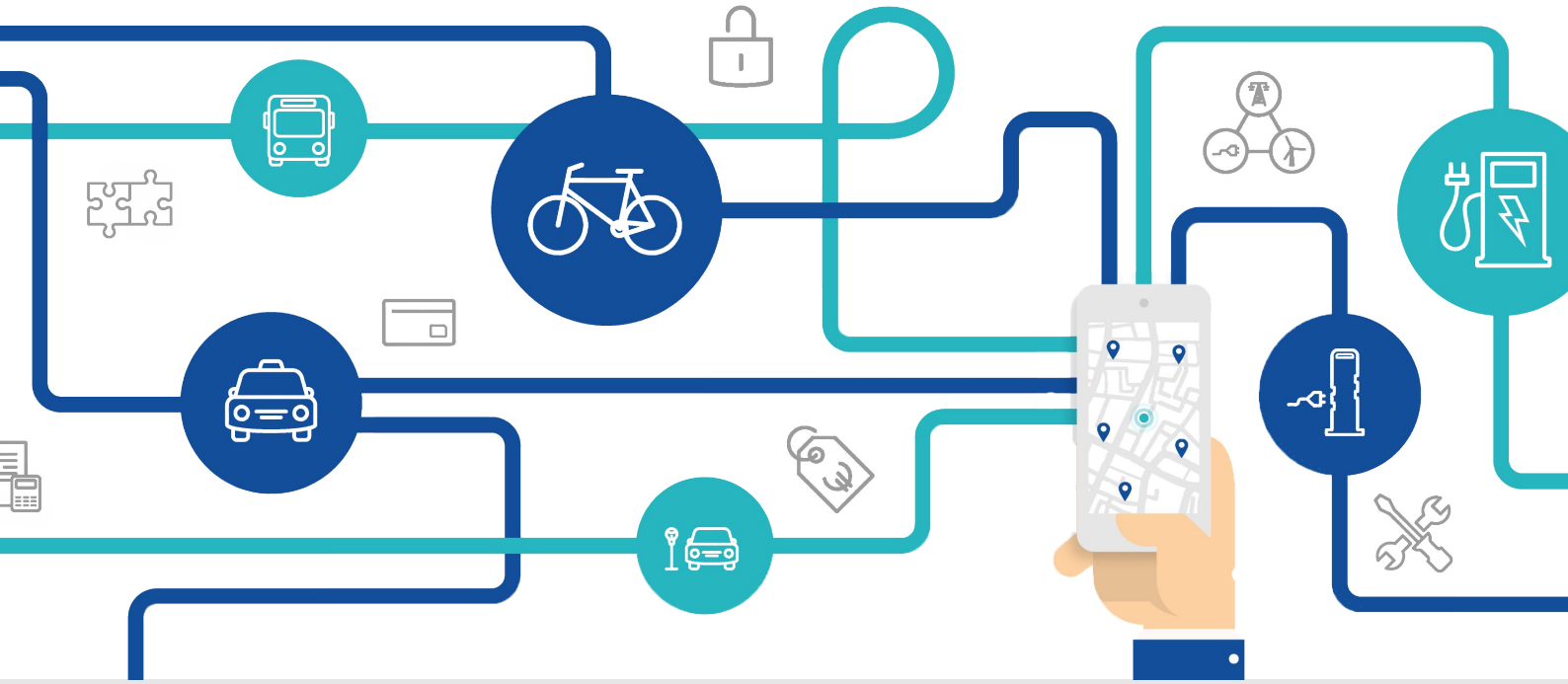
MaaS for commuting trips

Potential for success or deception?



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Goudappel Coffeng

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by
R.M. Knijn
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Preface

Dear reader,

Thank you for taking the time to read this preface, and to read my thesis. For the past months, I have been working on this research at Goudappel Coffeng as part of my MSc Transport, Infrastructure and Logistics at the Delft University of Technology. In this preface, I would like to explain the motivation behind the topic of this research and to thank the people who contributed to the overall research process.

This final chapter of my study has definitely been a journey. It all started with finding a subject for my thesis. It always intrigued me that parked cars are a substantial part of the streetscape. Especially in cities, they take up much of the available space, and I think that this space could be used more efficiently. When searching for a graduation topic, I was looking for something related to this. So when I heard about Mobility as a Service (MaaS) and the prospects of MaaS, I took this as the starting point. The early stage of the graduation process was the hardest. I found it challenging to identify and clarify my research topic. When the research took more shape, it became more fun. Looking back at performing research on this scale by myself makes me very proud. I learned a lot about structuring, the essence of the main research line and about formulating my thoughts and ideas.

All this was not possible without the help of many people around me. First, I want to thank my graduate committee. Eric, thank you for your critical view on my thesis, especially at the beginning of the process. Furthermore, thank you for the detailed feedback and for continuously keeping me thinking about the mainline of my research. I want to thank Niels for always making time and for providing me with advice and lots of extra information in a positive way. Furthermore, I want to thank Bert for making the meetings pleasant experiences and for providing me with helpful feedback. Last but not least, I want to thank Arthur for guiding me through this process. Thank you for the detailed feedback, the practical view on my topic and for the delightful time at Goudappel Coffeng.

Second, I want to thank my friends and family for supporting me during this graduation process. I want to thank my roommates and friends for showing interest in my research and thinking along with my ideas. Sascha, thank you for reading parts of my thesis and for your constructive feedback. Tijmen, thank you for your feedback, for always having my back and for being there when needed. At last, I want to thank my parents for their endless support and love and for convincing me that everything will turn out all right.

I wrote the end of this document in the middle of the corona crisis. This will make the graduation ceremony different as expected. I found this quite difficult at first, but taking this into perspective made me realise that this is not so bad at all and that I am lucky to be healthy and to have lovely people around me.

With this thesis, my time as a student in Delft has officially ended. I look back on a fantastic time in Delft. I have met friends for life. I am grateful for all the opportunities I have got, and for everything I have learned, both personally and study-related.

I hope you will enjoy reading my thesis.

R.M. Knijn

Rotterdam, May 2020

Summary

Mobility as a Service (MaaS) is a new mobility concept which lately got much attention in practice and literature. ”MaaS is a transport concept that integrates existing and new mobility services into one single digital platform. MaaS provides customised door-to-door transport and offers personalised trip planning and payment options” (Durand & Zijlstra, 2018). The expectations of MaaS are high. Multiple researchers agree upon the fact that MaaS has excellent potential to address the growing need for more sustainable mobility (Giesecke et al., 2016). With MaaS, one can easily vary in different modes which makes it possible to, for example, use a more sustainable mode when it suits the travel motive. Furthermore, MaaS offers personalisation. One can set goals too, for example, use public transport several times a week. So, compared to the current situation, the MaaS platform offers alternatives.

It is expected that the easy access to different modes positively influences travel behaviour in the form of new attitudes regarding (shared) modalities and an increase in travelling via a multi-modal way (Kamargianni, Maria and Li, Weibo and Matyas, Melinda; Krantz, 2018). This can again lead to less car dependency and more efficient use of space which is in particular beneficial for crowded cities (Zijlstra, 2019). Moreover, it is expected that MaaS makes it possible to steer travel behaviour in the form of, for example, discounts for environmentally friendly modes or discounts when travelling outside rush hours. Accordingly, travellers will be more spread throughout the day, which benefits congestion. These are all enormous promises. However, most of these thoughts are still only thoughts and remain based on speculations. MaaS is a relatively new concept, and there are still many uncertainties, ambiguities and knowledge questions related to MaaS (Zijlstra, 2019).

Research from The Netherlands Institute for Transport Policy Analysis (KiM) explored potential early markets for MaaS and identified commuting trips as the second most promising travel motive. The work-related trips were identified as the first most promising travel motive (Zijlstra, 2019). Clarification lacked regarding the underlying reasons of the identifications. It might be associated with the fact that employers often finance commuting and work-related trips, which perhaps lowers the threshold to try new ways of travelling. Alternatively, it might be associated with the idea that employers can encourage their employees to travel in a certain way.

Besides the scientific perspective, interest in MaaS for the work-related sector grows. Local authorities emphasise that smarter and more sustainable commuting behaviour leads to benefits for organisations, employees and the environment (Luca, 2015). The environmental awareness among employers increases, which also results in interest in new ways of organising their employees commuting behaviour. A couple of years ago, this resulted in interest in the mobility budget, and nowadays, employers show their interest in MaaS. Possible explanations for this interest are the flexibility of MaaS, which is beneficial for their employees and the fact that employers can outsource the whole aspect of the mobility of their employees to the MaaS service. Moreover, MaaS can play a role to solve parking space problems for companies.

The predictions of experts, and the interest from employers together with the fact that commuting is a big part of everyday travelling and the expectations that MaaS could play a role here makes that this research focuses on the potential of MaaS for commuting trips. Most research about MaaS contemplates the concerns and thoughts of experts. Literature lacks information about end-users, while a focus on the end-users is yet of great importance to make an innovation successful. This study focuses on MaaS for commuting from an end-user perspective, which are employees in this context.

The main research question is:

"What is the potential for the use of MaaS for commuting trips by employees?"

By exploring the interest of potential users, this research provides insight into if the promises that are associated with MaaS are realistic or that they might be overestimated. This information is valuable for policymakers because MaaS might have the potential to address societal issues by contributing to, for example, less congestion, more available space and an increase in the use of environmentally friendly modes.

Commuting trips are combinations of choices of both employees and employers. Research into commuting mode choice showed that getting reimbursement for a mode to commute increases the probability that that mode will be used (Ton et al., 2020). Therefore, the opportunity arises to examine whether the policy of employers, regarding financing commuting trips, is associated with the interest of employees to use MaaS to commute. This information is valuable for policymakers and employers because they possibly have the capability to influence the interest of employees, which might, in the end, benefit societal and environmental related problems.

This research focuses on commuting trips only. Firstly, because almost every employee commutes and not every employee makes work-related trips during the day. Moreover, the commuting trips of an average inhabitant of the Netherlands account for over 160 trips per year and subsequently 3000 kilometres a year (CBS, 2017a). 60% of these trips are made by car (CBS, 2018a). So, there is much to win if the mode choice concerning commuting changes. Work-related trips only account for 4% of the total amount of trips (OVIN, 2020).

Literature research, interviews, desk research and a group discussion were used to get an idea of MaaS from different perspectives. Moreover, literature research was done to identify background factors that could influence the interest in MaaS. A questionnaire was designed to gather information on the interest of employees to use MaaS for commuting trips. According to the theory of planned behaviour, the attitude towards a behaviour is a determinant for the intention to perform a behaviour, and the latter is the determinant for actual behaviour. In this research, the interest of employees is, therefore measured by asking for the intention to use MaaS for commuting trips. The attitude towards using MaaS to commute was also included to explore the thoughts of employees. The questionnaire was distributed online among individuals who work in the Netherlands for at least 12 hours a week. This resulted in 269 valid responses that were used for the data analyses.

As a result of the growing attention for MaaS in society and literature, it was expected that many people are familiar with the new mobility concept. However, this is not the case at all. The statistics of the questionnaire show that only 12% of the employees have heard of MaaS before participating in this research. Moreover, due to the trend of increasing attention from employers to re-organise mobility policies, it was expected that many employers are concerned, or involved, with environmental awareness of their employees. However, the results show that only 12% of the employees feel encouraged by their employers to think consciously about the way they commute.

First, the thoughts of employees about MaaS were explored. Latent class cluster analysis was used to identify groups of employees with different modality styles. Because this gives more detailed information than exploring the thoughts in general. The goal of latent class cluster analysis (LCCA) is to divide the sample into groups to maximise the heterogeneity between groups and the homogeneity within the groups. Based on the frequency of the currently used modes to commute the three identified groups are (1)multi-modal travellers, (2)car-oriented travellers and (3)lease car users.

Sixteen statements were presented to the respondents about the opportunities and challenges of MaaS in order to explore their thoughts of MaaS. These statements were categorised into two new variables, or factors, by performing factor analysis. The two new factors were called 'hesitant about MaaS' and 'positive about MaaS'. Comparing these factors showed that the three different groups of travelling employees differ in their thoughts about MaaS.

Multi-modal travellers are more positive about MaaS than they are hesitant. The other two groups are more hesitant than positive. The multi-modal travellers regularly commute by train, but also by car, and tram/metro/bus. In the groups of car-oriented travellers and lease car users, the most considerable amount of individuals never uses public transport to commute. Furthermore, the car-oriented travellers and the lease car users have a high car affection compared to the multi-modal travellers. These two differences might be associated with the fact that they are less positive about MaaS than multi-modal travellers.

The overall intention to use MaaS to commute in the current situation is low. Only 21% of the respondents showed interest in using MaaS to commute. However, when comparing the intentions of usage between the three groups, differences appear. Especially the car-oriented travellers show extremely low intention to use MaaS to commute. This is only 9% compared to 27% and 31% among multi-modal travellers and lease car users. According to these results, the factors 'hesitant about MaaS' and 'positive about MaaS' are probably not associated with the intention to use MaaS to commute. The substantial difference in intention to use between the car-oriented travellers and the lease car users is remarkable since both groups mainly travel to work by car. This difference might be related to the fact that the lease car users travel to more urbanised areas for their work than the car-oriented travellers. Moreover, both groups have a high car affection, but the car affection of the lease car users is lower compared to the car-oriented travellers. Also, the multi-modality might explain this difference as the car-oriented travellers never use other transport modes to commute. In the group of lease-car users, some individuals, also, travel with public transport or with the bicycle to work a couple of times per week or month.

After exploring the thoughts of employees, it was examined whether reimbursement of employers influences the intention to use MaaS for commuting trips. As shown in Table 1, the intention to use increases comparing the first scenario (S1) to the current situation (S0). However, only the multi-modal travellers show a significant increase of 12% points and the intention is still not that high, namely 39%. The car-oriented travellers and the lease car users do not show significant differences between scenario 0 and 1 (an increase of 8% points and 3% points). Overall, stimulating the use of MaaS by receiving finances from the employer seems to have a limited effect.

Table 1: Intention to use MaaS to commute per employee group with different modality styles

	Intention to use MaaS to commute in the:	
	Current situation (S0)	Scenario where the employer financing MaaS (S1)
Multi-modal travellers (42%)	27%	39%
Car-oriented travellers (39%)	9%	12%
Lease car users (19%)	31%	39%

To examine car users in more depth, another scenario was presented to the respondents. In this scenario, a more extreme measure is taken wherein employers still finance MaaS to commute but wherein they do not finance car use anymore. Notably, the car users are not the same group as the car-oriented travellers. The employees to whom this scenario was presented were employees who have a car as their primary commuting mode. In general, 17% of these employees has the intention to use MaaS to commute in the current situation. This increased to 34% in the presented scenario, which is a significant increase. However, still 66% of the employees who commute by car are willing to pay for their commuting car costs when their employers stop financing this and only finance MaaS. The car-oriented travellers show, also in this scenario, a low intention to use MaaS compared to the multi-modal travellers and the lease car users.

The previous results emphasise the fact that the intention to use MaaS to commute differs among employees. To explore this even more, another latent class cluster analysis was performed. This time, the identified groups were based on the attitude and intention to use MaaS in the current situation and in the situation wherein the employer finances MaaS (scenario

1). This resulted in groups of employees with a different attitude and intention concerning the usage of MaaS for commuting trips.

The largest group, 31%, does not know what they will do. These people appear to be more susceptible to influence than people with a strong opinion already. 40% of the respondents show no interest in using MaaS based on the latent class cluster analysis. These individuals can mainly be characterised as people who seldom use more than one mode per trip and are therefore not multi-modal. Furthermore, the environmental consciousness is lower compared to individuals with the intention to use MaaS. 22% of the respondents have interest to use MaaS to commute. This group was divided into individuals that are interested and individuals that are very interested. Interested individuals have low car affection. The very interested individuals are environmentally conscious individuals who often or always travel in a multi-modal way. Even though the MaaS knowledge before participating in this research is low in every group, a difference is noticeable. The groups without interest or opinion have an extremely low prior knowledge, on average only 8% heard of MaaS before. The groups with interest have a substantially higher percentage of beforehand knowledge with an average of 25%.

Apart from the group which is not interested in using MaaS at all, every group showed an increase in intention to use MaaS when employers start financing it. However, this is not a substantial increase. There is one group (6%) who switches from not interested to interested when the employer starts financing MaaS to commute. This group is highly educated but, remarkably, rarely travels in a multi-modal way. Noticeably, there are also some car-oriented travellers in this group. Furthermore, it is striking that the groups who do not have a strong opinion yet have a higher increase in intention to use MaaS to commute than individuals who do have a strong opinion already.

In literature, the expectations of MaaS are high. MaaS could positively influence travel behaviour, such as increasing multi-modal travelling or new attitudes regarding (shared) modes. MaaS could have benefits for both employees and employers. However, to make an innovation successful and to achieve the possible effects of MaaS, the interest of end-users is essential. The small number of employees that show interest in using MaaS to commute indicate that, from the perspective of the employees, the potential for the use of MaaS for commuting trips is low. Even if the employer would finance the use of MaaS to commute, the intention does not increase substantially, only 8% points.

Nevertheless, identifying different groups of employees showed that there is potential for particular employees. Employees who showed interest in using MaaS to commute are environmentally conscious individuals with a low car affection who often travel in a multi-modal way. These are probably individuals who already use public transport. Therefore, it can be assumed that when MaaS is implemented, only the individuals that already use public transport and already travel in a multi-modal way will use the MaaS application and thereby perform the same behaviour.

Concluding, MaaS does not appear to be the Holy Grail that it may seem like according to the information that is currently presented. The potential user interest is underexposed, and researchers and policymakers are probably overestimating the stated contribution of MaaS to all the mentioned issues. A realistic impression of the potential of MaaS lacks.

This does not imply that there are no prospects, or there is no potential at all. There are potential users for MaaS and MaaS is probably a pleasant addition to the current options for travelling in a multi-modal way. Although the interest seems low, small changes in mode choice can achieve, for example, less congestion or a bit more space in cities, which is already an accomplishment. Furthermore, satisfied users might inspire people around them and MaaS might become more popular over the years. This is already a step in the right direction, and in the long term, MaaS can potentially contribute to the promises many researchers make. For now, it is important to present MaaS in a more realistic way instead of the Holy Grail.

The findings of this research suggest a couple of recommendations for policy, further research and practice. The first recommendation is related to the ongoing MaaS pilots of the Ministry of Infrastructure and Water Management. This research displayed the fact that interest in MaaS differs per type of employee. Looking at the bigger picture, it is suspected that these findings can be scaled up to the population on a national level, as different types of travellers will have various ideas and preferences regarding MaaS. Therefore, it is useful to analyse the data coming from the pilots with LCCA. Performing LCCA provides a better understanding of behaviour and makes it possible to design tailor-made policies suited to the specific preferences of various identified groups. Secondly, lease car users showed more interest in using MaaS to commute than individuals who travel to work by their own car. Therefore, if policymakers want to stimulate MaaS, or destimulate car use in general, it is an option to address the provision of lease cars by companies. These individuals seem to be more open to travelling in a multi-modal way instead of only using the car. So, if the lease car is not an option for these people anymore, it might be the right timing to stimulate other ways of travelling.

The last recommendation for policymakers is to introduce the concept of MaaS to more people since there is a difference in interest between people who already have MaaS knowledge and the ones that do not. In general, the prior knowledge is very low; only 12% of the participants were familiar with the concept. Out of the employees who showed interest, a substantially higher percentage seemed to know about MaaS (25%), compared to the knowledge of uninterested employees (8%). Moreover, this research concluded that many people do not know what they will do or just do not have an opinion about using MaaS to commute yet. It is assumable that people are initially more hesitant or reluctant to innovations. This can be seen as an opportunity as these people still need to form an opinion about MaaS. The way of advertising or sharing information about MaaS influences the way people think about it. There might be opportunities to steer the thoughts of people about MaaS according to the current level of awareness. Nevertheless, it must be well considered how to present MaaS to the public.

There are two main recommendations for further research. This research confirmed the difficulty of decreasing car use. It is useful to explore if and how MaaS could be made attractive to car users. The ongoing MaaS pilots from the Ministry of Infrastructure and Water Management can be used to explore this. However, likely, car users can not easily be persuaded to use MaaS. Since MaaS is not the only way to address environmental issues related to car use, it is of importance to explore other options to seduce car users to make different choices concerning mode choice. Secondly, this research explored the potential for MaaS for commuting trips. The potential for other travel motives remains unknown. Where an average inhabitant of the Netherlands makes 160 trips a year to commute, there are also 163 trips made to travel to sports, hobbies or restaurants and 110 trips to visits. The potential of MaaS could be higher for leisure trips because of the occasional nature of the trips. It is useful to perform research that explores the interest in MaaS in general and thereby differentiates between reasons to travel. This must be done from the viewpoint of the end-users. In that way, the potential of, for example, MaaS for commuting trips can be compared to, for example, using MaaS for leisure trips.

Al last, it is recommended that employers let their employees think about the way they commute as they do affect the way their employees' commute. The employers do not have to steer extremely, but a bit of attention might already be beneficial. Some employees might use environmentally modes more often, which decreases the CO2 footprint of the company and may also boost the image.

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Introduction

This first chapter introduces the core concept of this research, namely Mobility as a Service (MaaS), in Section 1.1. Afterwards, Section 1.2 identifies the research problem. Subsequently, Section 1.3 elaborates on the scope of this research. The main research question and the related sub-questions are introduced in Section 1.4. The fifth section sheds light on the scientific, practical and societal contribution of this research, and this chapter ends with a reading guide for the further report.

1.1. Introduction in Mobility as a Service

The ongoing growth in mobility brings severe threats to our social and ecological environment. Environmental pollution, congestion and the costs of noise annoyance are three critical threats (Karlsson et al., 2016; Rienstra et al., 1999) or one could say, challenges to face. Furthermore, the demand for transportation in urban areas is still rising, and the pressure on these systems grows. To guarantee the accessibility of cities, new and innovative solutions are needed (Kamargianni et al., 2016; MuConsult, 2017). A way to respond to the rising demand for new and innovative solutions is the sharing economy (Kamargianni et al., 2016). This new internet-based sector relies on access over ownership and has grown exponentially over the last decade (Ganapati & Reddick, 2018). In several sectors sharing platforms are already leading, such as Netflix, Spotify and Airbnb. Recently, shared modalities have become more popular in the transport sector (Kamargianni et al., 2016). An increase in the use of shared modalities in the transport sector is expected to reduce ownership which, for example, benefits the available space in cities. Building on these developments in the transport sector, together with developments in information and communication technologies, Mobility as a Service (MaaS) comes around (Kamargianni et al., 2016). According to Durand & Zijlstra (2018): ”MaaS is a new transport concept that integrates existing and new mobility services into one single digital platform, providing customised door-to-door transport and offering personalised trip planning and payment options”. MaaS aspires to make changes in the transport sector by offering an alternative for the ownership of private vehicles (Jittrapirom et al., 2017; Sochor et al., 2018).

In the last couple of years, the concept of MaaS has been popping up in literature many times. The expectations are high. Multiple researchers agree upon the fact that MaaS has excellent potential to address the growing need for more sustainable mobility (Giesecke et al., 2016). Within MaaS, one can easily vary between different modes which makes it possible to, for example, use a more sustainable mode when it suits the travel motive. Furthermore, MaaS offers personalisation. One can set goals to, for example, use public transport several times a week, and try to reach this with the MaaS application. So, compared to the current situation, the MaaS platform offers alternatives. It is expected that the easy access to different modes positively influences travel behaviour in the form of new attitudes regarding (shared) modalities and an increase in travelling via a multi-modal way (Kamargianni, Maria and

Li, Weibo and Matyas, Melinda; Krantz, 2018). This can again lead to less car dependency and more efficient use of space which is in particular beneficial for cities (Zijlstra, 2019). Moreover, it is expected that MaaS makes it possible to steer travel behaviour in the form of, for example, discounts for environmentally friendly modes or discounts when travelling outside rush hours. Accordingly, travellers will be more spread throughout the day, which benefits congestion.

These are all enormous promises. However, most of these thoughts are still only thoughts and remain based on speculations. MaaS is a relatively new concept, and there are still many uncertainties, ambiguities and knowledge questions related to MaaS (Zijlstra, 2019).

1.2. Problem description

When wanting to make an innovation a success, focus on the end-user is of great importance. Lyons et al. (2019) conclude that there is a great need for research to get a clearer view of the attitudes of potential MaaS users to help decision-makers and other relative stakeholders to make well-considered choices (Lyons et al., 2019). To the authors' knowledge, there is one research that focuses on MaaS in the Netherlands from the viewpoint of the end-user. The Netherlands Institute for Transport Policy Analysis (KiM) launched a study to research MaaS. Through focus group meetings, they collected information about the threshold for and driving forces behind the acceptance and use of MaaS. The potential cost advantage was identified as the most important condition. Next to this, the availability, ease of use and reliability of the potential MaaS system are important conditions for the acceptance of MaaS (Harms & Hoogendoorn-Lanser, 2018). The conclusion from this research provide valuable information about the potential users of MaaS in the Netherlands, but it was limited to three specific focus groups.

Research from the same researchers explored potential early markets for MaaS through a questionnaire among experts in the Netherlands. They concluded that work-related travel has the highest potential for travelling with MaaS as 92 out 100 experts mentioned this as the most promising trip purpose for MaaS (Zijlstra, 2019). Work-related travel is here overarching and includes commuting trips and business trips during the day. The second promising travel motive, according to the experts, is commuting. The third and fourth most mentioned trip purposes with a high potential for MaaS are visits and other free time-related travelling. This research of The Netherlands Institute for Transport Policy Analysis does not elaborate on why the experts think that these are potential early markets for MaaS. Jittrapirom et al. (2017) executed international research, which is in line with the outcomes of the study from Zijlstra (2019). In this research, experts express their forecast that early adopters of MaaS will use the platform mostly for commuting and business-related journeys. When the bigger mass follows, there can be a shift to using MaaS for shopping, social recreative and work-school related trips (Jittrapirom et al., 2017). This research is, same as the research from Zijlstra (2019), based on thoughts of experts. It is a fact that everyone who works needs to commute and not everyone who works makes other business-related journeys. Therefore, this research only focuses on commuting trips and not on the overarching concept of work-related trips, which also include trips during work.

Thus, commuting trips are the central point of this research. 68.7% of Dutch inhabitants between 15 to 75 years old work and they all have to travel to their work via car, public transport, bicycle or by foot (CBS, 2019). An average inhabitant of The Netherlands travels above ten thousand kilometres a year in their country, and the most considerable amount of the total travelled kilometres, 30%, is to commute. The car dependency is high, 60% of all commuting trips are done by car (CBS, 2018a). At the moment, policy in The Netherlands focuses on discouraging car use and wants to stimulate using public transport and bicycle. Local authorities of the four largest cities in the Netherlands want to accomplish a shift to more sustainable and active modalities (Jonkeren, 2019). According to literature, MaaS could potentially play a role in achieving this.

Local authorities are already trying to emphasise that smarter and sustainable commuting behaviour leads to benefits for organisations, employees and the environment (Luca, 2015). It is seen that some employers are already busy with introducing sustainability into companies. This also reflects on the way employers provide financing for the commuting trips of their employees. The role of the employer in the mode choice of employees when commuting is essential. Currently, most employers finance the commuting of their employees in a conservative approach. Employees choose car finance or a public transport card. However, things are changing. More and more employers are looking further than the conservative approach and are exploring different options. A couple of years ago, there was attention for the mobility budget, and nowadays, more and more employers show their interest in MaaS.

Besides the fact that experts express their thoughts that commuting can be appropriate for the use of MaaS. Employers show their interest in exploring new options, and the fact that commuting is such a large part of everyday travel, there is another reason to believe that MaaS for commuting trips has potential. MaaS is such a new concept, and it is expected that individuals are not suddenly going to change from their current modes to using MaaS if this comes widely available. Zijlstra (2019) already mentioned the benefits that MaaS must have compared to current modalities and Willumsen (2019) and De Viet (2019) also express the thoughts that the expectation of MaaS might be overestimated. To change modality preferences, one needs more than a hype (Ho et al., 2018). Since commuting mode choice can be a habit, it is expected that users need an incentive to let people reconsider their commuting mode. Commuting trips may be an appropriate market to introduce MaaS because there are opportunities to include incentives in the relation between the employer and employee. For example, in terms of costs, so whether the employer finances particular commuting mode choice or not.

So, experts express their opinion and think that commuting might be an appropriate market for the first adopters of MaaS. Moreover, almost 8 million people in the Netherlands work, they all need to commute in some way, and there is a high car dependency here. Furthermore, employers are already busy with searching for other, most of the times more sustainable, options to provide their employees' choices to commute. All these developments emphasise that there might be potential for MaaS for commuting trips. However, to contribute to all the promises that researchers state concerning MaaS, users are needed. Researchers and experts expressed their opinions and thoughts, but what to potential users think of MaaS? Are they interested in using MaaS? Information about the end-users of MaaS lacks. This altogether makes that this research explores the potential of MaaS for commuting trips. The employees, the end-users, are the point of attention as they are the people that will or will not use MaaS in the future.

1.3. Scope

Individuals travel from activity to activity during the day, for example, from home to work, to the gym, to the grocery store and back home again. The particular behaviour people perform during these trips is called travel behaviour (Axhausen, 2007). When someone makes a trip, there are multiple decisions to make. These decisions can be categorized in short-, medium- and long-term decisions. Long-term decisions refer to choices regarding housing location and work location. Medium-term decisions refer to ownership, so does someone one a car, a bicycle or a public transport card. The short-term decisions are related to day-to-day choices. This includes destination choice, route choice, time of the day choice and at last mode choice (De Dios Ortúzar & Willumsen, 2011). This research only focuses on mode choice as this is seen as the most critical choice considering commuting travel behaviour. Mode choice is a choice that is mostly up to the employees themselves, while the other choices are more fixed.

1.4. Research objective and research questions

Since this research is, to the authors' knowledge, one of the first that dives into MaaS for commuting, it is exploratory. It is not the intention to provide straightforward solutions to the threats to our social and ecological environment. This research aims to provide insights for authorities in the Netherlands into whether MaaS can play a role in commuting trips. The information is valuable for policymakers because MaaS might have the potential to address some big societal issues by contributing to, for example, less congestion, more available space and an increase in the use of environmentally friendly modes. However, to achieve this, users are essential. By researching the potential of MaaS from the users' side, this research provides insight into if the promises that are associated with MaaS are realistic or that they might be overestimated.

Since commuting trips are combinations of choices of employees and employers, the opportunity arises to examine if the policy of employers on financing commuting is related to the interest of employees in using MaaS for commuting trips. This information is valuable for the government and employers because they might have the capability to influence the interest of employees. This might, in the end, benefit societal and environmental related problems. The main research question in this research is:

"What is the potential for the use of MaaS for commuting trips by employees?"

To be able to answer the main research question, four sub research questions are formulated. It is clear what MaaS can potentially offer, but it is not researched yet how potential end-users think about MaaS. So, the first research question is about the thoughts of employees about MaaS in the current situation. This question explores the perceptions, the attitude and the interest of employees to use MaaS for commuting trips. Perceptions, also called beliefs, refer to expected outcomes and attitude, refers to being in favour of, or against, doing something. It is expected that current modality styles affect the thoughts of employees about MaaS. For example, it is expected that car-users think differently about MaaS compared to public transport users. So, different modality styles are identified here to research the thoughts of employees in detail.

The following research question dives deeper into the interest of employees to use MaaS for commuting trips, which is explored by measuring the intention to use MaaS. The second research question explores if and how finances from employers are related to the intention to use. This is done by presenting two scenarios. First, the scenario is presented that employers will finance MaaS. Second, a scenario is presented to only car users to explore this largest commuter group in more depth. The scenario is presented that employers stop financing commuting car use and only finance commuting costs with MaaS. By exploring if car users are willing to pay for their costs themselves, it can be measured how determined the car users are.

The last two research questions analyse the characteristics of employees with high and low intention to use MaaS by identifying different employee groups. These groups are identified based on the attitude and the intention to use MaaS in the current situation and in the situation where the employer would finance MaaS (scenario 1). This information is valuable for policymakers to target the interested, or not interested employees, effectively.

1. What are the thoughts of employees with different modality styles about MaaS?
2. To what extent does the cost reimbursement from the employer influence the intention to use MaaS for commuting trips by employees in general and among only car users?
3. What is the relation between belonging to a particular employee group, with different intentions to use MaaS to commute, and characteristics of those employees?
4. Which type(s) of employees show a substantial difference in intention to use MaaS to commute when they receive reimbursement from their employer?

1.5. Scientific, practical and societal contribution

This research provides added value in three ways. First of all, for scientific relevance, as it gives insights on a potential market for MaaS that has not been analysed in the literature yet. Since MaaS is in such an early stage, it is expected that many interesting topics for further research will derive from this research. Secondly, insights for practice will be given. These insights focus on the role of the employer on the mode choice of their employees. Thirdly, from a societal point of view, this research is valuable because it provides information about the potential of MaaS in a sector that could potentially be appropriate for the first implementation of MaaS. This information is relevant and interesting for policymakers to see if MaaS can play a role in this sector and eventually contribute to the higher goals regarding, for example, the environment.

1.6. Reading guide

This chapter provided an introduction to this research. The next chapter, Chapter 2, provides information about the context of this research which includes background information about MaaS and commuting mode choice. To gather this information, literature is mostly used. Complementary, to get a complete overview of the context of this research, interviews, a group discussion and desk research are used.

Afterwards, Chapter 3 presents the methodologies that are used to answer the mentioned research questions. Chapter 4 builds on this chapter and explores the literature to identify personal characteristics that are associated with interest and non-interest in MaaS and commuting mode choice. Hereafter, Chapter 5 is devoted to the design of the questionnaire. Executing an online questionnaire is the main data gathering method in this research. This chapter shines light on the content of the questionnaire with the factors from Chapter 4 as the basis. After this, Chapter 6 elaborates on the descriptive statistics of the data gathered through the designed questionnaire. Insights in the sample are presented to conclude to what degree the sample in this research is representable for the working population in the Netherlands.

After that, Chapter 7 analyses the gathered data and thereby presents the results. The primary data analysing technique in this research is the latent class cluster analysis. This is a technique that divides the sample into groups with maximum homogeneity within the groups and heterogeneity between the groups based on particular indicators. Dividing the respondents into such groups provides a sufficient understanding of the intended behaviour. Furthermore, the characteristics of employees with and without interest in using MaaS for commuting trips can be identified, which is useful information for policymakers. Finally, Chapter 8 provides the main conclusion and discusses the limitation of this research. Moreover, this last chapter provides recommendations for further research, practice and policy. The structure of this thesis is visualised in Figure 1.1.

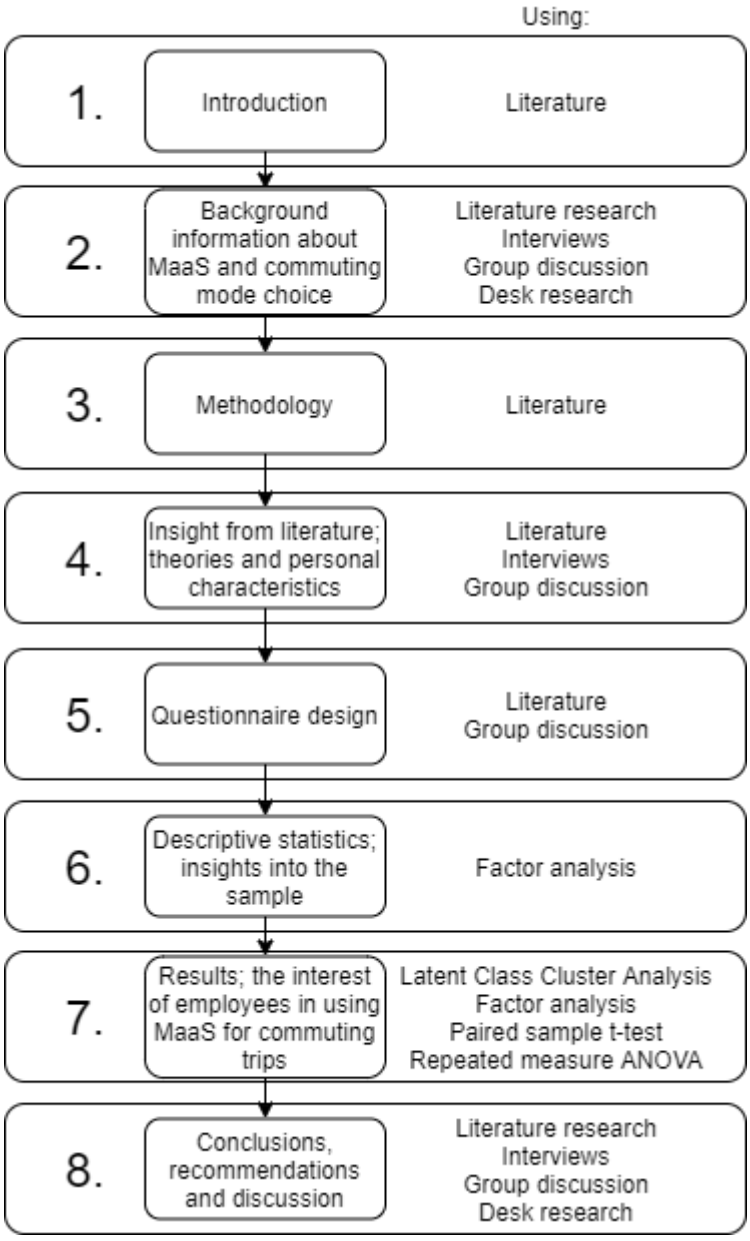

Figure 1.1: Outline of this thesis

2

Background information about MaaS and commuting mode choice

This chapter discusses the concepts mentioned in the introduction from multiple angels to get information from the whole spectrum. The goal of this chapter is to establish a theoretical foundation for the further research.

Two main concepts need further elaboration. The first concept is MaaS, being the core concept in this research. As pointed out in the introduction, the focus is on MaaS for commuting trips. Therefore, it is essential to also gain knowledge about commuting in the Netherlands. The first subject is elaborated in Section 2.1 and the second concept in Section 2.3. Currently; there is much attention from the government into MaaS in the form of seven pilots. In between the discussion of the two concepts, Section 2.2 elaborates on the pilots and especially on two pilots that are related to this research. At last, Section 2.4 provides a conclusion of this chapter where the previous sections come together.

2.1. Mobility as a Service

This section sheds light on the concept Mobility as a Service (MaaS). Researching MaaS requires a clear definition and precisely formulated focus points because MaaS is such a broad, and sometimes vague, concept. To define MaaS, existing literature is reviewed. Subsection 2.1.1 elaborates on MaaS in the literature and discusses its definitions and core characteristics. This results in a definition of MaaS in Subsection 2.1.2. Afterwards, Subsection 2.1.3 addresses the potential first users and markets for MaaS. Since the promises of MaaS are mentioned a lot, Subsection 2.1.4 provides information on the promises of MaaS for society and potential users. On the other hand, not everyone agrees with the hype around MaaS and Subsection 2.1.5 elaborates on the difficulties and ambiguities surrounding MaaS.

2.1.1. What is MaaS?

The first description of MaaS is presented in 2014 by Hietanen. He describes MaaS as ”a mobility distribution model that delivers users’ transport needs through a single interface of a service provider. It combines different transport modes to offer a tailored mobility package, like a monthly mobile phone contract.” (Jittrapirom et al., 2017).

Throughout the years’ many extensions to this definition have been made and every article emphasises a different aspect of MaaS. In some definitions the function of the internet is seen as the main component (Nemthanu et al., 2016), other researchers emphasise the role of subscription (Holmberg et al., 2016), and multiple other researchers emphasise the user-centred perspective of MaaS (Ghanbari et al., 2015; Rantasila, 2015). Jittrapirom et al. (2017) reviewed existing literature to find the core characteristics of MaaS. These characteristics of MaaS are summarised in nine items, as presented in Table 2.1.

Table 2.1: An overview of the core characteristics of MaaS (Jittrapirom et al., 2017)

Characteristics of MaaS:	**Elaboration on the characteristics:**
Integration of transport modes	MaaS offers a platform where multiple modes are combined in one trip. These modes can be traditional modes as public transport, bicycles and private cars but also shared modalities.
Tariff option	MaaS offers payment in the form of packages or pay-as-you-go. With packages, one pays per month. A package can include a certain number of kilometres, stops or minutes to travel with a particular mode. Pay-as-you-go is paying per trip.
One platform	MaaS offers service on one platform, or app, where customers can plan, book and pay for their door-to-door trip.
Multiple actors	In the field of MaaS, various actors are involved. From authorities to platform owners to customers. The interaction of the related actors is important.
Use of technologies	MaaS needs multiple technologies such as a smartphone, internet connection, GPS and a system to pay for the trip.
Demand orientation	MaaS is a user-centric concept that offers a tailored trip to every customer.
Registration requirements	Registration is required to use the service and to allow personalisation and customisation.
Personalisation	Every customer is unique, and MaaS offers a tailor-made solution whereby the needs of customers are centralised. Additionally, MaaS can provide tailored recommendations based on the profile of customers (expressed preferences and past travel behaviour).
Customisation	It is possible to tweak the service according to customers preferences. For example, the number of kilometres stops or minutes travelling with a mode within a package.

As mentioned, many researchers defined MaaS. In the introduction of this research, the definition of Durand & Zijlstra (2018) was cited: “MaaS is a new transport concept that integrates existing and new mobility services into one single digital platform, providing customised door-to-door transport and offering personalised trip planning and payment options. Instead of owning individual modes of transportation, or to complement them, customers would purchase mobility service packages tailored to their individual needs, or pay per trip.” This definition was stated after a comprehensive literature review (Durand & Zijlstra, 2018).

Another definition comes from the MaaS Alliance. The MaaS Alliance is a public-private partnership that wants to unlock economies of scale for MaaS to implement MaaS in Europe and beyond. They describe MaaS as: “In MaaS, the services available to consumers ideally include everything from car-sharing, bike-sharing, taxi services, ride-hailing, micro-transit to public transportation, all of which aims to offer consumers an alternative to using and/or owning a personal vehicle. To offer such a wide array of mobility alternatives MaaS has become an overarching concept, whose goal it is to combine all types of shared mobility and offering them to consumers as a single service with integrated travel planning, information, ticketing and payment systems, usually through a mobile application (Alliance, n.d.).”

Sochor et al. (2018) researched existing definitions of MaaS. They concluded that, in most times, the definitions of MaaS mention the following aspects:

- Offering a service with as focus point the customer/user/traveller/consumer
- Offering integration of transport service, information, payment and ticketing
- Offering multi-modal mobility

The latter two aspects need some further elaboration.

Integration levels of MaaS

Multiple researchers describe MaaS in terms of the level of integration. Sochor et al. (2018) proposed a typology of four levels of integration within MaaS. This topology enables a more precise definition of MaaS and makes it easier to compare the results of pilot studies. The levels of integration are depicted in Table 2.2.

Table 2.2: Levels of integration within Maas (Sochor et al., 2018)

Level of integration:	Integration of:
0	No integration
1	Information
2	Booking and payment
3	Service offer
4	Societal goals

The first integration level is where an application provides information about the possibilities to make a MaaS trip. So, an app offers information on how to travel from door-to-door, in all probability, with different modes. The second integration level makes it possible to book and pay for this trip; this level focuses on one trip at the time. Within this way of integration, it is easier for people to access multiple services as they are visible in one application and can also be paid for in one app. The third integration level focuses on the complete mobility needs of customers. This level focuses on transportation throughout the year. It offers a full alternative to owning a car, rather than a trip from A to B. A mutual commitment is needed, in the form of a monthly subscription at least. The pricing is non-transparent; customers pay for a bundle and do not know which part of the money goes to what service operator. The highest integration level integrates for societal goals. Particular incentives can help to achieve societal goals such as decreasing car use. An example of such an incentive is a discount when one travels outside rush hour. Authorities can set conditions for providers so that the desired behaviour can be achieved (Sochor et al., 2018).

The multi-modal character of MaaS

The other aspect that needs some further elaboration is the multi-modal character of MaaS. In every definition, this multi-modality gets some attention, but what is this multi-modality and what modes can be included in MaaS to provide this multi-modal trip? Multi-modality is defined as using two or more modes to travel in one trip. So, for example, take the bike to the train station and the train to travel to the final destination.

Figure 2.1 presents an overview of several MaaS pilots. It presents the level of integration and the modes that are included in the pilots. These pilots are from around the world, for example, Smile is from Vienna, UbiGo from Gothenburg and Tuup from Finland. From the 13 initiatives, ten are level 2 integrated and three are level 3 integrated; it should be noted that one of the level 3 pilots was never operational. Another point of attention is that this list is not comprehensive; this table does not include all the pilots in the world but gives an overview of modes that are mostly included in MaaS pilots. Furthermore, it must be said that there is not always a hard line between the integration levels, and it is difficult for some pilots to identify the level of integration.

	Level of integration	Bike sharing	Car sharing	Car renting	Taxi	Urban PT	Regional PT	International PT	Parking	Valet parking	Collective DRT	Tank filling	Electric car loading	Microbuses
moovel	2		x		x	x	x							
myCicero	2					x	x	x	x					
NaviGoGo	2		x		x	x	x							
iDPASS	2			x	x					x				
Tuup	2	x	x		x	x								
Hannovermobil	2		x		x	x	x							
EMMA (TaM)	2	x	x			x	x							
Business travellers cards	2	x	x	x	x	x	x		x		x	x		
Smile	2	x	x		x	x	x		x					
WienMobile Lab	2	x	x		x	x			x					
SHIFT	3	x	x		x					x			x	
UbiGo	3	x	x	x	x	x								
Whim	3	x	x	x	x	x	x							
Kutseplus	2													x

Figure 2.1: Overview of the pilots and the included modes (Durand & Zijlstra, 2018)

In most of the MaaS initiatives bike sharing, car sharing, taxi, and urban and regional public transport are included. Bike-sharing is the concept that one can rent a bike and use it for some minutes or even up to 24 hours. In the Netherlands, the pubic transport bike is a popular concept. With this concept, one must return the bike to the station where one rented it or has to pay a fine of 10 euros. Nowadays, more and more initiatives pop up with shared bikes. For example, shared bikes in big cities, where there are various crewless bike stations and one can rent the bike, use it and put it back at another bike-sharing station. Alternatively, there are even more flexible initiatives, for example, MoBike. One can drop the bike everywhere around the city, the next person can grab that bike and drop it somewhere else.

Car sharing works similarly as bike-sharing. One pays to rent a car, for a couple of minutes, hours or days. The options to bring the vehicle back are the same as with the shared bikes. There are initiatives where one needs to bring the car back to the same renting station. Others make it possible to bring the car back to another renting station. The other option is to leave the car somewhere in a designated area where it can be picked up by someone else. Examples of initiatives with shared cars are Greenwheels and car2go. Greenwheels has 1800 locations in the Netherlands where one can get and drop the shared vehicles. One can make a reservation via the app, open the car by screening the Greenwheels card and take the key from the board computer to start the vehicle. One can leave the car on the original parking spot when the reservation comes to an end (Greenwheels, n.d.). Car2go is an initiative that is active worldwide in big cities as New York, Berlin and Madrid. In the Netherlands, Car2Go is operational in Amsterdam; you pay per ride, and there is no need for subscription (Ramaer, 2017).

Sometimes, MaaS goes as far as to demand-responsive transportation (DRT). DRT are transport services that are not following a time-schedule but operate on demand. The Buurtbus in the Netherlands is an example of collective DRT; one needs to call a number for the bus to come. Individual DRT is a step further and allows for ride-sourcing, or, ride-sharing. This means that a system checks real-time where one wants to go and matches supply and demand to, if possible, combine these trips. This type of DRT is not yet included in MaaS initiatives. Despite, there are signs that this may happen in the nearby future (Alliance, n.d.).

The Kutseplus pilot is added to the list made by Durand & Zijlstra (2018). This pilot was operated in Helsinki. The service was demand-responsive. Vehicle routing algorithms and optimising combining trips were used to create a sufficient system of microbuses.

The list of available modes in the MaaS initiatives miss shared e-scooters. Lately, e-scooters are popping up in the Netherlands. In Amsterdam, Den Haag and Rotterdam, Felyx is rising in popularity. Felix is a shared e-scooter system where one pays per minute. The app can be used to find, reserve and activate the nearest scooter. Afterwards, one can leave the scooter somewhere in the designated areas for someone else to pick it up (Felyx, n.d). Meanwhile, also Check and GO sharing are operational in Rotterdam, the Netherlands (Check, n.d; GoSharing, n.d).

A couple of other modes are not included in these pilots but can be added in future MaaS pilots. These are shuttle services, carpooling, special wheelchair buses, steps and segways. Especially shuttle services and carpooling are interesting in the context of travelling between home and work. These are extra services that MaaS can offer for companies. One might register to a company account, and the MaaS app provides information about, for example, carpooling options. Shuttles services are small buses that drive from a public transport location to a company at places where there is a demand for this because, for example, there are many people that make this trip which makes it more efficient to bundle.

2.1.2. MaaS in this research

All in all, MaaS is an overarching concept and knows many definitions and characteristics. The definitions and core characteristics mentioned above are a selection of the available literature.

Different words are used in the definitions of MaaS: user transport needs, single interface, single digital platform, combines transport modes, offer tailored mobility, door-to-door-transport, personalised trip planning and payment options, aim to offer an alternative for using/owning a personal vehicle, a wide array of mobility alternatives, integrated travel planning, information, ticketing and payment systems.

In this research, MaaS is a service that offers:
- Multi-modal, door-to-door trips, including the following modalities: shared cars, shared bikes, shared scooter, taxi, carpooling, shuttle services and public transport
- On one platform where one can plan, book and pay for the trip.

MaaS makes a customised trip possible, not only per individual but also per travel motive. For example, nowadays, when one travels by car in the morning because the kids need to be dropped off before going to work, means that every other trip that day needs to be made with the car. With MaaS, it is possible to adjust the transport mode to particular trip purposes.

This research is exploratory. Because of the preliminary phase where MaaS is in now, it is difficult to give specific details about the costs or details about how a trip with MaaS for someone would look like. The same accounts for the payment options. MaaS knows two payment options, bundles and pay-as-you-go. Bundles are in the form of a monthly payment where a bundle includes a particular way of access to modalities. For example, unlimited access to public transport, a discount for public transport or a certain amount of hours or rides with a shared car etcetera. The other form is paying per trip. The difficulty of specifying costs together with the exploratory nature of this research and the fact that in many cases, employers finance commuting, makes that the element of the expenses for MaaS is not included in terms of specific amounts in this research. The fact that payments can be made through a bundle or per trip is also excluded. It might be assumable that, for commuting, employers would pay for bundles for their employees instead of paying per trip, but at the moment there is little information on what such a bundle might look like. Besides, this research does not focus on exploring bundle options, so it is not mentioned in the definition whether the payment is in the form of a bundle or per trip.

The participants in this research work and most of them probably get finance for commuting. For them, it does not matter how the payment goes, it does matter who pays for it, themselves or their employer. Therefore, the price is not ignored. It is expected that price plays an essential role in the interest in MaaS. There is no focus in this research on the particular costs of MaaS. However, this research explores the relationship between costs and intention to use MaaS through differing financing for commuting from the employers.

Subsection 2.1.1 provided information on the integration levels possible within MaaS. As Sochor et al. (2018) mentioned, the strict topology might be too simplistic as combinations of levels also exist. It is difficult to place the MaaS definition of this research in an integration level because the focus is not on the costs and payment. It floats between level two and three. As this research focuses on commuting, it is not a complete mobility option which offers a full alternative for using and/or owning a car, and it is not one trip at a time either. People commute when they go to work, and this happens in most of the cases multiple times a week. Since the focus is not on the exact payment, it does not matter if this is paid in a package or per trip.

2.1.3. Potential users and markets for Maas

To make an innovation a success, it is crucial to focus on the end-users as they are the people that are, or are not, using the innovation (Lyons et al., 2019).

In the Netherlands, there are two papers about the potential users of MaaS. As stated in the introduction, the potential cost advantage when using MaaS was identified as the most critical condition for using MaaS. This is another indication that costs play a role in mode use when commuting. Next to this, the availability, ease of use and reliability of the potential MaaS system are essential conditions for the acceptance of MaaS (Harms & Hoogendoorn-Lanser, 2018).

Additionally, The Netherlands Institute for Transport Policy Analysis (KiM) did research on the potential first users of MaaS in the Netherlands. These potential first users are young, from high social classes, deeply concerned about the environment, fly multiple times a year and frequently use public transport. All in all, the potential first users of MaaS in the Netherlands are people with a hypermobile lifestyle. Furthermore, the most appropriate areas for the first adaptation of MaaS are big cities according to this research (Zijlstra & Harms, 2018).

The same researchers looked into potential early markets for MaaS and concluded that work-related travel has the highest potential. This is primarily about business trips during work hours and secondary about commuting. Social and recreative journeys also score high, according to the interviewed experts (Zijlstra, 2019). Studies from Australia and Vienna confirm the latter on. These studies state that MaaS will mostly be used for social, recreational journeys (Karlsson et al., 2016). Jittrapirom et al. (2017) executed international research which is more in line with the outcomes of the study from Zijlstra (2019). In this research, experts express that early adopters of MaaS will use the platform mostly for commuting and business-related journeys. They also conclude that the followers will use MaaS for other reasons, namely shopping and leisure and social trips (Jittrapirom et al., 2017). This paper concluded with an identification of the first market. It stated that the first MaaS concepts would focus on commuting and business trips. It is unclear whether they think that this potential primary market is based on what potential consumers want. This research is, same as the research from Zijlstra (2019) based on thoughts of experts. There is no information on why experts think about MaaS the way they do. As can be read, the thoughts about the potential first markets differ throughout literature.

Information about what the end-users think of MaaS lacks, while they are the people who need to use MaaS in the future. There is some research about the ideas of end-users in the form of an essential conditions for using MaaS. However, there is a need for research about the attitudes of potential MaaS users regarding MaaS (Lyons et al., 2019).

2.1.4. Promises of MaaS for society and benefits for end-users

The expectations of MaaS are high. Many promises for the society are mentioned throughout literature. The most mentioned promise is the effect on private car ownership. Smith et al. (2018) interviewed experts and they all believe that MaaS can lead to decrease of car ownership in the long term. For the short term, experts believe that the car ownership of a second car by people living in urban and suburban areas will decrease first. Two pilot studies show that the use of the private car decreases because of MaaS. In the MaaS pilot in Vienna, one fifth of the participants uses the private car less. In Sweden this is more extreme as 44% of the UbiGo participants decreased their private car use. The UbiGo pilot also showed another promise as the perception about other modes than the car were positively influenced. A large comment which has to me made is the degree of self selection among the participants in the pilots. Individuals probably joined the pilots because they were interested in MaaS already. This makes it not possible to generalise the results to the population (Harms et al., 2018). A decrease in car use, positively influences the environment and also has spatial benefits. Less cars are stationary which gives more space for, for example, more green in cities.

Furthermore, as the UbiGo pilot already pointed out, MaaS can lead to new attitudes regarding modalities such as the public transport and shared cars. MaaS lowers entry barrier for these modes and therefore it is expected that the use will increase. Furthermore, MaaS promises network efficiency because travellers can be spread during the day by for example including road pricing at particular moment of the day (Wong et al., 2018).

To achieve these promises, MaaS needs to be operational and users need to have interest in this new way of organising their travel needs. When MaaS is not going to be used, the ultimate societal goals can be forgotten. So, why are the benefits for users?

First of all, MaaS brings alternatives. There is an increase in a variety of travel options; one can choose the option that fits a particular trip best. Secondly, MaaS unburdens from door-to-door and guarantees the journey. So, for example, when a train gets cancelled, the MaaS application provides the best back-up journey to reach your destination. Thirdly, MaaS gives easy access to full mobility. The full range of mobility needs are in one app and it is possible to pay for it in the app as well. At last, the customisation aspect might be interesting for users. With MaaS, one can create their own ideal trip. The application makes it possible to include personal preferences which are an upgrade compared to the currently available options. For example, a certain amount of non-car kilometres.

2.1.5. Difficulties around MaaS

Not everyone is as enthusiastic about MaaS as it might seem like. Multiple researchers express their concern about the positivity around MaaS, while there are still so many uncertainties and ambiguities.

Willumsen (2019) analysed the impacts of MaaS and predicted that MaaS is only going to cause problems. Many people think that MaaS is going to be a solution for various problems. However, Willumsen (2019) states that MaaS is only attractive for people who are now using public transport. People who use the car as primary mode of transport are not willing to change because of perceived travel costs and travel time. People ignore fixed costs when comparing different modes, and MaaS will be more expensive than the marginal costs of cars. Above that, the travel time increases with MaaS compared to using the car, which also makes it an unattractive mode for people who now use the car. Willumsen (2019) states that to reduce car use, using the car must be priced instead of trying to pull people into other modes. De Viet (2019) confirms the statements Willumsen (2019) as he concluded that the bundles he researched are not attractive enough for car users to switch from using their own car to MaaS. He also sees an indication for the fear that people who now use public transport will use the car more often because it is available in the form of the shared car within MaaS (De Viet, 2019). Individuals that now use public transport every day may consider taking the shared car more often when this becomes available. This can cause more vehicles instead of fewer vehicles on the road, which is unfavourable from the environmental viewpoint of MaaS. Important to mention is that there is yet no research on the actual behaviour of potential

users, so it is unknown whether the users will act upon the presented travel options. This emphasises the importance of researching the end-users. Research is needed to explore whether people will change behaviour, but before researching that, it is interesting to explore what potential users think of MaaS.

Another point of attention is the interference of the government. In the Netherlands, the government has much control about mobility; they subsidise public transport and are a grantor. The government interferes with public transport to reach her goals regarding accessibility, livability, social participation and the economic situation in terms of competition (Zwaneveld & Berveling, 2009). Besides, it is part of the Dutch culture to gain as many information as possible before making big decisions. To the authors' knowledge, this reflects on the approach of the MaaS pilots. The government wants to keep the control and explores MaaS at the moment in term of seven pilots run by the Ministry of Infrastructure and Water Management (see Section 2.2). This makes it impossible for market firms to start MaaS innovations in the regions where the pilots are running. These pilots take time and hold back fast progress (Appendix B).

Another challenge, or difficulty, is that it is necessary to have a sufficient working system from the beginning. For example, if one looks into shared cars. The cars need to be widely accessible and available for people to use them. Whether people want to use MaaS is dependent on the performance of the system. Ideally, it needs to be reliable and ideally accessible everywhere (Harms & Hoogendoorn-Lanser, 2018).

Furthermore, a big challenge is that people are attached to their car. Not only because it provides flexibility and a feeling of freedom, but also because it is a status symbol. It is challenging to motivate people to not use their car anymore. An example of this is a pilot within the green mobility program at the Delft University of Technology (DUT). The pilot allowed employees and students of the DUT to replace their car with an e-bike for two months. It appears that promoting cycling is not enough to get people out of the car (Kocaman, 2019). Kocaman (2019) states that car-demotivating measures are needed to get people out of the car.

Difficulties become apparent when looking into a large pilot. UbiGo is a project in Gothenburg, Sweden. This pilot started to see whether a new service, which aims for more sustainable transport, can get paying customers and how it should look like to please these customers. The UbiGo MaaS pilot included existing transport solutions as public transport, car- and bike-sharing, taxi and rental cars. Costumers payed per month and bought a package adapted to the transport needs of the family. Furthermore, UbiGo included a phone line that is open 24 hours a day. The app makes it possible to make bookings, pay for them and look into travel history (Karlsson et al., 2016). Karlsson et al. (2016) provided information on the findings from the pilot. Overall, this pilot was very successful. The private car use decreased, users were satisfied with the product and attitudes towards various travel modes changed in the form of more positivity towards alternative modes. Although the effects were positive, the pilot did not continue and ended in its pilot form. There are a couple of reasons for this. One is the financial aspect; at the end of the pilot, there was not enough financial support to go to a fully operational service. The second barrier evolves around laws and regulations. Public transport is a large part of MaaS and the regulations to include public transportation in MaaS where lacking. At last, the involved partners lacked real business experience, which made them back off because of the uncertainties for the future. All-in-all, there was no strategy made (on time) to be able to take the project to the next level.

The Kutseplus pilot also did not go through end ended as a pilot of three years. The reason is similar as for the UbiGo pilot. The learned lessons mostly revolve around "how to" questions. These organisational questions are related to policymaking; creating a fruitful context, fare and funding policy and decision-making processes (Jokinen et al., 2017). Jokinen et al. (2017) mentioned that creating a sustainable financial model is just the tip of the iceberg. The advanced technology that is needed is neither the most significant barrier, the policy and organizational factors around MaaS are.

At last, an aspect that must be considered is social inclusion. There is evidence that older people are not comfortable with paying online and using an application (Demirguc-Kunt et al., 2018). MaaS might exclude these people (Pangbourne et al., 2020). This difficulty should be kept in mind but is most relevant when MaaS is largely operational and not so much in the preliminary phase where it is in at the moment.

2.2. MaaS in the Netherlands

Besides the body of literature about MaaS, the number of pilots that experiment with MaaS are also growing. Together with seven regions, the government in the Netherlands is setting up MaaS pilots, see Figure 2.2. The pilots have focus points. Some focus on transporting individuals who need extra help and other focus on work-related trips. The goal of the pilots is to learn, expand mobility knowledge and explore effects of MaaS. Are people going to make different travel choices because of MaaS? And, is it possible to bend travel behaviour via MaaS, into, for example, more sustainable behaviour (Overheid van Nu, n.d.)? The government wants to take the first step towards a sustainable transport future with MaaS, where ownership becomes less important, and service provision becomes more important. The pilots use the following definition for MaaS: the offer of multi-modal, demand-driven mobility services, whereby tailor-made travel options are offered to customers via a digital platform (e.g. a mobile application) with real-time information, including payment and transaction processing (Van der Linden, 2018).

Figure 2.2: MaaS pilots in the Netherlands (Miltenburg, 2018)

Two examples that are particularly interesting for this research are the pilots in Eindhoven and Amsterdam. The pilot in Eindhoven focuses on MaaS for companies and collaborates with the municipality of Eindhoven, Brainport and ASML. ASML has interest in the MaaS pilot because they are growing extremely fast. So fast that they do not have enough space to facilitate new employees and their lease cars, therefore they need to build new buildings and new garages. ASML, as a company, realises that this is not efficient and explores the option to encourage employees to take other modes to travel to work. The municipality in Eindhoven has the ambition to make all business-related trips sustainable in 2025. Therefore they are participating in this pilot as a customer. They are committed and even go that far in providing MaaS for their employees that they force every employee to use MaaS to commute.

This means that there are no lease cars anymore. Interesting to mention is the fact that this thus passed the Works Council, which is a participation body of employees within a company who communicate with employers on behalf of the staff. The employees seem to be open to new kinds of mobility contracts.

The pilot at the ZuidAs in Amsterdam is a collaboration between the Ministry of Infrastructure and Water Management, the municipality of Amsterdam and employers at the ZuidAs. This pilot wants to offer an attractive alternative for commuting with the car (Ministerie van Infrastructuur en Waterstaat, 2019). The ZuidAs is an area in Amsterdam where many big firms are settled. Around 35.000 people work here, and they all commute to work multiple times a week. From the end of 2019 onward, the area around the Zuidas will encounter hindrance from roadworks and renovation of the station at the ZuidAs. The construction work offers an opportunity for MaaS. Without interventions, the companies become less accessible, and employers want to prevent this. Besides, employees are probably more willing to use different forms of travelling because of the rising pressure on the roads. Besides the construction work, employers acknowledge the fact that the satisfaction of employees can get a boost by offering a flexible mobility policy. Mobility is one of the factors related to sustainability in companies, mainly in firms that are, for example, located at the Zuidas, big professional service-related companies. So, logically, employers see chances to reduce the CO2 footprint by MaaS.

The first reason is specific for the ZuidAs, but the other two relate to employers in general. Not only involved employers in the pilots are busy with exploring new options concerning the mobility of their employees. For example, Schiphol Group is also working on a MaaS service for its employees.

The main goal of the pilots is to learn and explore the effect of MaaS. This is going to be an iterative process. For example, there will be a real-time evaluation of the data; in this way, the effects of specific features in the application can be explored. If features do not bring the wanted effect, it is possible to explore other features to try to get the wanted effects. The pilots are going to provide insights in if and how MaaS influences travel behaviour and also provide knowledge on the efficiency of MaaS in different sectors because of the different set-ups of the pilots throughout the country.

2.3. Commuting in the Netherlands

Mobility is on the move, new technologies and modalities emerge, and the government is busy regarding measures for the environment. For younger generations, a lease car is not necessarily the best and only option anymore. Freedom and flexibility become more important when it comes to mobility (Hanselaar, 2018). Employers cannot deny these changes and are moving along.

This section sheds light on commuting in the Netherlands as this is part of the focus point in this research. At first, numbers are presented in Subsection 2.3.1. Afterwards, policy regarding commuting in the Netherlands is described in Subsection 2.3.2.

2.3.1. Facts about mode choice when commuting in the Netherlands

Almost 9 million Dutch inhabitants have a job, and they all commute in some way (CBS, 2019). This ensures many travelled kilometres. An average inhabitant of the Netherlands travels above ten thousand kilometres a year in their own country. Table 2.3 presents the percentages of trips per travel motive for six cities in the Netherlands. The most substantial amount of the total trips is to travel from and to work, to commute. Remarkably, the business visits only account for 4% of the total amount of trips. When comparing these numbers for the six cities with the average in the Netherlands, the distribution looks similar. In the Netherlands in general, the most substantial amount of the total travelled kilometres, 30%, is to commute (CBS, 2018a).

Table 2.3: Percentages of trips per travel motive in six cities in the Netherlands (OVIN, 2020)

	Groningen	Deventer	Utrecht	Amsterdam	Rotterdam	Eindhoven	Mean
From and to work	26%	24%	31%	30%	29%	28%	28%
Business visits	3%	3%	5%	4%	4%	3%	4%
Services / personal care	5%	4%	4%	4%	5%	5%	4%
Shopping	21%	18%	17%	18%	18%	18%	18%
Education / courses	14%	13%	13%	11%	13%	12%	13%
Visit / stay	9%	10%	9%	8%	9%	10%	9%
Other social recreation	12%	12%	12%	13%	11%	11%	12%
Touring / walking	4%	6%	3%	4%	4%	4%	4%
Other motive	7%	10%	8%	7%	8%	8%	8%
Total	100%	100%	100%	100%	100%	100%	100%

Table 2.4 shows the average amount of commuting trips per person per year and the modal split for the Netherlands in general. The car is the most used transport mode when commuting, almost 60% of the employees in the Netherlands commutes by car. The modal split for commuting trips in the Netherlands and in the six cities, see Table 2.5, do not differ that much. However, it is noticeable that public transport use for commuting trips is higher in cities than in the Netherlands in general. This was expected since the supply of public transport is denser in cities. Furthermore, car use is most of the times demotivated in cities by little parking spots under high costs. Subsequently, especially in Amsterdam, relatively low car usage is measured for commuting trips.

Table 2.4: Average amount of commuting trips per person per year (CBS, 2017b)

Main mode of transport:	Number:	Percentage:
Car	93	57%
Bicycle	40	25%
Public transport	16	10%
Other	13	8%
Total	162	100%

Table 2.5: Modal split of trips from and to work (OVIN, 2020)

	Groningen	Deventer	Utrecht	Amsterdam	Rotterdam	Eindhoven	Mean:
Car	51%	63%	50%	41%	56%	63%	54%
Bicycle	33%	22%	19%	21%	14%	21%	22%
Public transport	9%	10%	25%	31%	22%	10%	18%
Other	7%	5%	6%	7%	8%	7%	7%
Total	100%	100%	100%	100%	100%	100%	100%

2.3.2. Policy about commuting in the Netherlands

There is no law about financing commuting trip by employers in the Netherlands. In most cases, information about the finances of commuting are stated in the collective labour agreements or otherwise in contracts (HR-Kiosk.nl, 2017; Van den Hurk, 2010).

However, there are rules about maximum untaxed compensation. From 1-1-2017 onward, the maximum that an employer can finance untaxed is 19 cents per travelled kilometre (HR-Kiosk.nl, 2017). There is no difference between commuting and business-related trips for the tax authorities. Financing above 19 cents is allowed, but it is taxed. These rules apply to people that travel by private car. Travelling with public transport is different, an employer can finance all travelled kilometres with the public transport untaxed, or choose to pay a

fixed kilometre allowance of 19 cents (RitAssist, n.d.). How employers arrange the finances of commuting for their employees is up to them.

The agreement of 19 cents per kilometre is frequently used, but sometimes the employer sets limitations (Van den Hurk, 2010). An example of this is when the first 5 kilometres are not financed or that it goes up to 30 kilometres, or 50 kilometres (Van den Hurk, 2010). In the health care sector, for example, employers do not finance commuting when people live less than 10 kilometres from work (HR-Kiosk.nl, 2017). This differs per company or organisation.

Some employers have a fixed compensation for commuting, independent on the travelled kilometres; this is also called the mobility budget (HR-Kiosk.nl, 2017; RitAssist, n.d.). This form of financing gained attention a couple of years ago (Mobility, 2019). The budget is fixed, and one can choose the way to travel that suits him or her the best. So, the needs of the employees are the starting point. The employees are responsible for the costs they make, and everything that remains from the budget is for themselves, on the other hand, if the costs are higher than the budget they must pay for it themselves (MKBlease, n.d.).

There are a couple of reasons why organisations choose for a mobility budget. For employers, the mobility budget:

- Brings a sustainable image. With the budget, employers challenge employees to think about the way they commute. If they travel by bike when the weather is good, they save money. This is an incentive for employees to use the bike. Which decreases the CO2 pollution of the company as a whole and therefore, better the image.
- Brings transparent costs and takes away administrative tasks. The costs are more transparent and easier to manage because they are fixed. Employers and employee know what to expect.
- Comes with no dependence on multi-year lease car contracts. If an employee leaves, there are no problems with ending the lease car contracts.
- Increases chances on the labour market. Especially the younger generation wants to have responsibility. With the mobility budget, one responds to the desire for freedom and flexibility of millennials.

For employees, the mobility budget brings:

- Choice of freedom. Employees have the flexibility to choose a mode that suits them for a particular trip. Choice of freedom is an important factor to increase employee satisfaction.
- Extra money when part of the budget is left. This stimulates people to make more conscious choices.

Muconsult (2009) conducted research and analysed the results of some big companies that provided their employees with a mobility budget. People who chose the mobility budget did this mostly out of financial reasons, but also the environment played a role.

Various employers try to stimulate commuting in a more active and environmentally friendly way. For example, by offering the mobility budget, by offering special bicycle schemes (UMC, n.d.), or by stimulation of the purchase of a more environmentally friendly car by offering a cheap loan. An example of an employer that is busy with stimulating their employees to commute in an environmentally friendly way is Goudappel Coffeng. Their policy results in a high usage of public transport. In terms of kilometres, 54% of the total amount of kilometres for commuting is done with public transport, 38% by car and 8% with the bicycle. More information on the commuting policy of Goudappel Coffeng can be found in Appendix D.

2.4. Conclusion

The body of literature about MaaS is extensive. This chapter provided information as a background for further report.

The government shows interest in MaaS in the form of the MaaS pilots. Also, employers show interest and are already exploring options to redefine employees mobility. Furthermore, commuting is a big part of everyday travel, and there are opportunities and needs here to change the corresponding mode use when commuting. There is a high car dependency, and MaaS might have the potential to lower this dependency by offering flexibility, unburdening, easy access to full mobility and customisation.

From multiple sides, organisations show interest in redesigning the car dependency for commuting trips. However, information about the thoughts and interests of the end-users lacks. This all makes that this research focuses on MaaS for commuting trips and so, the end-users are employees.

A lesson can be learned from the mobility budgets. Namely, that employees are sensitive to financial incentives and also take environmental aspects into account when making travel choices. Willumsen (2019) and De Viet (2019) state people who now use the car to commute are not likely willing to switch to using MaaS for commuting trips without any incentive. Therefore, this research goes deeper into the intention to use MaaS for commuting trips and researches if changes in the financing from the employers influence this intention.

Using MaaS for commuting trips might be the first step into a more open attitude towards shared modalities to eventually make it possible to go to a world where sharing is more convenient than owning. The first step needs to be made somewhere, and commuting might be an environment for this first step.

3

Methodology

This chapter contains information on the methods that are used to answer the research questions presented in the introduction. The first section, Section 3.1, discusses the data collection methods. Followed by Section 3.2, which elaborates on the different data analysing techniques. This chapter ends with a conclusion in Section 3.3.

3.1. Data collection methods

There are five methods used to collect the data. Four methods are used to gather qualitative data: literature research, desk research, interviews, and a group discussion. Additionally, one method is used to gather quantitative data, an online questionnaire.

3.1.1. Literature research

Literature research is conducted to identify personal characteristics that might influence the interest of employees to use MaaS for commuting trips. These characteristics are relevant to include in the questionnaire to explore characteristics of interested and not interested individuals. Furthermore, theories concerning travel behaviour are used to design the questionnaire. For example, to decide on how to measure the interest of employees since one can not directly ask for this. Information about the theories and factors that are important when researching MaaS for commuting trips is presented in the next chapter, Chapter 4. This information is used for designing the questionnaire, which is described in Chapter 5.

Online databases are used to find relevant articles. Google Scholar is used as the main database. Because of the uncontrolled nature of this database, it provides broad content, which is not always available in controlled databases (Halevi et al., 2017). The controlled database Science Direct is used as a supplementary database. The time frame was set from 2014 to 2020, since MaaS is a relatively new concept.

Based on titles, abstracts, introductions, and conclusions, articles were selected. Through forward and backward snowballing relevant literature was found. This means looking in the bibliographies of used articles to search for new articles Ridley (2012). Multiple keywords were used to find this literature; the most frequently used keywords are: 'Mobility as a Service', 'transport as a service', 'end-users', 'mode-choice', 'travel behaviour', 'commuting', 'mobility concepts' and 'user perspective'. Operators 'not' and 'and' were used to limit the number of results when searching for relevant literature. The operator 'or' was used to increase the number of results.

3.1.2. Desk research and interviews

In literature, MaaS is often presented as a solution for many problems, such as environmental pollution and congestion. In practice, it might be not that easy to implement MaaS and attract users for it. Therefore, desk research and a couple of interviews were used as an addition to

the literature to get an idea of MaaS from a practical perspective.

Desk research is used in the form of searching the internet to collect facts and information on several topics. These non-scientific sources are helpful to gather real-time information, as statistics from the CBS, and to gather information about ongoing projects like the MaaS pilots of the Ministry of Infrastructure and Water Management.

The exploratory interviews at the beginning of the research helped gathering information from people who are involved with MaaS in practice. The interviews were semi-structured. Some questions were formulated upfront, but most of the conversations were guided by the interaction between the interviewer and interviewee. The most important details obtained from the interviews can be found in Appendix B. Five employees of Goudappel Coffeng with different opinions about MaaS were interviewed. Two of them have a direct link with the MaaS pilots of the Ministry, which helped to get a better understanding on how MaaS is currently evolving within the Netherlands. One employee was interviewed because he has a strong and clear opinion about the potential of MaaS in the Netherlands, in a negative way. The last two interviewees were not involved with MaaS in particular. Therefore they had opinions of more neutral employees.

Besides gathering information on MaaS in general, the information obtained from the interviews was also used as an addition to the literature to identify personal characteristics that are related to the interest or non-interest to use MaaS for commuting trips. These characteristics are elaborated in the next chapter, Chapter 4.

3.1.3. Group discussion

A group discussion was planned at the beginning of the research to explore thoughts of different participants about MaaS in general and the use of MaaS for commuting trips. Furthermore, the way of presenting MaaS to participants was tested. A video that explains MaaS was showed and the ideas of MaaS after watching the video were discussed to see if the video sufficiently explained MaaS.

Five young professionals from the surroundings of the researcher joined the group discussion. These youngsters all recently started working and are therefore inside the scope of this research which is the working population in the Netherlands. Furthermore, the researcher asked a mix of man and woman to join the group discussion as their might be differences in opinions between the two sexes. For example, man might have a higher car affection than woman. Since this was a small group, the results cannot be generalised to the population. Nevertheless, the group discussion was useful to explore different thoughts and gather information about the ideas of potential users of MaaS. The results of the group discussion were used as addition to the literature to identify personal characteristics that might be in relation to the interest in MaaS. These personal characteristcs are identified in Chapter 4.

The discussion was structured in the following way:

- Welcome and explanation of the discussion
- Exploring key performance indicators when commuting
- Introduction MaaS by showing a video
- MaaS for commuting trips, pro's and con's
- Requirements for using MaaS for commuting trips

A summary of the discussion can be found in Appendix C.

3.1.4. Online questionnaire

An online questionnaire is used to gather the needed data to answer the research questions. An online questionnaire is an appropriate method for different reasons. First of all, conducting an online questionnaire is a fast way to collect data. The participants complete the questionnaire, and the data is immediately available to analyse. Secondly, there is flexibility

and freedom in terms of which questions to include in the questionnaire. This makes it possible to design a questionnaire for a specific problem formulation. Thirdly, performing the questionnaire online, makes it possible for the participants to stay anonymous, which is comforting for the participants. Another advantage of performing an online questionnaire is that respondents do not encounter time pressure (Debois, 2017). Also a couple of disadvantages can be defined, or one could say, things to keep in mind when using an online questionnaire to gather data. First of all, it is essential to assure respondents that their personal information is safe, and the questionnaire is anonymous. In this research, the ISO90001 is followed to save and process the results. Secondly, the questionnaire should be designed carefully. People can get bored when text is too long, and respondents might not fully understand what it is about when questions are unclear. Concluding, an online questionnaire was used, because it is an efficient way to gather a wide range of data in a short amount of time. When designing the questionnaire, it is crucial to keep in mind that questions need to be clear, simple and not too long and that there is attention for the anonymity of the respondents. Chapter 5 elaborates on the design of the questionnaire.

The questionnaire is executed through PanelClix to reach a fair amount of respondents. PanelClix has a large and diverse panel and execute questionnaires for research bureaus, universities and for the government (PanelClix, 2020). Members of the panel receive money in return for completing a questionnaire and therefore, the data can be collected in a fast way. The number of respondents for this research was dependent on the available budget at Goudappel Coffeng.

When analysing the data, it should be kept in mind that using a panel has a disadvantage. A certain degree of self-selection likely plays a role in the membership of online panels since participants can choose the questionnaire that they want to execute. Moreover, the monetary aspect of the participants joining the questionnaire must be kept in mind when analysing the data.

An important aspect of PanelClix is the possibility to set particular conditions for the respondents. Since this research is about employees, the working population in the Netherlands is set as the target group. The Central Bureau for Statistics (CBS) defines the working population in the Netherlands as the group of all 15- to 75-year-old people who live in the Netherlands and perform paid work (CBS, 2018c). The CBS has information about specific characteristics of this working population group which is helpful when looking at the representativeness of the data obtained from PanelClix.

Furthermore, researchers can ask for a particular distribution in the number of respondents. For this research, the primary commuting modality is of importance. To be able to compare people who are now using the car and, for example, use public transport to commute, both groups need to be represented in the data. Gathering data via PanelClix makes it possible to monitor this, and steer a bit so that there is diversity in main commuting mode.

3.2. Data analysis

The collected data must be analysed to answers the research questions mentioned in the introduction. This section elaborates on the two main data analysing methods, factor analysis and latent class cluster analysis. Moreover, the paired sample t-test and the repeated measure ANOVA were used. Figure 3.1 presents for which research questions the methods were used. Two software packages, called LatentGold and SPSS, were used to perform the analyses. The former to perform the latent class cluster analysis and the latter for the other analyses.

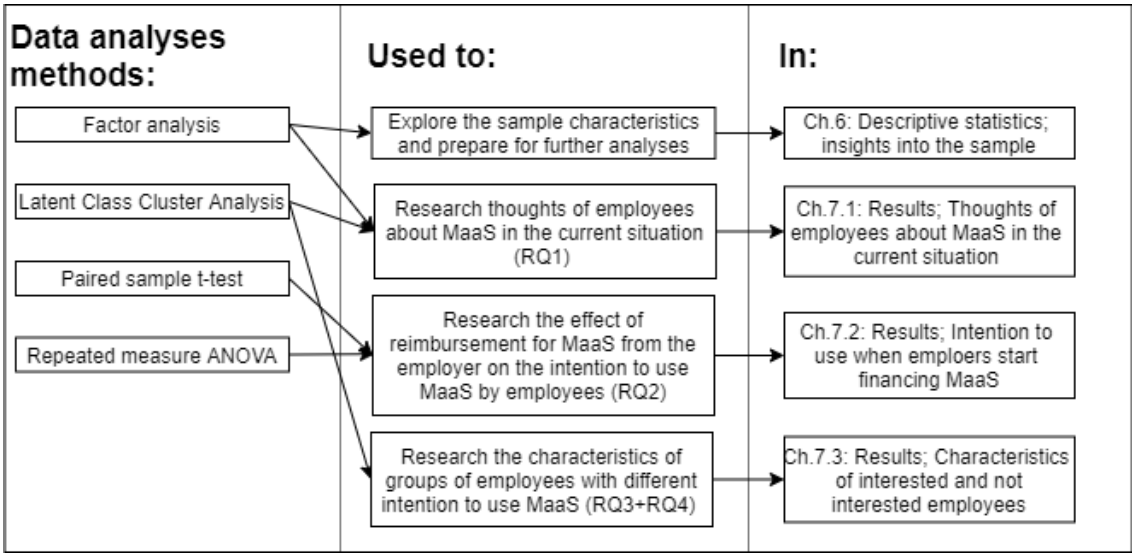

Figure 3.1: Overview of the data analyses methods

3.2.1. Factor analysis

Factor analysis is a multivariate statistical procedure that checks whether there are underlying patterns and correlations between different variables to make a new common variable, also called a factor (Williams et al., 2010).

This research uses factor analysis two times. At first, to see whether statements about attitudes regarding the environment, public transport, private car use and attitudes about the multi-modal character of employees, can be combined into new factors. It is not accurate to directly ask participants for, for example, their degree of environmental consciousness. Therefore, multiple statements were presented to the participants of the questionnaire and factor analysis was used to explore whether the presented statements measure the intended attitudes. In this way, multiple statements can be categorised into one factor that measures, for example, the environmental consciousness of employees. This factor can then be included in further research.

The second factor analysis is used to explore whether there are underlying patterns in the perceptions of employees about MaaS. Perceptions can not be observed directly. Therefore, sixteen statements were presented to the respondents about the promises and difficulties of MaaS. Factor analysis is hereby useful to see if underlying patterns can be found. Besides, by making new factors, the factor analysis also reduces the number of variables. This is beneficial for further research since it is not possible to include all sixteen variables in further analysis. Performing the factor analysis on the statement helps to answer the first research question as it provides information on how the employees think about MaaS in the current situation.

There are two types of factor analysis: Confirmatory Factor Analysis (CFA) and Exploratory Factor Analysis (EFA). As the name already says, EFA is exploratory and is used when the researcher has no expectations of the number of (new) factors. In contrary, CFA is used when there are expected groups of variables. Therefore, the CFA can be used to test particular ideas or to test a proposed theory. In this research, the factor analysis is used in an exploratory way. A bunch of questions were presented to the respondent, and exploratory factor analysis explores which variables are sufficiently interdependent to combine (Molin, 2019c).

Before the factor analysis can be performed, it must be checked whether the data is suitable. The Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) test and Bartlett's Test of Sphericity are used for this. The KMO test values between 0 and 1, and a KMO greater than 0.7 is adequate (Field, 2013). The Bartlett's Test of Sphericity needs to be significant and above a threshold. This research assumed that a KMO greater than 0.7 is adequate (Field,

2013).

When performing factor analysis, the researchers' choices are essential. The researcher decides which variables to include and exclude from the analysis. Furthermore, choices must be made about the extraction method and the rotation method. In this research, the principal axis factoring extraction method with Varimax rotation is used as these showed the most simple pattern of relations between the indicators within the factors. Detailed information on how to make these choices and how to perform a factor analysis are presented in Appendix E.

3.2.2. Latent class cluster analysis

Latent class cluster analysis (LCCA) is a probabilistic clustering method which aims at finding similar groups based on observed characteristics (Molin et al., 2016). Hence, groups are identified based on particular behaviour. An unknown latent variable X accounts for the associations between the observed indicators so that the associations between indicators become insignificant (Vermunt & Magidson, 2004). In this way, LCCA maximizes homogeneity within clusters and heterogeneity between clusters (Kroesen, 2019). The software package LatentGold is used to perform the LCCA.

This research performs two latent class cluster analyses. The first LCCA is performed with the current mode use of employees as indicators. In this way, groups of employees with different modality styles were identified. This LCCA is performed to get a better understanding of behaviour by providing more context than examining the results in general. In this way, the LCCA helps to answers the first research question as the interest of employees in MaaS in the current situation can be explored for different groups. The second LCCA helps in answering the last two research questions by exploring the characteristics of interested and not interested employees by identifying different groups, with different characteristics, based on the intention to use Maas for commuting trips.

There are a couple of advantages of LCCA over other clustering methods that make this method useful for the data in this research. With LCCA, it is possible to include variables of all measures, categorical and continuous. With K-means clustering, for example, one can only include continuous variables (Kroesen, 2019). Furthermore, there are tests available to determine the optimal number of classes instead of letting the researcher decide the number of clusters upfront (Kroesen, 2019).

When executing an LCCA, two models are estimated; the measurement model and the structural model, see Figure 3.2. The measurement model is estimated first and only includes the indicators. When estimating this model, the appropriate number of clusters must be chosen based on the Bayesian Information Criterion (BIC) and bivariate residuals (BVR). The lower the BIC value, the more parsimonious the model is for the particular data (De Oña et al., 2013). BVR's below 3.84, imply insignificant residual association (Kroesen, 2019) which is needed because this indicates there are no associations between a pair of indicators left (Vermunt & Magidson, 2005).

The structural model is added to predict class membership and to include observed factors, or covariates, to explore the characteristics of the groups. The Wald test is used to test the relationship between the included covariates and the latent class variable. A significant Wald value ($p=0.000$, $Wald>3.84$) indicates significant covariates. Backward elimination is used to exclude insignificant covariates. Hence, the most insignificant covariate is excluded first. The excluded covariates can be included as inactive covariates. Inactive covariates do not influence cluster probabilities, but the distribution of the variable throughout the clusters is presented which might be useful for the interpretation of the clusters (Molin et al., 2016).

Detailed information on how to perform an LCCA is described in Appendix E.

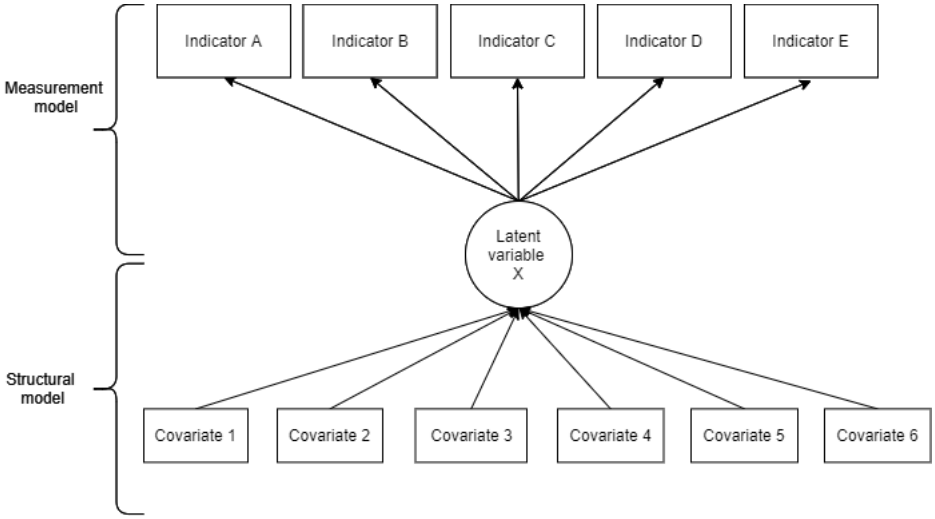

Figure 3.2: Full latent class cluster model

3.2.3. Paired sample t-test and repeated measure ANOVA test

The paired sample t-test and the repeated measure ANOVA are simple statistical tests to explore whether there is a significant difference between two, or more, means. The paired sample t-test is the appropriate method when comparing two means from the same sample. ANOVA tests are used when there are three or more groups.

With both tests, the hypotheses are the following:

- H0: The null hypothesis assumes that the true mean difference is equal to zero.
- H1: The alternative hypothesis assumes that the true mean difference is not equal to zero.

(Mee & Chua, 1991)

If the test are significant, meaning a p-value below 0.05, there is 95% certainty that the null hypothesis needs to be rejected. So, the first hypothesis needs to be assumed, which indicates that a difference between the means of the groups indeed exists.

3.3. Conclusion

This chapter elaborated on the used methods in this research. Literature research, interview, a groups discussion and desk research are used to get an overview of the context of this research and to identify background factors which are related to MaaS and mode choice when commuting. To gather data, an online questionnaire is designed. To analyse this data, factor analysis is used and two latent class cluster models are estimated. By performing these analysis the potential of MaaS from the viewpoint of end-users can be identified. Furthermore, the latent class cluster analysis will present detailed information on interested and not interested employees which is valuable information to identify the potential of MaaS and to possibly target potential users when implementing MaaS.

4

Insights from literature; theories and personal characteristics

This chapter dives into the literature to build a theoretical foundation for designing the questionnaire. The structure of this chapter is as follows. Section 4.1 elaborates on literature that is related to MaaS and related to mode choice when commuting, to identify factors to include in the questionnaire. Afterwards, Section 4.2 explains the two theories which are used to design the questionnaire. At last, Section 4.3 builds further on one of these theories and elaborates on the scenarios that are included in the questionnaire to research the effects of reimbursement for the employer on the intention to use MaaS for commuting trips. At last, Section 4.4 gives a conclusion of this chapter.

4.1. Factors related to this research from literature

Two main concepts are essential in this research, namely MaaS and mode choice when commuting. This section explores research that is done in these fields to address background factors to include in the questionnaire. If other researchers already concluded that for example, the factor age is related to the interest in MaaS, it is useful to include this factor in this research as well.

Table 4.1 present an overview of the background factors. Literature about MaaS was used as the basis for this list. Complemented by literature about commuting mode choices and information from the interviews with experts. It is important to mention that there are still other factors that might play a role concerning mode choice when commuting and MaaS. However, because of the scope of this research and the limited time that is available, it is not possible to include every factor that is mentioned in literature. The factors mentioned in Table 4.1, are the most critical factors and most applicable to the context of this research.

It also must be mentioned that travel time and travel costs are two important factors for individuals when making travel choices, so also for mode choice when commuting (De Palma & Rochat, 2000). In the context of this research, as MaaS is in such preliminary phase, it is difficult to express about expected travel time and travel costs. Travel time is left out of the scope. The travel costs are not included with a specific number but in another way, by presenting a scenario to the respondents. Section 4.3 elaborates on this.

Table 4.1: Background factors related to this research

	Mentioned in literature about Maas:	Extra from literature about commuting:	Extra from interviews:
Socio-demographic factors			
Age	x		
Gender		x	
Education level	x		
Household type		x	
Household income	x		
Smartphone availability	x		
Neighborhood type	x		
Individual values			
Environmental consciousness	x		
Openness to innovation	x		
Car affection	x		
Attitude towards public transport	x		
Attitude towards MaaS	x		
Mode related factors			
Car ownership	x		
Use of a lease car			x
Current mode use	x		
Mode travel experience	x		
Multi-modal travel experience	x		
Work related factors			
Travel for work outside commuting			x
Environmental concern employer			x
Work location type			x
Financing from employer			x
Work hours per week		x	

4.1.1. Socio-demographic factors

Table 4.2: Socio-demographic factors included in this research

Socio-demographic factors			
Age	Gender	Education level	Household income
Household type	Smartphone availability	Neighborhood type	

There are seven socio-demographic factors included in this research. In general, most research on MaaS describes youngster as the first users of MaaS (Zijlstra & Harms, 2018). Consequently, age is included. Furthermore, an aspect of MaaS is the reliance on the mobile phone; this makes the ICT skills of users an important factor (Durand & Zijlstra, 2018). This factor is included as smartphone availability. Besides age and smartphone availability, education level and income level are also included in this research. These two factors are logically related to each other; high education often results in high income. Multiple researchers state that typical users of shared modes are younger people with high incomes and high education levels (Fishman, 2016; Le Vine & Polak, 2019; Ricci, 2015). Since MaaS includes the use of shared modes, these two factors are both valuable to include. Researchers also mention that the most appropriate areas for the first adaptation of MaaS are big cities (Zijlstra & Harms, 2018). The availability of transport modes is somewhat different per living area. For example, someone who lives in the city has more public transport options available on a short distance than someone who lives in a rural area. Therefore the neighbourhood type is also included. This is measured in the form of degree of urbanity which can be derived from postal codes.

To complement the factors conducted from research about MaaS, four articles about mode choice when commuting were reviewed. Appendix F shows an overview of all mentioned factors in these articles. All socio-demographic factors, except for smartphone availability, are mentioned in these articles. Gender and household type are added to the socio-demographic factors as multiple researchers conclude that these two factors, besides the already mentioned factors, play a significant role when making commuting choices (Feng et al., 2014; Kalter et al., 2015; Schwanen & Mokhtarian, 2005).

4.1.2. Individual values

Table 4.3: Individuals values included in this research

Individual values		
Car affection	Environmental consciousness	Openness to innovation
Attitude towards PT	Attitude towards MaaS	

Five individual values are added in the questionnaire. These values refer to how individuals think of, for example, the car, or the environment. All these values are mentioned in literature as factors that are or might be associated with the interest in MaaS.

An aspect of MaaS is the focus on sharing instead of ownership; the attachment to ownership is associated with this. It is a fact that many people are still attached to their car. Especially older generations are holding on to the traditional ownership model (Spickermann et al., 2014). This attachment to ownership of a car is called the car affection. It is expected that individuals who have a high car affection have a lower interest in MaaS than individuals who have a low car affection.

Secondly, the degree of environmental consciousness is included. Lately, the importance of environmental concern is mentioned by more and more researchers. Studies show that there is a relation between concern about the environment and actually performing more environmentally friendly behaviour (Wang et al., 2016). Also, Alonso-González et al. (2020) mention this factor and the association with MaaS; they call it the environmental friendliness of individuals. Alonso-González et al. (2020) did research into the drivers and barriers in adopting MaaS. More car-driven individuals appear to be less environmentally friendly than less car-driven individuals. Furthermore, only 25% of the car-driven individuals take the environment into account when making travel choices where this number is around 40% among the other individuals. So, the environmental consciousness is included in this research to explore the relationship between this factor and the intention to use MaaS for commuting.

Thirdly, the degree of openness to innovation of individuals is important as MaaS is an innovation in the transport sector. This includes two aspects; the openness to try new modes and the attachment to certainty. The first aspect measures how willing someone is to try new modes of transport. The latter aspect is based on the fact that for some people commuting is a habit. Where MaaS offers flexibility, some people might be attached to the stability and clarity of commuting, in the same way, every day. This, attachment to certainty is named by Alonso-González et al. (2020), they call it habit' importance. Moreover, this was the main factor that was discussed during the group discussion Appendix C.

MaaS focuses on sharing over ownership, and this makes public transport important. Therefore the attitude towards public transport is also included in the questionnaire. Durand & Zijlstra (2018) mention that if and how the travel behaviour of people changes with MaaS is related to the attitude towards MaaS and the current travel behaviour. That is why the attitude towards MaaS is included.

Literature about mode choice when commuting also mentions these individual values. For example, car affection. Schwanen & Mokhtarian (2005) mention the status seeker. The status seekers are associated with a higher probability of using a private vehicle to commute. People who see the car as a status symbol are more likely to commute by car (Golob & Hensher, 1998). The research from Schwanen & Mokhtarian (2005) also concluded that

environmental awareness of an individual partly functions as an indicator for mode choice in commuting.

4.1.3. Mode related factors

Table 4.4: Mode related factors included in this research

Mode related factors		
Car ownership	Lease car use	Mode travel experience
Current mode use	Multi-modal travel experience	

The third group of included factors are mode related factors. Five factors are included, starting with the ownership of a car. Almost 60% of commuting trips in the Netherlands is done by private car and ownership precedes this. Interviews with experts also pointed to lease car use. Individuals who use a lease car to commute might differ in their thoughts about MaaS compared to people who use their own car, or other modes. The current mode use is also included. This is an essential factor as it is expected that people who for example, already use public transport are more open to using MaaS to commute than people who only use their car to commute. This information is needed to identify different groups of employees based on the mode use for answering the first research question.

The last two factors are the multi-model travel experience and the mode travel experience. The multi-modal travel experience explores whether people already travel multi-modal in some way (Alonso-González et al., 2020; Durand & Zijlstra, 2018). Since MaaS wants to increase the amount of multi-modal trips, it is important to include. Multi-modal travelling is defined as using more than one mode per trip. The other factor is the experience with a particular mode. For example, with shared modes, people might be less willing to use such a mode when they never heard of it before. As Alonso-Gonzalez, Maria and van Oort, Niels and Cats, Oded and Hoogendoorn, Serge mention that the experience with a mode might be an obstacle for people to use MaaS.

4.1.4. Work related factors

Table 4.5: Work related factors included in this research

Work related factors		
Travel for work outside commuting	Environmental concern employer	Work location type
Financing from employer	Work hours per week	

Five factors are not specially mentioned in the reviewed literature but are important for this research. These are work-related factors as this research focuses on using MaaS to commute.

The first included factor is if people travel for their work outside commuting. An interviewee mentioned this as an important aspect since it makes travelling for work less predictable (Appendix B). It might be that people who have many business meetings think differently about MaaS than people who do not travel for their work outside commuting at all. The second factor is the attitude of the employer regarding the environment and the degree of how involved they (already) are in influencing their employees to act in a particular way. The previous chapter pointed out that employers influence the way their employees commute. This is also seen at the commuting behaviour of employees of Goudappel Coffeng. There might be a difference between employees which employer stimulates them to make environmentally friendly choices, and employees which employer gives no attention to this at all. This factor is called the environmental concern of the employer. The urbanity of the work location is also included in this research. It is called the work location type and the postal codes of employees work locations give information on this degree of urbanity. An interviewed expert mentioned this as an essential factor (Appendix B). People might think that there work location is not accessible with MaaS which probably influences the intention to use MaaS. This does not have to be the case in reality, but it can influence what people think.

The fourth factor that is included in the fact if people get their commuting travel behaviour financed or not. Including this factor makes it possible to explore if there are changes between people who get their commuting financed by the employer and people who not get any financing. This question is also relevant because this research explores the intention to use MaaS of employees by presenting scenarios that are related to the financing from the employer. Section 4.3 elaborates on this.

At last, research about commuting pointed out that work duration is important when researching mode choice when commuting. Longer working hours are associated with the use of faster transport modes (Feng et al., 2014).

4.2. Theory related to this research

If there are multiple options to, for example, travel to a destination, humans tend to choose the option with the highest expected utility. This concept is referred as the utility maximisation theory. However, commuting trips are a form of a habit. Therefore, it is assumable that individuals do not evaluate all the options continuously because the circumstances stay the same. If a trip or activity pattern, is perceived as pleasant, travellers prefer to repeat that trip (Schlich & Axhausen, 2003). Verplanken et al. (2008) researched habits and hypothesises that when the environment of the context of individual changes, it is more likely that the travel behaviour changes compared to no change in environment or context at all. An example of such a changing context is the relocation of home or work. This disruption of the context breaks the habit and individuals are more likely to reconsider their way of travelling, in this case, their way of commuting. The changing context opens, therefore, an opportunity.

There is another theory that is related to this research as it describes, predicts and explains behaviour; the theory of planned behaviour. This theory was initially designed for social sciences, as advertising and public relations (Ajzen, 1991). However, throughout the years, this theory has been used in other fields. For example, to research behaviour towards new green innovations, as predicting the intention of consumers to adopt hybrid electric vehicles (Wang et al., 2016). Alternatively, exploring the acceptance of consumers for sharing electric vehicles (Zhang et al., 2018).

The theory of planned behaviour theory argues that intention to use is the determinant for actual behaviour, so when the intention is measured in an appropriate way it provides a prediction for actual behaviour. The stronger the intention to use a particular innovation, the higher the likeliness it will be used in reality. This intention to use, also called behavioural intention, is determined by attitude, subjective norm and perceived behavioural control. The theory of planned behaviour by Fischbein and Ajzen is visualised in Figure 4.1.

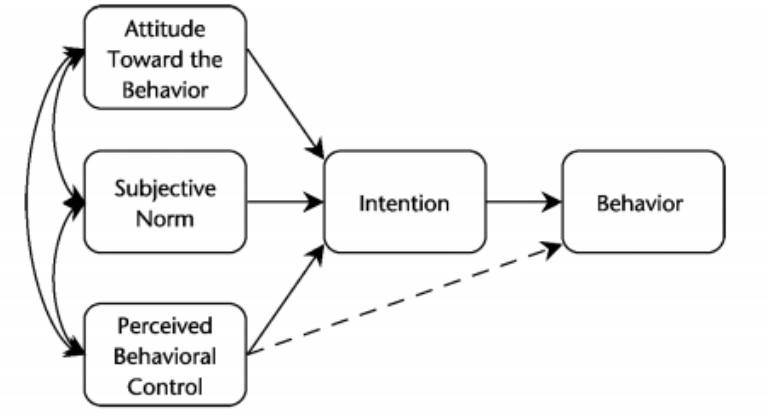

Figure 4.1: Theory of planned behaviour (Ajzen, 1991)

So, generally, people intend to perform particular behaviour if they have a positive feeling/attitude towards the behaviour, when they feel social pressure (subjective norm) and when they believe that they have the opportunity to perform the behaviour (perceived behavioural control).

Both theories are used in designing the questionnaire. The theory of Verplanken et al. (2008) indicates the importance of a changing context when wanting to change travel behaviour (mode choice in this research). The theory of Ajzen (1991) indicates that intention to use predicts behaviour. So, measuring the intention to use says something about actual behaviour. Furthermore, this theory indicated that the attitude towards innovation is also essential to take into account as it is a predictor of intention to use. This was also mentioned in literture as mentioned in the previous section. The subjective norm and the perceived behavioural control are not included in this research. The first because MaaS is still in a preliminary phase and not many people heard of it and the latter because it is not valuable to take the perceived behavioural control as a determent when individuals have little information about the behaviour or when new, unknown aspects entered the situation (Ajzen, 1991), which is the case in this research.

4.3. Use of scenario's

The intention to use MaaS for commuting is analysed by presenting two scenarios to the respondents, the employees. Before the scenarios are presented the current situation need to be explored. This included asking for the intention to use MaaS to commute in the current situation, which gives valuable information about the potential of MaaS for commuting trips. Besides, exploring the current situation makes it possible to analyse the differences in intention to use MaaS.

The pilot study at the Delft University of Technology, which provided electric bicycles to their students and employees, showed that it is not easy to get people to change their commuting mode choice (Kocaman, 2019). This is probably also the case for MaaS as it is unlikely that, for example, people who now use the car immediately switch to MaaS when it becomes available. Furthermore, the research from Verplanken et al. (2008) points out that a changing environment or context increases the likelihood that individuals change their travel behaviour. This is relevant because commuting can be a habit for employees. Therefore, an incentive (changing environment/context) is presented to the respondents of the questionnaire to see if the intention to use MaaS increases. The mobility budget showed that employees are influenceable by monetary incentives. Furthermore, research into commuting mode choice showed that getting reimbursement for a mode to commute increases the probability that that mode will be used (Ton et al., 2020). So, the first scenario states that the employer will finance commuting with MaaS. It is expected that this will influence the intention to use positively, especially for the employees who do not get any financing in the current situation.

It is expected that most of the employees that use the car to commute are not interested in using MaaS in the current situation. Therefore the second scenario presents an extreme measure to see if such a measure increases the intention to use MaaS to commute or that (even) this has no influence. This second scenario is only presented to employees that currently travel by car to work and includes the more extreme measure that employers do not finance commuting by car anymore but only finance MaaS. It is interesting to see what the intention to use is in this scenario and if it changes compared to the current situation. It might be that employees are extremely attached to their car, even if this is not financed anymore. This gives valuable inside about the potential of MaaS since many people use the car to commute at the moment.

4.4. Conclusion

Examining the literature as presented in this chapter leads to implications that are important to include in the questionnaire. As Figure 4.2 presents, multiple background factors are essential to include in the questionnaire because it is expected that they are associated with the intention to use MaaS to commute by employees. Furthermore, based on the theory of planned behaviour, this research measures the interest by asking for the intention to use MaaS by employees.

Commuting mode choices are expected to be a habit. As Verplanken et al. (2008) states, when wanting to break a habit, a changing context is needed. Otherwise, people are not reconsidering their mode choices. All this information, together with the monetary aspect that plays a role with commuting travel behaviour, makes that two scenarios will be presented to the respondents to explore the intention to use MaaS for commuting trips. This information says something about the interest and therefore, about the potential of MaaS for commuting trips from the viewpoint of employees.

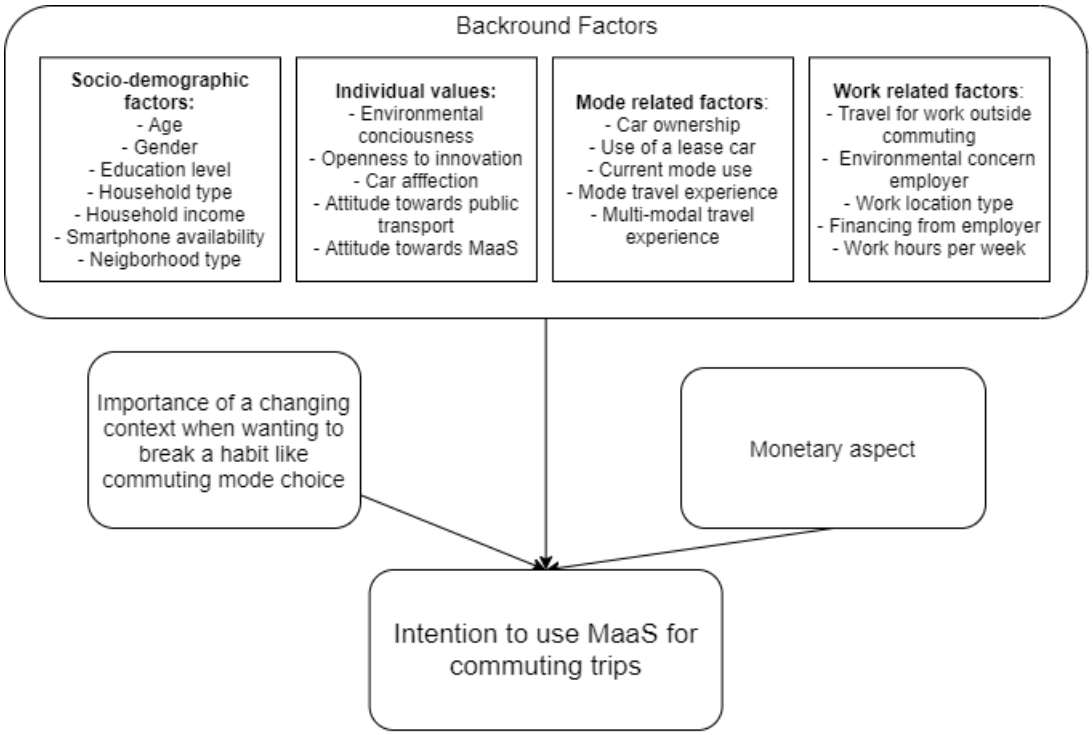

Figure 4.2: Facets that are expected to have a relation with the intention to use MaaS

5

Questionnaire design

The previous chapter provided a theoretical foundation for the design of the questionnaire. The background factors that need to be included in the questionnaire were identified and the scenario's were presented. This chapter builds further on this foundation by elaborating on the final design of the questionnaire. The full content and explanation of the questionnaire structure can be found in Section 5.1. Afterwards, Section 5.2 sheds light on finalising the questionnaire and Section 5.3 gives a short conclusion of this chapter.

The online panel PanelClix was used to gather data from the working population in the Netherlands. Extra information on using an online questionnaire and recruiting the wanted respondents was stated in Subsection 3.1.4.

5.1. Final questionnaire content

Much attention is paid to the design because it must be logical and understandable for the participants. This section provides information on what kind of questions were used in the questionnaire and elaborates on the structure and content of the questionnaire. The final questionnaire can be found in Appendix G.

5.1.1. Questions used

Two types of questions were used. First of all, closed questions, these questions include several answer options where the respondents need to choose from. This forces the respondents to select one of the pre-defined options. It might be that the answer a respondent wants to give is not included in the pre-defined answer options. Therefore, the answer option "other, namely" is added to prevent biases in the results. These biases can occur because respondents might pick an answer where they do not agree with because of the pre-defined options.

The second way of gathering information is through presenting statements to the respondents. The Likert scale is used to present these statements. Likert scale questions make it possible to measure things that are usually difficult to measure, such as opinions, views and possible behaviour (SurveyMonkey, n.d.). With Likert scale questions, there are a series of statements on which the respondent can indicate his or her degree of agreement. This makes it possible to gather detailed information because the answer is more than just a yes or no. The answer possibilities are on a 5 or 7 point scale from one extreme to the other. A 7 point scale can be experienced as unclear and confusing by respondents because of the many options that seem similar (Onderzoekdoen.nl, n.d.). A 5 point scale is easier to understand and the most used scale. Therefore, this research uses a 5 point scale from totally disagree to totally agree; the middle option is the neutral one. Also, with statements, one must realise that it is essential to add an answer option when someone does not have an opinion or when the statement does not apply to his or her situation. To prevent that respondents

pick an answer option where they do not agree with, the statement questions, all included the “not applicable/no opinion” option. These answers will be excluded from the analysis. However, the number of participants giving this answer will be checked to prevent losing too much data. Furthermore, the statements are formulated positively and negatively to keep the respondents sharp.

5.1.2. Questionnaire structure

The Research Ethics Committee of the Delft University of Technology provided permission to perform this questionnaire among the panel members from PanelClix. Besides, the results of the questionnaire are saved and processed according to the ISO90001. The questionnaire starts with an introduction. This introduction elaborates on the context of the questionnaire and mentions the goal of this research. Furthermore, the introduction mentions that the gathered data is entirely anonymous and is only used for this research. At the end of the questionnaire, there is room for comments to reassure the respondents.

The questionnaire consists of five parts. Figure 5.1 shows the content and structure. The questions that were needed for the quotation and therefore, mandatory to answer are marked with a grey background.

The first part of the questionnaire includes background factors and other questions that were important to ask at the beginning. On the one hand, because these questions are needed to guide respondents through the questionnaire. On the other hand, because it is valuable to ask some questions before MaaS is introduced. The latter are statements that measure the multi-modal mindset, the attitude regarding public transport and private car ownership and environmental consciousness of the respondents. The statements to measure these factors are mostly based on existing literature (Kriwy & Mecking, 2012; Nilsson & Küller, 2000; Song et al., 2012).

To introduce MaaS to the respondent, the second part of the questionnaire shows a video that explains MaaS. When the participants are not in the position to watch the movie; they can read the summary. Before executing the questionnaire, it was tested if the movie explains MaaS in an understandable way. This was tested during the organised group discussion (Appendix C) and by showing the video to related people who are and are not, familiar with MaaS.

The third part of the questionnaire reflects on the null situation. This makes it possible to research how respondents think of MaaS in the current situation, which is essential for researching the potential of MaaS for commuting trips. First of all, the perceptions about MaaS are asked in the form of multiple statements. Three subjects of perceptions followed from combining existing literature, interviews and the group discussion (Appendix B and Appendix C). The first set of statements are about why people would use MaaS for commuting trips. This resulted in the following subjects: environment, flexibility, comfort, fastest option and customisation. The second set is based on the questions: what has MaaS to offer? and What are the promises of MaaS? This resulted in: freedom of choice, unburdening, customised travel advice, reducing the dominance of owning a car, increase travelling in a multi-modal way, new attitudes towards (shared)modalities and network efficiency. The last subject of perceptions revolved around characteristics that travellers consider when making travel choices. The characteristics that are relevant for this research are travel time, travel costs, nature of the activity, weather, amount of transfers, responsibility, private ownership, safety and amount of combined modalities. All these items were combined in statements. The statements are negatively and positively formulated and mixed to challenge the respondents to read clearly. Afterwards, a statement about the attitude and a question to ask the intention to use MaaS for commuting are included. These are based on the theory of planned behaviour as the intention to use is the determinant for actual behaviour (Ajzen, 1991). The latter two questions are asked twice more in scenario one and two to be able to compare the outcomes when analysing the data.

The fourth part of the questionnaire is about the scenarios. Presenting the scenarios makes it possible to explore the effect of the reimbursement of the employer on the intention to use MaaS. The last part of the questionnaire contains questions to measure multiple background factors. The included background factors are mentioned in Chapter 4. Measuring these background factors is useful to identify what kind of travellers are interest in using MaaS and what kind of travellers are not. Identifying these characteristics give insights in the potential of MaaS for commuting trips since the characteristics can be compared with data from the population to see how large or small these groups are in the population.

5.2. Testing and finalising

After designing the first draft version of the questionnaire, the questionnaire was tested by a handful of friends and family and adjustments were made according to their input. For example, the length of the questionnaire, as it was experienced as quite long. The order of the questions was also mixed up a bit because some questions seemed out of the blue. Besides, some words are not understandable for people who are not familiar with the transport and mobility world, so some questions were adjusted to make it more understandable. Making the adjustments resulted in the second draft version of the questionnaire. The second draft version was discussed with four experts in the field during a meeting at the Delft University of Technology. Adjustment on, for example, sentence structure and completeness of questions, were made, and this resulted in the final questionnaire. Which can be found in Appendix G.

5.3. Conclusion

This chapter elaborated on the questionnaire that is used to explore the intention to use MaaS to commute among employees. The questionnaire consists of five parts. Two parts about background factors, one part about introducing MaaS to the respondents and the other two parts relate to the intentions to use MaaS to commute. Besides the current situation, two scenario's are presented that change the situation of the respondents regarding receiving finances for their commuting trips or not. This makes it possible to research the effect of the reimbursement of employers on the intention to use MaaS to commute by employees.

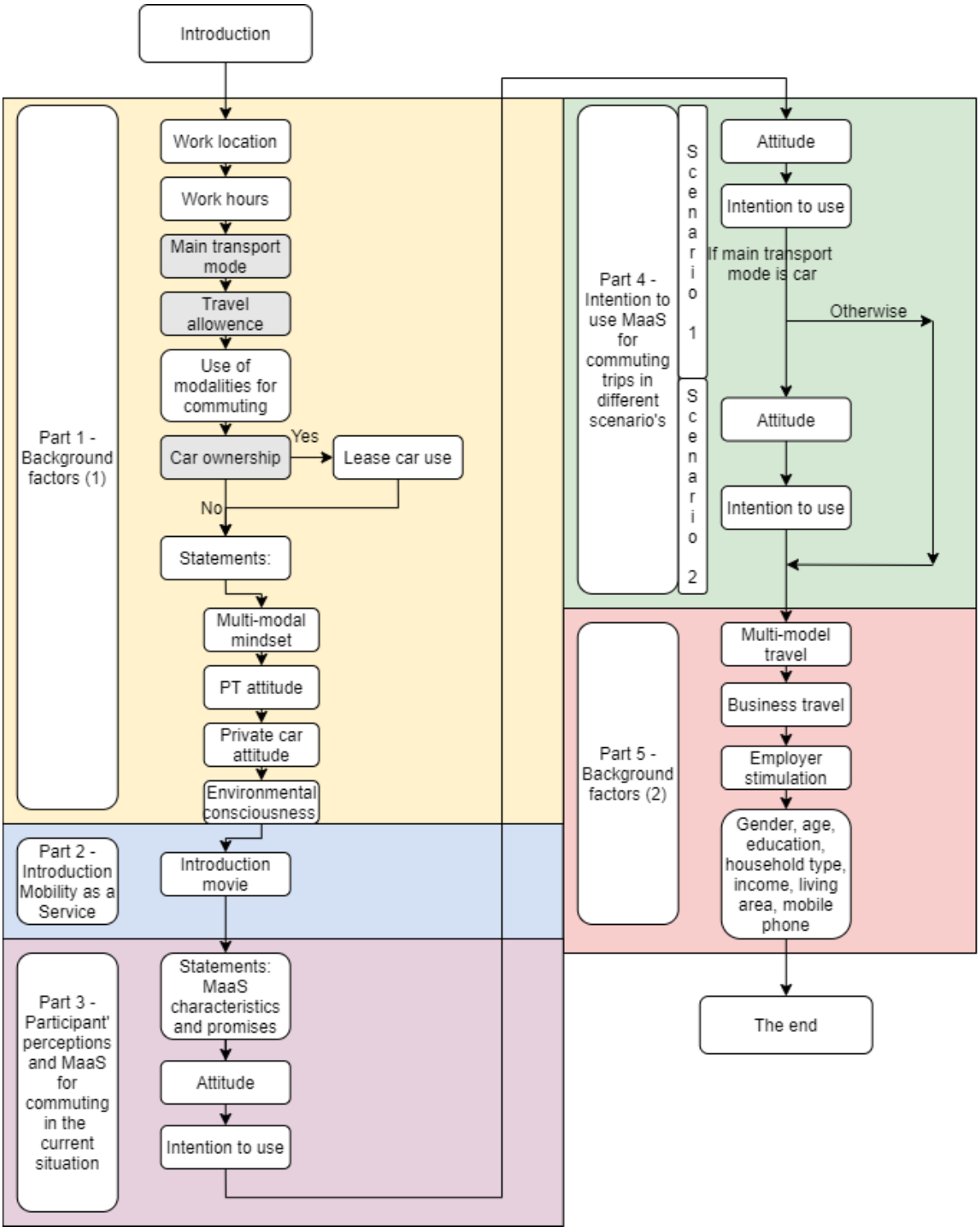

Figure 5.1: Context and structure of the questionnaire

6

Descriptive statistics; insights into the sample

This chapter explores the data gathered through the questionnaire and forms the basis for further data analysis. First, Section 6.1 sheds light on the collected data and the responses that got deleted. Subsequently, the sample characteristics of the data are presented in Section 6.2. Section 6.3 elaborates on the representativeness of the gathered data and this chapter ends with a short overview in Section 6.4.

6.1. Data cleaning

The online panel, PanelClix, was used for the data gathering. On the 21th and 22th of January, a total amount of 324 responses were collected. Not every response can be included in the data analysis. The following items were checked, and responses were deleted based on these checks in the following order:

- 3 responses were test results.
- 6 responses did not have a unique ID code, which indicates that people completed the questionnaire twice.
- The average duration of completing the survey was 13.4 minutes with a minimum of 1.65 minutes. Some panel members might be fast because of experience, but there is a minimum time that is needed to read and answer the questions. The researcher herself and two individuals that are not involved in this research tested completing the questionnaire in a fast way with different answer options. The latter because the amount of questions is dependent on a couple of answers at the beginning of the questionnaire. These results, together with the fact that some panel members might answer questions quick, resulted in a minimum completion time of 4 minutes. So, it is assumed that one can not fulfil the questionnaire in a reliable way below 4 minutes. In total, 36 responses had to be deleted because of an unreliable duration time.
- PanelClix filtered on people that work but some respondents got through anyway. 10 respondents did not meet the requirements of participating in this research, as mentioned in Subsection 3.1.4. Five did not work, and the other five work less than 12 hours per week, which is not in line with the definition of the working population depicted by the Central Bureau for Statistics (CBS, 2018c).

In total, 55 responses were deleted, and a dataset of 269 responses remained for further analysis.

The data from the questionnaire is not immediately ready to analyse. Variables need to be named and labelled, some variables need to be added by hand, variables need to be re-organised, and missing values need to be defined. Section H.1 elaborates on the data preparation.

6.2. Sample characteristics

The sample characteristics of the respondents in this research are presented in Table 6.1. Apart from the direct sample characteristics, a couple of distributions are plotted against each other to confirm or disclaim expectations. Besides, the correlations between variables are checked. The following enumeration presents the remarkable aspects. The full cross-tables and correlation matrix are presented in the appendix (Section H.2).

- Approximately 65% use the car as main commuting mode, which is roughly in line with statistics from the CBS, as in the Netherlands 57% commutes by car (CBS, 2018a).
- The urbanisation rate of respondent's homes is relatively spread, but looking into the urbanisation rate of work locations, 73% (43% plus 30%) of the work locations are in very high or high urbanised area's, compared to 55% (26% plus 29%) of the location of homes. So, it can be concluded that many people move from less urbanised area's to more urbanised areas for their work.
- It was expected that the share of young people would be higher in more urbanised area's, but this is not the case. The largest part of young people (15 to 24 years old) lives in little urbanised areas. This can be explained by the fact that almost 85% answered the question about their household type with 'Other'. Looking into the elaborations on the question indicate that most of these young people are living with their parents.
- Only 12% of the sample heard of the concept MaaS before participating in the questionnaire. This number is lower than expected. It indicates that there was no self-selection in participating in the questionnaire. Self-selection refers to the fact that people who execute questionnaires via a panel might only join questionnaires which they find interesting. This can cause biases in the results since the sample probably then includes particular individuals.
- It was expected that younger people have heard of MaaS more often than older people, but there is no significant relationship found between age and MaaS knowledge before participating in this research (r=.044; p=.500). There is also no significant relationship between MaaS knowledge and education level (correlation=-.081; p=.190). However, there are some differences noticeable between the education level segments in this sample. In three segments within education level (Highschool, HBO and WO) 15% heard of MaaS beforehand and within the 'MBO' education level, only 4% heard of MaaS.
- There is also no significant relationship between MaaS knowledge and the urbanisation degree of people's home (r=-.019;p=.765). It was expected that the more urbanised an area is, the more people heard of MaaS, but this is not the case.
- As expected, there is a significant correlation between MaaS knowledge and multi-modal travelling (correlation=-.228; p=.000). The more multi-modal people travel, the more people knew MaaS before participating in this research.
- More than half of the employees (52%) indicated that their employers do not pay any attention to encouraging their employees to think consciously about commuting mode choice. It is not a proof that employers do not do this at all because it was only asked to the employees. However, it is an indication that employees do not perceive it anyway. This is unexpected since desk research concluded that nowadays, employers encourage this more and more. This might be because the desk research mostly conducted information on companies where highly educated people work, but this is not the case in this sample. There is no significant relationship between this encouragement from

the employer and education level (correlation=.077; p=0.210). There is a difference in the sample that fits the expectation. In the education level segments 'WO' the middle group, so 'My employer encourages this slightly' is almost double compared to the other education level segments. There is a significant, but small positive correlation between the incentive of the employer and multi-modal travelling (correlation=0.159; p=0.009).

- There is significant relation between whether people make business trips outside commuting and education level (correlation=-.263; p=.000). The majority of lower educated people (high school and MBO) never makes these trips, were for the higher education levels (HBO and WO) the majority sometimes travels for work outside commuting.
- Some logical relations are found to be statistically significant as education level and income level and work hours per week and income.

Table 6.1: Sample characteristics

Socio-demographic variables	Number of respondents	Sample share
Gender		
Male	141	54%
Female	121	46%
Age		
15-24 years old	13	6%
25-34 years old	55	24%
35-44 years old	54	23%
45-54 years old	48	21%
55-64 years old	53	23%
65-75 years old	11	5%
Education level		
Highschool	36	14%
MBO	78	29%
HBO	108	40%
WO	45	17%
Yearly income		
30.000 euro or less	36	15%
30.000-40.000 euro	58	24%
40.000-50.000 euro	40	17%
50.000-70.000 euro	46	19%
70.000 euro or more	59	25%
Smartphone possession		
Yes	251	95%
No	13	5%
Workhours per week		
12-34 hours (parttime)	122	45%
35 or more hours (fulltime)	147	55%
Household type		
Single or living together without children living at home	143	55%
Single or living together with children living at home	116	45%
Urbanisation rate home		
Very high urbanised	69	26%
Highly urbanised	79	29%
Mild urbanised	42	16%
Little or not urbanised	69	26%
Urbanisation rate work		
Very high urbanised	111	43%
Highly urbanised	77	30%

Table 6.1: Sample characteristics

Socio-demographic variables	Number of respondents	Sample share
Mild urbanised	30	12%
Little or not urbanised	39	15%
MaaS knowledge beforehand		
Yes	32	12%
No	236	88%
Main commuting mode		
Car	172	64%
Public transport	57	21%
Bike	35	13%
Other	5	2%
Car ownership		
No car	12	5%
1 car	163	61%
2 or more cars	94	35%
Lease car construction		
Yes	62	24%
No	193	76%
Travel allowance		
Yes, fully	92	34%
Yes, partial	100	37%
No	68	25%
I don't have any commuting costs	9	3%
Multi-modal traveling		
When traveling, I almost never use more than one mode in a trip	140	52%
When traveling, I sometimes use more than one mode in a trip	71	27%
When traveling, I often or always use more than one mode in a trip	57	21%
Business trips outside commuting		
Yes, regularly	50	19%
Yes, sometimes	99	38%
No, never	113	43%
Incentive from employer to think consciously about commuting		
My employer pays no attention to this	134	50%
My employer encourages this slightly	95	35%
My employer fully encourages this	31	12%

Apart from the sample characteristics mentioned above, attitudes were also part of the questionnaire and are included as background factors in further analysis. These attitudes were measured through statements with the idea that they can be categorised to include less statements in further analysis. This categorisation is done by factor analysis and resulted in two factors. One factor includes statements about the attitude regarding private car use, this factor is called 'Pro-car'. The second factor includes statements about the environment and this factor can be summarised as 'Environmental consciousness'. The appendix (Section H.3) elaborates on the performed factor analysis.

There are four other statements included in the questionnaire, about multi-modal mindset, two statements about the 'openness to innovations' and two statements about the 'attachment to certainty when travelling'. Factor analysis showed that the four statements could be reduced to two factors. But, to check the reliability of the factors a Cronbach's Alpha test was performed and this test showed that the scales were not reliable (value<0.7). It is not unexpected that the Cronbach's alpha's are low because the factors only consist of two variables. However, since they are not even close to 0.7, these statements are not categorised in factors and will be included in further analyses as loose variables. The means of the factors and the loose statements are presented in Table 6.2. Noticeable is that employees in general like travelling in the same way to work every day as this statements knows a high mean.

Furthermore, the commuting modalities play a big role in this research. Table 6.3 shows the distribution of the modes to commute in general.

Table 6.2: Means and standard deviations of attitudes

	Mean	Standard deviation	
Attitude Pro Car	3.63	0.93	
Attitude Environmental Consciousness	3.72	0.83	
			Measuring:
Att_Open1 - I do not mind which mode of transport I use, as long as it fits my travel needs	3.61	1.02	Multi-modal mindset- Openness to innovations
Att_Open2 - I am willing to try new ways of travelling	3.55	0.94	
Att_Cert1 - I like travelling in the same way to work every day	3.97	0.88	Multi-modal mindset- Attachment to certainty
Att_Cert2 - I do not like changing my travel plans during, or right before, a trip	3.64	1.05	

Table 6.3: The commuting mode use of the respondents

Use: / Mode:	Car	Lease car	Bike	Ebike	Train	Taxi/ Uber	Tram/ metro/ bus	Motor/ moped/ scooter	Shared car	Shared bike	Shared scooter	Other
Almost daily	34%	12%	12%	4%	7%	1%	7%	0%	0%	0%	1%	1%
1 to 4 days per week	27%	5%	15%	5%	12%	1%	13%	2%	0%	1%	1%	3%
1 to 3 days per month	9%	1%	12%	4%	10%	3%	6%	3%	1%	0%	1%	0%
6 to 11 days per year	4%	0%	6%	2%	6%	2%	4%	2%	0%	1%	1%	1%
1 to 5 days per year	5%	1%	8%	2%	7%	3%	6%	1%	3%	1%	1%	2%
Less than 1 day per year	3%	1%	2%	2%	4%	4%	4%	0%	1%	1%	0%	0%
Never	18%	81%	46%	81%	55%	86%	60%	92%	94%	97%	97%	94%
Unfamiliar with mode	0%	4%	0%	3%	0%	3%	2%	3%	7%	10%	10%	

Remarkable, but not unexpected, is that shared modalities are not popular to travel to work, more than 94% never uses the shared car, bike or scooter. Using the motor/moped/scooter is also not popular among the respondents as 91% never uses these modes to commute.

A row is added about the familiarity with the modes, the numbers present the percentage of the total amount of responses that is unfamiliar with the mode. So, for example, only 7% of the respondents are unfamiliar with the shared car. There is a maximum of 10% (out of the total responses), so most of the respondents are familiar with all mentioned modes.

6.3. Represenativeness of the sample

The sample is compared with the working population in the Netherlands to explore whether the sample represents the population. The distribution of gender, age, education level, and working parttime or fulltime within the working population in the Netherlands is available via the CBS. Table 6.4 shows the share of these variables and the segments in the sample and the population. The variables age and education level had to be re-organised to be able to get to the same segments as the data from the CBS.

Table 6.4: Frequencies of the sample compared to the population

Socio-demographic variables	Number of respondents sample	Share sample	Share NL (CBS)
Gender			
Male	141	54%	53%
Female	121	46%	47%
Age			
15-24 years	13	6%	16%
25-34 years	55	24%	21%
35-44 years	54	23%	19%
45-54 years	48	21%	23%
55-64 years	53	23%	18%
65-75 years	11	5%	3%
Education level			
Low	17	6%	20%
Middle	97	36%	40%
High	153	57%	39%
Unknown	1	0.4%	1%
Workhours per week			
Parttime	122	45%	51%
Fulltime	147	55%	49%

Since the variables are categorical, the Chi-square test is used to check whether the sample represents the population of working people in the Netherlands. The chi-square test calculates the expected numbers and compares them with the observed numbers in the sample. When the chi-square values are significant (p-value<0.05) it indicates that there is a difference between the deviation of segments in the population and the sample, so the sample is not representative for that variable in the population (Molin, 2019a). It must be mentioned that this is just a proxy for the overall representation of the sample. If the variables that are not representative are not related to the main variable, which is in this research the intention to use MaaS, there is no indication that the conclusion from the sample cannot be drawn to the population. This is something to keep in mind when analysing the data and when drawing conclusions.

In this research, gender and work hours per week are not significant (p-value>0.05). This means that, for these variables, the sample used in this research does not differ from CBS statistics. Thus, these variables are representative of the population of working people in the Netherlands. Age and education level are, however, not representative for the population (p-values of 0.000). Youngster (15-24 years old) are underrepresented, and the older population (55+ years old) is slightly overrepresented in the sample. The sample also knows an overrepresentation of highly educated people (Higher Vocational Education and University Education). Almost 60% is highly educated, and around 35% is middle educated, whereas these shares in the population of the Netherlands are, according to the CBS statistics, almost even (40% and 39%). It is essential to keep the under and overestimated segments in mind when analysing the data and when reviewing the conclusions to see whether the conclusions are in line with the over and underrepresented groups. The results of the chi-square tests can be found in the appendix (Section H.4).

The way respondents are recruited also needs to be reviewed when describing the representativeness (Molin, 2019a). Ideally, there is no selectivity on who got included in the sample. The low percentage of knowledge about MaaS before participating in this research is a good sign that there was no, or little, self-selection by the panel members. Using an online panel for recruiting participants knows a disadvantage. Panel members might value time and money a bit different than the population because panel members receive money for participating in the questionnaires. Since this research does not focus on a consideration between time

and money, it is expected that executing the questionnaire via a panel does not give major problems.

Concluding, based on the chi-square tests results, the sample in this research is representative for gender and for working parttime or fulltime, but not for age and education level. The distribution of commuting by car is approximately the same as in the population. Moreover, the low percentage of people that heard of the concept MaaS before participating in this research is a good sign for the representativeness of the data. It can not be said that this sample fully represents the population, but it is expected that the found differences are not going to cause problems. Nevertheless, interpreting the results and generalising these to the population must be done with care.

6.4. Conclusion

The main takeaways from this chapter are:

- In total, 269 responses are available for data analysis.
- As a result of the growing attention for MaaS in society and literature, it was expected that many people are familiar with the new mobility concept. However, this is not the case at all. The statistics of the questionnaire show that only 12% of the employees in the sample have heard of MaaS before participating in this research.
- Due to the trend of increasing attention from employers to re-organise mobility policies, it was expected that many employers are concerned, or involved, with the environmental awareness of their employees. However, the descriptive results show that 50% of the employers do not pay any attention to this at all. 35% of the employers of the employees in this research do this slightly. Only 12% of the employees are sufficiently encouraged by their employers to think consciously about the way they commute. This is only the perception of the employees and not from the employers, but it is an indication that the expectation that many employers are concerned about the commuting travel behaviour of their employees is probably overestimated.
- The sample in this research has an overrepresentation of highly educated people. When drawing conclusions from the results, it must be examined if the under- and over-represented variables are related to the goal variable, the intention to use MaaS to commute. If they are related to the goal variable, it might affect the conclusions. Otherwise, it is not expected to cause any problems.
- Comparing the different measures for testing the representativeness of the sample shows that the sample is representable for the population. Nevertheless, the conclusions must be drawn with care.

7

Results; the interest of employees in using MaaS for commuting trips

This chapters presents and discusses the results. The answers of the respondents of the questionnaire are used as input for the analyses. Section 7.1, elaborates on the current situation and describes the perceptions of employees about MaaS. Moreover, the attitude and intention to use MaaS for commuting in the current situation will be addressed. Analysing the current situation forms the basis in exploring the potential of the use of MaaS for commuting trips.

Afterwards, the effect of travel allowance from the employer on the intention to use MaaS is researched in Section 7.2. The last section, Section 7.3, addresses the intention to use MaaS in more detail and identifies different groups of employees based on the attitude towards and intention to use MaaS for commuting trips. The identified groups provide inside in the characteristics of employees that are and are not interested in using MaaS for commuting trips.

Each section ends with a conclusion where the sub research questions are answered.

7.1. Thoughts of employees about MaaS in the current situation

First, Subsection 7.1.1, identifies employee groups with different modality styles. Identifying these groups is valuable because it provides more detailed insights than discussing the perceptions and intention to use MaaS for commuting in general. Hereafter, Subsection 7.1.2 explores the perceptions of employees about MaaS and Subsection 7.1.3 examines the attitude and intention to use MaaS for commuting trips in the current situation. This section ends with a conclusion, Subsection 7.1.4, where research question number one is answered: ”What are the thoughts of employees with different modality styles about MaaS?”.

7.1.1. Different groups in the way employees commute

Employees have multiple options to commute; they can travel to work by car, bicycle, tram etcetera. It is expected that the current mode use of employees is related to the interest in using MaaS for commuting trips. For example, someone who currently uses public transport to commute is already familiar with searching for the most suitable trip on an application and with travelling in a multi-modal way. These individuals might value and see the benefits of MaaS more than employees who currently commute by car. For this reason, the sample is divided into different groups based on the commuting mode use. Latent class cluster analysis (LCCA) is used to find these groups. The goal of LCCA is to estimate groups with maximum homogeneity within the groups and maximum heterogeneity between the groups.

LCCA identifies clusters based on respondents having the same response pattern. The used modes for commuting trips are the indicators in estimating the clusters. So, for example, one cluster always commutes by car, and another cluster uses different modes to commute. Not every mode is included as an indicator, see Figure 7.1. There is no point in adding the modes 'Ebike', 'Taxi/Uber', 'Motor/Moped/Scooter', 'Shared car', 'Shared bike', 'Shared scooter', and the variable 'Other' because almost no one uses these modes to commute (see Table 6.3). Consequently, the measurement model consists of five indicators that subdivide the sample into multiple clusters.

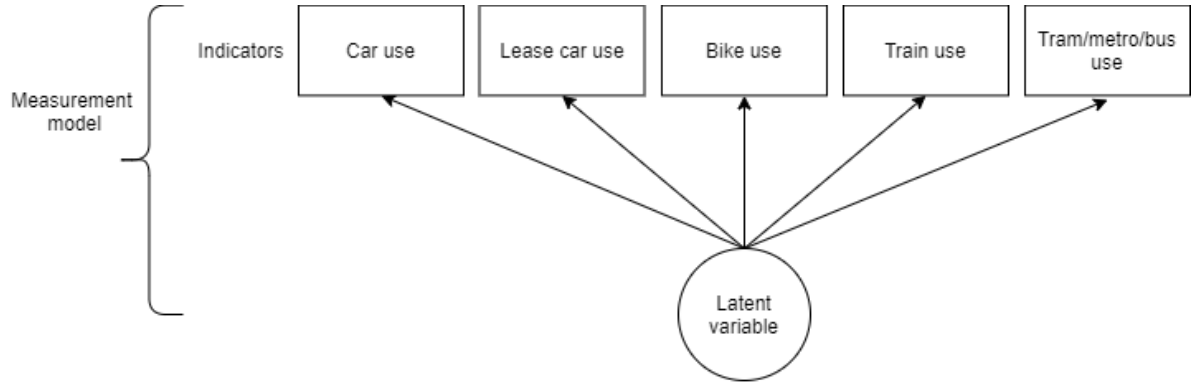

Figure 7.1: Latent class cluster measurement model

The measurement model was estimated for a range between one and eight clusters to determine the optimal number of clusters. Table 7.1 summarises the results for the eight models. The Bayesian Information Criterion (BIC) is an information criterion to asses the model fit, and it works well in the context of latent class cluster analysis (Nylund et al., 2007). The guideline is to select the amount of clusters with the lowest BIC value. As the results in Table 7.1 show, the model with three clusters is the most parsimony according to the BIC values. The other measure to indicate the optimal amount of clusters is considered as well, namely the bivariate residuals (BVR). Values higher than 3.84 indicate that there is a covariation between a pair of indicators. Such a covariation is undesirable since homogeneity within clusters and heterogeneity between clusters is preferred. Based on the BVR values, the 3-cluster model is the first model which accounts for the associations between the indicators (Molin et al., 2016). Consequently, the 3-cluster model was selected as the most optimal amount of clusters.

Table 7.1: Model overview 1-8 clusters

	Npar	LL	L^2	df	BIC (LL)	p-value	Highest BVR
1-Cluster	30	-1693.1	1317.8	239	3554.0	0.00	40.75
2-Cluster	36	-1635.3	1202.3	233	3472.0	0.00	11.17
3-Cluster	42	-1608.3	1148.3	227	**3451.7**	0.00	**1.43**
4-Cluster	48	-1600.6	1132.8	221	3469.7	0.00	0.41
5-Cluster	54	-1586.8	1105.2	215	3475.7	0.00	1.00
6-Cluster	60	-1575.3	1082.3	209	3486.3	0.00	0.62
7-Cluster	66	-1563.6	1059.0	203	3496.5	0.00	0.34
8-Cluster	72	-1551.7	1034.4	197	3505.6	0.00	0.36

BIC (LL) = bayesian information criterion
BVR = bivariate residuals
Npar = number of parameters
LL = final log-likelihood of the model
L^2 = likelihood-ratio chi-squared statistic
df = degrees of freedom

Subsequently, all factors influencing mode choice and all work related factors (according to the literature research, see Chapter 4) are added to the model as covariates to predict class membership. For example, respondents with a higher car affection will likely have more probability to belong to a class who often uses the car to commute. To obtain a parsimony model, the insignificant factors were made inactive using backwards deletion. This deletion is based on the Wald scores of the covariates, which indicate whether the means and probabilities between clusters are, or are not, significant (Vermunt & Magidson, 2002). The factor with the lowest Wald score was deleted first. On top of the selected factors, the remainder factors were included one by one. It was checked if the factors positively influenced the BIC value. Only lease car ownership is added as an extra active factor to predict class membership. Figure 7.2 presents the full latent class cluster modal with the indicators and the active covariates.

Consequently, the distributions of the indicators and covariates are presented in Table 7.2. Two inactive covariates are showed. The inactive covariates do no predict class membership, but they are valuable for the interpretation of the factors, and for the comparison to other research.

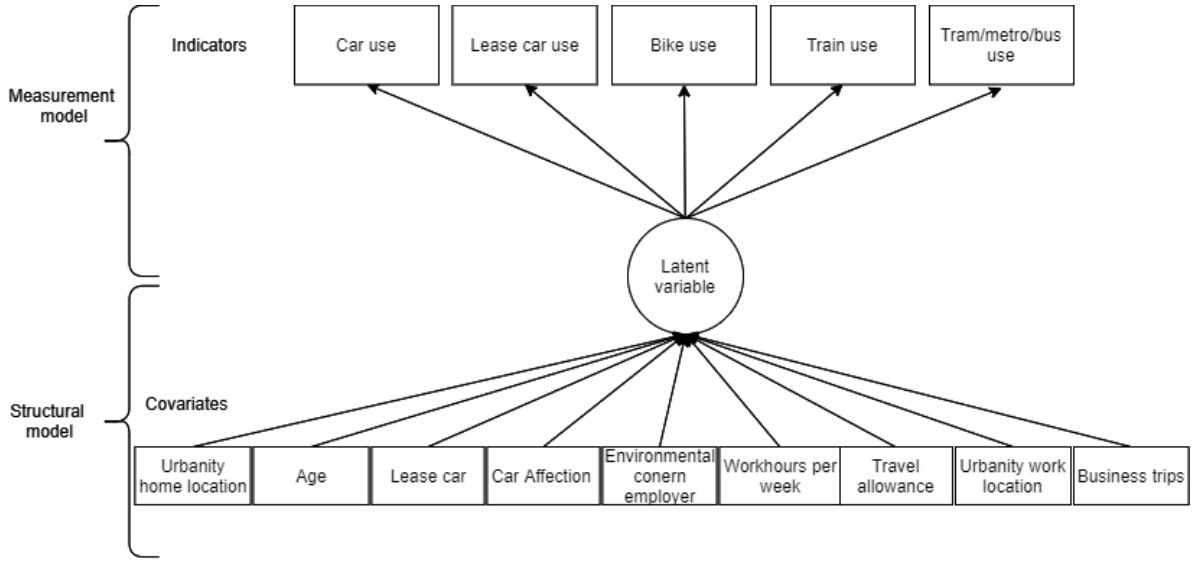

Figure 7.2: Full latent class cluster modal

Table 7.2: The distribution of indicators and covariates throughout the clusters

Factor:	**1**	**2**	**3**
Cluster size:	42%	39%	19%
Indicators			
Car use			
Almost daily	12%	67%	9%
1 to 4 days per week	28%	30%	23%
1 to 3 days per month	14%	3%	13%
6 to 11 days per year	6%	0%	6%
1 to 5 days per year	9%	0%	9%
Less than 1 day per year	4%	0%	5%
Never	28%	0%	35%
Lease car use			
Almost daily	0%	0%	59%
1 to 4 days per week	0%	0%	22%
1 to 3 days per month	0%	0%	4%
6 to 11 days per year	0%	0%	2%
1 to 5 days per year	0%	1%	2%

Table 7.2: The distribution of indicators and covariates throughout the clusters

Factor:	**1**	**2**	**3**
Less than 1 day per year	1%	1%	1%
Never	99%	98%	10%
Bike use			
Almost daily	19%	3%	12%
1 to 4 days per week	22%	6%	16%
1 to 3 days per month	16%	7%	13%
6 to 11 days per year	7%	5%	7%
1 to 5 days per year	8%	8%	9%
Less than 1 day per year	2%	2%	2%
Never	27%	70%	42%
Train use			
Almost daily	12%	1%	7%
1 to 4 days per week	19%	3%	14%
1 to 3 days per month	14%	3%	11%
6 to 11 days per year	8%	3%	8%
1 to 5 days per year	7%	5%	8%
Less than 1 day per year	3%	4%	4%
Never	36%	80%	48%
Tram/metro/bus use			
Almost daily	14%	0%	4%
1 to 4 days per week	25%	0%	11%
1 to 3 days per month	11%	1%	6%
6 to 11 days per year	7%	1%	5%
1 to 5 days per year	8%	3%	8%
Less than 1 day per year	4%	4%	5%
Never	31%	91%	60%
Covariates (Active)			
Age			
Mean	44	46	40
Attitude Pro Car			
Mean	2,95	4,24	3,88
Lease car ownership			
Yes	5%	7%	96%
No	86%	91%	0%
No answer	9%	2%	4%
Travel allowance			
Yes, fully	33%	30%	45%
Yes, partial	37%	47%	18%
No	24%	22%	35%
I don’t have commuting costs	6%	1%	2%
Business trips			
Yes	14%	17%	33%
Sometimes	40%	26%	51%
No	43%	55%	14%
Other	3%	2%	2%
No answer	3%	2%	2%
Incentive from employer to think consciously about commuting			
Employer pays no attention to this	40%	59%	51%
Employer encourages this slightly	39%	31%	37%
Employer fully encourages this	17%	6%	10%
Other	4%	3%	2%
No answer	0%	0%	1%

Table 7.2: The distribution of indicators and covariates throughout the clusters

Factor:	1	2	3
Workhours per week			
12-34 hours (parttime)	55%	41%	33%
35 or more hours (fulltime)	45%	59%	67%
Urbanisation rate Home			
Very high urbanised	36%	18%	18%
Highly urbanised	35%	22%	31%
Mild urbanised	11%	20%	18%
Little or not urbanised	14%	37%	28%
No answer	3%	3%	6%
Mean	2.01	2.77	2.57
Urbanisation rate Work			
Very high urbanised	56%	25%	41%
Highly urbanised	27%	32%	25%
Mild urbanised	7%	15%	14%
Little or not urbanised	5%	25%	16%
No answer	6%	3%	4%
Mean	1.60	2.39	2.03
Covariates (Inactive)			
Multi-modal travelling			
Never	35%	73%	47%
Sometimes	31%	17%	35%
Often or always	34%	10%	18%
Attitude environmental consciousness			
Mean	3.89	3.46	3.88

Three groups of employees with different modality styles

The clusters can be interpreted based on the used modes and on the characteristics corresponding to the groups. The percentages that are presented in Table 7.2 reflect on the probability of belonging to a particular cluster. For example, the variable lease car ownership, when there is a high percentage of individuals that have a lease car in a cluster, individuals who have a lease car have a high probability of belonging to this cluster. This section describes the clusters by interpreting the distribution of indicators and covariates in the clusters. This results in three groups of employees with different modality styles. These groups can be used throughout the research to explore whether the current modality styles are related to the interest in using MaaS for commuting trips.

Cluster 1 - Multi-modal travellers (42%)

The largest group consists of 42% of the sample and includes multi-modal travellers. The individuals in this group use all modes, except the lease car, to commute. Some use the bike daily, and others the public transport or the car. This group uses multiple modes mixed throughout the week, so the individuals are probably not so attached to performing the same behaviour every day. This multi-modality reflects in the small number for the attitude 'Pro car'. Where the other groups score a 4.2 and 3.9 out of 5.0, the multi-modal travellers only score a 2.9. So, the individuals in this group have less car affection than the other two groups.

The employees in this group receive the most encouragement from their employer to think consciously about the way they commute. This is in line with the higher use of public transport compared to the other groups. Furthermore, multi-modal travellers live and work mostly in very high urbanised areas. They are the only group that travels from these very high urbanised areas to other (or the same) high urbanised areas for their work. The other groups move from less urbanised areas to higher urbanised areas for their work. This can be related to the mode use. Moving within, from, and/or to very high urbanised areas can be more convenient with the bike or public transport than with the car.

The variable 'Multi-modal travelling' does not predict class membership but the percentage of individuals in this group that often or always uses more than one mode when travelling is a lot higher compared to the other groups.

Cluster 2 - Car-oriented travellers (39%)

The second largest group includes 39% of the respondents. This group is car-oriented. Individuals in this group rarely use other transportation modes than the car to commute. This reflects in the highest number for the 'Pro car' attitude. Furthermore, the car-oriented travellers are the oldest group, with an average age of 46 years old, compared to 44 and 40 years old in the other groups.

Moreover, the car-oriented travellers mostly live in little or not urbanised areas, which is a significant difference compared to the other groups, who mostly live in more urbanised areas. This might explain the fact that this group is car-oriented since public transport is most of the time less accessible in less urbanised areas compared to high urbanised areas. Residential self-selection might play a role here. Residential self-selection refers to the fact that there is probably not a direct link between travel behaviour and living area as specific individuals, with particular characteristics, are attracted to live in certain areas. So, people select themselves into a particular neighbourhood with specific characteristics concerning accessibility with the car, or for example, the train. This is not the focus point of this research, but something to keep in mind. The urbanisation rate of the work locations of employees in this group is also the lowest compared to the other groups. Another factor that is in line with the extensive focus on the car is the fact that this group receives the least encouragement from employers to think about the way they commute. The inactive variable multi-modal travelling shows that a large number of individuals in this group (74%) always travels with one mode per trip. This is very high compared to the other groups, which makes this group the least multi-modal group of the three groups.

Cluster 3 - Lease car users (19%)

The smallest group of employees consists of 19% of the sample. This group mostly uses a lease car to commute. In contrast to the car-oriented travellers, the lease car users are not only using the lease car to commute. A fair amount of individuals in this group also travels by car, bike, and train. This reflects in the average number for the 'Pro car' attitude, which is high compared to the first group but lower than the second group. The high percentage that uses the lease car can also be related to the fact that this is the group where the highest percentage of individuals receive full travel allowance. Furthermore, this group travels more for work outside commuting than the other two groups, which was expected because of the use of a leased car. The individuals in these groups travel more multi-modal than the car-oriented individuals but less than the multi-modal travellers.

Remarkable observations

This section elaborates on the remarkable observations concerning the identification of employee groups with different modality styles.

The class membership is mainly predicted by work related factors, the urbanisation rate of the work and home location, and the attitude regarding 'Pro car'. It was expected that, for example, the household type would affect the class membership. For example, employees with children living at home might travel more by car because they are driving around schools and day-care to pick up the children. However, work related factors seem to be dominant in predicting class membership.

Another remarkable observation is that the attitude regarding the environment is similar among the different employee groups. The car-oriented travellers score a bit lower on this attitude compared to the multi-modal travellers and the lease car users, but the scores are close together. They all agree with the three statements that were categorised into the 'environmental consciousness' factor. That the degree of environmental consciousness is not significantly related to predicting classes is not unexpected. Recent research of Kroesen & Chorus (2020) shows that the relation of attitude on behaviour is less strong than the other

way around. Furthermore, numerous studies identified the gap between the attitudes of individuals and the actual behaviour regarding the environment. Individuals tend to answer questions about the environment in a socially desirable way (Ewert & Galloway, 2009).

There is no proof, but there are indications that policies of companies regarding travel allowance and the incentive from employers to think consciously about commuting mode choice indeed is related to the commuting mode choice of employees. Although the most substantial part of the employees have the idea that their employers do not pay any attention to encouraging them to think about the environment when commuting, this factor is an active covariate. The multi-modal travellers receive the most encouragement and the car-oriented individuals the least. This is in line with the expectations and the related mode choice since multi-modal travellers travel with more sustainable modes than the car-oriented travellers.

The mode use might be related to the work individuals do. This is not asked directly but reflects in, for example, if individuals travel for work outside commuting. Almost every member of the lease car user groups sometimes or often makes business trips. Only 14% never makes these trips, compared to 43% and 55% in the other groups.

Comparison to other research

Molin et al. (2016) performed a latent class cluster analysis among Dutch travellers and identified five clusters based on car use, bicycle use, train use and bus use. In the order from the largest group to the smallest group, the groups are the following. The first cluster uses the car most often and also uses the bike and the public transport and is summarised as car multi-modal. Subsequently, there is a bike multi-modal group, a bike plus car group, a car mostly group and the smallest group is the most multi-modal group which is summarised as public transport multi-modal group. It is not possible to compare these results one on one with the results from the performed latent class cluster analysis in this research because, in this research, the groups are based on mode use when commuting instead of general use. Nevertheless, some comparison can be made.

From the five identified groups identified by Molin et al. (2016), four groups use different modes to travel, and one group only uses the car. This distribution is similar to the groups in this research since there is also only one group that never uses other modes than the car to commute. However, the car-oriented group in this research is a lot larger than in the research from Molin et al. (2016). This is probably related to the fact that commuting trips are for many people the same trip every day. The car-oriented employees might travel more multi-modal in their free time, but always travel to work with the car. The car mostly group in the research from Molin et al. (2016) appears to be the group with the strongest attitudes. They are very positive about the car, negative towards bicycle and extremely negative towards public transport. The car-oriented employees in this research also have a high car affection compared to the other two groups. The attitude regarding public transport is merged with the environmental consciousness of individuals in this research (see Section 6.2), so it is not possible to compare those. Besides, all groups score high on this attitude which mostly measures environmental consciousness. Another similarity is the living area's of car users, as in both analyses, the car user predominantly live in smaller cities. Subsequently, individuals who are more multi-modal live in more urbanised areas.

Molin et al. (2016) concluded that multi-modal travellers are associated with young, highly educated individuals who live in small households. This is not directly found in this research. However, it must be kept in mind when looking into the intention to use MaaS because it is expected that individuals who are more multi-modal are more interested in using MaaS.

Ton et al. (2020) researched determinants for mode choice when commuting in the Netherlands. They concluded that work conditions and especially the reimbursement by the employer is particularly essential for the mode choice. The second group of important factors were the availability of modes. The car availability could not be included in the model in this research, but the ownership of a lease car actively predicts the membership to the clusters in this research. The same holds for the travel allowance from the employer as it actively

predicts class membership. The effect of the travel allowance is researched further in this research by presenting multiple scenarios to the respondents. The next section elaborates on the results of these analyses.

7.1.2. Perceptions of employees about MaaS

This section elaborates on the perceptions of employees about MaaS and thereby partially answers the first research question about the thoughts of employees about MaaS in the current situation.

First, the general perceptions are presented. Afterwards, the factor analysis that is performed to bundle the perceptions is discussed, and the bundled perceptions per identified employee group are described.

Perceptions about MaaS in general

Sixteen statements were included in the questionnaire to measure the thoughts of employees about MaaS. The statements were formulated based on the promises and difficulties of MaaS. For example, the promise that MaaS will reduce car ownership and that MaaS will spread travellers throughout the day. Difficulties or uncertainties that are related to MaaS were also included. For example, the fact that enough vehicles need to be available everywhere and always and the dependency on a charged mobile phone with an internet connection. By asking these statements it is possible to examine how potential futures users think about MaaS. The statements were asked on a five-point scale from 'totally disagree' to 'totally agree'. The middle option is the neutral one. Table 7.3 presents the means and standard deviations (s.d.) of the statements.

Table 7.3: Overview of perceptions

#	Statement:	Mean	s.d.
1	MaaS provides tailor-made solutions (personal preferences are taken into account).	3.95	0.791
2	Travelling with MaaS contributes to the climate in a positive way.	4.01	0.750
3	Maas will not reduce private car ownership in society.	3.32	0.948
4	MaaS offers freedom of choice (offering a wide range of modes that can vary per destination).	3.95	0.699
5	It is impossible to offer enough vehicles for everyone, always and everywhere with MaaS.	3.62	0.989
6	MaaS brings a new perspective on the possibilities of shared modes (shared bicycle, shared car, etc.).	3.93	0.782
7	With MaaS you have to plan ahead, it is less easy to undertake something spontaneously for which you have to travel.	3.80	0.891
8	MaaS offers the fastest option from A to B.	3.13	0.999
9	For me, it is no problem that MaaS is completely dependent on a charged telephone with an internet connection.	3.40	1.104
10	For me, MaaS brings ease of travel (one app in which information is provided and where booking and payment of a door-to-door journey is possible).	3.55	0.950
11	MaaS spreads travellers better throughout the day.	3.16	0.939
12	For journeys planned at the last minute, I cannot imagine that MaaS can match the ease of availability of owning a mode.	3.76	0.907
13	Travelling with MaaS is sensitive to weather conditions.	3.47	0.912
14	MaaS provides an increase in the use of different modes in one journey (e.g., tram + train).	3.77	0.789
15	Travelling with MaaS will be more expensive than travelling by personal car.	3.37	0.956
16	Maas unburdens when travelling (guarantee for the journey, new options are offered in the event of delays).	3.50	0.868

The six statements with the most extreme means are presented in grey. The means of the statements range from 3.13 to 4.01. So, the respondents seem to agree with some of the promises of MaaS. However, they also seem to be hesitant or neutral about other promises. The respondents mostly agree with the fact that MaaS positively contributes to the climate. The respondents also feel that MaaS can offer a tailor-made solution and that MaaS offers freedom of choice. The respondents agree less with the promises of MaaS about spreading the travellers throughout the day and also with the fact that MaaS can offer the fastest option from A to B. The respondents are agreeing, but not so much agreeing, with the fact that MaaS will not reduce private car ownership.

Bundled perceptions

A factor analysis is performed to see whether there are underlying patterns between the statements and therefor to see if a new common variable, or factor, can be extracted.

Extracting factors with a factor analysis is an iterative process. Combinations of statements are explored to find factors with a simple structure which are logical to interpret. In the factor analysis, five variables were excluded from the analysis and two factors are extracted. Appendix I provides detailed information on performed factor analysis.

The rotated factor matrix is depicted in Table 7.4. The factor loadings present the correlation between a statement and the factor and thereby show which statement is included in which factor. All variables load above the threshold of a factor loading of 0.5 on the related factor and low (<0.3) on the other factor. This simple structure was found by performing an orthogonal rotation (Varimax). This is a rotation method where the factors do not correlate with each other. So, there is no overlap in the interpretation of the factors.

Table 7.4: Rotation factor matrix

#	Statement:	Factor	
		1	2
16	Maas unburdens when travelling (guarantee for the journey, new options are offered in the event of delays).	0.770	
6	MaaS brings a new perspective on the possibilities of shared modes (shared bicycle, shared car, etc.).	0.769	
4	MaaS offers freedom of choice (offering a wide range of modes that can vary per destination)	0.740	
1	MaaS provides tailor-made solutions (personal preferences are taken into account).	0.739	
10	For me, MaaS brings ease of travel (one app in which information is provided and where booking and payment of a door-to-door journey is possible).	0.737	
2	Travelling with MaaS contributes to the climate in a positive way.	0.690	
8	MaaS offers the fastest option from A to B.	0.608	
11	MaaS spreads travellers better throughout the day.	0.537	
7	With MaaS you have to plan ahead, it is less easy to undertake something spontaneously for which you have to travel.		0.806
12	For journeys planned at the last minute, I cannot imagine that MaaS can match the ease of availability of owning a mode.		0.594
5	It is impossible to offer enough vehicles for everyone, always and everywhere with MaaS.		0.522

Extraction Method: Principal Axis Factoring.
Rotation Method: Varimax with Kaiser Normalization
a. Rotation converged in 3 iterations

Statements that are positively formulated and describe the promises, load high on factor one. Factor two includes statements that are negatively formulated or are about the difficulties of MaaS. Therefore, factor two is called 'Hesitant about MaaS' and factor one is called 'Positive about MaaS'. It is noticeable that the positive and negative formulated statements are bundled in different factors. This indicates that respondents which are positive about MaaS, mostly agree with all the positively formulated statements and the other way around. So, the respondents do not differ that much in thoughts about which aspects they find promis-

ing. This is also an indication that the formulation of the statements is influencing the way respondents think, or respond.

The means and the standard deviations of the two new factors are depicted in Table 7.5. As can be seen, the means do not differ substantially. In general, the respondents are a bit more hesitant than positive about MaaS. These factors are used as variables throughout further research to see whether the perceptions of MaaS are related to the interest of the employees in MaaS.

Table 7.5: Means and standard deviations of the perceptions of MaaS in general

	Mean	Standard deviation
Factor 1: Positive about MaaS	3.66	0.629
Factor 2: Hesitant about MaaS	3.72	0.719

Bundled perceptions per modality style of the employees

The two identified factors say something about how individuals think about MaaS in general. To dive deeper into these thoughts, the means of the factors are presented per employee group, see Table 7.6.

In general, multi-modal travellers are more positive than hesitant about MaaS. The car-oriented travellers and the lease car users are both more hesitant than positive about MaaS. The differences in means between the different employee groups within the factors are significant (Factor 1: $F(2.263) = 7.808$; $p=.001$, Factor 2: $F(2.261) = 4.469$; $p=0.012$).

Comparing the means of the car-oriented travellers and the multi-modal travellers are as expected. Car-oriented travellers are less positive and more hesitant about MaaS than multi-modal travellers. This was as expected since MaaS is all about travelling multi-modal.

The perceptions of the lease car users are not entirely as expected. The lease car users and the multi-modal travellers differ less than was expected. The lease car users are the most positive and also most hesitant about MaaS. So, two extremes. This might be because also within a cluster, the respondents differ. For example, 42% never uses the bike to commute, and 12% uses it every day. The difference that occurs within the clusters might explain the extremes. However, it can also, for example, be because individuals in this group just have a stronger opinion and are more inclined to pick the extremer answer options than other individuals.

Table 7.6: Means and standard deviations of the perceptions of MaaS per modality style of the employees

	Factor 1: Positive about MaaS		Factor 2: Hesitant about MaaS	
	Mean	**s.d.**	**Mean**	**s.d.**
Multi-modal travellers	3.76	0.589	3.60	0.702
Car-oriented travellers	3.47	0.610	3.75	0.691
Lease car users	3.80	0.671	3.95	0.763

7.1.3. Attitude and intention to use MaaS for commuting

To see whether there is interest from employees to use MaaS to commute, the current attitude and intention to use MaaS are explored. This section presents these results. First, in general, and afterwards, attention is paid to the distribution among the employees groups with different modality styles to get more detailed information.

Attitude and intention to use in general

The attitude is asked in the form of a statement. The respondent must express their degree of agreement with the following statement: ”I find MaaS an attractive option for travelling to work”. There were five answer options possible, being totally disagree, disagree, do not agree/do not disagree, agree, and totally agree. To analyse these answers, answer options are merged. The answer options where respondents show their agreement are merged to agree. The disagreeing answer options are merged with the neutral option to be able to get a binary scale for the further analysis. Agreeing and disagreeing with this statement remain. The distribution of the answers are depicted in Table 7.7.

The attitude says something about how individuals think of MaaS. The question then arises: are they interested to actually use it? This was measured by asking the following question: ”To what extent do you expect to use MaaS to travel to work?” The answer options go from ’I will definitely not do that’ to ’I will definitely do that’. Same as with the attitudes, answer options are merged to analyse the results and make them more understandable. The answer option ’I do not know’ is merged with the answer option that state that respondents will not use MaaS to commute because these people are not convinced and did not show any interest. It is not fair to say that there is interest among these individuals. Table 7.8 shows the distribution of the intention to use per answer option. The totals of the measured attitudes and intention to use differ because missing values, and the option ’no opinion’, were both excluded from the analysis.

In general, the interest in using MaaS to commute is rather low, only 21% of the respondent probably or definitely will use MaaS to commute. The number of people who find MaaS an attractive option, the measured attitude, is a bit higher, 28%. This was expected because the attitude measures an interest-only and the question about the intention to use measures a possible action. Many respondents answer that they do not know what they will do. There is no information on why individuals answer in this way, but it is expected that they do no understand MaaS so good yet. Other explanation could be because the respondents do not see the benefits compared to there current situation or because the respondents hear from MaaS for the first time so they have not made up their mind yet.

As the theory of planned behaviour states, it was expected that the attitude and the intention to use MaaS relate to each other. The results in this research confirm this as a strong positive significant correlation is found between the attitude and the intention to use MaaS (correlation=.791, p=.000).

Table 7.7: Attitude towards using MaaS to commute in the current situation

Attitude towards MaaS as attractive option to commute:	**Frequency:**	**Percentage:**
Agree	72	28%
Disagree	181	72%

Answer distribution:		
Totally disagree	33	13%
Disagree	70	28%
Do not agree, do no disagree	78	31%
Agree	55	22%
Totally agree	17	7%
Total	253	100%

Table 7.8: Intention to use MaaS in the current situation

Intention to use MaaS for commuting trips:	Frequency:	Percentage:
Yes	55	21%
No	207	79%

Answer distribution:		
Definitely not (no)	61	23%
Probably not (no)	73	28%
I don't know (no)	73	28%
Probably do (yes)	41	16%
Definitely do (yes)	14	5%
Total	262	100%

Attitude and intention to use per modality style of the employees

Table 7.9 and Table 7.10 show the attitude and the intention to use MaaS for commuting trips per group of employees with different modality styles. There is a clear difference noticeable. The car-oriented travellers have by far the lowest interest in using MaaS. This was expected since these individuals are only using the car, score low on the environmental consciousness and show no multi-modality at all. Which is an important aspect of MaaS.

The intention to use MaaS for commuting trips among multi-modal travellers and lease car users is around 30%. This is not a substantial part of the total, but it is a lot higher than the intention to use of the car-oriented travellers. The multi-modal travellers and lease car users do not differ that much, with 27% and 31%. On the one hand, this was expected because both groups travel multi-modal in some way. However, it was not expected that the differences are so small. Since, for example, the car affection of the lease car users is more in line with the car-oriented travellers than with the multi-modal travellers. Besides, perceptions of lease car users are not in line with multi-modal travellers or car-oriented travellers. The lease car users are most hesitant about MaaS, but also most positive.

The attitudes and the intentions to use are in line with each other when comparing the groups. The interest goes from smallest to largest from the car-oriented travellers, to multi-modal travellers to lease car users. It must be mentioned that the groups are not even. The lease car users are in total, almost half of the other groups. So, the results of the lease car users might be less reliable than the results of the other groups.

Table 7.9: Attitude towards using MaaS to commute per modality style of the employees

	Attitude towards MaaS as attractive option to commute:		
	Agree	Disagree	Total
Multi-modal travellers	36% (37)	64% (66)	100% (103)
Car-oriented travellers	13% (13)	87% (88)	100% (101)
Lease car users	45% (22)	55% (27)	100% (49)

Table 7.10: Intention to use MaaS to commute per modality style of the employees

	Intention to use MaaS for commuting trips:		
	Yes	No	Total
Multi-modal travellers	27% (30)	73% (83)	100% (112)
Car-oriented travellers	9% (9)	91% (90)	100% (99)
Lease car users	31% (16)	69% (35)	100% (51)

7.1.4. Conclusion

This section discussed the current situation of what and how employees think about using MaaS in general and about using MaaS for commuting trips to answer the following research question: ”What are the thoughts of employees with different modality styles about MaaS?”. To analyse this in detail, three groups of employees with a different modality style were identified by performing a latent class cluster analysis. The three groups are multi-modal travellers, car-oriented travellers and lease car users.

In general, employees are positive about MaaS but also hesitant. The employee groups differ in opinions about MaaS. The car-oriented travellers are less positive and more hesitant about MaaS than the multi-modal travellers. The lease car users are the most positive and the most hesitant about MaaS.

Differences are also found when exploring the attitude and the intention to use MaaS for commuting. The overall intention to use MaaS to commute is low since only 21% of the respondents show intention to use MaaS. However, this average gives a biased view. The intention to use MaaS for commuting trips is higher among multi-modal travellers and lease car users compared to car-oriented travellers, respectively 27%, 31% compared to 9%. These results indicate that the factors positive or hesitant about MaaS are probably not associated with the intention to use. Since the lease car users are more hesitant than positive, which is in line with the car-oriented travellers and the intention to use is in line with the multi-modal travellers.

The substantial difference in intention to use between the car-oriented travellers and the lease car users is remarkable since both groups mainly travel to work with a car. However, the lease car users interest is more in line with the multi-modal travellers. This difference might be related to the fact that the lease car users travel to more urbanised areas for their work than the car-oriented travellers. Moreover, both groups have a high car affection, but the car affection of the lease car users is lower than the car affection of the car-oriented travellers. Also, the multi-modality might explain this difference as the car-oriented travellers never use other transport modes than the car to commute. In the group of lease car users, some individuals travel, apart from the lease car, with public transport or with the bicycle to work a couple of times per week or month.

7.2. Intention to use MaaS to commute when employers start financing MaaS

The previous section focused on exploring the thoughts of employees about MaaS in general and about using MaaS to commute. This section dives deeper into the potential of MaaS for commuting trips and explores the relationship between employers financing MaaS and the intention to use MaaS. Receiving reimbursement for a particular mode increases the probability that that mode will be used (Ton et al., 2020). Therefore, it is expected that the reimbursement from employers for commuting costs influences the interest and therefore, the intention to use MaaS. The following research question is answered at the end of this section: ”To what extent does the cost reimbursement from the employer influence the intention to use MaaS for commuting trips by employees in general and among only car users?” Answering this question provides information on the possibilities to influence the intention to use MaaS to commute among employees by varying in reimbursement from employers. This question is researched by presenting two scenarios to the respondents of the questionnaire.

The first subsection discusses the first scenario, and examines the differences in the intention to use MaaS to commute in the current situation and when employers would finance MaaS. Every respondent got to see this scenario and needed to complete the related questions about the intention to use MaaS. In this scenario, the situation was sketched that every employee receives full reimbursement for travelling to work with MaaS.

The second subsection only focuses on car users. So this scenario was only shown to respondents who identified the car as their primary commuting mode. The situation was sketched that employers would finance MaaS to commute and they would stop financing commuting by car. As a result of this, this section explores whether such a drastic measure increases the intention to use MaaS to commute or not. This is relevant information for policymakers because it provides insights in if and possibly how car users can be persuaded to other mode choices in their commuting travel behaviour.

This section only focuses on the intention to use MaaS and does not include the attitude towards using MaaS to commute. The attitude is included in the previous section because it says something about the current thoughts as attitude is referred to as: ”a settled way of thinking or feeling about something” (by Oxford, n.d.). Including the attitude in this section is less relevant since attitude is not about an action, but more about a feeling/opinion.

7.2.1. Employers start financing MaaS; Changes among all employees

The first scenario is the situation where the employer starts financing MaaS. This situation is sketched to the respondents, and the intention to use was asked in the same way as for the current situation, which makes it possible to compare these with each other. This section presents the changes in general first. Afterwards, the changes per employee group are presented.

Changes in general

Table 7.11 presents the intention to use MaaS to commute when the employer finances MaaS (scenario 1) and shows the differences with the current situation (scenario 0). In general, the intention to use MaaS to commute increases among employees when the employers would start financing it. Examining the answer distributions show that the employees who are more certain (definitely going to use or definitely not going to use) react the least on the changing situation.

The differences per scenario are checked for significance with the paired sample t-test. It turns out that there is a significant difference between the different scenarios for both intention, yes and no (yes: mean=.21, SD=.41; mean=0.29, SD=.45;p=.001 and no: mean=.79, SD=.41; mean=0.71, SD=.45;p=.001).

Table 7.11: Intention to use MaaS to commute in scenario 0 and scenario 1

Intention to use MaaS to commute:	Scenario 0:	Scenario 1:	Difference:
Yes	21% (55)	29% (75)	+8%
No	79% (207)	71% (187)	-8%
Answer distribution:			
Definitely not (no)	23% (61)	21% (54)	-2%
Probably not (no)	28% (73)	20% (53)	-8%
I don’t know (no)	28% (73)	31% (80)	+3%
Probably do (yes)	16% (41)	22% (58)	+6%
Definitely do (yes)	5% (14)	7% (17)	+2%
Total	100% (262)	100% (262)	

Changes per modality style of the employees

The intention to use MaaS is distributed over the identified groups of employees in Table 7.12. Differences are noticeable. The car-oriented travellers barely respond to the changing situation (an increase of only 3% points). The multi-modal travellers react more on the changing situation than the lease car users and car-oriented travellers, but it is not that much, an increase in intention to use MaaS of 12% points.

The differences between the scenarios for answers option yes and no are tested on significance with the paired t-test for every group. Only the differences between scenario 0 and 1 in the group of multi-modal travellers are significant (yes: mean=.27, SD=.44; mean=0.38, SD=.49;p=.002 and no: mean=.73, SD=.44; mean=0.63, SD=.49;p=.002). The differences between scenario 0 and 1 for both the car-oriented travellers and the lease car users are not significant (respectively p=.181 and p=.261). The insignificance means that there is no significant difference between the intention to use MaaS in scenario 0 and scenario 1 for the car-oriented travellers and the lease car users in the population.

Table 7.12: Intention to use MaaS to commute in scenario 0 and scenario 1 per modality style of the employees

	Intention to use:	Scenario 0:	Scenario 1:	Difference:
Multi-modal travellers	Yes	27% (30)	39% (44)	+12%
	No	73% (82)	61% (69)	-12%
Car-oriented travellers	Yes	9% (9)	12% (12)	+3%
	No	91% (90)	88% (88)	-3%
Lease car users	Yes	31% (16)	39% (19)	+8%
	No	69% (35)	61% (30)	-8%

7.2.2. Employers stop financing current car use; Changes among car users

The results in the previous section showed that especially car-oriented travellers are not willing to use MaaS to commute, also not when the employer starts financing it. This result was as expected, and therefore a second scenario was included in the questionnaire. In the presented scenario, the employer stops financing current car use and only finance MaaS to commute. This scenario was only presented to respondents who identified the car as their primary commuting mode. It must be noted that the car-oriented travellers are not the same group as the participants who identified the car as their primary commuting mode. Identifying the group of car-oriented travellers was based on the performed latent class cluster analysis. The car users in this section are employees who indicated the car as their primary commuting mode.

Table 7.13 presents an overview of the intention to use MaaS to commute among car users. The percentages of employees that have the intention to use MaaS increases through the scenarios. However, they are still low. It was expected that the intention to use MaaS would increase more in the third scenario because the car users must pay for their car commuting costs. However, even such an extreme measure is not enough to increase the intention to use MaaS to commute substantially. 66% of the car users are not interested in using MaaS to commute and willing to pay for their own commuting costs with the car when their employer would stop doing this.

Table 7.13: Intention to use MaaS to commute among car users in the different scenarios

Intention to use MaaS to commute:	Scenario 0	Scenario 1:	Scenario 2:
Yes	17% (29)	27% (44)	34% (57)
No	83% (137)	73% (122)	66% (111)

Answer distribution:			
Definitely not (no)	25% (42)	24% (40)	18% (30)
Probably not (no)	27% (44)	20% (34)	21% (36)
I don't know (no)	31% (51)	29% (48)	27% (45)
Probably do (yes)	13% (21)	20% (34)	26% (44)
Definitely do (yes)	5% (8)	6% (10)	8%(13)
Total	100% (166)	100% (166)	100% (168)

The Repeated Measure ANOVA test was used to test these differences for significance. Mauchly's test showed that the assumption of sphericity is not met (p=.000). Therefore the degrees of freedom Greenhouse-Geisser have been corrected. The results show that the differences are significant, so the intention to use differs between the presented scenarios ($F(1.83, 295.96)=14.07$, $p<.001$).

The results in the previous section indicated that lease car users are more interested in using MaaS to commute than car-oriented travellers. To explore the intention to use MaaS in more detail, another analysis is performed.

Table 7.14 presents the distribution of the different modality styles among the respondents with the car as the primary commuting mode. From the respondents that identified the car as their primary commuting mode, 17% is classified as multi-modal travellers. These respondents use the car most often but for example, sometimes travel by train or by tram. 25% of the respondents who mostly travel by car were classified as lease car user and 58% as car-oriented travellers.

Table 7.14: Distribution of the modality styles among the employees with the car as main commuting mode

Modality style:	Number:	Percentage:
Multi-modal travellers	29	17%
Car-oriented travellers	100	58%
Lease car users	43	25%
Total	172	100%

The changing intention to use of the employee groups with different modality styles are explored, and the results are presented in Table 7.15. Again, the multi-modal travellers show the highest intention to use, followed by the lease car users and then the car-oriented travellers. It is interesting to see the difference between the lease car users and car-oriented travellers. Despite the high car affection of both groups, multiple results in this research indicated that lease-car users can be persuaded more than the car-oriented travellers to a higher intention to use MaaS to commute. These results show that the intention to use in both groups does not increase substantially. However, the lease car users started with a higher intention to use. So, the intention to use is in scenario two indeed higher for the lease car users than for the car-oriented travellers.

A remarkable aspect of these results is the low intention to use MaaS to commute of the multi-modal travellers in scenario 0. This is caused by the fact that the five answer options were categorised in two options, 'yes' and 'no'. In scenario 0, most of these multi-modal respondents did not know what they will do, which is categorised as 'no' intention to use MaaS to commute. These respondents switched in the first and second scenario to 'probably going to do this' which is categorised as 'yes'. Furthermore, this group only exists of 28 respondents, so a relative small switch of the most popular answer option influences the total percentages more than in groups with more respondents.

Table 7.15: Intention to use MaaS to commute in scenario 0, 1 and 2 per modality style of the employees

	Intention to use:	Scenario 0:	Scenario 1:	Scenario 2:
Multi-modal travellers	Yes	29% (8)	62% (18)	61% (17)
	No	71% (20)	38% (11)	39% (11)
Car-oriented travellers	Yes	9% (9)	13% (12)	23% (22)
	No	91% (86)	88% (84)	77% (75)
Lease car users	Yes	28% (12)	34% (14)	42% (18)
	No	72% (31)	66% (27)	58% (25)

The Repeated Measure ANOVA test was used to test the differences for significance. Mauchly's test showed that the assumption of sphericity for the first group, the multi-modal travellers, are met (p=.403). Following, the results show that the differences are significant (F(2,54)=9.634, p=.000). For the second group of travellers, the car-oriented travellers, Mauchly's test showed that the assumption of sphericity is not met (p=.000). Therefore the degrees of freedom Greenhouse-Geisser have been corrected. The results show that the differences are significant (F(1.54,143.01)=7.347, p=.002). The third group, the lease car users, did meet the assumption of sphericity (p=.000). The results show that the differences between the scenarios are not significant (F(2,80)=2.051, p=.135).

The differences in the first and the second group are significant. So, the intention to use differs between the presented scenarios. For the third group, the lease car users, the intention to use does not differ significantly between the scenarios.

7.2.3. Conclusion

This section researched the intention to use MaaS for commuting trips in different scenarios to answer the following research question: "To what extent does the cost reimbursement from the employer influence the intention to use MaaS for commuting trips by employees in general and among only car users?"

It was expected that receiving travel allowance influences the interest in MaaS. However, examining this by presenting the scenario that employers would finance MaaS does not fully confirm this. Stimulating the use of MaaS by receiving finances from the employer seems to have a limited effect. There is a little increase (8% points) in the intention to use MaaS to commute when comparing the current situation to this first scenario. Individuals who are less sure about what they will do or will not do react more on the changing situation. This was expected since people who answered with definitely not, or definitely yes, are more certain about what they will do.

Exploring the differences per employee group gives interesting results. Only the multi-modal travellers respond significantly to the changing situation, and they have an increase in intention to use MaaS to commute of 12% points. This number is not extremely high. The car-oriented travellers and the lease car users do not show significant differences between scenario 0 and 1 (an increase of 8% points and 3% points). Remarkably, the multi-modal travellers are not the group with the lowest percentage that receives financing from the employer. This indicates that the finances from the employers do not influence the intention to use as much as expected.

It was also researched if another, more drastic measure, can persuade car users to a higher intention to use MaaS to commute. Exploring the employees who have the car as primary commuting mode showed that still, 66% of these respondents do not have the intention to use MaaS to commute and they are willing to finance the commuting costs by car themselves when the employer stops financing it. It seems that the car users can not be influenced substantially by a measure, as presented in this section. Again, the results showed differences between car-oriented travellers and lease car users. The lease car users are easier to influence towards more intention to use MaaS to commute than the car-oriented travellers.

7.3. Characteristics of interested and not interested employees

This section explores the intention to use even more and identifies groups based on the attitude towards MaaS and the intention to use MaaS in the current situation and in scenario one. This provides detailed information about the characteristics of individuals that are and are not interested in using MaaS to commute.

The first section elaborates on executing the latent class cluster analysis to identify the groups. Afterwards, the characteristics of the different groups are presented. Furthermore, remarkable observations are presented, and the results are compared to other research. At the end of this section, the following two research questions will be answered: ”What is the relation between belonging to a particular employee group, with different intentions to use MaaS to commute, and characteristics of those employees?” and ”Which type(s) of employees show a substantial difference in intention to use MaaS to commute when they receive reimbursement from their employer?”

7.3.1. Identifying groups with different intention to use MaaS to commute

The same as in Subsection 7.1.1, a latent class cluster analysis is used to find groups which have maximum homogeneity within the groups and heterogeneity between the groups. In this analysis, the indicators are the attitudes towards MaaS and the intention to use MaaS to commute in scenario zero and scenario one. Scenario two is excluded from this analysis because scenario two was only presented to respondents with the car as the primary commuting mode. Therefore, the number of respondents that answered the questions in scenario zero and scenario one are not the same as the number of respondent in scenario two. So, the groups are identified based on four indicators, see Figure 7.3.

The measurement model was estimated for a range between one and eight clusters to determine the optimal number of clusters. Table 7.16 summarises the results for the eight models. The Bayesian Information Criterion assesses the model fit. The number of clusters with the lowest BIC value should be chosen. According to this information criteria, the model with six clusters is the most parsimony. The other measure that is considered to choose the number of clusters is the measure of bivariate residuals (BVR). This is a more local measure. When there are no BVR’s above 3.84, it can be concluded that there are no covariations between pairs of indicator left. This measure indicates another model than the BIC. The BVR values indicate a model with four clusters. Subsequently, both models are explored and interpreted. The model with six clusters gives more detailed information and knows the most meaningful clusters for this research. Consequently, the 6-cluster model was selected as the most optimal amount of clusters.

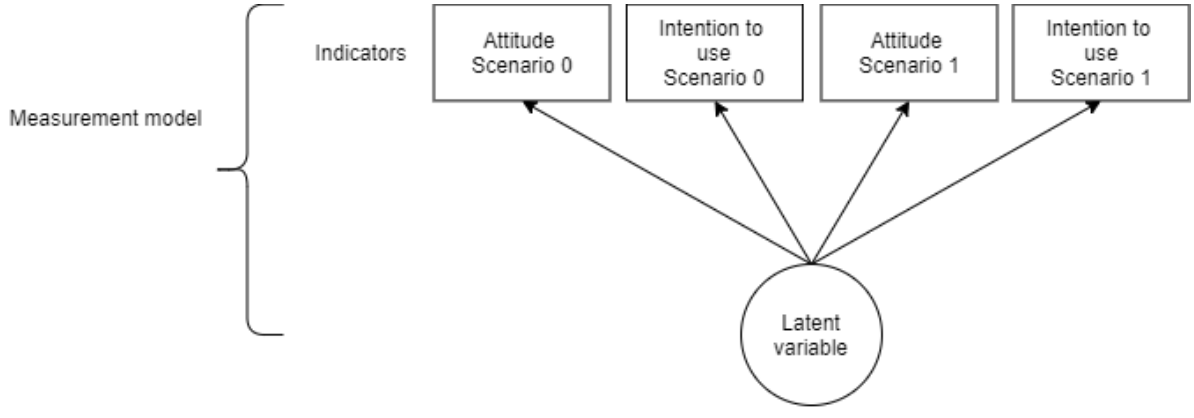

Figure 7.3: Latent class cluster measurement model

Table 7.16: Model overview 1-8 clusters

	Npar	LL	L^2	df	BIC (LL)	p-value	Highest BVR
1-Cluster	16	-1563.5	1314.6	253	3216.5	0.00	234.59
2-Cluster	21	-1292.2	772.0	248	2701.8	0.00	41.56
3-Cluster	26	-1155.6	498.9	243	2456.7	0.00	8.70
4-Cluster	31	-1101.9	391.4	238	2377.2	0.00	**2.15**
5-Cluster	36	-1067.7	323.1	233	2336.9	0.00	1.10
6-Cluster	41	-1050.5	288.6	228	**2331.9**	0.00	1.59
7-Cluster	46	-1040.7	269.0	223	2338.7	0.02	0.69
8-Cluster	51	-1026.1	239.8	218	2353.2	0.15	0.81

BIC (LL) = bayesian information criterion
BVR = bivariate residuals
Npar = number of parameters
LL = final log-likelihood of the model
L^2 = likelihood-ratio chi-squared statistic
df = degrees of freedom

Subsequently, the full model is estimated, by adding the structural model, to predict class membership. The full latent class cluster model is depicted in Figure 7.4. Through backwards deletion, covariates were added. Six covariates resulted to be significant (a Wald score below 3.84) and are kept in the model as active covariates. Other covariates are kept included the model as inactive covariates to use the distribution for the interpretation of the clusters.

The distribution of the indicators, active covariates and inactive covariates are presented in Table 7.17.

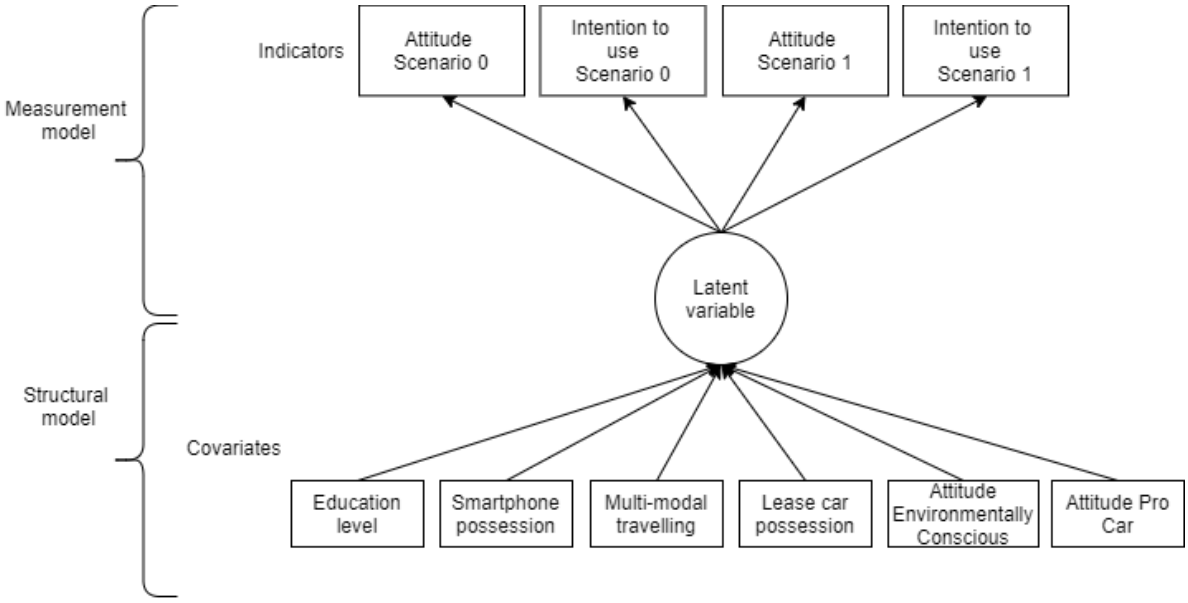

Figure 7.4: Full latent class cluster model

Table 7.17: The distribution of indicators and covariates throughout the clusters

Factor:	**1**	**2**	**3**	**4**	**5**	**6**
Cluster size:	31%	21%	19%	16%	6%	6%
Indicators						
Attitude Scenario 0						
Totally disagree	0%	7%	58%	0%	0%	1%
Disagree	18%	59%	40%	0%	0%	32%
Not agree, not disagree	64%	33%	2%	2%	0%	59%
Agree	17%	1%	0%	92%	14%	8%
Totally agree	0%	0%	0%	6%	86%	0%
Intention to use Scenario 0						
Definitely not do it	0%	24%	93%	0%	0%	1%
Probably not do it	32%	69%	7%	0%	0%	40%
Do not know	59%	7%	0%	30%	0%	53%
Probably do it	8%	0%	0%	67%	25%	5%
Definitely do it	0%	0%	0%	3%	75%	0%
Attitude Scenario 1						
Totally disagree	0%	4%	63%	0%	0%	0%
Disagree	8%	64%	36%	0%	0%	0%
Not agree, not disagree	73%	32%	0%	1%	0%	2%
Agree	20%	0%	0%	87%	21%	91%
Totally agree	0%	0%	0%	12%	79%	7%
Intention to use Scenario 1						
Definitely not do it	0%	7%	97%	0%	0%	0%
Probably not do it	10%	80%	3%	0%	0%	0%
Do not know	85%	13%	0%	10%	0%	5%
Probably do it	5%	0%	0%	83%	31%	81%
Definitely do it	0%	0%	0%	7%	69%	13%
Covariates (Active)						
Education level						
Highschool	10%	8%	23%	16%	24%	0%
MBO	42%	33%	29%	12%	12%	11%
HBO	34%	47%	36%	39%	30%	75%
WO	12%	12%	10%	34%	35%	14%
No answer	1%	0%	2%	0%	0%	0%
Smartphone possession						
Yes	95%	98%	85%	95%	83%	100%
No	5%	2%	12%	3%	5%	0%
No answer	0%	0%	3%	2%	12%	0%
Multi-modal travelling						
Almost never	47%	68%	75%	27%	12%	54%
Sometimes	34%	15%	13%	46%	18%	25%
Often or always	19%	15%	12%	27%	70%	21%
No answer	0%	2%	0%	0%	0%	0%
Lease car ownership						
Yes	16%	29%	23%	29%	41%	7%
No	78%	68%	74%	64%	59%	81%
No answer	6%	3%	3%	7%	0%	12%
Attitude Environmental Conciousness						
Mean	3.68	3.52	3.26	4.12	4.66	4.08
Attitude Pro Car						
Mean	3.52	3.79	4.08	3.25	3.50	3.25
Covariates (inactive)						
Age						
Mean	44	43	46	43	44	41

Table 7.17: The distribution of indicators and covariates throughout the clusters

Factor:	1	2	3	4	5	6
MaaS knowledge beforehand						
Yes	9%	7%	8%	16%	36%	23%
No	91%	93%	92%	84%	58%	77%
No answer	0%	0%	0%	0%	6%	0%
Travel allowance						
Yes, fully	30%	28%	37%	36%	53%	46%
Yes, partial	43%	37%	33%	42%	28%	20%
No	26%	33%	23%	20%	19%	24%
I don't have commuting costs	1%	2%	7%	2%	0%	10%
Environmental concern employer						
No attention	49%	58%	67%	27%	20%	64%
A little	41%	34%	18%	52%	47%	12%
Fully	9%	8%	6%	18%	33%	13%
Other	1%	0%	9%	3%	0%	5%
No answer	0%	0%	0%	0%	0%	6%
Employee group						
1:Multi-modal travellers	44%	35%	25%	59%	47%	63%
2:Car-oriented travellers	41%	46%	59%	16%	12%	30%
3:Lease car users	15%	18%	17%	26%	41%	7%
Perception: Positive about MaaS						
Mean	3.64	3.51	3.19	4.06	4.58	3.70
Perception: Hesitant about MaaS						
Mean	3.57	3.91	3.87	3.56	3.87	3.65
Openness to innovation: I am willing to try new modes of traveling						
Totally disagree	0%	1%	10%	0%	0%	1%
Disagree	7%	15%	17%	6%	3%	1%
Not agree, not disagree	49%	41%	40%	10%	24%	8%
Agree	37%	38%	25%	50%	57%	84%
Totally agree	6%	4%	4%	34%	11%	0%
Mean	3.55	3.25	2.96	4.14	3.69	4.77

7.3.2. Six employee groups based on (changing) attitude and intention to use

Figure 7.5 shows an overview of the distribution of the clusters and their interest. This section describes the identified clusters. The cluster can be interpreted based on the distribution of the indicators, active covariates and inactive covariates. The percentages reflect on the chance of giving a particular answer and belonging to the particular group.

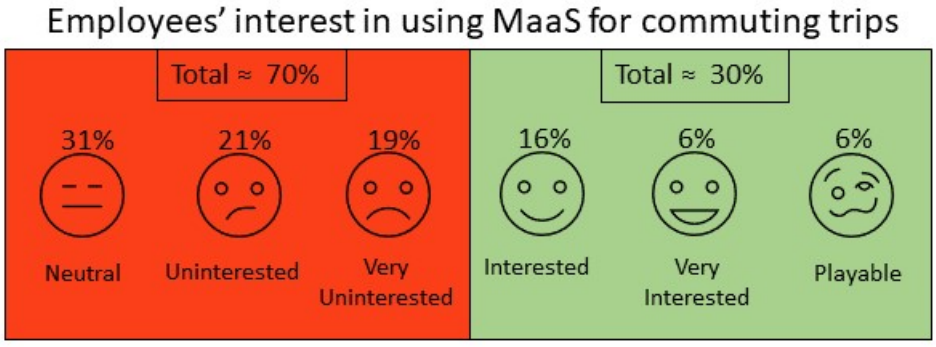

Figure 7.5: Overview of the six clusters and their interest

Cluster 1 - Neutral employees (31%)

The first group presents 31% of the respondents. Most of the individuals in this group do not know what they will do, or, are neutral about what they think of the idea of using MaaS for commuting. However, there is a small shift to a less negative attitude and a low intention when their employer would finance MaaS. Besides, this group is the most average group regarding the characteristics. There are no outstanding characteristics compared to the other groups.

Cluster 2 - Uninterested employees (21%)

The second largest group holds 21% of the respondents, and most individuals in this group disagree with the attitude statements and have a low intention to use MaaS for commuting trips (most respondents answer with: probably not going to do it). Remarkably, the attitude and intention to use does not change comparing scenario 0 to scenario 1. So, the individuals in this group are not interested in using MaaS and are not sensitive to the change that the employer starts financing MaaS. It was expected that this would reflect in a high percentage of individuals that receive full travel allowance at the moment, but this is not the case.

This group scores rather low on the factor that measures environmental consciousness and high on the factor that represents a pro car attitude. Besides, most individuals never travel multi-modal in one trip. These characteristics were expected after the previous analyses since it was seen that low environmental consciousness, high car affection and low multi-modality is associated with low interest in MaaS.

The inactive covariates are in line with the low interest as well. From the groups that are identified in Subsection 7.1.1, the car-oriented travellers are mostly represented in this group of employees that are not interested in using MaaS for commuting. Besides, this group is the most hesitant about MaaS, and the individuals in this group are not open to trying new modes of travelling.

Cluster 3 - Very uninterested employees (19%)

After the neutral employees and the uninterested employees in using MaaS for commuting trips, this groups is a more extreme group, and consists of 19% of the respondents. These respondents are negative about MaaS and have no interest in using MaaS for commuting at all. There is a small difference between scenario zero and the first scenario since some individuals change to 'probably not do it' instead of 'definitely not do it'. However, the most substantial part stays not interest at all.

Almost no employee in this group travels multi-modal. Besides, this group scores extremely low on the factor that measures the environmental consciousness and high on the factor that measures car affection. Furthermore, every group knows a high percentage of smartphone possession and this group shows the highest percentage of individuals who do not own a smartphone with an internet connection. This might be related to the highest average age. The same as the uninterested group mentioned above, the car-oriented travellers are represented the most in this group. Furthermore, there is a low score on the perception that measures how positive individuals are about MaaS. Most individuals in this group receive no attention from their employer to think about how they travel to work. The last factor that is noticeable is the openness to innovations. The employees that are extremely anti using MaaS for commuting score extremely low on this factor compared to the other groups.

Cluster 4 - Interested employees (16%)

The fourth-largest group represent individuals that are interested in using MaaS for commuting trips and consists of 16% of the respondents. There is a clear difference between scenario zero and scenario one noticeable. In scenario zero, there is a group that does not know what they will do, and in scenario one, this group is almost not existing. All the employees in this group are probably going to use MaaS to commute or even definitely.

This are individuals who already travel multi-modal sometimes. Besides, employees in this group score low on the factor that measures car affection. Furthermore, the individuals in this group are positive about MaaS. The multi-modal travellers are represented the most in

the group with employees who are pro using MaaS for commuting trips.

Cluster 5 - Very interested employees (6%)

6% of the respondents are identified as employees that are very interested in using MaaS for commuting trips. Most individuals in this group would definitely use MaaS to commute, and the other respondents probably. Although some individuals switch from probably to definitely in scenario one, this is not much. The intention is high already and this group not so sensible for the finances of the employer.

The extremely interested employees are environmentally conscious and have a low score for the factor that measures car affection. Most of the individuals in this group do not use a lease car, but, compared to the other groups, the lease car percentage is high. Also, the multi-modal character of the individuals in this group stands out. Compared to the other groups, this group knows an extremely high percentage of individuals that often or always travels with more than one mode per trip.

Another remarkable characteristic is the percentage of individuals that heard of MaaS before starting the questionnaire. This group knows the highest percentage of individuals that heard of MaaS before participating in the questionnaire. Furthermore, most individuals in this group receive a full travel allowance for their trips from their employers and make the most business trips compared to the other groups. This is in line with the high percentages that uses the lease car and with the low increase in intention to use in scenario one compared to the current situation. This groups also has employers that pay attention to encouraging their employees to think about the way they commute. At last, the multi-modal travellers and the lease-car users are both represented in this employee group.

Cluster 6 - Playable employees (6%)

The last group also consist of 6% of the respondents and this group is compassionate for the change that scenario one brings. In the current situation individuals do not know what they will do or are probably not going to use MaaS to commute. When the employer starts financing MaaS, almost everyone will probably use MaaS to commute. So this group is, as the only group, susceptible for the finances from their employers.

This group is highly educated compared to the other groups and knows a low car affection. Remarkably, this group is not extremely multi-modal oriented, and the lease car use is extremely low compared to the other groups. Besides, the environmental consciousness is high, but not extremely high.

This is the youngest group and also knows a high percentage of individuals that already heard of MaaS before participating in this research. Another remarkable observation is that the individuals in this group known a high percentage of employers that do not give any attention to encouraging their employees to think about the way they commute. So, it seems like these individuals have an intrinsic interest in using MaaS or value money that much that they switch from uninterested to interested.

7.3.3. Remarkable observations

Some results are noteworthy. First of all, evaluating the overall percentages of the groups shows that the first three groups, which resemble a large amount of the total respondents (71%), do not show interest in using MaaS for commuting trips. Regardless of the situation. Only 21% (group 4 plus group 5) show interest in MaaS in the current situation. This is not unexpected but yet still a low number.

Another valuable insight is the fact that individuals with a strong opinion or interest already are less influenceable than individuals with a less strong opinion or interest. The employees who are more in the middle and do not know what they will do are more influenceable than individuals with a strong opinion already.

The fourth group has a high, although not extremely high, intention to use MaaS to commute. It is unexpected that this group is not very multi-modal as only 27% in this group often or always uses more than one mode per trip. Another remarkable observation is the situation

with the employees of the fifth group. The intention to use MaaS to commute is very high in this group. However, when the employer starts financing MaaS (scenario 1), the intention to use MaaS decreases a bit. Overall, the intention stays very high. This group has the highest percentage of MaaS knowledge before participating in this research. This variable does not influence the class membership, but 36% have heard of MaaS before where this is substantially lower in the other groups. Comparing the three groups with interest (the last group only in the first scenario), these groups have a higher knowledge of MaaS before participating. This might be related with the intention to use because individuals who hear of something for the first time might be a bit more reluctant to express their opinion about, for example, using it or not.

The last noticeable element is the fact that there are car-oriented travellers included in the last group of playable employees. This indicates that there are some car users that can be persuaded towards using MaaS to commute. Nevertheless, this is a small percentage (30% within a group that is only 6% of the total).

7.3.4. Comparison to other research

MaaS is researched throughout the literature, and a couple of researchers explored the potential users of MaaS. These outcomes can be compared to the outcomes in this research to search for similarities.

The Netherlands Institute for Transport Policy Analysis (KiM) researched potential users for MaaS in the Netherlands. They concluded that potential first users are people with a hypermobile lifestyle. These are people who are young, from high social classes, deeply concerned about the environment who frequently use public transport (Zijlstra & Harms, 2018). In this research, group 4 and group 5 have a high intention to use MaaS for commuting trips. These groups are both environmentally conscious, which is in line with the research from KiM. The percentage of people that has a high education level (university) is also high in these two groups. Age is not a significant factor in this research, so nothing can be said about that. Another research examined the drivers and barriers to adopting MaaS (Alonso-González et al., 2020). The most considerable conclusion from this research, which is also in line with this research, is that individuals with the highest inclination to use MaaS are individuals who have multi-modal mobility patterns. Individuals who never travel in a multi-modal way are not likely to adopt MaaS. The two groups with a high intention to use in this research often or always travel with more than on mode per trip, so they are quite multi-modal. The two groups with the lowest intention to use MaaS rarely travel with more than one mode per trip.

De Viet (2019) researched the effect of monthly MaaS bundles on travel behaviour change in the Netherlands and his main conclusion was that car users have little interest in using MaaS. This research is in line with the research from De Viet (2019), as the groups with no intention to use MaaS are very positive about the car. The variable that accounts car ownership is not significant in this research, but examining the groups, the car-oriented travellers are mostly represented in the groups with no intention to use MaaS to commute.

It must be mentioned that these researchers all focused on using MaaS in general, and this research focuses on using MaaS to commute. The difference between those two is mostly that commuting trips are trips that people make every day, which can be different from occasional trips. Nevertheless, the characteristics that are identified as factors related to people with interest correspond to the factors related to high intention to use in this research. These factors are multi-modality, education level and the degree of environmental consciousness. This research also emphasises the degree of car affection as a factor that is related to the intention to use MaaS to commute.

7.3.5. Conclusion

This section researched the characteristics of employees that have a high or low intention to use MaaS to commute. Latent class clustering is used to divide the sample into groups based on the attitude towards and intention to use MaaS for commuting trips. The following research questions are answered in this section: ”What is the relation between belonging to a particular employee group, with different intentions to use MaaS to commute, and characteristics of those employees?” and ”Which type(s) of employees show a substantial difference in intention to use MaaS to commute when they receive reimbursement from their employer?”

The intention to use MaaS in the current situation is low. 40% of the respondents of the questionnaire have no interest in using MaaS. These individuals can mainly be characterised as people who (almost) never use more than one mode per trip and thus are not multi-modal. Furthermore, the environmental consciousness is lower than the individuals with interest. 22% has interest to use MaaS to commute, and this group is divided into interested and very interested individuals. The interested individuals have a low car affection, and the extremely interested individuals are environmentally conscious and often or always travel in a multi-modal way. A large part of the employees does not know what they will do (31%). These people are more susceptible to influence than people with a strong opinion already.

This section showed that, overall, individuals are slightly more interested in using MaaS when their employer starts financing it. The groups that do not have a strong opinion yet have a higher increase in intention to use than individuals that do have a strong opinion already. There is one group in particular who switches from not interested to interested when the employer starts financing it (6%). This group is highly educated but remarkably is not so multi-modal. Noticeably is that there are also some car-oriented travellers in this group.

8

Conclusions, recommendations and discussion

The previous chapter presented the results and answered the accompanied research questions. This chapter is the final chapter and presents the conclusions, followed by recommendations for further research, practice, and policy. Finally, the discussion on the performed research is provided.

8.1. Conclusion

This section presents the conclusions. The main research question is answered in the first section. The second section reviews the research conclusions and provides a conclusion in a broader context.

8.1.1. Research conclusion

The main research question in this research is: ”What is the potential for the use of MaaS for commuting trips by employees?”. The previous chapter answered the sub research questions and thereby provided the information to answer this main research question.

In the current situation, there is low intrinsic interest. In general, 21% of the total respondents of the questionnaire showed interest in using MaaS to commute. Exploring this interest in more depth shows that there are differences among employees regarding their modality style. Especially the car-oriented employees show an extremely low intention to use MaaS to commute, only 9% of the total of car-oriented employees show interest. The multi-modal travelling employees and lease car users showed a lot more interest, 27%, and 31% has the intention to use MaaS for commuting trips.

When presenting an incentive to the employees in the form of a reimbursement for MaaS from employers, the interest increases. However, the increase is not substantial. In general, the intention to use MaaS to commute increases from 21% to 29% of the total in the situation where employers finance the use of MaaS to commute. The multi-modal travellers and the lease car users show an increase of 12% points and 8% points. The car-oriented travellers are not impressed by the reimbursement from the employer, the intention to use only increases with 3% points. The small increase in interest from especially car-users is confirmed by the fact that 66% of the employees who commute by car are willing to pay for their own commuting car costs when their employers stop financing this and only finance MaaS. Overall, stimulating the interest in MaaS by receiving finances from the employer seems to have a limited effect.

The employees with interest in using MaaS to commute are environmentally conscious, have a low car affection and travel in a multi-modal way already. These characteristics correspond with the general characteristics of public transport users. This insight confirms that MaaS likely has higher potential in cities compared to villages and rural areas. Since, in cities, the part of employees that travels with public transport to their work is higher than for employees throughout the Netherlands in general. It can be assumed that when MaaS is implemented, only the individuals that already use public transport and travel in a multi-modal way will use the MaaS application and thereby perform the same behaviour. The MaaS application can be valuable for these users. However, contrary to how researchers and policymakers currently present MaaS, it is not likely that the MaaS concept will contribute to the big promises; MaaS being the solution to societal and environmental goals.

Taking everything into consideration, the small number of employees that show interest in using MaaS to commute indicates that the potential for the use of MaaS for commuting trips from the perspective of the employees is low.

This does not mean that there are no prospects, or that there is no potential at all. The MaaS platform is probably a pleasant addition for travellers because it provides an easy and clear way of booking and paying for a door-to-door trip. Furthermore, it provides new travel options when there is a disruption, which is a substantial benefit compared to the current situation. Six per cent of the employees indicated that they would definitely use MaaS for commuting trips when it comes widely available. This is already a start. When these users are satisfied with their experience with MaaS, they might trigger others to use MaaS and possibly change their travel behaviour. This might lead to, for example, an increase of multi-modal travelling or an increase in the use of shared modalities in the long run. Nevertheless, it is most likely that the first users are people who already travel in a multi-modal way. The change in behaviour will then be limited. The benefits of MaaS that literature states and policymakers discuss are probably overestimated.

8.1.2. Conclusion for the broader context

Researchers and policymakers present MaaS repeatedly as a solution to societal and environmental problems such as environmental pollution and full cities. This research contributes to neutralising the thoughts, and sometimes hope, that MaaS will solve these kinds of problems by researching the potential for MaaS from the users' side. Although the focus in this research is on MaaS for commuting trips, some results can be broadened. This section presents the two main broader conclusions that can be drawn.

The first one is the fact that the results of this research indicate that the user perspective of MaaS is currently underexposed. At the moment, researchers and policymakers mainly focus on the potential of MaaS to contribute to all sorts of problems. This creates a promising picture. However, to make an innovation a success; focus on the end-users is essential. Logically, without users, there is no successful innovation, and the complementary goals that are mentioned throughout literature can not be met. This research showed that the intrinsic interest among potential users to use MaaS is low. It is expected that the currently drawn promising picture of MaaS is unrealistic. This may foster false hope which can lead to disappointments.

Secondly, the success of MaaS depends on the initial goals that policymakers set. As mentioned above, if the goal is to provide a convenient platform where one can book and pay for a door-to-door trip, MaaS can be a sufficient option. However, in the current literature and communication of policymakers, MaaS is presented as the Holy Grail: a solution to many societal and environmental problems. For example, a solution for lower car dependency, more space in cities, more evenly spread travellers throughout the day, and so on. To reach such goals, a switch in behaviour is necessary. For example, individuals need to have interest in shared vehicles, need to have an open attitude towards flexibility instead of the certainty that ownership offers and car users need to be willing to switch to more environmental friendly modalities. This research implies the opposite. When implementing MaaS, there might be a small increase in multi-modal travelling and the use of shared cars. This increase is prob-

ably caused by people who are already travelling in such a way. Car users need more than just the implementation of MaaS to change their mode use. Even a monetary incentive is not enough to arouse substantial interest from car users. If money is not a sufficient stimulus, the question arises whether there is anything that would increase the interest of car users in MaaS? The immense contribution of MaaS to ongoing problems that literature and policymakers suggest seems to be overestimated.

Concluding, MaaS does not appear to be the Holy Grail that it may seem like according to the information that is currently presented. The potential user interest is underexposed, and researchers and policymakers are probably overestimating the stated contribution of MaaS to all the mentioned problems. A realistic impression of the potential of MaaS lacks.

Nevertheless, this does not imply that the MaaS concept should be discarded. There are potential users for MaaS and MaaS is probably a pleasant addition to the current options for travelling in a multi-modal way. Although the interest seems low, small changes in mode choice can achieve, for example, less congestion or a bit more space in cities, which is already an accomplishment. Furthermore, satisfied users than might inspire people around them and MaaS might become more popular over the years. This is already a step in the right direction, and in the long term, MaaS can potentially contribute to the promises many researchers make. For now, it is important to present MaaS in a more realistic way instead of the Holy Grail.

8.2. Recommendations

This section elaborates on the recommendations for policy, practice and further research. First, the recommendations for policy are presented. The policy recommendations build further on the previously mentioned conclusion for the broader context. Secondly, recommendation for employers are presented and the last section focuses on opportunities for further research.

8.2.1. Recommendations for policy

Complementary to the conclusions for the broader context, the advice for policymakers is to present and review MaaS in a realistic way to prevent disappointments. This research emphasised the fact that there are different travellers. Some travellers already show interest in MaaS, and some do not. It is important for policymakers to acknowledge different travellers. This will help in realistically exploring the potential of MaaS and makes it possible to target particular travellers.

At the moment, it is expected that the first users are already travelling in a multi-modal way and, therefore, will not change their travel behaviour substantially. The operationalisation of MaaS is pleasant for these users. However, to contribute to the promises accompanied by MaaS, behavioural change is needed. For car users a lot more is needed to change their mode choice. Perhaps, enthusiastic first users might help in opening up the attitude of the car users, which potentially leads to changing behaviour and therefore, a contribution to the societal and environmental problems. However, it is expected that this is something for the long term. If policymakers want to persuade uninterested people to make use of MaaS to contribute to the societal and environmental problems. It might be an option to demotivate car use by measures as higher costs for car users in the form of, for example, charging per kilometre or increase the costs for parking spots. Demotivating car use might result in a more open attitude for other travelling options.

Furthermore, this research showed that lease car users show more interest in using MaaS to commute than individuals who travel to work by their own car. Therefore, if policymakers want to stimulate MaaS, or destimulate car use in general, it is an option to address the provision of lease cars by companies. These individuals seem to be more open to travelling in a multi-modal way instead of only using the car. So, if the lease car is not an option for these people anymore, it is the right timing to stimulate different ways of travelling.

Following this, the MaaS pilots of the Ministry of Infrastructure and Water Management are important to explore and learn more about MaaS and the related travel behaviour. This is useful because these pilots give information about actual behaviour instead of all the speculations that are done at the moment. By continually evaluating the data, it can be checked whether particular measures have the desired effect on travel behaviour. If not, the measures can be adjusted to see whether other measures indeed accomplish the wanted effects. Such a measure is the reimbursement from employers for particular modes as this research indicates that this influences the intention to use MaaS a bit. Furthermore, the characteristics of the interested, and not interested people can be reviewed to be able to target particular groups more efficiently. Besides, there might be a group between the interested and not interested individuals that can be persuaded. The pilots might reveal this group and make it possible to explore what measures might persuade them. It is essential to attract car users in the pilot and to continually check whether the individuals change their behaviour since only changing behaviour will help to solve the societal and environmental problems.

For exploring and identifying different kind of travellers, it might be useful to analyse the data of the pilots with latent class cluster analysis (LCCA). Since the pilots provide data about actual travel behaviour, reliable data is generalised. Performing LCCA provides a better understanding of behaviour and makes it possible to design tailor-made policies suited to the specific preferences of various identified groups.

The last recommendation for policymakers is to introduce the concept of MaaS to more people as this is a difference between people with and without interest to use MaaS to commute. In general, the knowledge of MaaS before participating in this research is low, only 12%. Additionally, this low percentage might be overestimated because of the over-representation of highly educated people in this research. Employees with interest show a substantially higher percentage of beforehand knowledge than the employees without interest, an average of 25% compared to 8%. Moreover, this research concluded that many people do not know what they will do or do not have an opinion about using MaaS to commute yet. It is assumable that people are more hesitant or reluctant about innovations when hearing about it for the first time. This can be seen as an opportunity as this means that people still need to create an idea about MaaS. The way of advertising or sharing information about MaaS influences the way people think about it. There might be opportunities to steer the thoughts of individuals about MaaS according to the little current knowledge. Nevertheless, it must be well considered how to present MaaS to the public.

8.2.2. Recommendations for practice

To contribute to the goals that are mentioned to be associated with MaaS, behavioural change is needed. So, for example, the interest of employees who currently commute by car is needed. This research indicates that financing MaaS, or even stopping with financing car use, is not a sufficient measure to increase the interest of car using employees in MaaS to eventually let MaaS contribute to problems related to the high car dependency regarding commuting trips. However, it seems, also from desk research and literature research, that employers do affect the way their employees' commute. The effects of monetary incentives might be small, but it is already a step in the right direction if employers let their employees think about the way they commute. They do not have to steer extremely, but a bit of attention might already be beneficial. Some employees might use more environmentally modes more often which decreases the CO2 footprint of the company and may also boost the image.

8.2.3. Recommendations for further research

The spectrum of researching MaaS is complex. This research explored a piece of the whole spectrum. The aspects that are excluded in this research can be seen as opportunities for further research.

Since this research focused on commuting trips and not on MaaS in general, it is not possible to compare the potential for commuting trips to the total potential for MaaS or to other travel motives. Some researchers express their thoughts that MaaS has potential for leisure trips.

The potential of MaaS could be higher for these kinds of trips because of the occasional nature of the trips. Furthermore there might be potential here because these purposes also account for many trips per year. An average inhabitant of the Netherlands makes 160 trips a year to commute, and also 163 trips are made to travel to sports, hobbies or restaurants and 110 trips to visits. It is useful to perform research that explores the interest in MaaS in general and thereby differentiates between reasons to travel. It is essential that this is done from the viewpoint of the end-users. In that way, the potential of, for example, MaaS for commuting can be compared to, for example, using MaaS for leisure trips.

This research explored two measures, financing MaaS to commute and financing MaaS to commute while not financing car use any more. Further research can look into other measures to see whether the intention to use MaaS to commute can be increased. It is then important to focus on car users since a behavioural change is needed. However, it is likely that car users can not easily be persuaded to use MaaS. Since MaaS is not the only way to address environmental issues related to car use, it is relevant to explore other options to seduce car users to make different choices concerning mode choice. For example, by providing a bonus for employees who commute in a relatively sustainable way.

Next to the user' side aspects mentioned in this research, many organisational related questions remain. Research is needed on how to get MaaS operational. Two MaaS pilots could not be implemented as working systems after the pilot phase as there was no sufficient plan to keep it going. Besides, information is needed on the organisation of a MaaS application. For example, how should such an application look like? How do you get all different stakeholders involved and aligned? How to make MaaS profitable? Who should take the lead in upscaling this innovation? As mentioned before there are still many uncertainties, ambiguities and knowledge questions related to MaaS.

8.3. Discussion

This section discusses the performed research from multiple sides. At first, several implications concerning researching MaaS are discussed. Afterwards, a comparison is made to other research and at last, limitations are mentioned.

8.3.1. Difficulties concerning researching MaaS

The whole spectrum around MaaS is complex. By exploring the potential of MaaS for commuting trips, this research only explores a small piece of the MaaS spectrum. Other pieces are, for example, privacy, safety, the organisation of the governance of MaaS, the fact that multiple stakeholders that need to come together to be able to make a working MaaS application and so on. This emphasizes that a lot of information needs to be figured out before the whole picture of MaaS is clear.

MaaS is a hot topic in the scientific world. Some researchers see MaaS as a world-changing concept. Other researchers find the hype around MaaS overestimated and try to emphasise the difficulties around MaaS. Since MaaS is such a hot topic, a difficulty in researching MaaS is that new research is continuously published. It is not possible to keep track of every published article, but it is essential not to get behind the facts.

A difficulty that every researcher that explores MaaS faces is the definition of MaaS. MaaS is not yet a solid concept, and every researcher chooses their definition. This research explored the definitions mentioned by different researchers and picked pieces to come to the best definition for the context of this research. Another difficulty is the fact that MaaS is not a tangible product but an online service. This makes it sometimes difficult to envision MaaS, for both the respondents and the researcher.

Researching commuting trips comes with the implication that commuting can be a form of a habit. There is no data available on which share of employees work at the same location every day and which part travels for work. However, it is assumable that people who need to go to the same location every day have optimised their trip already. This optimisation can play a role in the interest in MaaS since people might not see the benefits of MaaS and therefore do

not show interest and keep travelling in the same way. It is assumable that something (way) better than their current option is needed to persuade them. For people who do not have the same work location every day, or change every week, or month, MaaS might be a solution since it is possible to change the mode per trip destination.

8.3.2. Comparison to other research

There is one other research that explored the potential of MaaS for commuting trips by conducting data through a survey and a focus group in Finland (Haahtela & Viitamo, 2017). The research of Haahtela & Viitamo (2017) explored this potential by conducting information on commuting travel behaviour and its determinants. The participants from the focus group saw possibilities for MaaS, being an application that integrates every possible mode of transport, gives real-time information and makes it possible to buy a ticket for a door-to-door trip. Furthermore, the fact that MaaS provides new options in case of a delay was mentioned as a benefit compared to the current situation. This is in line with this research, as this was mentioned in the group discussion as a potential benefit.
However, the results also from the research of Haahtela & Viitamo (2017) also showed that most commuters are highly contented with their current commuting mode. Despite the opportunities that they mention, they do not see a substantial added value of MaaS compared to their current commuting mode. This research did not go into depth about the current thoughts of employees about their mode but since the results from this research show that employees are not willing to switch to MaaS easily there are signs that respondents of this research are also satisfied with their current commuting mode.

Furthermore, other research also expressed the expectation and fear that MaaS only attracts people that are already travelling multi-modal and not current car users (De Viet, 2019). This research confirms this. The consequence of this is that the potential of MaaS is likely to be overestimated. Besides, car use might not decrease but instead increase since people who currently not use a car have easy access to a car with MaaS. This can be counteracted by, for example giving discounts when one uses more environmentally friendlier modes. It must be mentioned that there is no proof yet that such measures will have the wanted effect.

At last, research from The Netherlands Institute for Transport Policy Analysis (KiM) concluded that first potential users of MaaS are young, from high social classes, deeply concerned about the environment, fly multiple times a year and frequently use public transport. The results of this research are partial in line with the research from KiM as the employees that are environmental consciousness, already travel multi-modal and know a low car affection show interest in using MaaS to commute and therefore can be seen as first potential users. This research can not be compared one on one with the research from KiM because the first potential users mentioned by KiM most probably do not work and this research only focused on the working population in the Netherlands.

8.3.3. Limitations

This section discusses four categories of limitations.

Limitations concerning questionnaire design and content

The researcher self-designed the questionnaire that is used to gather the data. Although multiple other individuals, with and without transport knowledge, reviewed the questionnaire, it might be that the questionnaire is not as optimal as possible. Furthermore, trade-offs were made in what to include and what not, since the questionnaire can not be too long for respondents. So, only factors that assumed to be most relevant for the context of this research were included. Including other personal characteristics would result in a different questionnaire. This might given more detailed information on what kind of individuals are interested in using MaaS, but it would not have affected the main conclusions.

Furthermore, some aspects are difficult to include in the questionnaire, and the way of doing this might affect the results. First of all, the way of presenting MaaS to the respondents. In this research, this is done through a video and a summary of the video. Showing another

video or another text might resulted in a different view on MaaS by the respondents. To prevent this, the video and the text was reviewed by different people. However, it might be that some respondents did not understand MaaS as well as desired. This potentially results in less reliable results than when every respondent had the same clear view of MaaS. This is unavoidable when doing online research on an innovation. Since this research is exploratory, it is not seen as a big problem.

Additionally, perceptions are measured in this research by presenting statements to the respondents. Analysing these perceptions pointed out that people mostly agree with all the presented statements. This is remarkable since some statements were presented in a reversed way to challenge the respondents to think consciously about the statements. It might be that if a statement where respondents in this research agree with, was formulated negatively, people again agreed with it. The high percentages of agreeing to the statements might suggest that respondents just clicked on the same answer with every question. This makes the conclusions about the statements and therefore, the perception of employees about MaaS less reliable.

The intention to use was asked on a five-point scale. The answer options ”probably do” and ”definitely do” were summarised as ”yes” on the scale if the respondents have the intention to use MaaS or not (yes or no). It was a possibility to only identify the ”definitely do” answer option as ”yes” because these people know for sure that they will use it. This might give a more accurate prediction of the potential use of MaaS. This, together with the fact that this research measures a prediction of actual, indicates that the intention to use MaaS to commute might be lower in reality then identified in this research. Because of the exploratory nature of this research and the fact that the interest is already low, this is not seen as a problem. Consequently, this makes the pilots from the Ministry of Infrastructure and Water Management extra valuable since the pilots can research actual behaviour.

Limitations concerning data gathering

The data is gathered through the online panel, PanelClix. Using an online panel knows two main disadvantages. The first disadvantage is the degree of self-selection; people might participate in questionnaires that they find most interesting. This is undesirable because one does not get a complete representation of the whole population. The self-selection in this research seems to be minimal since there is a low percentage of people that heard of MaaS before participating in this research, only 12%. The second disadvantage of an online panel is that the participants receive money for participating in the questionnaire. This might attract particular individuals. Since this research is exploratory and does not focus on specific costs, using an online panel for this context is not seen a problem.

Another limitation concerning data gathering is the minimum time for executing the questionnaire. Participants who executed the questionnaire in less than 4 minutes were excluded from the data used in this research. The minimum of 4 minutes is based on testing the fastest way of executing the questionnaire. This means that the data includes participants who executed the questionnaire in 5 or 6 minutes. Participants who executed it in such a short time did probably not watch the video that explains MaaS, which has a duration of 2.5 minutes and therefore only read the summary about MaaS. This may caused that participants did not precisely understood the MaaS concept but did proceed with the questionnaire. The effect of this on the results is unknown. On the one hand, those people might be less enthusiastic about using MaaS because they do not fully understand what it can bring for them. However, on the other hand, the interest can be higher because they, for example, are more hesitant when they would fully understand it.

Limitations concerning the sample characteristics

Comparing the sample in this research to the working population in the Netherlands shows that individuals with a high education level are overestimated in this research. This may account for an overestimation of the intention to use MaaS since people with a high education level are more likely to adopt, for example, shared vehicles than people with a lower education

level (Fishman, 2016; Le Vine & Polak, 2019). Moreover, examining the main commuting modes showed that the sample in this research knows an overrepresentation of people using public transport to commute. People who travel in a multi-modal way have a higher intention to use MaaS to commute. This also probably caused an overestimation of the intention to use MaaS to commute in this research. So, the intention to use MaaS to commute might be lower among the whole working population in the Netherlands. This is not seen a problem for the main conclusions of this research because the conclusion is that the intention is low already. Furthermore, this research is exploratory. The results predict an indication and not actual behaviour.

The sample in this research also knows an underrepresentation of young people (18 to 24 years old) and an overrepresentation of people who are 55 years old or older. Since age is not related to the primary goal variable in this research, the intention to use, this also does not affect the conclusions.

Limitations concerning the methodology

This research performed a latent class cluster analysis (LCCA) to divide the sample into groups. Performing the questionnaire resulted in 269 respondents and by using this analysing technique, the sample is divided into smaller groups. Since the sample is divided into six groups in the second LCCA, the groups are rather small, with a range of 16 to 83 respondents per group. This decreases the reliability of the results and capability to generalise the conclusions to the population. However, for the same reason as above (the exploratory nature of this research) this is not seen as a problem for the overall conclusions.

Additionally, LCCA makes it possible to base the number of clusters on a statistical test. However, the degree of interpretation of the clusters stays essential. This also applies to the performed factor analysis, where the researcher plays a significant role in choosing the factors. Both choices bring subjectivity to the research. However, since the outcomes are discussed with several other researchers, it is not expected that another researcher would have chosen very different clusters/factors, so it is assumed not to be a problem.

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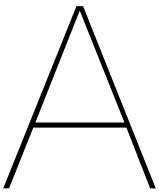

Scientific paper

Employees' intention to use MaaS for commuting trips; identifying groups of Dutch employees with latent class cluster analysis

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Abstract

The promises of Mobility-as-a-Service (MaaS) are generous, researchers and policymakers repeatedly present MaaS as a Holy Grail. MaaS has the potential to play a role in addressing issues as pollution, congestion and crowded cities. However, without interested users, these promises cannot be fulfilled. This study explores whether the proposed expectations are realistic by examining the interest of potential users in MaaS. The focus is on employees in the Netherlands. Commuting trips might make an interesting first market for MaaS since there are possibilities to increase the interest of employees by financing commuting MaaS trips by employers. A latent class cluster analysis is performed to identify groups of employees based on the attitude towards and the intention to use MaaS for commuting trips. The results indicate that the majority of employees are not interested in using MaaS to commute. An increase in interest is seen when employers finance MaaS. However, this increase is not substantial. The interested groups of employees are individuals with high environmental consciousness and low car affection which often travel in a multi-modal way. This study concludes that the benefits of MaaS that are proposed by researchers and policymakers are overestimated. However, this does not imply that the MaaS concept should be discarded. Recommendations for policymakers are provided at the end of this paper.

Keywords: Mobility as a Service, latent class cluster analysis, factor analysis, commuting mode choice, promises of MaaS

1.Introduction

Inhabitants of the Netherlands travel on average more than ten thousand kilometres in their own country annually. The most substantial part of the total travelled kilometres, 30%, is to commute [1]. Among the commuting trips, car dependency is high. Almost 60% of the employees in the Netherlands commute by car. This causes issues like congestion, pollution and crowded cities. A recent innovation, Mobility as a Service (MaaS), has the potential to play a role in decreasing car dependency and therefore, might positively influence the aforementioned problems.

MaaS "is a transport concept that integrates existing and new mobility services into one single digital platform. MaaS provides customised door-to-door transport and offers personalised trip planning and payment options" [2]. Multiple researchers agree that MaaS has the potential to address the growing need for more sustainable mobility [3]. Easy access to different transport modes might positively influence travel behaviour in the form of new attitudes regarding (shared) modalities and an increase in travelling via a multi-modal way [4,5]. This can lead to decreasing car dependency and more efficient use of space [6]. Moreover, it is expected that MaaS makes it possible to steer travel behaviour in the form of, for example, discounts for environmentally friendly modes or discounts when travelling outside rush hours. Consequently, travellers will be more spread throughout the day, which benefits congestion.

Existing literature mostly focuses on the above-mentioned enormous promises of MaaS. However, to make an innovation a success; attention for the end-user is of great importance. Currently, Information about the thoughts and interest of potential end-users for MaaS lacks [7]. This research focuses on the interest of end-users, which are in this case, employees, to use MaaS for commuting trips. The aim of this research is to explore whether the promises of MaaS are realistic by examining the interest of potential end-users.

This study focuses on MaaS for commuting trips since there is a lot to gain as the car dependency is high.

To change modality preferences, one needs more than hype [8]. The commuting mode choice is generally based on habits. Therefore it is expected that employees are not easily going to change their commuting mode [9]. Since employers might have the power to change the mode choices of their employees by financing particular commuting modes. This research also explores the relation between the finances of employers and the interest of employees to use MaaS to commute.

Latent class cluster analysis (LCCA) is applied to identify groups of employees that are or are not interested in using MaaS to travel to and from work. LCCA is a probabilistic clustering method which aims at finding similar groups based on observed characteristics [10].

The remainder of this paper is structured as follows. First, theories and literature which are important for the design of the questionnaire are addressed. Afterwards, information about the data sample will be given, and the methodology will be explained. The following section presents the results and describes the identified groups in detail. The final section provides a discussion on the results and elaborates, among other topics, on the interest of employees to use MaaS for commuting trips.

2. Methodology

2.1 Theory and designing the questionnaire

There were two theories used to the design the questionnaire, the main data gathering method in this study. The first theory is the theory of planned behaviour, which argues that intention to use is the determinant for actual behaviour. When the intention to perform specific behaviour is measured in an appropriate way, it provides a prediction for actual behaviour. This intention to use is determined by attitude, subjective norm and perceived behavioural control [11]. So, generally, people intend to perform specific behaviour if they have a positive feeling/attitude towards the behaviour (attitude), when they feel social pressure (subjective norm) and when they believe that they have the opportunity to perform the behaviour (perceived behavioural control). This theory indicates that the interest of employees can be measured by asking for the intention to use MaaS for commuting trips. The attitude is also taken into account as this is identified as a predictor of the intention to use. The subjective norm and the perceived behavioural control are not included in this study because it is expected that few people have heard of MaaS since it is still in a preliminary phase.

Second, Verplanken at al. researched habits and hypothesises that when the environment or the context of an individual change, it is more likely that travel behaviour changes compared to a constant context [12]. An example of such a changing context is the relocation of home or work. This disruption of the context breaks the habit. Therefore, individuals are more likely to reconsider their way of travelling. The changing context offers an opportunity. This is relevant because commuting can be a habit for employees. Therefore, an incentive (changing environment/context) is presented to the respondents of the questionnaire to see if the intention to use MaaS for commuting trips increases. This incentive revolves around the fact that people are influenced by monetary incentives. Research into commuting mode choice showed that getting reimbursement for a mode to commute increases the probability that that mode will be used [13]. So, a scenario is presented to the respondents of the questionnaire that states that the employer will finance commuting with MaaS. It is expected that this will influence the intention to use positively.

2.2 Data collection and sample

269 valid responses were gathered from the panel, PanelClix. The respondents are all working and living in the Netherlands. The distribution of the sample characteristics is fairly similar to the distribution of the working population in the Netherlands. Furthermore, it is not expected that there was any self-selection in participating in the questionnaire. So, the sample represents the working population in the Netherlands enough to generalise the conclusions of this study.

2.3 Operationalisation

Four groups of background factors that might influence the intention to use were included in the questionnaire. Firstly, the socio-demographic factors: age, gender, education level, household type, household income, smartphone availability and neighbourhood type. Secondly, the mode related factors: car ownership, use of a lease car, current mode use, mode travel experience and multi-modal travel experience. Thirdly, the work related factors: travel for work outside commuting, environmental concern employer, work location

type, financing from the employer and work hours per week. Fourthly, the individual values: environmental consciousness, car affection and attitude towards public transport. The individual values were measured by presenting multiple statements and performing factor analysis on these statements. Principal axis factoring with Varimax rotation was chosen. Two factors were identified in this analysis. The first factor includes statements about the attitude regarding private car use; this factor is called 'Pro-car'. The second factor includes statements concerning the environment; this factor can be summarised as 'Environmental consciousness'. Both factors are included in further research to measure the environmental consciousness and the degree of car affection (pro-car) of employees.

The attitude was asked by presenting the following statement: "I find MaaS an attractive option for travelling to work". There were five answer options possible, being totally disagree, disagree, do not agree/do not disagree, agree, and totally agree. The intention to use MaaS was asked by presenting the following question: "To what extent do you expect to use MaaS to travel to work?" The answer options go from 'I will definitely not do that' to 'I will definitely do that'.

2.4 Latent class cluster analysis

With LCCA, an unknown latent variable X accounts for the associations between the observed indicators so that the associations between indicators become insignificant [14]. In this way, LCCA maximises homogeneity within clusters and heterogeneity between clusters [15]. The software package LatentGold 5.1 is used to perform the analysis.

An exploratory latent class analysis was performed in this study since the number of classes was unknown upfront. When estimating this model, the appropriate number of clusters must be chosen based on the Bayesian Information Criterion (BIC). This criterion has shown the best performance to measure both parsimony and model fit compared to other measures [16]. The lower the BIC value, the more parsimonious the model is for the particular data [17].

When executing an LCCA, two models are estimated; the measurement model and the structural model. The measurement model is estimated first and only includes the indicators. Based on this model, the appropriate number of clusters was chosen. The indicators in this study were the attitude towards, the intention to use MaaS for commuting trips in the current situation and the situation where the employers start financing MaaS. Subsequently, all background factors were added to the model as covariates to predict class membership. This is called the structural model. To obtain a parsimony model, the insignificant factors were deleted using backwards deletion. This deletion was based on the Wald scores of the covariates, which indicated whether the means and probabilities between clusters are, or are not, significant [18]. The background factor with the lowest Wald score was deleted first. This resulted in a latent class cluster model with six covariates: education level, smartphone possession, multi-modal travelling, lease car possession, factor pro-car and factor environmentally consciousness.

3. Results

3.1 The latent class cluster model

The measurement model was estimated for a range between one and eight clusters to determine the optimal number of clusters. Table 1 presents the model fit statistics. The BIC criterion is the lowest for the model with six clusters. So, this model was selected as the most optimal [19].

Table 1: Model fit statistics

No. of clusters	No. of parameters	Log-likelihood	BIC
1	16	-1563.5	3216.5
2	21	-1292.2	2701.8
3	26	-1155.6	2456.7
4	31	-1101.9	2377.2
5	36	-1067.7	2336.9
6	**41**	**-1050.5**	**2330.3**
7	46	-1040.7	2338.7
8	51	-1026.1	8 2337.5

The structural model was added to predict class membership. To assess how well the model can predict class membership based on the covariates, the standard R-squared measure can be reviewed [20]. This measure yielded a value of 0.89 in this study, indicating that the variability in class membership is mostly explained by the included covariates.

3.2 Six identified employee groups

Table 2 present the distribution of the indicators and covariates among the six clusters. The top row presents the cluster sizes. The labels of the clusters were identified based on the distribution of the indicators. Furthermore, the distribution of the covariates were explored to describe the six clusters.

Cluster 1 – Neutral employees (31%). The largest group consists mostly of individuals that did not know what they would do, or, were neutral about what they thought of the idea of using MaaS for commuting trips. There was a small shift to a less negative attitude and a low intention to use MaaS when the employers would finance MaaS. This group was the most average group regarding the background characteristics; there were no outstanding characteristics in this group compared to the other groups.

Cluster 2 – Uninterested employees (21%). Most individuals in this second largest group disagreed with the attitude statements and had a low intention to use MaaS for commuting trips. Remarkably, the attitude and intention to use did not change comparing scenario zero to scenario one. So, the individuals in this group were not sensitive to the change that the employer starts financing MaaS. This group scored relatively low on the factor that measured environmental consciousness and high on the factor that represented a pro car attitude. Besides, most individuals never travel multi-modal in one trip.

Cluster 3 – Very uninterested employees (19%). This was the most extreme group. These respondents were pessimistic about MaaS and had no interest in using MaaS for commuting at all. There was a small difference between scenario zero and the first scenario since some individuals changed to 'probably not do it' instead of 'definitely not do it'. However, the most substantial part remained not interest at all. Almost no employee in this group travels multi-modal. Besides, this group scored extremely low on the factor that measured the environmental consciousness and high on the factor that measured car affection. This group showed the highest percentage of individuals who did not own a smartphone with an internet connection.

Cluster 4 – Interested employees (16%). The fourth-largest group represented individuals that were interested in using MaaS for commuting trips. There was a clear difference between scenario zero and scenario one noticeable. In scenario zero, there was a group that did not know what they would do, and in scenario one, this group was almost not existing. All the employees in this group were probably going to use MaaS to commute or even definitely. This were individuals who already travel multi-modal sometimes. Besides, employees in this group scored low on the factor that measures car affection. Furthermore, the individuals in this group were positive about MaaS.

Cluster 5 – Very interested employees (6%). Most individuals in this group would definitely use MaaS to commute; the other respondents would probably do this. Although some individuals switched from probably to definitely in scenario one, there were not many. The intention was high already, and this group was not so sensible for the finances of the employer. The extremely interested employees were environmentally conscious and had a low score for the factor that measures car affection. Most of the individuals in this group did not use a lease car, but, compared to the other groups, the lease car percentage was high. Also, the multi-modal character of the individuals in this group stands out.

Cluster 6 – Playable employees (6%). This group was compassionate for the change that scenario one brings. In the current situation, individuals did not know what they would do or are probably not going to use MaaS to commute. When the employer starts financing MaaS, almost everyone would probably use MaaS to commute. Thus, this group is, as the only group, susceptible to the finances from their employers. This group was highly educated compared to the other groups and had a low average score on the factor that measures car affection. Remarkably, this group was not extremely multi-modal oriented, and the lease car use was extremely low compared to the other groups. Furthermore, environmental consciousness was high but not extremely high.

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Table 2: Distribution of indicators and covariates among the identified clusters

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6
Cluster size	31%	21%	19%	16%	6%	6%
Indicators						
Attitude scenario 0						
▪ Totally disagree	0%	7%	**58%**	0%	0%	1%
▪ Disagree	18%	**59%**	40%	0%	0%	32%
▪ Not agree, not disagree	**64%**	33%	2%	2%	0%	**59%**
▪ Agree	17%	1%	0%	**92%**	14%	8%
▪ Totally agree	0%	0%	0%	6%	**86%**	0%
Intention to use scenario 0						
▪ Totally disagree	0%	24%	**93%**	0%	0%	1%
▪ Disagree	32%	**69%**	7%	0%	0%	40%
▪ Not agree, not disagree	**59%**	7%	0%	30%	0%	**53%**
▪ Agree	8%	0%	0%	**67%**	25%	5%
▪ Totally agree	0%	0%	0%	3%	**75%**	0%
Attitude scenario 1						
▪ Totally disagree	0%	4%	**63%**	0%	0%	0%
▪ Disagree	8%	**64%**	36%	0%	0%	0%
▪ Not agree, not disagree	**73%**	32%	0%	1%	0%	2%
▪ Agree	20%	0%	0%	**87%**	21%	**91%**
▪ Totally agree	0%	0%	0%	12%	**79%**	7%
Intention to use scenario 1						
▪ Totally disagree	0%	7%	**97%**	0%	0%	0%
▪ Disagree	10%	**80%**	3%	0%	0%	0%
▪ Not agree, not disagree	**85%**	13%	0%	10%	0%	5%
▪ Agree	5%	0%	0%	**83%**	31%	**81%**
▪ Totally agree	0%	0%	0%	7%	**69%**	13%
Covariates						
Education level						
▪ Highschool	10%	8%	23%	16%	24%	0%
▪ MBO	**42%**	33%	29%	12%	12%	11%
▪ HBO	34%	**47%**	**36%**	**39%**	30%	**75%**
▪ WO	12%	12%	10%	34%	**35%**	14%
▪ No answer	2%	0%	1%	0%	0%	0%
Smartphone possession						
▪ Yes	**95%**	**98%**	**86%**	**95%**	**83%**	**100%**
▪ No	5%	2%	12%	3%	5%	0%
▪ No answer	0%	0%	2%	2%	12%	0%
Multi-modal travelling						
▪ Almost never	**47%**	**68%**	**75%**	28%	12%	**54%**
▪ Sometimes	34%	15%	13%	**45%**	18%	25%
▪ Often or always	19%	15%	12%	27%	**70%**	20%
▪ No answer	0%	2%	0%	1%	0%	1%
Lease car ownership						
▪ Yes	16%	29%	23%	29%	41%	7%
▪ No	**78%**	**68%**	**74%**	**64%**	**59%**	**81%**
▪ No answer	6%	3%	3%	7%	0%	12%
Attitude Environmental Consciousness						
▪ Mean	3.68	3.52	3.26	4.12	4.66	4.08
Attitude Pro Car						
▪ Mean	3.52	3.79	4.08	3.25	3.50	3.25

4. Conclusion

Researchers and policymakers present MaaS repeatedly as a solution to societal and environmental problems such as environmental pollution and crowded cities. This research contributed to neutralising the thoughts, and expectations, that MaaS will solve all these problems by researching the potential for MaaS from the users' side.

This study revealed six clusters of employees with different attitudes towards and intentions to use MaaS for commuting trips. The results indicated that the intention to use MaaS in the current situation is low. 40% (cluster 2 plus cluster 3) of the respondents of the questionnaire had no interest in using MaaS. These individuals were characterised as people who (almost) never use more than one mode per trip and thus are not multi-modal. Furthermore, the environmental consciousness was lower compared to individuals with interest in MaaS. 22% (cluster 4 plus cluster 5) showed interest; this group was divided into individuals that are interested and individuals that are very interested. The interested individuals had a low car affection, and the very interested individuals were environmentally conscious individuals who often or always travel in a multi-modal way. A large part of the employees does not know what they will do (31%, cluster 1). These people were more susceptible to influence than people with an existing, strong opinion.

The changes in intention to use showed that, overall, individuals were slightly more interested in using MaaS when an employer would finance it. The groups that were indifferent had a higher increase in intention to use than individuals that did have a strong opinion. There is one group in particular that switched from not interested to interested when the employer finances MaaS (6%, cluster 6). This group was highly educated but, remarkably, not very multi-modal.

Other research substantiated the findings of this research on the characteristics of individuals with interest in using MaaS. The Dutch Institute for Transport Policy Analysis (KiM) concluded that potential first users of MaaS are people with a hypermobile lifestyle. These are young people from high social classes, deeply concerned about the environment and frequent public transport users [21]. In this study, the interested employees were environmentally conscious and already travel in a multi-modal way. The other factors were not significant; hence no conclusions can be drawn about those factors. Another research examined the drivers and barriers to adopting MaaS [22]. The conclusion from this research was that individuals who never travel in a multi-modal way are individuals that are not likely to adopt MaaS. This is in line with this study since the interested individuals often or always travel with more than on mode per trip.

It must be mentioned that the characteristics of interested employees correspond with the general characteristics of public transport users. Therefore, it can be assumed that when MaaS is implemented, only the individuals that already use public transport and already travel in a multi-modal way will use the MaaS application and thereby perform the same behaviour. The MaaS application can be valuable for these users. However, contrary to how researchers and some policymaker present MaaS at the moment, it is not likely that the MaaS concept will contribute to the big promises regarding MaaS; being the solution to societal and environmental goals in the short term.

This does not mean that there are no prospects, or there is no potential at all. The MaaS platform might be of added value for some travellers since it provides an easy and clear way of booking and paying for a door-to-door trip. Furthermore, it provides new travel options in case of unexpected disruptions, which is a substantial benefit compared to the current situation. When individuals are enthusiastic about MaaS, they might trigger others to use MaaS. This might lead to, for example, an increase in multi-modal travelling or an increase in the use of shared modalities in the long run. Nevertheless, it is most likely that the first users are people who already travel in a multi-modal way. The changing behaviour will then be limited. The benefits of MaaS that researchers and policymakers state are probably overestimated. For now, it is important to present MaaS in a more realistic way instead of the Holy Grail. For policymakers, it is recommended to acknowledge the different types of travellers. Some travellers already show interest in MaaS, the majority of travellers, however, does not. This will help in realistically exploring the potential of MaaS and enables targeting susceptible travellers.

A limitation of this study is that following from the theory of planned behaviour; the intention to perform particular behaviour predicts actual behaviour [11]. However, this intention to use is still solely a prediction. No actual behaviour is measured in this research. The actual use might be lower. Furthermore, by performing an LCCA, the sample gets divided into six, smaller groups. Since the total amount of respondents was 269, these groups are rather small, with a range of 16 to 83 respondents per group. This decreased the reliability of the results and capability to generalise the conclusions to the entire population. Nevertheless, these limitations are not seen as a problem for the main conclusions of this study, because of the exploratory nature of this study and because the intention is low already.

Further research can look into other measures to see whether the intention to use MaaS to commute can be increased. It is then important to focus on car users since a behavioural change is needed. However, likely, car users cannot easily be persuaded to use MaaS. Since MaaS is not the only way to address environmental issues related to car use, it is relevant to explore other options to seduce car users to make different choices concerning mode choice. For example, by providing a bonus for employees who commute in a relatively sustainable way.

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B

Interviews

Five interviews/conversation were held with employees from Goudappel Coffeng. The key outcomes of the interviews are stated in this appendix.

Interview with N. Juffermans

Learning points:

- Information on the successful pilot Whim in Finland.
- Personally N. Juffermans thinks that the regulations make a big difference in how quickly MaaS develops in countries. In the Netherlands, the government maintains control, wherein Finland, for example, the market has a clear track.
- Personally, N. Juffermans, sees the starting point of the pilots in the Netherlands as the main obstacle. Where in the Netherlands, the starting points are the social goals; this was not the intention of Whim. The social goals can be achieved by a successful MaaS application, but ultimately it is about making money.
- Personally, N. Juffermans, thinks that getting enough users to maintain a service like MaaS is a big challenge. Ultimately it is about money that has to be earned. Is the target group large enough?
- Personally, N. Juffermans, thinks that MaaS for commuting is attractive for places that are easily accessible and for people who have an office job. But how many people are this? The nature of the work plays a role in the adaptation.
- For N. Juffermans personally, MaaS cannot compete with the fact that you can drive away with your car in 1 second, the part of security is essential. Besides, everything has to be fully working with MaaS before N. Juffermans wants to use it and he does not want to feel that you no longer have a free choice as a citizen.
- For employers, MaaS is interesting because it might be cheaper than providing a car. Besides, employers want as less fuss as possible, and MaaS might take away hassles concerning financing work-related trips of employees.
- Furthermore, according to N. Juffermans there is little chance that people will let go of their car as it offers the option to drive away in 1 second. However, MaaS might have the potential to reduce the ownership of the second car in households.

Interview with N. Dogterom

Learning points:

- MaaS is interesting for employers. It might be cheaper and provides a sustainable image for employers.

- The role of employers on travel behaviour of their employees is large, with Goudappel Coffeng as an example, see Appendix D. How employees travel is partially dependent on the policy of their employer.

Interview with B. Bos
Part-time environment manager at the Ministry of Infrastructure and Water Management.

Learning points:

- Information on the organisation and focus points of the MaaS pilots of the Ministry of Infrastructure and Water Management.
- In the pilot in Eindhoven, the municipality, ASML, and Brainport are involved. The municipality has every employee using MaaS for their business travels and their commuting trips. ASML has interest in joining the pilot because they are growing so fast. For every new employee, ASML has to create a working space and working location as well as transportation and housing. With the use of MaaS services, these employees do not need a car and parking space. So they use the space they have more efficiently.
- In Limburg, MaaS will stimulate cross border traveling by public transport and free-floating services into Germany and Belgium. This will be a first for the Netherlands and an excellent gain for international travelling.
- Schiphol is setting up a MaaS system themselves.
- Personally B. Bas thinks that destimulation car use and car ownership through city legislation will help MaaS to become a severe alternative to privately owned cars. This will create opportunities for dense cities to use their space more effectively: fewer cars = less parking space.
- The Dutch government uses the pilots to learn and create a new policy in order to accommodate MaaS as much as they can.
- There are many challenges regarding upscaling MaaS because so many providers are involved.

Interview with M. Stemerding

Learning points:

- M. Stemerding told a lot about the pilots of the Ministry.
- M. Stemerding emphasised the fact that employers are interested in exploring new options for their employee' commuting trips, because of the companies sustainability ambitions, or to cut cost. For example, Schiphol Group and ASML. M. Stemerding also emphasised the fact that employers have the power to do so.
- Personally, M. Stemerding thinks that it is good that the government takes the lead. Because it may prevent undesirable companies entering the market, taking a monopoly position without any benefits to society.

Conversations with A.F. Scheltes

Learning points:

- A.F. Scheltes emphasised that it might be useful to include the background characteristic if people make a business trip for their work or not. MaaS has much to offer to employees who do not have a fixed working spot. With MaaS, it is possible to adjust the mode to a particular destination.
- A.F. Scheltes also mentioned the use of a lease car as a potential relevant factor. Individuals who use a lease car to commute might differ in their thoughts about MaaS compared to people who use their car, or other modes.

- Some other factors were mentioned in these conversations such as purchase price of a car. However, for the sake of the limited time of this research, it was not possible to include all factors.

C

Group discussion

This section provides a short recap of the group discussion the researcher organised on November 12th with five young professionals. This discussion aimed to test whether the concept of MaaS was understandable via the presented video and to explore thoughts and opinions of young professional about using MaaS for commuting trips.

The five participants were a mix of men and woman between 24 and 26 years old. They all started working recently at ASML, Deloitte and PGGM. They get finances from their employer to commute and do this by public transport in combination with the bike for four of them. The discussion was structured in the following way:

- Welcome and explanation of the discussion
- Exploring Key Performance Indicators (KPI's) when commuting
- Introduction MaaS via a video
- MaaS for commuting trips, pro's and con's
- Requirements for using MaaS for commuting trips

After the welcome and explanation of the discussion, important factors (KPI's) related to making travel choices when commuting were discussed. The following aspects were mentioned: time, costs, travelling with other people or not, moving during the journey (for example: bicycling), activity of the trip, capacity to store a vehicle, environment, amount of transfers, reliability, information provision, combination/number of modalities, crowdedness, accessibility and the option to do something for work during the trip. This question was asked to make the participants aware of the variety of important factors to keep this in mind when introducing MaaS for commuting.

Afterwards, MaaS was introduced using a video from Dutch mobility innovations:

https://dutchmobilityinnovations.com/spaces/1170/maas-kennisbibliotheek/video/liselottebingen/wall-videos/26511/wat-is-mobility-as-a-service

According to the participants of the discussion, the video explains MaaS in the right way. After the introduction in MaaS, a short discussion about MaaS followed. The researcher emphasised that this research is focused on commuting and that the participants do not need to think about the costs in this discussion (because their employer finances this).

Subsequently, the pros and cons of using MaaS for commuting trips were discussed . The following points were mentioned as pros:

- Flexibility, there is an increase in a variety of options to travel and they are shown in the application. One can choose an option that fits a particular trip.

- Environmental aspects. It is easier to share mode, and electric modes can be used more often without owning one. Furthermore, because MaaS provides a door-to-door trip, it might be easier, or more attractive for people to use public transport to travel.
- Customisation, choosing your own ideal trip. The application makes it possible to include personal preferences which are an upgrade compared to the currently available options. For example, a certain amount of non-car kilometres within mind that public transport is less harmful to the environment.
- The guarantee for the journey. MaaS guarantees a trip. So, for example, when a train gets cancelled, the application provides the best back-up journey to reach your destination.

The cons that were mentioned are:

- Routine when commuting. In contrast to the flexibility, one participant mentions that he likes routine in his every day commuting trips. He does not want to think about his commuting journey every day but just travel on routine.
- Value of the private property. The participants think that this may play a big role in the adaptation of MaaS. Not particularly for themselves, but for a lot of other inhabitants of the Netherlands. One participant also mentions that, when his employer would have the option to have a lease car, he would take it. Not only because of the convenience but also because of the idea to own a car.
- The participants get the feeling that when you book a trip, you are stuck with it. What if something happens during the trip? Do you need to book a new one or are there options to cancel it during the trip?
- Privacy is also mentioned as possible difficulty.

Overall, the participants think positively about MaaS. Most of all, because of the positive contribution to the environment and the flexibility it offers. Next to the cons of using MaaS for commuting, we also discussed the condition MaaS has to have before they want to use it. The following conditions are mentioned:

- Internet accessibility everywhere for everyone.
- A charged phone. So every train should, for example, have a charging station.
- Reliable system. The application should work all the time.
- Possibility to include personal preferences to make it an upgrade from the option now.
- Travel time must be equal or shorter than the current travel time.
- The application must be easy to use.

Concluding, the group discussion was beneficial to discuss the subject of this research with other people and gain insights into their thoughts and opinions. The most interesting points that can be concluded from this group discussion are stated below:

- People are generalising millennials a lot. They want freedom and flexibility, but this group discussion pointed out that there are also young people that do not want to share and value possible ownership of a car. One participant mentioned that if his employer would finance a car, he would immediately go for the car. This emphasises that car affection is also present by young people.
- How attached a person is to certainty might influence the interest in MaaS for commuting. One participant mentioned this as a disadvantage of MaaS as he favours the same modality to travel to work every day. Another participant sees the flexibility of MaaS as an advantage. She likes the fact that it is possible to use different modes for different purposes. So, it is valuable to include the attachment to certainty in this research to explore this. This reflects on the fact if people want the same journey every day or are open to diversity. This flexibility also includes the fact if people are willing to change

their travel plan during or right before their tip or that they want to stay to their initial plan.

- The participants confirm the thoughts that MaaS might lead to more car use because the shared car becomes available within MaaS as the participants mention that they would use the car more often when it is available. This emphasises that this might be a problem when introducing MaaS and that attention must be paid to this within a MaaS application. For example, exploring if there are options to stimulate using public transport through discounts.
- Showing other option when there is a delay is important in the MaaS application and is seen as an upgrade compared to the currently provided options to plan a trip in an app. Also, the personalisation aspects contribute to this. These two pros about MaaS are not only mentioned in this discussion but also in other conversations with people when talking about this research.
- This discussion emphasised the fact that employers want to change and are aware of the contribution of the commuting travel behaviour of their employees to the environment. Three of the five participants do not have the opportunity to lease a car via their employer out of environmental reasons.

There is one comment that must be made. All the participants are environmentally conscious, young people who never owned a car and are open to travelling with public transport. This gives a biased image. But, this discussion is used as inspiration and in the exploration phase, so it is not expected that is an issue.

Figure Figure C.1 shows a picture of the discussion and Figure C.2 shows an example of the papers used to gather the information.

Figure C.1: Picture of the discussion group

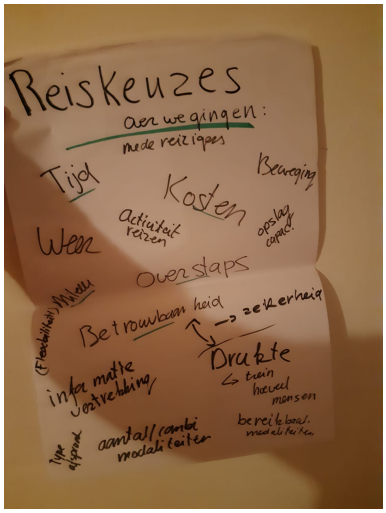


Figure C.2: Example of the gathered information from the discussion group

D

Financing commuting at Goudappel Coffeng

Goudappel Coffeng stimulates people to commute by public transport. In first instance because of the nature of the profession, as mobility advisors, but also from an environmental perspective. Their starting point is that every employee uses public transport to move around (if possible in combination with a bike). If it is difficult to commute by public transport, there are multiple other options: use of (e-)bike, use of own car for a part of the trip and the other part with the public transport, full use of own car and carpooling with a colleague.

If one chooses the use of public transport, Goudappel finances every part of the trip. Also, the first mile, from home to the station. If one chooses another mode of transport, you get a monthly allowance for the costs of your commuting. You receive 0.19 cents per driven kilometre with a minimum of 20 euros and a maximum distance from home to the work location of 40 kilometres. For trips during work, public transport is also the starting point. When a location is difficult to reach, it is possible to use a rental car or use your own car. For business-related trips with your own car, the owner gets a kilometre allowance of 0.30 cents net for the first 15.000 km. From 15.001 to 25.000, 0.25 cents and above 25.000 km 0.19 cents. Furthermore, because cycling is even more sustainable and healthier than the car or public transport, they have a cycle plan available for employees. This plan makes it possible to buy a bike under tax-friendly conditions.

So, employees are highly dependent on public transport. This is possible because of the locations of the offices since they are all very close to train stations, and because of the work they do. A lot of work is done at the office and customers are most of times organisations that are also good accessible, like municipalities. So, the nature of the profession and accessibility is important when one looks into the modes that are available to commute at the moment.

The policy of Goudappel Coffeng results in high usage of the public transport for commuting as can be seen in Table D.1.

Commuting by:	Percentage of the number of employees:	Percentage of the total amount of kilometres:
Car	25%	38%
Bike	43%	8%
Public transport	31%	54%
Total	100% (220 employees)	100% (1.066.420 kilometres)

Table D.1: Mode use of employees of Goudappel Coffeng

In terms of kilometres, 54% of the total amount of kilometres for commuting is done by public transport. In comparison, 38% with the car and 8% with the bike. People who take the bike to commute probably live close to their work and with certain modes one makes logically more kilometres. Therefore it is interesting to look into the number of people using the different modes. Goudappel Coffeng has 220 employees and 31% comes to work with public transport, 25% with the car and the people who come with the bike is surprisingly high, 43%.

As seen in Subsection 2.3.1, when looking into commuting kilometres in the Netherlands, 60% of the trips are made by car. The numbers at Goudappel Coffeng show that policy to stimulate employees to commute in a different way than the car works, the car use in terms of kilometres at Goudappel Coffeng is 38%. This is also confirmed by an employee of Goudappel Coffeng. For him, travelling from home to work is 30 minutes with the car and one hour with public transport. But, because of the policy of the employer, he travels one hour one way.

The policy of Goudappel also has an effect on business-related travels. A big amount of the total business kilometres is travelled with public transport (57%), followed by the car (23%) and at last the plane (11%).

E

Detailed information about factor analysis and latent class cluster analysis

E.1. Detailed information about performing a factor analysis

The first step in performing the Exploratory Factor Analysis (EFA) is checking if the data is suitable. The literature is varied about this suitability. Where Hair et al. (1998) mention that 100 samples are enough, Tabachnick et al. (2007) state that this must be over 300 cases. The software package SPSS offers a test to check whether the sample is big enough, the Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) test (Field, 2013). This test has a value between 0 and 1. Field (2013) state that a KMO value of greater than 0.5 is adequate. However, there are more strict measures that say that a KMO greater than 0.7 is average and greater than 0.8 is solid. A KMO lower than 0.5 is seen as unacceptable (Molin, 2019b). Besides, the included variables need to be intercorrelated, but the correlations can not be too high (Field, 2013). The Bartlett's Test of Sphericity in SPSS checks the intercorrelations. If the test is significant, the original correlation matrix is not an identity matrix, which indicates that there are correlations between the variables. Furthermore, there is no multicollinearity when the determinant of the correlation matrix is greater than 0.00001. This can also be checked in SPSS.

There are multiple extraction methods that can be used in performing factor analysis. The methods are quite different in statistical models, but they often have similar results (Molin, 2017; Williams et al., 2010). This research uses the principal axis factoring extraction method.

When performing an EFA, it is important to do this iteratively. When a variable got deleted, one starts at the beginning and performs the factor analysis again to search for factors that explain most of the variables and also fit the context. Keeping this in mind, the first step in extracting the factors is looking into the communalities. The communalities present the variance that a variable has in common with the other variables. When the communalities are lower than 0.25, the variables need to be excluded from the factor analysis (Williams et al., 2010). The number of factors that have an eigenvalue above 1 are the amount of extracted factors. These factors represent more variance than the individual variables already do and are, therefore, useful in reducing the number of variables.

The variable rotation is also important when performing factor analysis. The rotation method searches for the most simple pattern of relations between the indicators within the factors. With a simple structure, every variable loads high on one dimension/factor (preferably a value greater than 0.7 and a minimum of 0.5) and low on the other dimensions/factors (a value lower than 0.5). Ending with a simple structure is useful for interpreting the factors. It is also important that cross-loadings, so variables that load high on more than one factor,

are prevented. There are two methods to perform the rotation, the Orthogonal rotation and the Oblimin rotation. The Oblimin rotation produces factors that are correlated, and the Orthogonal rotation does not allow correlation between factors. The rotation method that suits the data best both conceptually and intuitively should be used (Williams et al., 2010). Eventually, variables might be excluded for different reasons, for example, because they load on every factor, or because the communalities were too low. The interpretation of the factors is the last step in the factor analysis. The researcher gives the factors a name by examining which variables belong to which factor.

The Cronbach alpha reliability coefficient was used to test the reliability of the extracted factors. This coefficient ranges between 0 and 1. The higher the score, the greater the internal consistency of the variables in the scale (Gliem, Joseph A and Gliem, Rosemary R). The rules of thumb that apply here are presented in Table E.1.

Cronbach's Alpha:	Reliability of the scale:
> 0.9	Excellent
> 0.8	Good
> 0.7	Acceptable
> 0.6	Questionable
> 0.5	Poor
< 0.5	Unacceptable

Table E.1: Rule of thumb concerning outcomes of the Cronbach's Alpha test (George & Mallery, 2003)

If the data does not meet the requirements to do an EFA, the simple structure can not be reached, the scales are not reliable or for example, the factors are not logical and interpreatable for the context of the research, the variables can not be captured in a common factor. Then, the variables, or a selection of the variables, need to be included in further research separately.

E.2. Detailed information about performing a latent class cluster analysis

The first step in executing an LCCA is estimating the measurement model based on chosen indicators, see Figure E.1. Afterwards, the appropriate number of clusters that explain the data as well as possible must be chosen. The Bayesian Information Criterion (BIC) is used for this as it has shown the best performance compared to other measures (Biernacki & Govaert, 1999). This information criterion is based on the log-likelihood and measures both model fit and parsimony (Kroesen, 2019). The lower the BIC value, the more parsimonious the model is for the particular data (De Oña et al., 2013).

Besides the BIC criterion, there is a local measure which also can be used to select the appropriate number of clusters, the bivariate residuals (BVR). This measure indicates whether the indicators in the model are independent (Kroesen, 2019). This is desirable to have heterogeneity between the groups. The BRV is chi-square distributed. Accordingly, a BVR greater than 3.84 implies significant residual association (Kroesen, 2019). Thus, when all BVR's are below 3.84, there are no associations between a pair of indicators left (Vermunt & Magidson, 2005).

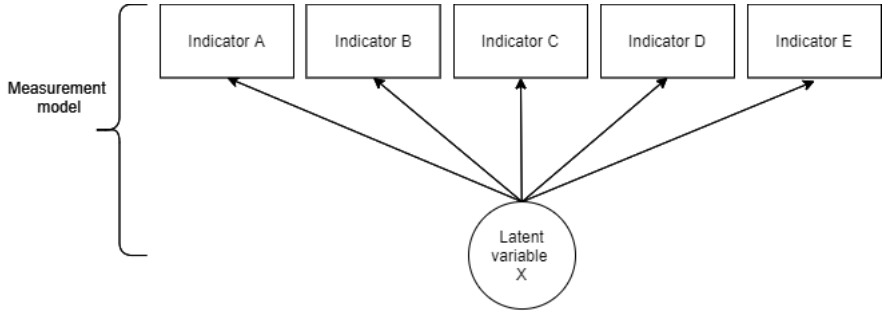


Figure E.1: Latent class cluster measurement model

Subsequently, the structural model, as depicted in Figure E.2, is added to the model. The structural model includes covariates. These are observed characteristics. For example, the socio-demographic characteristics, age and gender. By including the structural model, class membership is estimated as each respondent has a certain probability of belonging to a class according to their covariates.

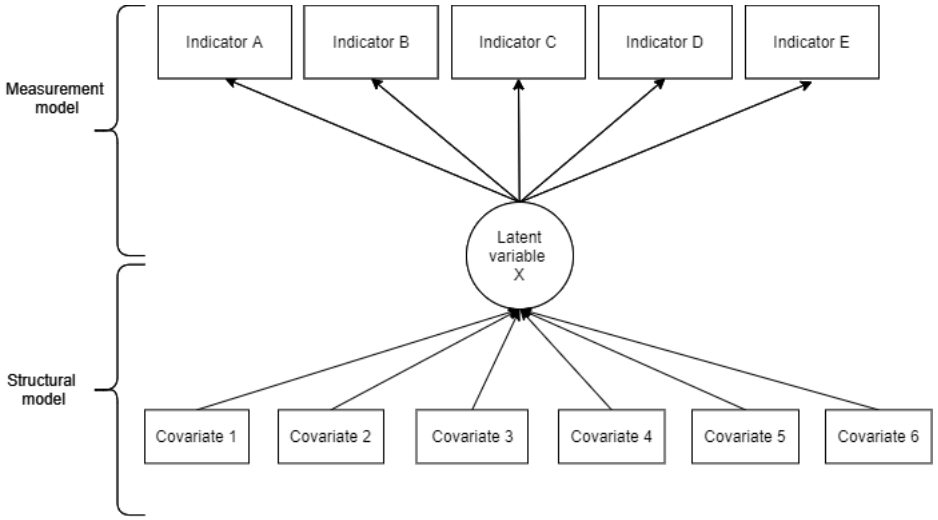


Figure E.2: Full latent class cluster model

To test the relationship between the included covariates and the latent class variable, the Wald test can be used (Kroesen, 2019). This measure is also chi-square distributed (Kroesen, 2019). Therefore, a significant Wald test (p=0.000, Wald>3.84) indicates significant covariates, which can be kept in the model. Backward elimination can be used to exclude covariates from the analysis. Hence, the most insignificant covariate is excluded first. The excluded covariates can be included as inactive covariates to use the distribution among the clusters for the interpretation. Inactive covariates do not influence cluster probabilities but the distribution of the variable throughout the clusters is presented (Molin et al., 2016).

The last step is interpreting the identified groups. This can be done by examining the probabilities of belonging to a cluster. For example, when a cluster knows a high percentage of man compared to woman, man have a high probability of belonging to that cluster and therefore act a certain way.

F

Literature review table

This tables present an overview of four articles which explore mode choice when commuting. They all take different factors, or a different combinations of factors, into account (De Palma & Rochat, 2000; Feng et al., 2014; Kalter et al., 2015; Schwanen & Mokhtarian, 2005).

The factors that are mentioned twice or more are presented in bold.

Table F.1: Literature review of four articles that focus on mode choices when commuting

	(De Palma and Rochat)	**(Schwanen and Mokhtarian)**	**(Feng et al.)**	**(Kalter et al.)**
Travel time	1			
Age	1	1	1	1
Travel costs	1			
Mode availability	1	1	1	1
Household size/type	1	1	1	1
Netword experience	1			
Neigborhood type		1	1	1
Adventures		1		
Travel freedom		1		
Frustration factor		1		
Household income		1		
Pro env factors		1		
Status seeker		1		
Profession		1	1	
Gender		1	1	1
Mobility constraints		1		
Education level			1	1
Work duration			1	
Distance to metro			1	
Population density			1	
Homework distance				1
Parking situation home				1
Preference car				1
Preference pt				1
Travelling with other household members				1
Preference bike				1

G

Final questionnaire

This appendix includes the final questionnaire. The questionnaire is in Dutch because the sample group is Dutch since the focus of this research is on employees in the Netherlands. Some boxes are ticked in a couple of questions to show the question that follows when a respondent chooses that answer. Furthermore, this is the full questionnaire, which is the longest when one identified the car as the primary commuting mode. These respondents see the second scenario. When one travels with public transport to work the respondent only see scenario 1.

It must be mentioned that the full questionnaire, as presented in this chapter, contains two aspects that were not used throughout the report. These questions revolved around the modes respondents were expected to use when they have the intention to use MaaS and the fact if people would abandon their (second) car or not. These questions are not used for the analyses in this research since the data was less valuable than expected. Furthermore, these answers were not used because little respondents showed interest in using MaaS, and these questions were only asked to respondents that are interested. So, the response rate was too low to make it valuable data.

The blue lines in between mean that participants saw a new page.

Mobility as a Service voor woon-werkverkeer

Beste deelnemer,

Bedankt voor uw deelname aan dit onderzoek. Deze vragenlijst is onderdeel van een afstudeeronderzoek om de master Transport, Infrastructuur en Logistiek aan de TU Delft af te ronden en wordt in samenwerking met mobiliteit adviesbureau Goudappel Coffeng uitgevoerd.

Het doel van dit onderzoek is om erachter te komen wat u van Mobility as a Service (MaaS) vindt en het gebruik hiervan voor woon-werkverkeer. Ook als u nu nog onbekend bent met MaaS wil ik u vragen de vragenlijst in te vullen, MaaS wordt na een aantal vragen geïntroduceerd.

Het invullen van de vragenlijst duurt ongeveer 10 minuten. Het wordt aangeraden om deze in te vullen op een computer of een tablet. Deelname aan dit onderzoek is volledig anoniem en de gegevens worden alleen gebruikt voor dit onderzoek. U kunt zich op ieder moment terug trekken uit de vragenlijst.

Mocht u vragen of opmerkingen hebben dat kunt u mij bereiken via onderstaande contactgegevens.

Vriendelijke groeten,

Robin Knijn
M: +31 (0)6 29 35 74 97
E: r.m.knijn@student.tudelft.nl

TU Delft adviseurs mobiliteit Goudappel Coffeng

Wissen | Volgende >>

Mobility as a Service voor woon-werkverkeer

Deel 1 - Achtergrondvragen

Wat is de gemeente van uw werklocatie?

Mocht u meerdere werklocaties hebben, gebruik dan de locatie waar u het vaakst naartoe reist.
In de rest van de vragenlijst kunt u deze werklocatie in gedachten houden wanneer de vragen gaan over woon-werkverkeer.

--Maak uw keuze--

Als u niet weet in welke gemeente uw werklocatie valt, dan kan u de plaatsnaam hieronder invullen:

Hoeveel uur per week werkt u gemiddeld (uren op uw contract)?

- ◯ Ik werk niet
- ◯ Minder dan 12 uur per week
- ◯ 12 tot 19 uur per week
- ◯ 20 tot 24 uur per week
- ◯ 25 tot 29 uur per week
- ◯ 30 tot 34 uur per week
- ◯ 35 of meer uur per week
- ◯ Anders, namelijk:

Stelt u zich uw meest voorkomende reis tussen huis en werk voor. Wat is uw hoofdvervoermiddel voor deze reis?
(Het vervoermiddel waar u de langste afstand mee aflegt in uw reis van huis naar werk.)

- ◯ Auto
- ◯ Trein
- ◯ Tram/metro/bus
- ◯ Motor/brommer/scooter
- ◯ Fiets
- ◯ Lopen
- ◯ Anders, namelijk:

Krijgt u reiskostenvergoeding voor uw woon-werkverkeer van uw werkgever?

- ◯ Ja, volledig
- ◯ Ja, gedeeltelijk
- ◯ Nee
- ◯ Ik heb geen woon-werk reiskosten

<< Vorige | Wissen | Volgende >>

Mobility as a Service voor woon-werkverkeer

Hoe vaak maakt u gebruik van onderstaande vervoermiddelen **voor woon-werkverkeer**?

	'vrijwel' dagelijks	1 tot 4 dagen per week	1 tot 3 dagen per maand	6 tot 11 dagen per jaar	1 tot 5 dagen per jaar	Minder dan 1 dag per jaar	Nooit	Onbekend met dit ver-voermiddel
Eigen auto	○	○	○	○	○	○	○	○
Lease auto	○	○	○	○	○	○	○	○
Fiets	○	○	○	○	○	○	○	○
Elektrische fiets (persoonlijk of gedeeld)	○	○	○	○	○	○	○	○
Trein	○	○	○	○	○	○	○	○
Taxi/Uber	○	○	○	○	○	○	○	○
Tram/metro/bus	○	○	○	○	○	○	○	○
Motor/brommer/scooter	○	○	○	○	○	○	○	○
Deelauto (SnappCar, GreenWheels etc.)	○	○	○	○	○	○	○	○
Deelfiets (bijv: MoBike)	○	○	○	○	○	○	○	○
Deelscooter (bijv: Felix)	○	○	○	○	○	○	○	○
Overige,	○	○	○	○	○	○	○	○

namelijk:

<< Vorige | Wissen | Volgende >>

Mobility as a Service voor woon-werkverkeer

Hoeveel auto's zijn er in uw huishouden in totaal aanwezig?

- ○ Geen auto
- ○ 1 auto
- ◉ 2 auto's
- ○ Meer dan 2 auto's

Heeft u, of een lid van uw huishouden, een leaseauto?

- ○ Ja
- ○ Nee

<< Vorige | Wissen | Volgende >>

Mobility as a Service voor woon-werkverkeer

In hoeverre bent u het eens met de volgende stellingen?

	Helemaal mee oneens	Mee oneens	Niet mee eens, niet mee oneens	Mee eens	Helemaal mee eens	Geen mening
Het bezitten van een auto is een must voor mij	○	○	○	○	○	○
Het is belangrijk om het openbaar vervoer te gebruiken om het milieu te beschermen	○	○	○	○	○	○
Ik vind het prettig om elke dag op dezelfde manier naar mijn werk te reizen	○	○	○	○	○	○
Ik maakt mij niet uit welk vervoermiddel ik gebruik, zolang het maar bij mijn reisbehoeften past	○	○	○	○	○	○
Ik vind het niet fijn om mijn reisplan te wijzigen gedurende, of vlak voor, een reis	○	○	○	○	○	○
Ik voel mij oncomfortabel in het openbaar vervoer, omdat ik met onbekenden reis	○	○	○	○	○	○
Wanneer de mogelijkheid er is, kies ik altijd voor de auto	○	○	○	○	○	○
Ik vind het openbaar vervoer schoon (niet vies)	○	○	○	○	○	○
Ik vind het fijn om met de auto te reizen	○	○	○	○	○	○
Ik ben bereid nieuwe manieren van reizen te proberen	○	○	○	○	○	○
Ook zonder auto kan ik alles doen wat ik wil/moet doen	○	○	○	○	○	○

<< Vorige | Wissen | Volgende >>

Mobility as a Service voor woon-werkverkeer

In hoeverre bent u het eens met de volgende stellingen?

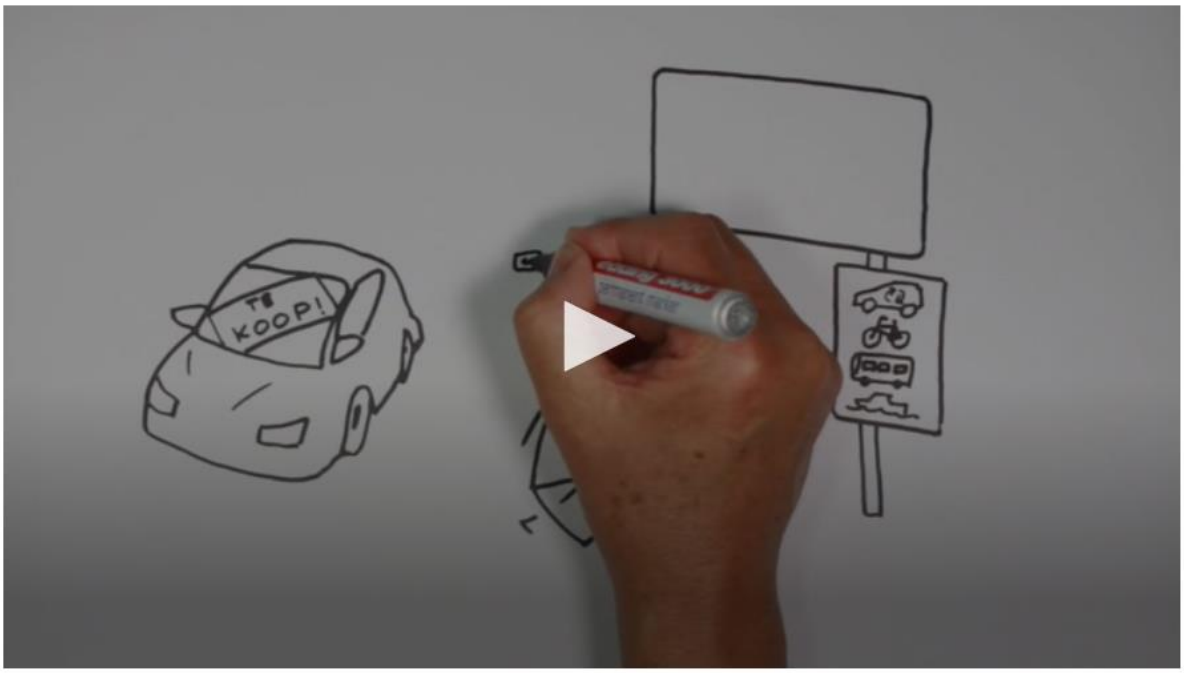
	Helemaal mee oneens	Mee oneens	Niet mee eens, niet mee oneens	Mee eens	Helemaal mee eens	Geen mening
Ik maak mij zorgen om het klimaat	○	○	○	○	○	○
Ik vind dat milieuproblemen genegeerd kunnen worden	○	○	○	○	○	○
Ik voel mij persoonlijk verantwoordelijk om bewust met mijn omgeving om te gaan voor het klimaat	○	○	○	○	○	○

<< Vorige | Wissen | Volgende >>

Mobility as a Service voor woon-werkverkeer

Deel 2 - Introductie Mobility as a Service

Het onderstaande filmpje geeft een introductie in Mobility as a Service. Mocht u niet in de gelegenheid zijn om het filmpje te bekijken dan kunt u eronder de samenvatting lezen.



Samenvatting filmpje:

Steeds betere data integratie en steeds betere route planners maken het straks mogelijk om op een alternatieve manier te reizen. Hierdoor wordt autobezit overbodig. Met Mobilty as a Service wordt u van deur tot deur ontzorgd in het maken van een reis. Deze reis kan met één, of een combinatie van, vervoermiddel(en) zijn, denk aan: deelfiets, deelauto, huurauto, taxi, trein, tram en/of bus.

Als u een reis wilt maken, krijgt u een op maat gemaakt reisvoorstel in de MaaS-applicatie. In deze MaaS-app kunt u uw eigen voorkeuren aangeven. Dit kan leiden tot bijvoorbeeld meer gezonde fiets- of loopkilometers of op een ander moment deelauto- of taxikilometers. Voor elke reis worden verschillende opties van vervoermiddelen aangeboden. In deze opties wordt rekening gehouden met het weer, zitplaatsen, parkeerplaatsen, vertraging, storingen, evenementen en files. Bij opstoppingen of vertragingen wordt er een passend alternatief geboden om uw reis te vervolgen, bijvoorbeeld door middel van een overstap naar een (deel)auto of deelfiets.

Plannen, boeken, betalen en de toegang tot de vervoermiddelen gebeurt allemaal in één MaaS-app. De app garandeert tevens dat het geadviseerde vervoermiddel ook echt voor u klaarstaat. Zo wordt reizen gemakkelijk en flexibel.

<< Vorige | Wissen | Volgende >>

Mobility as a Service voor woon-werkverkeer

Deel 3 - Uw idee over MaaS

De volgende vragen gaan over de verwachtingen die u van **MaaS in het algemeen** heeft na het kijken van het filmpje of het lezen van de introductie.

In hoeverre bent u het eens met de volgende stellingen?

	Helemaal mee oneens	Mee oneens	Niet mee eens, niet mee oneens	Mee eens	Helemaal mee eens	Geen mening
1. MaaS levert maatwerk (er wordt rekening gehouden met persoonlijke voorkeuren).	○	○	○	○	○	○
2. Reizen met MaaS levert een positieve bijdrage aan het klimaat.	○	○	○	○	○	○
3. Maas zal het bezit van een eigen auto in de samenleving niet verminderen.	○	○	○	○	○	○
4. MaaS brengt keuzevrijheid (aanbod van ene breed palet aan vervoermiddelen die kunnen verschillen per reisdoel).	○	○	○	○	○	○
5. Het is onmogelijk om altijd en overal genoeg vervoermiddelen voor iedereen aan te bieden met MaaS.	○	○	○	○	○	○
6. MaaS brengt een nieuwe kijk op de mogelijkheden rondom deelvervoermiddelen (deelfiets, deelauto, etc.).	○	○	○	○	○	○
7. Met MaaS moet vooruit gepland worden, men kan minder snel spontaan iets ondernemen waarvoor gereisd moet worden.	○	○	○	○	○	○
8. MaaS biedt de snelste optie van A naar B.	○	○	○	○	○	○

<< Vorige | Wissen | Volgende >>

Mobility as a Service voor woon-werkverkeer

In hoeverre bent u het eens met de volgende stellingen?

	Helemaal mee oneens	Mee oneens	Niet mee eens, niet mee oneens	Mee eens	Helemaal mee eens	Geen mening
9. Voor mij is het geen probleem dat MaaS volledig afhankelijk is van een opgeladen telefoon met een internet verbinding.	○	○	○	○	○	○
10. MaaS brengt voor mij gemak bij het reizen (één app waarin informatie wordt gegeven en waar boeken en betalen van een deur tot deur reis mogelijk is).	○	○	○	○	○	○
11. MaaS spreidt de reizigers beter over de dag.	○	○	○	○	○	○
12. Voor ritten die op het laatste moment bedacht worden kan ik mij niet voorstellen dat MaaS het gemak van de beschikbaarheid van een eigen vervoermiddel kan evenaren.	○	○	○	○	○	○
13. Reizen met MaaS is gevoelig voor weersomstandigheden.	○	○	○	○	○	○
14. MaaS zorgt voor een toename in het gebruik van verschillende vervoermiddelen in één reis (bijv, tram+trein).	○	○	○	○	○	○
15. Reizen met MaaS zal duurder zijn dan reizen met een persoonlijke auto.	○	○	○	○	○	○
16. Maas ontzorgt in het reizen (garantie voor de reis, bij vertragingen worden er nieuwe opties geboden).	○	○	○	○	○	○

<< Vorige | Wissen | Volgende >>

Mobility as a Service voor woon-werkverkeer

De volgende vragen richten zich op het gebruik van MaaS **voor woon-werkverkeer.**
In hoeverre bent u het eens met de volgende stelling:

Ik vind MaaS een aantrekkelijke optie om naar mijn werk te reizen.

- ○ Helemaal niet mee eens
- ○ Mee oneens
- ○ Niet mee eens, niet mee oneens
- ○ Mee eens
- ○ Helemaal mee eens
- ○ Geen mening

Wanneer MaaS ingevoerd is en dus beschikbaar is om te gebruiken, in hoeverre verwacht u dan dat u MaaS gaat gebruiken, **om naar uw werk te reizen**?

- ○ Ik ga dat zeker niet doen
- ○ Ik ga dat waarschijnlijk niet doen
- ○ Ik weet niet wat ik ga doen
- ◉ Ik ga dat waarschijnlijk doen
- ○ Ik ga dat zeker doen
- ○ Geen mening

Welke vervoermiddelen verwacht u te gebruiken bij de reis tussen huis en werk met MaaS:
(Meerdere antwoorden mogelijk)

- ☐ Eigen auto
- ☐ Persoonlijke fiets
- ☐ Elektrische fiets (persoonlijk of gedeeld)
- ☐ Trein
- ☐ Taxi/uber
- ☐ Tram/metro/bus
- ☐ Motor/brommer/scooter
- ☐ Deelauto (SnappCar, GreenWheels etc.)
- ☐ Deelfiets (bijv: MoBike)
- ☐ Deelscooter (bijv: Felix)
- ☐ Anders, namelijk:

<< Vorige | Wissen | Volgende >>

Mobility as a Service voor woon-werkverkeer

Deel 4 - MaaS voor woon-werkverkeer

Verandering 1
MaaS is (nog) niet beschikbaar in Nederland. Ik vraag u daarom om u voor te stellen dat MaaS beschikbaar is en de volgende situatie zou bestaan.

Momenteel ontvangt u volledige reiskostenvergoeding voor uw woon-werkverkeer. In deze situatie ontvangt u ook volledige reiskostenvergoeding voor het reizen met MaaS van huis naar uw werk.

Zo'n reis kan bestaan uit een combinatie van verschillende vervoermiddelen. Bijvoorbeeld het openbaar vervoer en vervolgens een deelauto naar de eindbestemming. Het kan ook een reis zijn met één vervoermiddel wanneer dit de beste optie is, zoals een deelauto.

Als deze situatie geldt, in hoeverre bent u het eens met de volgende stelling:

Ik vind MaaS een aantrekkelijke optie om naar mijn werk te reizen.

- ○ Helemaal niet mee eens
- ○ Mee oneens
- ○ Niet mee eens, niet mee oneens
- ○ Mee eens
- ○ Helemaal mee eens
- ○ Geen mening

Als deze situatie geldt, in hoeverre verwacht u dat u MaaS gaat gebruiken om naar uw werk te reizen?

- ○ Ik ga dat zeker niet doen
- ○ Ik ga dat waarschijnlijk niet doen
- ○ Ik weet niet wat ik ga doen
- ◉ Ik ga dat waarschijnlijk doen
- ○ Ik ga dat zeker doen
- ○ Geen mening

Welke vervoermiddelen verwacht u te gebruiken bij de reis tussen huis en werk met MaaS:
(U kunt meerdere vervoermiddelen aankruisen.)

- ☐ Eigen auto
- ☐ Persoonlijke fiets
- ☐ Elektrische fiets (persoonlijk of gedeeld)
- ☐ Trein
- ☐ Taxi/uber
- ☐ Tram/metro/bus
- ☐ Motor/brommer/scooter
- ☐ Deelauto (SnappCar, GreenWheels etc.)
- ☐ Deelfiets (bijv: MoBike)
- ☐ Deelscooter (bijv: Felix)
- ☐ Anders, namelijk:

<< Vorige | Wissen | Volgende >>

Mobility as a Service voor woon-werkverkeer

Verandering 2

In deze situatie **stopt** de reiskostenvergoeding van uw werkgever voor autogebruik met uw eigen auto of lease auto. U ontvangt wel een volledige reiskostenvergoeding wanneer u reist met MaaS.

Als deze situatie geldt, in hoeverre bent u het eens met de volgende stelling:

Ik vind MaaS een aantrekkelijke optie om naar mijn werk te reizen.

- ○ Helemaal niet mee eens
- ○ Mee oneens
- ○ Niet mee eens, niet mee oneens
- ○ Mee eens
- ○ Helemaal mee eens
- ○ Geen mening

Als deze situatie geldt, in hoeverre verwacht u dat u MaaS gaat gebruiken om naar uw werk te reizen?

- ○ Ik ga dat zeker niet doen
- ○ Ik ga dat waarschijnlijk niet doen
- ○ Ik weet niet wat ik ga doen
- ◉ Ik ga dat waarschijnlijk doen
- ○ Ik ga dat zeker doen
- ○ Geen mening

Welke vervoermiddelen verwacht u te gebruiken bij de reis tussen huis en werk met MaaS:
(U kunt meerdere vervoermiddelen aankruisen.)

- ☐ Eigen auto
- ☐ Persoonlijke fiets
- ☐ Elektrische fiets (persoonlijk of gedeeld)
- ☐ Trein
- ☐ Taxi/uber
- ☐ Tram/metro/bus
- ☐ Motor/brommer/scooter
- ☐ Deelauto (SnappCar, GreenWheels etc.)
- ☐ Deelfiets (bijv: MoBike)
- ☐ Deelscooter (bijv: Felix)
- ☐ Anders, namelijk:

<< Vorige | Wissen | Volgende >>

Mobility as a Service voor woon-werkverkeer

Als deze situatie geldt, in hoeverre bent u van plan om uw auto te verkopen / weg te doen?

- ○ Ik ga dat zeker niet doen
- ○ Ik ga dat waarschijnlijk niet doen
- ○ Ik weet niet wat ik ga doen
- ○ Ik ga dat waarschijnlijk doen
- ○ Ik ga dat zeker doen
- ○ Niet van toepassing / geen mening

Als deze situatie geldt, in hoeverre bent u van plan om uw tweede auto te verkopen / weg te doen?

- ○ Ik ga dat zeker niet doen
- ○ Ik ga dat waarschijnlijk niet doen
- ○ Ik weet niet wat ik ga doen
- ○ Ik ga dat waarschijnlijk doen
- ○ Ik ga dat zeker doen
- ○ Niet van toepassing / Geen mening

<< Vorige | Wissen | Volgende >>

Mobility as a Service voor woon-werkverkeer

Deel 5 - Achtergrond variabelen

Deze vraag gaat over reizen in het algemeen, dus niet specifiek over woon- werkverkeer.
Een voorbeeld van meerdere vervoermiddelen in één reis is met de fiets naar het station en dan met de trein naar de eindbestemming. Lopen wordt niet gezien als apart vervoermiddel.

Welke situatie is het beste op u van toepassing?

- ◯ Wanneer ik reis van A naar B, gebruik ik **nagenoeg nooit** meer dan één vervoermiddel in een reis
- ◯ Wanneer ik reis van A naar B, gebruik ik **soms** meer dan één vervoermiddel in een reis
- ◯ Wanneer ik reis van A naar B, gebruik ik **vaak** meer dan één vervoermiddel in een reis
- ◯ Wanneer ik reis van A naar B, gebruik ik **altijd** meer dan één vervoermiddel in een reis

Maakt u zakelijke reizen voor uw werk (buiten woon-werkverkeer om)?

- ◯ Ja, regelmatig
- ◯ Ja, soms
- ◯ Nee, nooit
- ◯ Anders, namelijk:

In hoeverre stimuleert uw werkgever u om bewust na te denken over het vervoermiddel waarmee u naar uw werk reist? (met betrekking tot de duurzaamheid van verschillende vervoermiddelen)

- ◯ Mijn werkgever besteed hier geen aandacht aan
- ◯ Mijn werkgever stimuleert dit enigszins
- ◯ Mijn werkgever stimuleert dit volledig
- ◯ Anders, namelijk:

<< Vorige | Wissen | Volgende >>

Mobility as a Service voor woon-werkverkeer

Wat is uw geslacht?

- ◯ Man
- ◯ Vrouw
- ◯ Zeg ik liever niet

In welk jaar bent u geboren?

--Maak uw keuze-- ▾

Wat is uw hoogst genoten voltooide opleiding?

- ◯ Basisonderwijs
- ◯ LBO/MAVO/VBMO
- ◯ HAVO/VWO
- ◯ MBO
- ◯ HBO
- ◯ WO
- ◯ Anders, namelijk:

<< Vorige | Wissen | Volgende >>

Mobility as a Service voor woon-werkverkeer

Tot welk type huishouden behoort uw huishouden?

- ◯ Alleenstaand zonder thuiswonende kinderen
- ◯ Alleenstaand met thuiswonende kinderen
- ◯ Samenwonend zonder thuiswonende kinderen
- ◯ Samenwonend met thuiswonende kinderen
- ◯ Anders, namelijk:

Wat is het totale bruto jaarinkomen van uw gehele huishouden?

- ◯ Minder dan 10.000 euro
- ◯ 10.000 – 20.000 euro
- ◯ 20.000 – 30.000 euro
- ◯ 30.000 – 40.000 euro
- ◯ 40.000 – 50.000 euro
- ◯ 50.000 – 60.000 euro
- ◯ 60.000 – 70.000 euro
- ◯ 70.000 – 80.000 euro
- ◯ 80.000 – 90.000 euro
- ◯ 90.000 – 100.000 euro
- ◯ 100.000 – 200.000 euro
- ◯ 200.000 euro of meer
- ◯ Zeg ik liever niet

<< Vorige | Wissen | Volgende >>

Mobility as a Service voor woon-werkverkeer

Wat is uw woongemeente?

--Maak uw keuze--

Bent u in het bezit van een mobiele telefoon met internet?

- ◯ Ja
- ◯ Nee

De allerlaatste vraag: Had u voor dit onderzoek al eens van MaaS gehoord?

- ◯ Ja
- ◯ Nee

<< Vorige | Wissen | Volgende >>

Mobility as a Service voor woon-werkverkeer

Slot

Bedankt voor uw medewerking aan dit onderzoek! Mocht uw vragen hebben of geïnteresseerd zijn in de resultaten van mijn afstudeeronderzoek, dan kunt u mailen naar: r.m.knijn@student.tudelft.nl.

Mocht u opmerkingen hebben dan kunt u die hier achterlaten.

<< Vorige | Wissen | Verzend

H

Descriptive results

H.1. Data preparation

The data from the questionnaire is not immediately ready to analyse. There are a couple of steps that need to be taken to prepare the data in the correct way.

First of all, the 'other, namely' answers, were checked to see whether the answers might fit in an existing answer. For example, two villages were added by hand by respondents but they did exist in the list, so these were changed in the dataset. Furthermore, three work locations were added by hand because people did not know in which municipality the city or village of their work location situates. For example, the village 'Bleiswijk' is part of the municipality 'Langsingerland'.

Secondly, the variables were named, labelled and defined as nominal, ordinal or scale variables. Furthermore, the variables are checked on outliers, this was only the case with the duration time of performing the questionnaire. The extreme values were already deleted, as explained in Section 6.1. Thirdly, the missing values are defined. The section below, Subsection H.1.1, elaborates on missing values and how to cope with these values when analysing data.

Fourthly, some variables need to be added by hand. A new variable for age is made as the respondents answered the question about age in the form of their birth year. Furthermore, the degree of urbanity of respondents home and their work location is added as a variable. This information is gathered from CBS (2018b), which shows the degree of urbanity per municipality. Comparing the data with municipalities in the sample, with the database from CBS formed the new variables with the degree of urbanity for each respondents home and work location.

As fifth, variables are re-organised. Most of them because the number of responses per group was too small. The rule of thumb of a minimum of 30 responses per segment is used (Molin, 2019a). Elaboration on which variables were categorised can be found in Subsection H.1.2.

H.1.1. Missing values

Missing values are values that are not present in the data, for example, because a participant forgot to answer a question. Or, also applicable in this research, because of routing in the questionnaire: the questions a respondent sees was dependent on the answers they gave on previous questions. It is not efficient to delete every respondent with missing data because a lot of information gets lost and the power of the further analyses decreases. One can state these non-existing values as missing values in SPSS and then tell SPSS how to cope with these missing values. In general, there are two ways to cope with missing values; SPSS can delete the missing values pairwise or listwise. Pairwise deletion only excludes the particular missing value but keeps the rest of the information of that respondent and listwise deletion

excludes every case with a missing value of the included variables (Tubbing, 2014). With pairwise deletion, less information gets lost compared to listwise deletion, but on the other hand, the correlations are based on a different amount of cases because the missing values are not the same everywhere. Listwise deletion is simple, but it decreases the power of the analyses a lot because cases will get completely excluded. Therefore it is essential to check the amount of excluded responses to prevent that the analyses are only done on a small data set. In this research the missing values when performing factor analysis were deleted pairwise to keep as many information as possible. For this LCCA in LatentGold, the missing data was not excluded in the estimations of the models to prevent that a large amount of data gets lost.

H.1.2. Re-organising segments

The combined segments are combined because the response was less than 30 counts. Some segments have fewer counts than 30 but are not changed because there are only two segments, for example, the variable 'smartphone possession', whom respondents answered with a yes or no. When taking the 30 counts as minimum, there is one variable where it is not useful to combine the segments, namely the car ownership. There are only 12 respondent who own no car. It is not useful to combine this with 1 car as it says something totally different. Therefore, this variable will be left out of further analysis. The answers on 'I would rather not say' were defined as missing values.

The following summary explains which segments are combined.

- The segments within the variable 'age' are categorised in groups of ten years. So, '20-24 years old' and '25-29 years old' are taken together as '20-29 years old', and so on.
- The 'education level' segments 'primary education', 'LBO/MAVO/VMBO' and 'HAVO-/VWO' are taken together as 'Highschool'.
- The 'household type' segments are combined based on living with children at home or not since it is expected that there might be a difference between those groups. So, the segments 'Single without children living at home' and 'Living together without children at home become 'Single or living together without children living at home'. And 'Single with children living at home' and 'Living together with children at home become 'Single or living together with children living at home'.
- The yearly income segments 'Less than 10.000 euro', '10.000-20.000 euro' and '20.000-30.000 euro' are combined into 'Less than 30.000 euro'. The segments '50.000-60.000 euro' and 60.000-70.000 euro' are combined into '50.000-70.000 euro'. The segments '70.000-80.000 euro', '80.000-90.000 euro', '90.000-100.000 euro', '100.000-200.000 euro' are combined into '70.000 euro or more'. The segment '200.000 euro or more' was not clicked on.
- Two segments are made within the variable 'Workhours per week'. One for working parttime (12-34 hours per week) and the other for working fulltime (35 or more hours per week).
- The segments 'Little urbanised' and 'Not urbanised' in the variable 'Urbanisation rate Home' are combined as 'Little or not urbanised'.
- The variable 'Urbanisation rate Work' is re-organised in the same way. So, he segments 'Little urbanised' and 'Not urbanised' are combined as 'Little or not urbanised'.
- The segments within the variable 'multi-modal travelling', 'When travelling, I often use more than one mode in a trip' and 'When travelling, I always use more than one mode in a trip' are combined into 'When travelling, I often or always use more than one mode in a trip'.
- The segment 'more than 2 cars' is combined with the segment '2 cars' into the segment 'two or more cars'.

- Within the variable 'Main commuting mode' there where only 2 responses for motor-/moped/scooter, 2 for walking and one other, therefore these were merged in 'Other' and marked as a missing value. The car, public transport and bike remain.

Table H.1 shows all the socio-demographic variables, their segments, number of respondents and the share of the sample. To be able to use the variables in regression models the variables need to be recoded, this is also shown in the figure. The variable age is presented in categories to shown the distribution, in the models this variable is included as scale variable.

Table H.1: Sample characteristics

Socio-demographic variables	Number of respondents	Sample share
Gender		
Male	141	54%
Female	121	46%
Education level		
Highschool	36	14%
MBO	78	29%
HBO	108	40%
WO	45	17%
Yearly income		
30.000 euro or less	36	15%
30.000-40.000 euro	58	24%
40.000-50.000 euro	40	17%
50.000-70.000 euro	46	19%
70.000 euro or more	59	25%
Smartphone possession		
Yes	251	95%
No	13	5%
Workhours per week		
12-34 hours (parttime)	122	45%
35 or more hours (fulltime)	147	55%
Household type		
Single or living together without children living at home	143	55%
Single or living together with children living at home	116	45%
Urbanisation rate home		
Very high urbanised	69	26%
Highly urbanised	79	29%
Mild urbanised	42	16%
Little or not urbanised	69	26%
Urbanisation rate work		
Very high urbanised	111	43%
Highly urbanised	77	30%
Mild urbanised	30	12%
Little or not urbanised	39	15%
MaaS knowledge beforehand		
Yes	32	12%
No	236	88%
Main commuting mode		
Car	172	65%
Public transport	57	22%
Bike	35	13%
Car ownership		
No car	12	5%

Table H.1: Sample characteristics

Socio-demographic variables	Number of respondents	Sample share
1 car	163	61%
2 or more cars	94	35%
Lease car construction		
Yes	62	24%
No	193	76%
Travel allowance		
Yes, fully	92	34%
Yes, partial	100	37%
No	68	25%
I don't have any commuting costs	9	3%
Multi-modal traveling		
When traveling, I almost never use more than one mode in a trip	140	52%
When traveling, I sometimes use more than one mode in a trip	71	27%
When traveling, I often or always use more than one mode in a trip	57	21%
Business trips outside commuting		
Yes, regularly	50	19%
Yes, sometimes	99	38%
No, never	113	43%
Incentive from employer to think conciously about commuting		
My employer pays no attention to this	134	50%
My employer encourages this slightly	95	35%
My employer fully encourages this	31	12%

H.2. Figures sample characteristics

This section includes some cross tables and a correlation matrix. Both are used in Section 6.2 to explore the characteristics of the sample.

Furthermore, two pages which show the sample characteristics in a figure are included.

Table H.2: Categories of the urbanisation rate of homes plotted against age

	Very high urbanised	Highly urbanised	Mild urbanised	Little urbanised	Not urbanised	Total
15-24 years old	17% (2)	25% (3)	8% (1)	41,7% (5)	8% (1)	100% (12)
25-34 years old	20% (11)	30% (16)	15% (8)	26% (14)	9% (5)	100% (54)
35-44 years old	28% (15)	34% (18)	9% (5)	23% (12)	6% (3)	100% (53)
45-54 years old	28% (13)	39% (18)	15% (7)	15% (7)	4% (2)	100% (47)
55-64 years old	31% (16)	23% (12)	27% (14)	8% (4)	12% (6)	100% (52)
55-75 years old	9% (1)	46% (5)	18% (2)	27% (3)	0% (0)	100% (11)
Correlation	-.095					
Sig.	.153					

Table H.3: MaaS knowledge beforehand plotted against age

	Knowledge of MaaS		
	Yes	**No**	**Total**
15-24 years old	8% (1)	92% (12)	100% (13)
25-34 years old	15% (8)	86% (47)	100% (55)
35-44 years old	13% (7)	87% (47)	100% (54)
45-54 years old	13% (6)	88% (42)	100% (48)
55-64 years old	12% (6)	89% (46)	100% (52)
55-75 years old	0% (0)	100% (11)	100% (11)
Correlation	0,044		
Sig.	0,500		

Table H.4: MaaS knowledge beforehand plotted against education level

	Knowledge of MaaS		
	Yes	**No**	**Total**
Highschool	14% (5)	86% (30)	100% (35)
MBO	4% (3)	96% (75)	100% (78)
HBO	16% (17)	84% (91)	100% (108)
WO	16% (7)	84% (38)	100% (45)
Correlation	-.081		
Sig.	.190		

Table H.5: Correlation matrix

		Knowledge of MaaS	Urbanisation rate Home	Multi-modal travelling	Education level	Incentive employer	Smartphone possession	Business trips	Income level	Workhours per week
Knowledge of MaaS	**Correlation**	1	-0,019	-0,228	-0,082	-0,081	0,029	0,198	-0,026	-0,129
	Sig.		0,765	0.000	0,184	0,188	0,643	0,001	0,695	0,035
	N	268	258	267	267	267	264	262	238	268
Urbanisation rate Home	**Correlation**	-0,019	1	-0,103	-0,044	-0,037	-0,091	-0,005	-0,016	0,033
	Sig.	0,765		0,099	0,485	0,550	0,149	0,940	0,811	0,599
	N	268	258	267	258	258	254	253	230	259
Multi-modal travelling	**Correlation**	-0,228	-0,103	1	0,180	0,159	-0,005	-0,022	0,044	-0,023
	Sig.	0	0,099		0,003	0,009	0,937	0,723	0,496	0,705
	N	267	258	268	267	267	263	262	239	268
Education level	**Correlation**	-0,082	-0,044	0,180	1	0,077	-0,019	-0,263	0,433	0,052
	Sig.	0,184	-0,485	0,003		0,21	0,757	0,000	0,000	0,396
	N	267	258	267	268	267	263	262	238	268
Incentive employer	**Correlation**	-0,081	-0,037	0,159	0,077	1	-0,014	-0,005	0,067	0,054
	Sig.	0,188	0,550	0,009	0,210		0,816	0,940	0,302	0,378
	N	267	258	267	267	268	263	263	238	268
Smartphone possession	**Correlation**	0,029	-0,091	-0,005	-0,019	-0,014	1	0,023	-0,036	-0,072
	Sig.	0,643	0,149	0,937	0,757	0,816		0,717	0,587	0,245
	N	264	254	263	263	263	264	258	234	264
Business trips	**Correlation**	0,198	-0,005	-0,022	-0,263	-0,005	0,023	1	-0,160	-0,177
	Sig.	0,001	0,940	0,723	0	0,940	0,717		0,015	0,004
	N	262	253	262	262	263	258	263	233	263
Income level	**Correlation**	-0,026	-0,016	0,044	0,433	0,067	-0,036	-0,160	1	0,142
	Sig.	0,695	0,811	0,496	0	0,302	0,587	0,015		0,028
	N	238	230	239	238	238	234	233	239	239
Workhours per week	**Correlation**	-0,129	0,033	-0,023	0,052	0,054	-0,072	-0,177	0,142	1
	Sig.	0,035	0,599	0,705	0,396	0,378	0,245	0,004	0,028	
	N	268	259	268	268	268	264	263	239	269

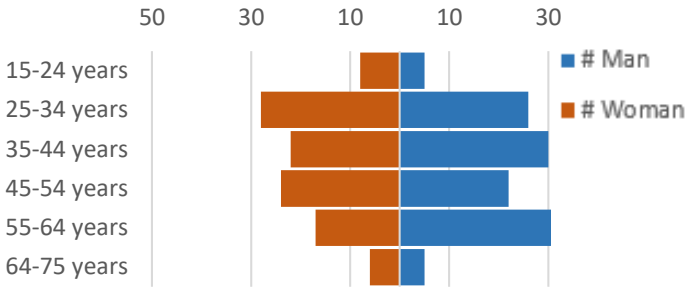
Sample characteristics (1)

269 useful responses

Gender

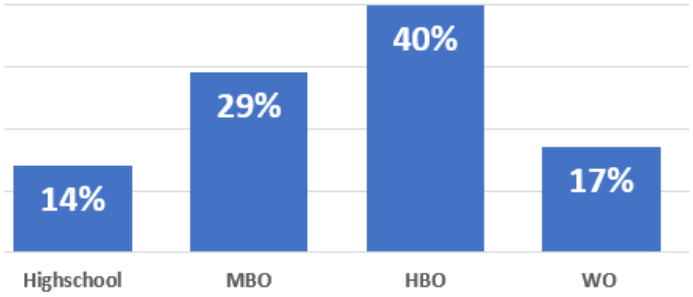
54% 46%

Age



Yearly income

Education level



Smartphone possession

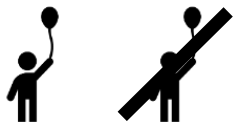
95%

Working

Fulltime Parttime

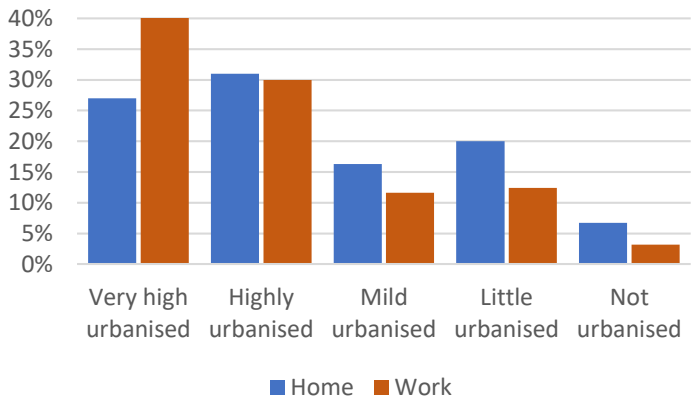
55% 45%

Household type

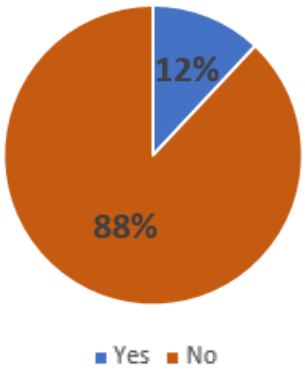


45% 55%

Urbanisation level home and work



Maas knowledge beforehand



Sample characteristics (2)

269 useful responses

Main commuting mode

65% 22% 13%

Car ownership

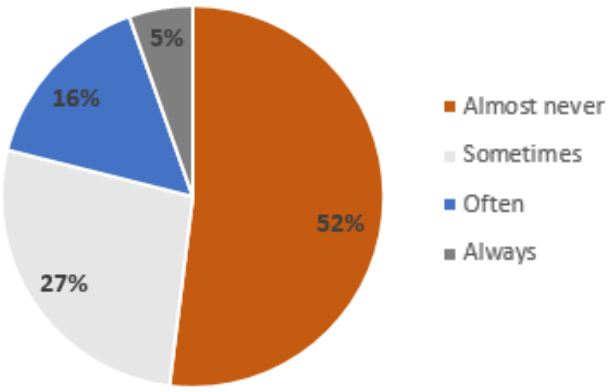
5% 61% 35%

Travel allowance

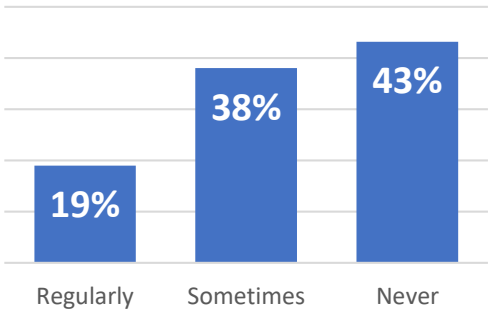
Lease car

24% 76%

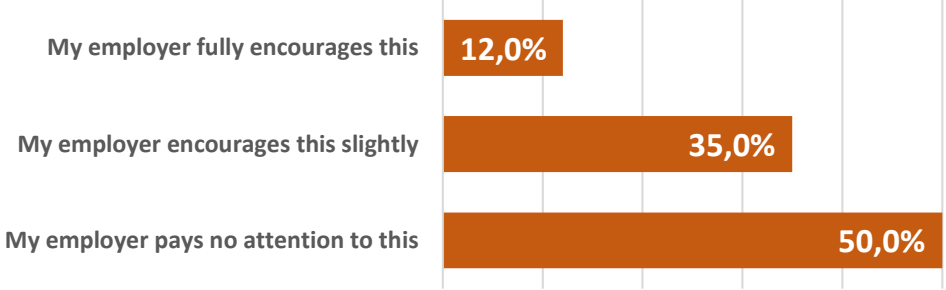
Multimodal traveling



Business trips outside commuting



Employer incentive to think consciously about commuting



H.3. Factor analysis on attitudes

Factor analysis is executed on the variables that measure the attitudes regarding the environment, public transport and private car. They are measured using multiple statements. Performing factor analysis shows if these statements indeed measure something similar. If so, they can be categorised within a new variable; a factor. Before performing the factor analysis it must be checked if the data is appropriate to do this analysis. There are two checks as mentioned in Subsection 3.2.1. As seen in Table H.6, the KMO index meets the requirement of 0.5 or higher and Bartlett's Test of Sphericity is significant, so both conditions are met and the factor analysis can be performed. The missing values are deleted pairwise to keep as many information as possible.

Table H.6: KMO index and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.757
Bartlett's Test of Sphericity	Approx. Chi-Square	685.650
	df	21
	Sig.	.000

At first, the communalities are taken into account. Variables with a communality lower than 0.25 are excluded from the factor analysis (Molin, 2017). From now on it is an iterative process of looking for a simple structure and interpretable factors. In this research, the principle axis factoring with an oblimin rotation method is taken as basis. One variable got deleted in the beginning because of a low communality. The factor analysis extracts three factors. There are three reasons why the variables belonging in the third factor are excluded. First of all, the factor consists of 2 variables, this is a minimum. Secondly, the interpretation of the factor is not clear and not usefull in this research, especially compared to the other factors. Furthermore, the factor loading of these variables are at a minimum of around 0.5.

The cleanest simple structure is extracted via the Varimax rotation methods. The rotated component matrix is presented in Table H.7. Figure H.1 gives an overview of which variable got included in which factor and which variables got deleted. The variables that do no fit a factor are excluded from further research.

Table H.7: Rotation factor matrix

Variable name:	Variable label:	Factor	
		1	2
Att_Car2	Whenever there is the possibility to travel by car I always choose the car	0.799	
Att_Car3	I like to travel by car	0.728	
Att_Car1	Car ownership is a must for me	0.714	
Att_Car4	Even without a car I can do everything that I want/must do	-0.513	
Att_Env1	I worry about the climate		0.884
Att_Env3	I feel personally responsible for consciously dealing with my environment for the climate		0.737
Att_PT1	It is important to use the public transport to protect the environment	-0.319	0.677

Extraction Method: Principal Axis Factoring.
Rotation Method: Varimax with Kaiser Normalization
a. Rotation converged in 3 iterations

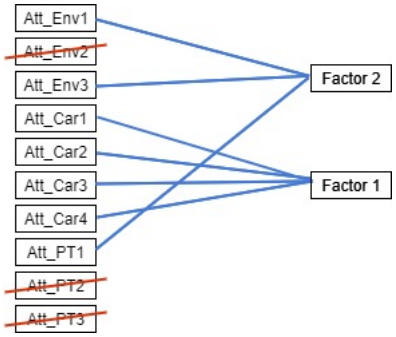


Figure H.1: Factor analysis on attitudes

The rotated factor matrix (Table H.7) shows that (almost) every variable load high on their factor (factor loading>0.6) and low on the other factor (lower than 0.3 is not visible, so a blank cell). There is one variable with a double loading, which is not seen as a critical point because it loads high on factor 2 and low (almost (-)0.3) on the other factor. One factor loads slightly below 0.5 on factor 1, this variable fits the factor as being 'Pro car' and the loading is close to 0.5 so it is not excluded. Interpreting the factors shows that the first factor is focused on car use and the second factor measures environmental consciousness.

Before checking the reliability scale and computing the new variables, the variable 'Att_Car4 needed to be reversed in polarity because this statement was reversed in direction for including it in the questionnaire. Repoling is done by making a new variable in SPSS and recoding the "High" answers into "Low" answers, so 5 (totally agree) becomes 1 (totally disagree) and so on.

The reliability of the factors is checked via the Cronbach's Alpha values which are shown in Table H.8. They both have a Cronbach Alpha value of higher than 0.7. Which means that the scale is reliable (Molin, 2020).

Table H.8: Cronbach's Alpha factors

	Cronbach's Alpha	N of Items
Factor 1 (Pro Car)	0.771	4
Factor 2 (Environmental conciouss)	0.820	3

There is the option to include statistics about the 'Cronbach's Alpha if item Deleted'. This shows that the Cronbachs alpha will increase with 0.021 if 'Att_Car4' got deleted. This is a minor improvement and since the variable fits the interpretation of the factor, this variable is kept in factor 1.

So, two new variables need to be made in SPSS: factor 1 (Pro-car) and factor 2 (Environmental consciousness). There are three ways to do this, using som scores, means or factor scores. Factor scores make a new score and take the weights of the factor loadings into account. This means that low loading variables also are included in the factor score. A som score adds every score of the variable, so every variable has the same weight. Adding these scores up results in a different measuring scale than before. This research uses means to compute the new factors. It has the same information as the som scores, but the advantage is that the original measuring scale is being kept. Using means provides a straightforward score because only the high loading factors got included in the new score (Molin, 2020).

H.4. Representativeness

The results of the chi-square tests can be found below in Table H.9.

Table H.9: Results Chi-square test

Socio-demographic variables	Chi-square	P-value
Gender	0.07	.791
Age	24.396	.000
Education level	49.502	.000
Workhours per week	3.432	.064

Factor analysis of perceptions about MaaS

Factor analysis is also performed to identify underlying variables among the perceptions of employees of MaaS. The sixteen statements that measure the perceptions were the input for the factor analysis. In an iterative way, two factors are extracted. Low communalities and double loadings resulted in excluding five statements. These were also excluded for further research. The Kaiser-Meyer-Olkin (KMO) index and Bartlett's Test of Sphericity are presented in Table I.1. As can be seen, they meet the conditions of a KMO higher than 0.5 and a significant Bartlett's Test of Sphericity test. The missing values are excluded pairwise to keep as much information/data and to prevent biases in the results.

Table I.1: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.856
Bartlett's Test of Sphericity	Approx. Chi-Square	1033.518
	df	55
	Sig.	.000

The direct Oblimin rotation method was again used as the default option, but the Varimax rotation method provided a more simple structure. This simple structure is presented in the rotation factor matrix in Table I.2.

Table I.2: Rotation factor matrix

Variable name:	Variable label:	Factor	
		1	2
Perc16	Unburdens when travelling	0,77	
Perc6	New perspective on shared modes	0,769	
Perc4	Freedom of choice	0,74	
Perc1	Customization	0,739	
Perc10	Concenience when travelling	0,737	
Perc2	Positive contribution climate	0,69	
Perc8	Fastest option	0,608	
Perc11	Distributes travellers better throughout the day	0,537	
Perc7	Need to plan ahead		0,806
Perc12	Last moment trips cannot match ease of owning one		0,594
Perc5	Impossible to offer enough transport modes always and everywhere		0,522

Eight statements load on the first factor and three statements on the second factor. The statements that load high on the first factor are statements that are formulated as positive statements about MaaS. For example, MaaS offers freedom of choice and convenience when traveling. The statements that load high on the second factor are more negatively formulated statements. For example, it is impossible to offer enough transport modes everywhere and always. Therefore, the first factor is called 'positive about MaaS', and the second factor is called 'hesitant about MaaS'.

The Cronbach's alpha's are depicted in Table I.3. With a Cronbach's alpha of 0.880, the first factor is reliable. Factor two does not meet the minimum of a Cronbach's Alpha of 0.7. However, since 0.7 is not a hard-line, and since there are only three variables, this factor is kept in the research.

Two new variables are made by taking the means from the perceptions. These two new variables are included in further research.

Table I.3: Cronbach's Alpha factors

	Cronbach's Alpha	N of Items
Factor 1 (Positive)	0,880	8
Factor 2 (Hesitant)	0,672	3