid Wi-Fi	Ritprijs in vergelijking met huidig OV
16	Ja	On demand	Vaste haltes (1,0)	Laag	Ja	150%

8.3 Validity

Leeftijd

	Observed N	Expected N	Residual
18-25	21	60,8	-39,8
25-40	51	95,5	-44,5
40-65	191	147,6	43,4
65+	93	52,1	40,9
Total	356		

Test Statistics

	Leeftijd
Chi-Square	91,648[a]
df	3
Asymp. Sig.	,000

a. 0 cells (0,0%) have expected frequencies less than 5. The minimum expected cell frequency is 52,1.

Chi-Square test for age.
Assymp. significance is below 0.05. This means that the observed frequencies differ significantly from the expected frequencies. The sample is thus not representative when it comes to age.

Frequencies

Geslacht

	Observed N	Expected N	Residual
Man	194	168,5	25,5
Vrouw	157	182,5	-25,5
Total	351		

Test Statistics

	Geslacht
Chi-Square	7,434[a]
df	1
Asymp. Sig.	,006

a. 0 cells (0,0%) have expected frequencies less than 5. The minimum expected cell frequency is 168,5.

Chi-square gender. Assymp. significance is below 0.05. This means that the observed frequencies differ significantly from the expected frequencies. The sample is thus not representative when it comes to gender

Opleiding

	Observed N	Expected N	Residual
Primary education	17	39,1	-22,1
Secondary education	96	166,9	-70,9
Higher education	242	149,1	92,9
Total	355		

Test Statistics

	Opleiding
Chi-Square	100,419[a]
df	2
Asymp. Sig.	,000

a. 0 cells (0,0%) have expected frequencies less than 5. The minimum expected cell frequency is 39,1.

Chi-Square education level. Assymp. significance is below 0.05. This means that the observed frequencies differ significantly from the expected frequencies. The sample is thus not representative when it comes to education.

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean		Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Cijfer peoplemover 1	381	10	0	10	4,33	,139	2,712	7,357	-,104	,125	-,944	,249
Cijfer peoplemover 2	380	10	0	10	4,49	,135	2,636	6,947	-,235	,125	-,854	,250
Cijfer peoplemover 3	373	10	0	10	4,25	,133	2,575	6,629	-,186	,126	-,891	,252
Cijfer peoplemover 4	381	10	0	10	6,75	,136	2,654	7,043	-1,075	,125	,608	,249
Cijfer peoplemover 5	363	10	0	10	5,77	,144	2,741	7,511	-,717	,128	-,294	,255
Cijfer peoplemover 6	362	10	0	10	5,81	,135	2,573	6,622	-,812	,128	,008	,256
Cijfer peoplemover 7	361	10	0	10	5,71	,135	2,563	6,567	-,799	,128	-,037	,256
Cijfer peoplemover 8	362	10	0	10	5,84	,142	2,694	7,260	-,786	,128	-,163	,256
Cijfer peoplemover 9	353	10	0	10	5,86	,145	2,721	7,406	-,746	,130	-,276	,259
Cijfer peoplemover 10	351	10	0	10	4,31	,135	2,521	6,353	-,246	,130	-,835	,260
Cijfer peoplemover 11	354	10	0	10	4,90	,138	2,601	6,766	-,448	,130	-,586	,259
Cijfer peoplemover 12	352	10	0	10	5,52	,135	2,540	6,450	-,701	,130	-,080	,259
Cijfer peoplemover 13	350	10	0	10	4,23	,131	2,453	6,019	-,293	,130	-,750	,260
Cijfer peoplemover 14	348	10	0	10	5,16	,139	2,598	6,750	-,556	,131	-,483	,261
Cijfer peoplemover 15	345	10	0	10	4,50	,131	2,441	5,960	-,467	,131	-,644	,262
Cijfer peoplemover 16	344	10	0	10	4,06	,132	2,446	5,984	-,180	,131	-,791	,262
Valid N (listwise)	320											

Variance, skewness and kurtosis of the research results. Almost every peoplemover has a high score on either Skewness or Kurtosis. This means the distributions of the peoplemover ratings are not normally distributed. This assumption for parametric data is thus not been met.

Univariate Statistics

	N	Mean	Std. Deviation	Missing		No. of Extremes[a]	
				Count	Percent	Low	High
peoplemover1	381	4,33	2,712	59	13,4	0	0
peoplemover2	380	4,49	2,636	60	13,6	0	0
peoplemover3	373	4,25	2,575	67	15,2	0	0
peoplemover4	381	6,75	2,654	59	13,4	31	0
peoplemover5	363	5,77	2,741	77	17,5	30	0
peoplemover6	362	5,81	2,573	78	17,7	25	0
peoplemover7	361	5,71	2,563	79	18,0	26	0
peoplemover8	362	5,84	2,694	78	17,7	28	0
peoplemover9	353	5,86	2,721	87	19,8	26	0
peoplemover10	351	4,31	2,521	89	20,2	0	0
peoplemover11	354	4,90	2,601	86	19,5	0	0
peoplemover12	352	5,52	2,540	88	20,0	0	0
peoplemover13	350	4,23	2,453	90	20,5	0	0
peoplemover14	348	5,16	2,598	92	20,9	0	0
peoplemover15	345	4,50	2,441	95	21,6	0	0
peoplemover16	344	4,06	2,446	96	21,8	0	0

a. Number of cases outside the range (Q1 - 1.5*IQR, Q3 + 1.5*IQR).

Number of extremes for each peoplemover. Peoplemover 4-9 show a number of extremes ranging from 26-31. The other peoplemovers show no extreme values, as their boxplots cover all ratings from 0 to 10.

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
Cijfer peoplemover 1	,368	5	345	,871
Cijfer peoplemover 2	,321	5	344	,900
Cijfer peoplemover 3	2,539	5	338	,028
Cijfer peoplemover 4	,930	5	346	,462
Cijfer peoplemover 5	,498	5	343	,778
Cijfer peoplemover 6	,502	5	342	,774
Cijfer peoplemover 7	,806	5	341	,546
Cijfer peoplemover 8	,349	5	341	,883
Cijfer peoplemover 9	,458	5	342	,807
Cijfer peoplemover 10	1,830	5	340	,106
Cijfer peoplemover 11	,527	5	343	,756
Cijfer peoplemover 12	1,046	5	341	,391
Cijfer peoplemover 13	2,001	5	343	,078
Cijfer peoplemover 14	1,072	5	341	,375
Cijfer peoplemover 15	,654	5	338	,659
Cijfer peoplemover 16	1,014	5	337	,409

Homogeneity of variance test. Executed for level of education. Only for peoplemover 3, the mean difference is significant.

8.4 Result tables

Urbanity level	Frequency	Travel time	Steward	Comfort	Wi-Fi	Travel-Fare
Rural	23,0	20,0	12,9	11,0	10,6	22,5
Semi-rural	22,3	16,0	17,2	11,3	10,7	22,4
Sub-urban	21,6	18,4	15,6	13,1	9,3	21,9
Urban	21,3	20,6	14,0	11,0	10,4	22,6

Importance value for each attribute set out for urbanity levels

Current public transport use	Frequency	Travel time	Steward	Comfort	Wi-Fi	Travel-Fare
Daily	25,5	19,4	15,4	10,1	9,4	20,2
Weekly	20,4	18,0	14,8	13,1	11,4	22,3
Monthly	19,9	21,1	12,1	11,5	9,1	26,2
Yearly	20,3	18,9	16,4	13,1	9,3	21,9

Importance values for each attribute set out for current public transport use.

8.5 Survey

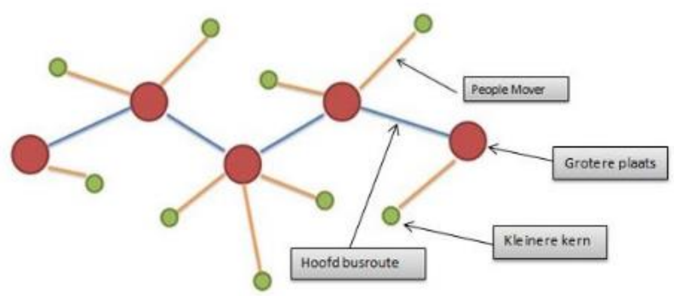
Zelfrijdende bus

1. Toelichting enquête

Hartelijk dank voor deelname aan deze enquête! Uw feedback is erg belangrijk. Het invullen van de vragenlijst zal ongeveer 15 minuten in beslag nemen.

Wellicht heeft u al eens gehoord van de ontwikkelingen rondom zelfrijdende voertuigen. In de toekomst rijden er waarschijnlijk zelfrijdende auto's, taxi's en busjes zelfstandig op onze wegen. Deze vragenlijst richt zich op de mogelijkheden die zelfrijdende busjes bieden om de bereikbaarheid van het platteland te verbeteren. Deze bereikbaarheid van het platteland komt meer en meer onder druk te staan doordat lokale busdiensten verdwijnen. Bussen rijden steeds meer in rechtgetrokken lijnen tussen de grotere plaatsen, waardoor voor veel plattelandsbewoners de afstand naar de dichtstbijzijnde bushalte groter wordt. Het openbaar vervoer wordt hierdoor minder aantrekkelijk. Een toekomstige oplossing voor dit probleem zou de 'peoplemover' kunnen zijn. De peoplemover is een zelfrijdend busje dat de kleinere dorpskernen met de hoofdbusroutes verbindt. Het voordeel van een peoplemover is dat er geen chauffeur meer aanwezig hoeft te zijn en daardoor veel voordeliger kan rijden. De peoplemover vertrekt op maximaal 200 meter van uw huis, waardoor het openbaar vervoer weer aantrekkelijk kan worden gemaakt. Het idee van de peoplemover staat hieronder uitgebeeld.

Het concept van de peoplemover



De peoplemover zal in ieder geval de volgende eigenschappen hebben:

- Een snelheid van 20-40 km/h.
- Rijden over een eigen rijbaan, om moeilijkheden met andere weggebruikers te voorkomen.
- Toegankelijk voor minder-validen.
- Plaats voor ongeveer vijftien personen.
- Uitgerust met een noodrem.
- Uitgerust met verschillende camera's aan binnen- en buitenkant die vanuit een centraal controlecentrum te bekijken zijn.

In geval van nood kan vanuit dit controlecentrum worden ingegrepen. Dat wil zeggen dat het voertuig kan worden gestopt en er hulpdiensten naartoe kunnen worden gestuurd.

Op dit moment worden er al verscheidene proeven gedaan met vergelijkbare zelfrijdende busjes, in onder andere Appelscha en Ede-Wageningen. De verwachting is dan ook dat de peoplemover met bovenstaande eigenschappen binnen 10 jaar operationeel kan zijn.

Met dit onderzoek willen we achterhalen wat de wensen zijn van de bevolking wat betreft de eigenschappen van deze peoplemover. In een experiment kunt u verschillende varianten van de peoplemover beoordelen, die verschillen wat betreft ritprijs, reistijd, frequentie, comfort en het al dan niet aanwezig zijn van een steward en Wi-Fi.

Uw enquête zal anoniem worden verwerkt. Indien u kans wilt maken op een bol.com cadeaubon t.w.v. 20 euro en/of de eindresultaten van het onderzoek wilt ontvangen, kunt u aan het einde van de enquête uw e-mailadres opgeven.

Nogmaals bedankt dat u deel wilt nemen aan het onderzoek!

2. Inleidende vragen

1. Heeft u een geldig rijbewijs?

- Ja
- Nee

2. Heeft u de beschikking over een auto?

- Ja
- Nee

3. Bent u in het bezit van een OV-reisproduct?

- Studentenkorting
- Altijd korting
- OV maand- of jaarabonnement
- Kortingsregelingen voor leeftijdsgroep (4-12 en 65+)
- Weekend vrij
- Daluren korting
- Nee

4. Hoe vaak gebruikt u het OV?

- Dagelijks
- Wekelijks
- Maandelijks
- Jaarlijks
- Nooit

5. Wat is de afstand die u naar de dichtstbijzijnde bushalte moet afleggen?

- Minder dan 200 meter
- 200-500 meter
- 500-1000 meter
- 1-3 km
- Meer dan 3 km

6. Hoe gaat u op dit moment vanuit thuis naar de dichtstbijzijnde bushalte?

- Te voet
- Fiets
- Auto
- Taxi
- Brommer/Scooter
- Ik ga nooit met de bus
- Anders, namelijk...

7. Heeft u al eens eerder gebruik gemaakt van een zelfrijdend voertuig? Denk hierbij bijvoorbeeld aan het zelfrijdende busje in Appelscha en Ede-Wageningen en de zelfrijdende shuttle bij Capelle aan den IJssel.

- Ja
- Nee

8. In welke gemeente woont u?

9. In hoeverre zou u de gemeente waar u woont omschrijven als stedelijk?

- ◯ Niet-stedelijk (landelijk)
- ◯ Weinig stedelijk
- ◯ Matig stedelijk
- ◯ Sterk stedelijk

3. Stated Preference Experiment uitleg

In dit gedeelte van de enquête krijgt u de mogelijkheid uw voorkeuren uit te spreken over verschillende varianten van de peoplemover en zijn eigenschappen. Dit wordt ook wel een 'stated preference experiment' genoemd.
De verschillende eigenschappen en de daarbij behorende varianten worden nu eerst toegelicht:

Aanwezigheid steward
In de peoplemover zal geen chauffeur meer aanwezig zijn. Wel is het mogelijk dat er een steward aanwezig is voor het ontvangen van passagiers, het bewaken van de orde en het ingrijpen in geval van nood.

Frequentie
De peoplemover zou met verschillende frequenties kunnen gaan rijden. Een hogere frequentie betekent dat er meer voertuigen per dag vertrekken, maar ook dat er meer voertuigen nodig zijn. Dit leidt tot hogere kosten voor het vervoersbedrijf, die al dan niet aan u als gebruiker worden doorberekend. In dit onderzoek zijn de volgende varianten wat betreft frequentie opgenomen:
1. On demand: het voertuig kan op afroep op elk moment van de dag vertrekken. Hiervoor moet u dan wel van te voren online of telefonisch reserveren waarbij u de gewenste vertrektijd aangeeft.
2. Elk half uur.
3. Ieder uur.

Haltes & reistijd
De peoplemover zal volgens een vaste route rijden van het beginpunt naar de dichtstbijzijnde bushalte. Wel is het mogelijk tussentijds te stoppen op al dan niet vaste haltes, maar dit kost extra reistijd. Met flexibele haltes wordt bedoeld dat de peoplemover tijdens de route altijd kan worden gestopt om overal op de route uit te stappen. De reistijd wordt uitgedrukt ten opzichte van de reistijd met de fiets.
- Direct: 2x zo snel als de fiets
- Vaste haltes: Net zo snel als de fiets
- Flexibele haltes: 1,5x langzamer dan de fiets

Comfort
Het comfort tijdens een reis is vooral afhankelijk van de beschikbaarheid van een zitplaats en de reistijd. Onder een hoog comfortniveau wordt dan ook verstaan dat u gegarandeerd kunt zitten. Onder een laag comfortniveau wordt verstaan dat u tijdens de spits mogelijk moet staan.

Wi-Fi
De peoplemover kan al dan niet worden uitgerust met gratis Wi-Fi.

Ritprijs
De prijs die een rit met de peoplemover kost kan variëren. Deze prijs wordt uitgedrukt ten opzichte van de prijs die u nu betaald voor het reguliere OV. Dit bedrag kan variëren van 50% van de reguliere OV kosten tot 150% van de reguliere OV kosten. De reguliere OV kosten zijn opgebouwd uit een vastgesteld basistarief van 0,89 euro en een kilometertarief. Het kilometertarief is ongeveer 0,15 euro/km.

Nu u de verschillende factoren hebt gelezen bent u in staat een afweging te maken tussen verschillende varianten van de peoplemover. U krijgt zometeen 16 verschillende varianten van de peoplemver gepresenteerd. De bedoeling van het experiment is dat u elke variant van de peoplemover beoordeelt met een cijfer van 0 (zou ik absoluut niet gebruiken) tot 10 (zou ik zeker gebruiken).

Zelfrijdende bus

4. Stated Preference Experiment (1/4)

Beoordeel de volgende peoplemovers met een cijfer van 0 (zou ik absoluut niet gebruiken) tot 10 (zou ik zeker gebruiken).
In totaal krijgt u 16 verschillende peoplemovers gepresenteerd, verdeeld over 4 pagina's. U kunt eerder gegeven antwoorden nog wijzigen door terug te gaan in de enquête.

Peoplemover 1
Aanwezigheid Steward: Nee
Frequentie: Ieder uur
Haltes & reistijd: Vaste haltes (net zo snel als de fiets)
Comfort: Laag
Aanwezigheid Wi-Fi: Nee
Ritprijs in vergelijking met huidig OV: 50%

10. Met welk cijfer beoordeelt u peoplemover 1?

0 Peoplemover 1 10

Peoplemover 2
Aanwezigheid Steward: Nee
Frequentie: On Demand
Haltes & reistijd: Flexibele haltes (1,5x de reistijd met de fiets)
Comfort: Laag
Aanwezigheid Wi-Fi: Nee
Ritprijs in vergelijking met huidig OV: 50%

11. Met welk cijfer beoordeelt u peoplemover 2?

0 Peoplemover 2 10

Peoplemover 3
Aanwezigheid Steward: Nee
Frequentie: Ieder uur
Haltes & reistijd: Direct (2x zo snel als de fiets)
Comfort: Hoog
Aanwezigheid Wi-Fi: Nee
Ritprijs in vergelijking met huidig OV: 150%

12. Met welk cijfer beoordeelt u peoplemover 3?

0 Peoplemover 3 10

Peoplemover 4
Aanwezigheid Steward: Ja
Frequentie: On Demand
Haltes & reistijd: Direct (2x zo snel als de fiets)
Comfort: Hoog
Aanwezigheid Wi-Fi: Ja
Ritprijs in vergelijking met huidig OV: 50%

13. Met welk cijfer beoordeelt u peoplemover 4?

0 Peoplemover 4 10

5. Stated Preference Experiment (2/4)

Beoordeel de volgende peoplemovers met een cijfer van 0 (zou ik absoluut niet gebruiken) tot 10 (zou ik zeker gebruiken).

Peoplemover 5
Aanwezigheid Steward: Nee
Frequentie: Elk half uur
Haltes & reistijd: Direct (2x zo snel als de fiets)
Comfort: Laag
Aanwezigheid Wi-Fi: Ja
Ritprijs in vergelijking met huidig OV: 50%

14. Met welk cijfer beoordeelt u peoplemover 5?

0 Peoplemover 5 10

Peoplemover 6
Aanwezigheid Steward: Ja
Frequentie: Elk half uur
Haltes & reistijd: Vaste haltes (net zo snel als de fiets)
Comfort: Hoog
Aanwezigheid Wi-Fi: Nee
Ritprijs in vergelijking met huidig OV: 50%

15. Met welk cijfer beoordeelt u peoplemover 6?

0 Peoplemover 6 10

Peoplemover 7
Aanwezigheid Steward: Ja
Frequentie: On demand
Haltes & reistijd: Flexibele haltes (1,5x de reistijd met de fiets)
Comfort: Hoog
Aanwezigheid Wi-Fi: Nee
Ritprijs in vergelijking met huidig OV: 50%

16. Met welk cijfer beoordeelt u peoplemover 7?

0 Peoplemover 7 10

Peoplemover 8
Aanwezigheid Steward: Nee
Frequentie: On demand
Haltes & reistijd: Direct (2x zo snel als de fiets)
Comfort: Laag
Aanwezigheid Wi-Fi: Ja
Ritprijs in vergelijking met huidig OV: 50%

17. Met welk cijfer beoordeelt u peoplemover 8?

0 Peoplemover 8 10

6. Stated Preference Experiment (3/4)

Beoordeel de volgende peoplemovers met een cijfer van 0 (zou ik absoluut niet gebruiken) tot 10 (zou ik zeker gebruiken).

Peoplemover 9
Aanwezigheid Steward: Ja
Frequentie: Ieder uur
Haltes & reistijd: Direct (2x zo snel als de fiets)
Comfort: Hoog
Aanwezigheid Wi-Fi: Ja
Ritprijs in vergelijking met huidig OV: 50%

18. Met welk cijfer beoordeelt u peoplemover 9?

0 Peoplemover 9 10

Peoplemover 10
Aanwezigheid Steward: Nee
Frequentie: Elk half uur
Haltes & reistijd: Flexibele haltes (1,5x de reistijd met de fiets)
Comfort: Hoog
Aanwezigheid Wi-Fi: Ja
Ritprijs in vergelijking met huidig OV: 150%

19. Met welk cijfer beoordeelt u peoplemover 10?

0 Peoplemover 10 10

Peoplemover 11
Aanwezigheid Steward: Nee
Frequentie: On demand
Haltes & reistijd: Vaste haltes (net zo snel als de fiets)
Comfort: Hoog
Aanwezigheid Wi-Fi: Ja
Ritprijs in vergelijking met huidig OV: 100%

20. Met welk cijfer beoordeelt u peoplemover 11?

0 Peoplemover 11 10

Peoplemover 12
Aanwezigheid Steward: Ja
Frequentie: Elk half uur
Haltes & reistijd: Direct (2x zo snel als de fiets)
Comfort: Laag
Aanwezigheid Wi-Fi: Nee
Ritprijs in vergelijking met huidig OV: 100%

21. Met welk cijfer beoordeelt u peoplemover 12?

0 Peoplemover 12 10

7. Stated Preference Experiment (4/4)

Beoordeel de volgende peoplemovers met een cijfer van 0 (zou ik absoluut niet gebruiken) tot 10 (zou ik zeker gebruiken).

Peoplemover 13
Aanwezigheid Steward: Ja
Frequentie: On demand
Haltes & reistijd: Direct (2x zo snel als de fiets)
Comfort: Laag
Aanwezigheid Wi-Fi: Nee
Ritprijs in vergelijking met huidig OV: 150%

22. Met welk cijfer beoordeelt u peoplemover 13?

0 Peoplemover 13 10

Peoplemover 14
Aanwezigheid Steward: Nee
Frequentie: On demand
Haltes & reistijd: Direct (2x zo snel als de fiets)
Comfort: Hoog
Aanwezigheid Wi-Fi: Nee
Ritprijs in vergelijking met huidig OV: 100%

23. Met welk cijfer beoordeelt u peoplemover 14?

0 Peoplemover 14 10

Peoplemover 15
Aanwezigheid Steward: Ja
Frequentie: Ieder uur
Haltes & reistijd: Flexibele haltes (1,5x de reistijd met de fiets)
Comfort: Laag
Aanwezigheid Wi-Fi: Ja
Ritprijs in vergelijking met huidig OV: 100%

24. Met welk cijfer beoordeelt u peoplemover 15?

0 Peoplemover 15 10

Peoplemover 16
Aanwezigheid Steward: Ja
Frequentie: On demand
Haltes & reistijd: Vaste haltes (net zo snel als de fiets)
Comfort: Laag
Aanwezigheid Wi-Fi: Ja
Ritprijs in vergelijking met huidig OV: 150%

25. Met welk cijfer beoordeelt u peoplemover 16?

0 Peoplemover 16 10

8. Afsluitende vragen

Beeld uzelf in dat uw favoriete peoplemover gerealiseerd zou worden en beantwoord de volgende vragen:

26. Zou u deze peoplemover gebruiken in plaats van uw huidige vervoer naar de dichtstbijzijnde bushalte?

- ◯ Ja
- ◯ Nee
- ◯ Misschien

27. Zou u vaker het OV gaan gebruiken?

- ◯ Ja
- ◯ Nee
- ◯ Misschien

Dan volgen nu nog enkele vragen naar persoonskenmerken die relevant zijn voor het onderzoek.

28. Wat is uw leeftijd?

- ◯ Jonger dan 18
- ◯ 18-25
- ◯ 25-40
- ◯ 40-65
- ◯ 65+

29. Wat is uw geslacht?

- ◯ Man
- ◯ Vrouw

30. Wat is uw hoogst genoten opleiding?

- ◯ Basisonderwijs
- ◯ VMBO
- ◯ Havo
- ◯ VWO/Gymnasium
- ◯ MBO
- ◯ HBO
- ◯ Universiteit

31. Geef hieronder aan of u kans wilt maken op de bol.com cadeaubon t.w.v. 20 euro en/of de eindresultaten van het onderzoek wilt ontvangen.

- ◯ Ik wil alleen kans maken op de Bol.com cadeaubon t.w.v. 20 euro
- ◯ Ik wil alleen de eindresultaten van het onderzoek ontvangen
- ◯ Ik wil zowel kans maken op de Bol.com cadeaubon als de eindresultaten van het onderzoek ontvangen
- ◯ Geen van beide

Zelfrijdende bus

9. E-mailadres

Geef uw E-mailadres op als u heeft aangegeven kans te willen maken op de bol.com cadeaubon t.w.v. 20 euro of de eindresultaten van het onderzoek wilt ontvangen.

32. E-mailadres

E-mailadres [ ]

Hiermee is er een einde gekomen aan deze enquête. Hartelijk bedankt voor uw medewerking! Uw antwoorden zijn van grote waarde voor het onderzoek.

8.6: First Mile Overview Tom Welzen (2014, p.76)

Overzicht van de beoordeling van de 10 initiatieven						
Initiatief	**Flexibiliteit**	**Reistijd**	**Toegankelijkheid**	**Beschikbaarheid**	**Kosten**	**Betrouwbaarheid**
Buurtbus	Route en bus zijn weinig flexibel, maar chauffeur probeert met (kleine) wensen rekening te houden.	Langere reistijd t.o.v. auto, maar reizigers stellen zich hier op in. Betrouwbaarheid wordt geprezen.	Bussen zijn vaak niet toegankelijk voor rolstoelgebruikers i.v.m. ontbreken lage instap.	Vergelijkbaar met regulier openbaar vervoer, m.u.v. avonduren; reizigers stellen zich hier op in.	Voor reiziger (vaak) gelijk aan regulier OV. Kostenbesparing buurtbusproject door vrijwillige chauffeurs.	Betrouwbaarheid wordt positief beoordeeld.
Regiotaxi	Flexibel, want er is sprake van een van-deur-tot-deurdienst.	Tijden liggen niet vooraf vast, want chauffeur heeft speling en haalt meerdere reizigers op.	Reserveren is geen probleem. Bij keuze voertuig kan rekening gehouden worden met behoeften passagier.	Ruim beschikbaar, ook in weekend. Indien uitgedund regulier OV, dan minder interessant voor first/last mile.	Voor reiziger hoger dan regulier OV. Voor vervoerder is regiotaxi dure kostenpost.	Vanwege onbekende aankomst- en vertrektijd, lastig om te plannen en daardoor weinig betrouwbaar.
Omnibus	Weinig flexibel vanwege vaste routes, waarvan enkele "verplichte" naar dagopvang.	Vergelijkbaar met auto en ook sneller dan fiets.	Reservering niet nodig bij vaste ritten. Bus niet toegankelijk en bus was niet te vinden in reisplanners.	Een handvol ritten per dag voor reguliere reizigers, die vaak beperkt aansloten op regulier OV.	Voor reiziger relatief lage ritprijs. Kostenbesparing door vrijwillige chauffeurs.	Onbekend; betrouwbaarheid waarschijnlijk niet bepalend voor falen project.
Digitale duim	Zeer flexibel, vaak van-deur-tot-deurdienst.	Vergelijkbaar met auto.	Reserveren geschiedt altijd via internet; impulsrit is lastig en vergt planning	Afhankelijkheid van anderen is groot; alternatief is buren of familie vragen.	Bespreken reizigers onderling. Interesse marktpartijen voor onderhoud website.	Vergelijkbaar met auto.
Multibus	Flexibel, niet per se van-deur-tot-deur.	Langzamer dan auto en vergelijkbaar met regiotaxi.	Reserveren noodzakelijk, bus geen lage instap.	Rijdt wanneer regulier OV niet rijdt.	Voor reiziger vergelijk-baar met regulier OV. Sprake van kostenbe-sparing, maar chauffeurs worden betaald.	Expliciet bedoeld om de first/last mile te overbruggen, dus hier wordt rekening mee gehouden.
Byabussen	Flexibel binnen bepaalde kaders, alleen bestemd om naar OV-knooppunt te rijden.	Vergelijkbaar met auto.	Reserveren noodzakelijk, impulsrit is lastig i.v.m. reserveren.	Auto is altijd beschikbaar, maar reizen is alleen toegestaan als meerdere mensen reserveren.	Kosten volledig voor overheid.	Betrouwbaarheid is gegarandeerd.
Postbus	Vaste routes, post brengen heeft prioriteit.	Vergelijkbaar met auto.	Reserveren meestal niet nodig.	Zeer beperkte dienstregeling, planning is noodzakelijk.	Kosten voor reiziger variabel, vergelijkbaar met regulier OV.	Discutabel, omdat reizigers vervoeren geen prioriteit heeft.
C.A.T.	Vaste routes, afgestemd op de vraag.	Langer dan de auto.	Reserveren niet nodig, bus heeft lage instap.	Beperkte dienstregeling, maar dienstregeling bevredigd behoeften reizigers.	Leunt sterk op (overheids)subsidie, kosten voor reiziger variabel.	Beperkt aantal ritten per dag of week vergt planning.
Fietsen naar OV	Flexibel indien ruimte voor fietsen en fietsen worden aangeboden.	Langer dan de auto.	Toegankelijkheid hoog als ook fietsen worden aangeboden.	Stallingen zijn 24/7 beschikbaar, maar er is niet altijd aansluiting op OV.	Kosten stallingen bij overheid. Reiziger betaalt voor (huur)fiets.	Indien geen eigen fiets, dan is voorwaarde dat er huurfietsen aanwezig zijn.
Fiets in OV	Flexibel, first/last mile geïntegreerd.	Vergelijkbaar met initiatief "Fietsen naar OV".	Niet altijd toegestaan, soms reserveren verplicht.	OV niet altijd beschikbaar, of onvoldoende fietsrekken.	Vouwfietsen gratis, vervoerder moet ruimte beschikbaar stellen.	Overbruggen first/last mile gegarandeerd, mits vervoer en fietsrekken beschikbaar.

Tabel 10: Beoordelingsoverzicht van de 10 initiatieven