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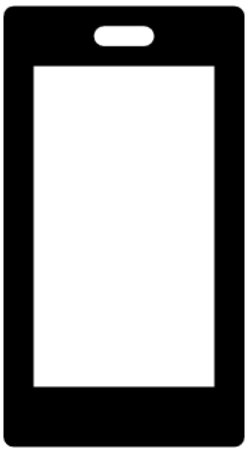
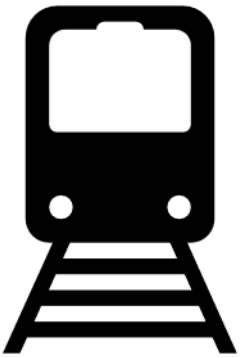
MaaS – How it can replace the (private) car in the Northern Netherlands





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Bachelor project	Spatial Planning and Design (SPD)
Title	MaaS – How it can replace the (private) car in the Northern Netherlands
Place	Groningen
Date	June 9, 2019
Version	Definitive
Word count	7.168 (excluding references and appendices)

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Preface and acknowledgements

In front of you is my bachelor thesis. During the past few months, I have worked on the theme Mobility as a Service (from now on also referred to with the abbreviation MaaS), which might be a replacement for the (traditional) car in the near future. With the use of technology and subscriptions, we can car-free move from A to B, making use of different modes of transport at once. This subject personally interests me as well, because how can we move from A to B in rural areas in the future without owning a private car? Since this is a relatively new concept, I wanted to learn more about it and especially I wanted to know more about how to implement this concept in rural areas in the Northern Netherlands.

After an intensive period of approximately four months, I think that I am now able to say that I have learned a lot about this relatively new concept. I want to thank my supervisor, dr. F. Bahrami, who was always available for answering my questions with regard to my bachelor thesis. I also want to thank dr. S. Verweij, who was always available for answering my questions with regard to the 'public-private partnership part' of my thesis. He gave me helpful recommendations for the interviews that focused on this theme.

Yordi Geurtsen

Kollum, June 9, 2019

Summary

There is a need for more sustainable transportation in the near future. Because cars are polluting and public transport is not always viable on the countryside (Eckhardt et al., 2018), there is a need for other modes of transport in rural areas. Here, Mobility as a Service can play an important role. In this research, the possibilities for Mobility as a Service in rural areas in the Northern Netherlands are discovered. In the first sub-question, the current modal split and the current accessibility by public transport is given and discussed. Subsequently, some international Mobility as a Service pilots and projects are discussed and analyzed. Their most important characteristics and (dis)advantages are given. Thereafter, some national pilots will be discussed and analyzed. As a result of this, the possibilities for this relatively new concept in the Northern Netherlands can become clear. Finally, the development scenarios and possibilities for public-private partnerships (PPPs) for Mobility as a Service in the Northern Netherlands are discussed. These scenarios were analyzed and discussed with the help of interviews with people who were involved in the Mobility as a Service pilots.

It becomes clear that the current public transport lines can form a backbone for Mobility as a Service in rural areas. Smart transportation solutions will then cover the so-called first and last mile towards and from a public transport stop. Next to that, it is shown that public-private partnerships are the most ideal development scenario for Mobility as a Service projects, since it can save costs for the public sector.

Keywords: Mobility as a Service (MaaS), pilots, public transport, Northern Netherlands, public-private partnerships

1 – Introduction

In this first part of this research, the background of the study is presented first. Then, the research problem is discussed. Further, the societal and academic relevance of this research is clarified. At the end of this introduction, a reader's guide for the research is given.

1.1 – Background of the study

The concept of automobility is not very often used in the globalization literature, but nevertheless the consequences of this system are huge and it has changed the world enormously in the last few decades (Urry, 2004). As a result of this, it is difficult to reverse today's car dependence (Banister, 2008). According to Urry (2004), the system of automobility consists of six interdependent components. One of these is the individual consumption of the car, and hence automobility is one of the most important causes of resource use (Graham-Rowe et al., 2011). It is thus important to search for more sustainable modes of transport in the near future.

More and more (private) automobility in the world (Urry, 2004), causes, as described above, different kinds of problems. To make the impact of the automobile even more visible, for example the number of passenger cars in the Netherlands even increased in the last few years, from 7 million in 2005 towards 8.2 million in 2017 (KiM, 2018). In the last few years, the usage of more sustainable modes of transport is getting more and more attention, because of the worries about the environment and sustainability in general (Li & Voege, 2017).

There is, thus, a need for more sustainable modes of transport, but yet it is still unclear what kind of interventions will reduce the amount of car use (Graham-Rowe et al., 2011). Here the concept of Mobility as a Service can play an important role. With this door-to-door service, customers can easily subscribe to a service and by several modes of transport they can go from A to B. This service can also make the rural areas more accessible without the need to own a private car, so it can also have an effect on the amount of (private) passenger cars in the Netherlands.

1.2 – Societal relevance

In rural areas, the population density and thereby the level of facilities is lower than in urban areas. In some parts of the periphery of the Netherlands, there is even a decline in population (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2018). To perform certain activities in rural areas, people have to travel further and further, something which will be usually done by car. Public transport in rural areas is not existing anymore, because it is not economically viable in these areas (Eckhardt et al., 2018). Frequencies of bus lines will decline, the amount of bus stops will decline and sometimes bus lines in their totality will disappear. But for people without a car in these areas, it becomes more and more difficult to travel long distances in rural areas. Next to this, the transportation from and to a public transport stop will become more difficult in peripheral areas when population declines (Aapaoja et al., 2017). The question is how to sustain the current amount of facilities in rural areas if the population declines.

According to Klein & Smart (2017), the current generation is less likely to own a car compared to the previous generations. But they are still willing to fulfill their transportation needs. As a result of the ongoing digitalization, new types of transport services can come up (Smith et al., 2018).

Mobility as a Service can make supply and demand in rural areas more flexible. With this concept, it will become easier to travel from door-to-door without the need of owning a private car. An additional advantage of Mobility as a Service will be that the customer just chooses one journey with all modes of transport in it. This will offer a more pleasant journey to the customer. Mobility as a Service will thus offer a multimodal journey to the customer via one, single interface.

1.3 – Academic relevance

Mobility as a Service is a relatively new concept, not yet discussed a lot in academic papers. Although the concept becomes more and more popular in the last few years, most of the literature focuses on definitions and the sustainability of this concept. Since it is discussed more and more, there is also a need for a clear definition of the concept (Kamargianni & Matyas, 2017; Giesecke et al., 2016). Moreover, most of the (academic) papers about Mobility as a Service are about projects and pilots within cities or urban areas (see for example Goodall et al., 2017).

Yet, the possible developments and implementation of Mobility as a Service is less described in the literature. The goal of this research is thus to describe the possible development scenarios of Mobility as a Service, and how it can be implemented in rural (and less populated) areas in the Northern Netherlands. There is thus a knowledge gap about how to implement Mobility as a Service in rural areas. As described in the societal relevance, the conditions will be different on the countryside as compared to urban areas.

1.4 – Research problem

Since Mobility as a Service is a relatively new concept, research about the possible implementations, especially in the case of rural areas in the Northern Netherlands, is not very common. Nevertheless, Mobility as a Service might have a great potential in rural areas, because the coverage of public transport is sometimes not sufficient because of the lower population density in rural areas (Eckhardt et al., 2018). The aim of this research is to discover how Mobility as a Service can be implemented in rural areas in the Northern Netherlands, as a replacement for the traditional car.

To research this, a main research question and four sub-questions have been formulated:

- Main research question: “How can Mobility as a Service be implemented as a replacement for the traditional car in rural areas in the Northern Netherlands?”
    - Sub-question 1: “What is the modal split and accessibility of public transport in the research area?”
    - Sub-question 2: “How is Mobility as a Service implemented in other (rural) areas around the world?”
    - Sub-question 3: “What is the current state of Mobility as a Service in the Netherlands and what can we learn from pilots for implementing Mobility as a Service in the future?”
    - Sub-question 4: “Which development scenario is the best for implementing Mobility as a Service in rural areas in the Northern Netherlands?”

The research methods used to answer these research questions, are described in the chapter methodology (page 11).

1.5 – Structure of the thesis

The research is structured as follows: First of all, there will be an attempt to give a clear definition of the concept Mobility as a Service. Since it is a relatively new concept, it will be valuable to answer the research questions. After that, the conceptual model for this research is presented and some hypotheses are formulated. Then, the used research methodologies are described. What follows then is the results section, in which the answers to the main research question and the four sub-questions are given. Finally, some conclusions and suggestions for further research will be given.

2 – Theoretical framework

This part of the research deals with the concept of Mobility as a Service. First of all, several definitions of the concept are discussed. According to Kamargianni & Matyas (2017) and Giesecke et al. (2016), a clear definition of Mobility as a Service is needed, because it is a more and more used concept nowadays. Next to this, the main concepts are discussed and analyzed in this chapter. Furthermore, a conceptual model is proposed, which will later on be used to answer the sub-questions and the main research question. Finally, some hypotheses will be presented.

2.1 – Definition of Mobility as a Service (MaaS)

Figure 1. Mobility as a Service meets all transportation needs at once. Source: Parliament, 2018.

Mobility as a Service is gaining more and more popularity in the last few years. First of all, a clear and complete definition of MaaS is needed. It is a relatively new concept, and it was first described in 2014 by the Finnish ministry as a service whereby all transportation needs are met at once, provided by a single service provider (Ministry of Transport and Communications, 2014). Hietanen (2014) defines it as a model "in which a customer's transportation needs are met by one, single service provider". MaaS thus integrates all different modes of transport (see figure 1) into one, user-friendly platform (KiM, 2018; MaaS alliance, 2019), in which users can choose the modes of transport that best meet their transportation needs at a certain moment (Hietanen, 2014). It can thus be seen as an on-demand transport service that integrates different types of transport, so that the customer can get from A to B (Atkins, 2015). New technologies creates possibilities towards a more integrated transport system, in which customers with a smartphone can plan and execute their journey on one platform (MuConsult, 2017).

MaaS can be an efficient method to contribute to the change towards more sustainable modes of transport (Matyas & Kamargianni, 2017). According to Giesecke et al. (2016) and König et al. (2016), sustainability is one of the key factors for implementing MaaS, and during the last few years sustainability is getting more and more attention in the transportation sector (Li & Voege, 2017). MaaS can change the travel behavior of people and make their travel behavior more sustainable. It is thus one of the goals in order to achieve more sustainable transportation by implementing MaaS (König et al, 2016). According to the KiM (2018), people are willing to change their travel behavior if the service is economically feasible for their own household, and if the price for the service meets the actual value. Next to that, they change their travel behavior if there is still a high degree of flexibility and autonomy in the transportation solutions they can choose.

2.2 – Main concepts

According to Mulley (2017) MaaS consists of three main concepts. First of all, it is **transport on demand**. MaaS fully meets the needs of a customer, and thus provides a mode of transport that best fits the current needs of a customer. Next to that, customers do not need to buy single transport tickets. Customers are subscribed to the provided services for an agreed period of time. The last important concept is the possibility to establish new markets. For transport providers, MaaS will offer more data on, for example, travel demand. According to Hietanen (2014), MaaS can have several benefits for both the users, the public sector and the businesses. The transport needs for users will

be more personalized and they will have an easier access to mobility. For the public sector, the effectiveness of the transport system will increase. Finally, for businesses there might be a chance to create new, profitable markets in which they can deliver transport needs for the users. MaaS can thus create value for the users by bundling diverse mobility services and by sharing mobility data the services provided by transport providers can be improved (Transport Systems Catapult, 2016).

Sochor et al. (2017) propose a MaaS typology, which depends on **the level of integration**. In level 0, there is no integration at all. Public transport companies and other companies offer their own services. In the first level, information will be brought together. This means that a customer can plan his own journey, making uses of several modes of transport. In the second level, a customer can book and pay a separate journey. In the third level, the customer can even subscribe to the mobility services and this means that they can conclude a contract with the service provider. In the fourth and last level of integration, also societal problems will be tackled. This means for example that there will also be a reduction of private cars, thus contributing to sustainability.

MaaS can **develop in three different ways** (Smith et al., 2018). First of all, market-driven development is possible. Next to that, public-controlled and public-private development are possible development scenarios for MaaS. With market-driven development, the public transport provider and the transport service provider will be private actors. With the public-controlled, public transport authorities will play a bigger role. The public sector will be responsible to integrate and operate MaaS. In the last development scenario, the public-private development, both public and private actors are developing the concept of MaaS. A public-private collaboration is also known as a Public-Private Partnership (PPP). It is a collaboration between a public organization with an organization outside of the public sector (Bovaird, 2004). According to Polis (2017), MaaS requires a collaboration between public and private sectors. Eckhardt et al. (2017) researched the possibilities for PPPs in implementing MaaS. It can save costs for the public sector, and as a result of that it can be more viable in rural areas.

2.3 – Conceptual model

In figure 2, the conceptual model for this research is visualized. First of all, the current accessibility by public transport and today's modal split in the Northern Netherlands is researched. After that, the possibilities for MaaS become clear. In sub-question 2 and 3, several (inter)national MaaS-pilots are compared with each other, to find the best characteristics out of those pilots. In sub-question 4, the role of the public and private sector separately or together is researched. After that, in the main research question, it will be described how MaaS can be implemented in the Northern Netherlands.

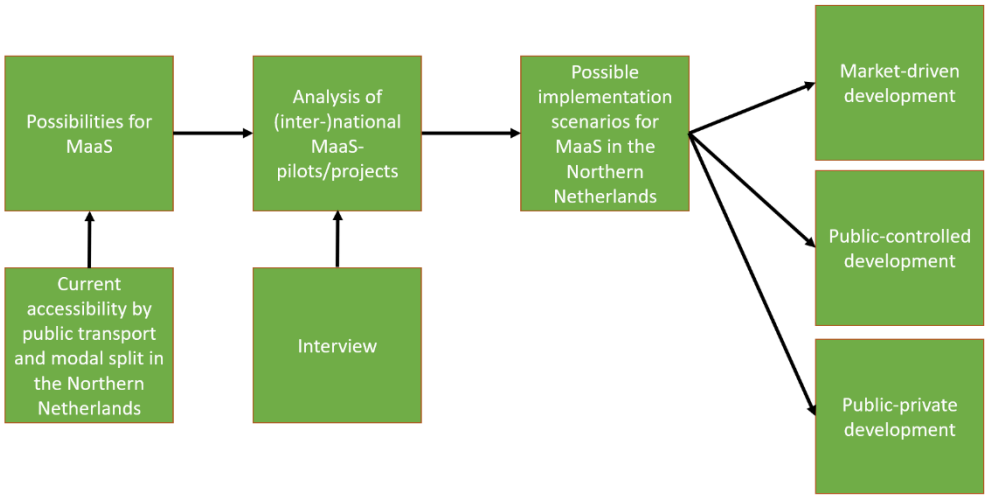

Figure 2. Conceptual model as used in this research. Source: Own work (2019).

2.4 – Hypotheses

Following the theoretical framework and the research questions, a hypothesis, also known as a predictive answer to the (main) research question (Punch, 2014), can be composed. First of all, I assume that the possibilities for MaaS will be relatively high in rural areas. Since some of the areas are not covered by public transport, other means of transportation are needed. To promote more sustainable modes of transport, MaaS can be a solution in those areas. It is also assumed that the public-private development scenario is most likely to be the best one. Since it can save costs for the public sector (Eckhardt et al., 2017), it can especially be helpful for the implementation of MaaS in rural areas. Next to this, I assume that today's modal split in the research area is mostly based on the car (CBS, 2016). This is because of the fact that more residents in cities do not own a car, compared to residents on the countryside who more often own a car (KiM, 2017).

3 – Methodology

In this part of the thesis, the used research methods will be described. In this research, several methods are used, which makes this a mixed-methods research. Secondary data about MaaS will play an important role, but also primary data about MaaS in practice is important. Finally, the ethical considerations will be discussed.

3.1 – Primary data

The last sub-question of this research: "Which development scenario is the best for implementing MaaS in rural areas in the Northern Netherlands?" will be mainly addressed by means of an interview, thus gathering qualitative data. To discover what the opportunities for MaaS in the rural areas in the Northern Netherlands will be, an interview with a policy makers from the MaaS-pilot project Groningen Drenthe is conducted. The interview will be semi-structured (Clifford et al., 2016), whereby some of the interview questions are prepared beforehand. These predetermined interview questions are shown in appendix 4 on page 30. The order of the questions is only partly structured by the interviewer. By interviewing the policy makers, additional information might be given and this can lead to certain follow-up questions which might be asked to clarify the given information (Punch, 2014). This is also the reason why I chose this type of interview instead of for example structured interviews, whereby the sequence and amount of questions is predetermined.

For the accessibility maps, ArcGIS is used. With the help of literature about acceptable walking and cycling distances, a network analysis has been performed. The results of these analyses are shown in the results section and in the appendices.

3.2 – Secondary data

Secondary data will also play an important role in this research. This will be gathered by means of (academic) journal articles, but also by means of MaaS-project websites, news articles about the recent projects and some brochures.

First of all, the first sub-question tries to find out what the current modal split and accessibility by public transport is in the research area. Next to that, some (inter)national Mobility as a Service (MaaS) pilots are discussed and analyzed in the second and third sub-question. As a result of this, their most important (dis)advantages will become clear. Finally, the possibilities for public-private partnerships (PPPs) are discussed in the last sub-question.

3.3 – Ethical considerations

While collecting the primary data by means of an interview, also ethical issues play an important role, especially confidentiality and anonymity (Clifford et al., 2016). All the data needs to be secure and only used for research purposes. Next to that, it needs to be clear if the interviewees want to be anonymous while processing the interview results or not. After conducting the interview, all the gathered data will be analyzed and used to answer the research question(s).

4 – Results: Sub-questions and main research question

In the following section, the results will be analyzed and discussed. While doing this, first the answers are given to the sub-questions and subsequently to the main research question of this research.

4.1 – Sub-question 1: Modal split and accessibility by public transport of the research area

The first sub-question "What is the modal split and accessibility by public transport of the research area?" will be addressed as first in the results section. But first of all, it is useful to discover what is meant by the modal split. With modal split (also known as modal share), the distribution of trips between different modes of transport is meant (McDonald, 1967). For example, the use of private motor vehicles in cities in the United States is relatively high. In Europe, the modal share of public transport is higher. In the Netherlands, and in particular the provinces of Friesland, Groningen and Drenthe (the Northern Netherlands), the use of cars is relatively high compared to the rest of the Netherlands (CBS, 2017a). It is clear that the amount of car ownership increases as the urbanity of an area decreases (CBS, 2017b).

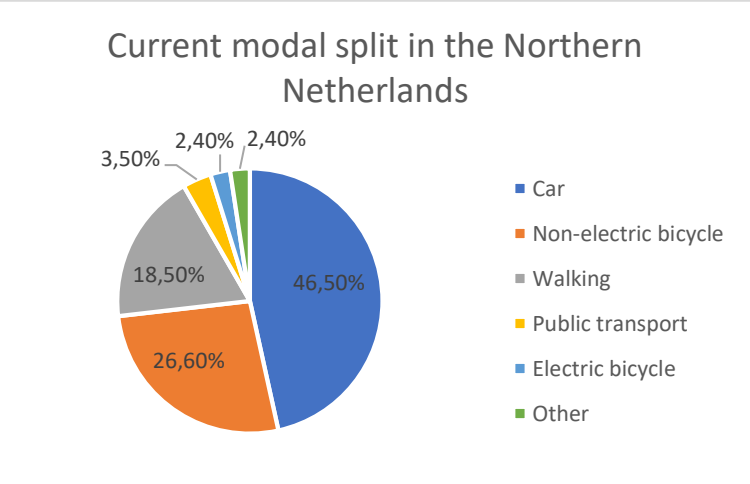

Figure 3. Current modal split in the Northern Netherlands. Source: CBS, 2017a.

In the Northern Netherlands, which consists of the provinces of Groningen, Friesland and Drenthe, the car is the most used mode of transport, as shown in figure 3. Public transport is only responsible for 3,5 per cent of the trips being made in the Northern Netherlands. Because of the fact that public transport is not always economically viable on the countryside due to a lower population density in these areas (Eckhardt et al., 2018), MaaS might have a great potential in these areas to decrease the amount of private cars. It can create a move away from privately owned cars towards combined mobility services (The Conversation, 2018).

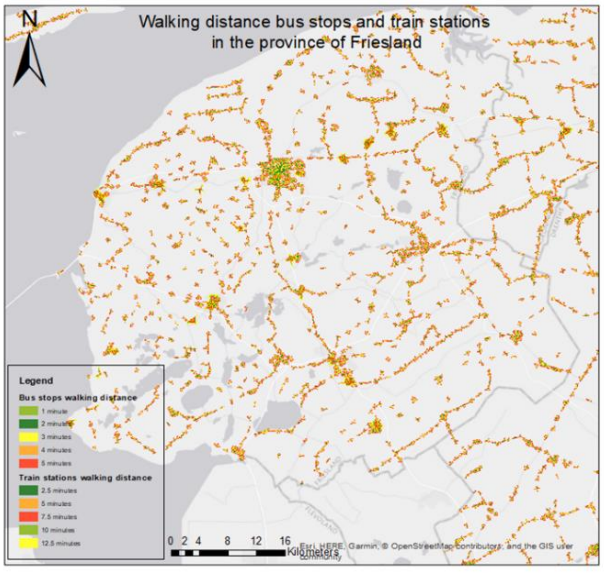

Figure 4. Walking distance bus stops and train stations in the province of Friesland. Source: Own work, 2019.

First of all, it is checked how well-accessible by public transport the research area is nowadays. The reason for this is that MaaS services will preferably use existing public transport lines as well, by combining them with extra transportation for the 'first and last mile' from and towards a certain destination (The Conversation, 2018). The current public transport stops are shown in appendix 1 on page 22, and consist of the bus stops and train stations together. To check the current accessibility by public transport, a network analysis is performed in ArcGIS, as described in

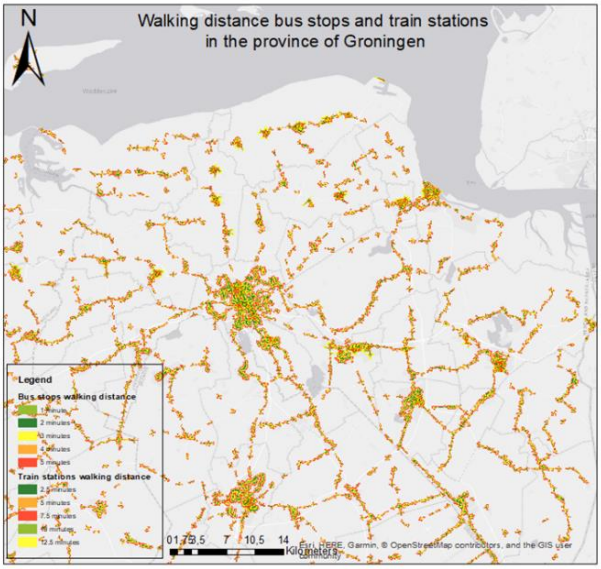

Figure 5. Walking distance bus stops and train stations in the province of Groningen. Source: Own work, 2019.

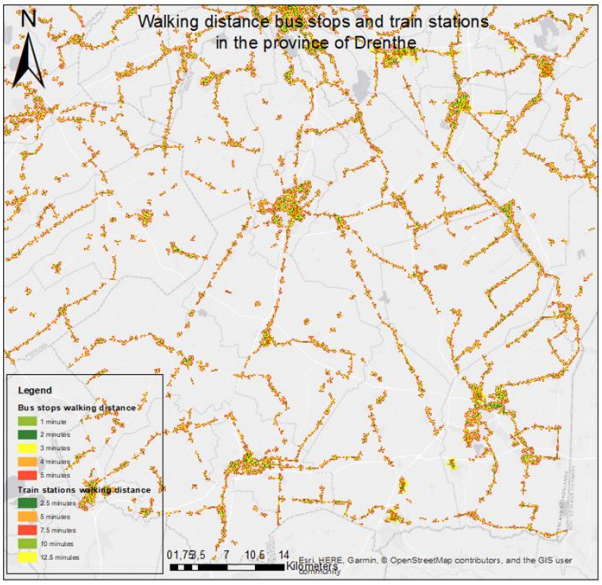

Figure 6. Walking distance bus stops and train stations in the province of Drenthe. Source: Own work, 2019.

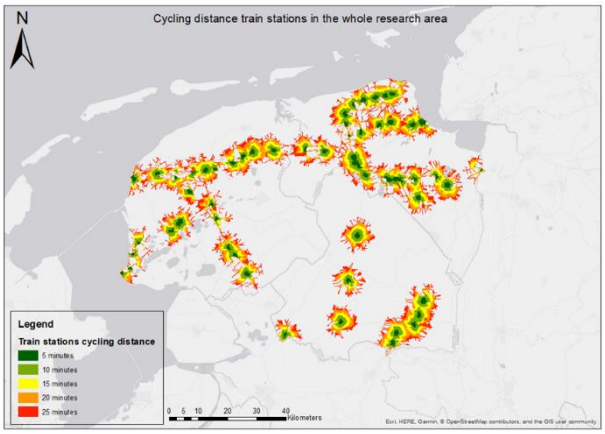

Figure 7. Cycling distance train stations in the whole research area. Source: Own work, 2019.

the methodology on page 11. To do this, a service area was created around every public transport stop in the area, keeping in mind the acceptable walking distance to a bus stop and train station. An acceptable walking distance to a bus stop is approximately 5 minutes, which equals 400 meters (Methorst, 2005; Van der Blij et al., 2010; Daniels & Mulley, 2013; Demetsky & Lin, 1982). An acceptable walking distance to a train station is approximately 12 minutes, which equals 1000 meters (Daniels & Mulley, 2013; CROW, 2004). By keeping these acceptable walking distances into account, a map is created in which the accessibility to public transport stops is shown. Since walking is more and more recommended because of the accompanying health benefits, the maximal acceptable walking distance to bus stops and train stations might increase in the future (Rissel et al., 2012). The maps with the current maximal acceptable walking distances towards a bus stop and a train station are shown in figure 4, 5 and 6 and also in appendix 2 on page 24 until 28. In the appendix, also a figure of the whole research area is shown.

The same accessibility maps have been made for cyclists, as shown in figure 7 as well as in appendix 3. Since most of the people reach a train station by bike in the Netherlands (KiM, 2017), it is important to also research the accessibility by this mode of transport. The average cycling velocity is 16 kilometers per hour (City of Copenhagen, 2013), and is taken into account while making the accessibility maps for cycling. Since most of the people walk towards bus stops, the cycling distance towards bus stops is not taken into account in the maps in appendix 3 on page 26. It becomes clear from the maps that not all areas are well-accessible by public transport nowadays. Here, MaaS can play an important role. Promoting more sustainable modes of transport for people who are not living in a cycling or walking distance of a public transport stop can become possible by integrating an entire journey into one, single application, where customers can book and pay their trip in advance.

4.2 – Sub-question 2: Implementation of MaaS in other (rural) areas around the world

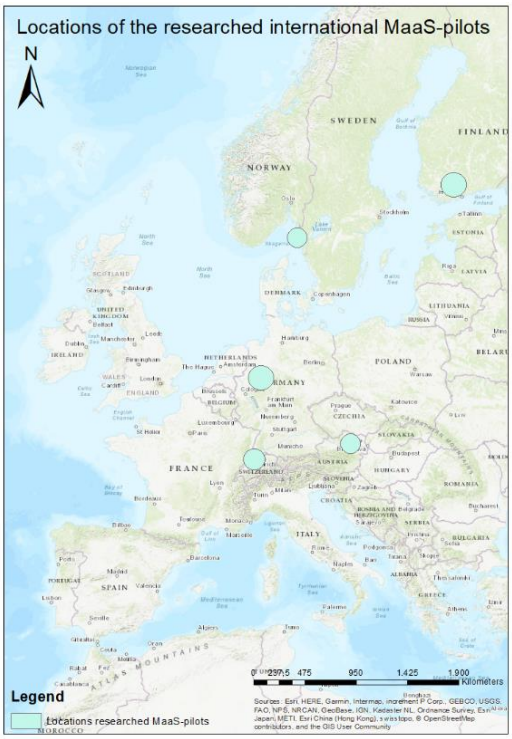

Figure 8. Locations of the researched international MaaS-pilots. Source: Own work, 2019.

The second sub-question deals with the implementation of MaaS in other (rural) areas around the world. As said before, it is a relatively new concept and this means that the amount of discussed MaaS-pilots is still relatively small (Smith et al., 2018). The goal of this sub-question is to bring five MaaS-pilots together and to compare these pilots with each other. The researched MaaS-pilots are shown on a map in figure 8 on the left. In table 1 some of the most important characteristics are summarized. The level of integration (Sochor et al., 2017) is based on the theoretical framework on page 9.

The MaaS-concept was first introduced in 2013 as the UbiGo pilot in the city of Gothenburg. Karlsson et al. (2016) analyze and discuss this specific MaaS-pilot. During this pilot, 195 people from 83 different urban households became subscribed customers for six months in a row. Within this pilot, current transportation systems were used. The selected households could book and pay these services in advance. A commercial actor negotiated with different transportation providers, to give the customer a car-less experience. After this pilot, a sharp decline of 48 percent in private car use was discovered. Next to that, participants became more positive about other modes of transport.

In Vienna, a similar project called Smile was executed. With a special designed smartphone app, customers could book and pay a single journey without only informing themselves about a journey (Smile, 2015). As a result of this, the most suitable journey for a certain person on a certain time was chosen. People could register themselves for this pilot, and more than thousand people ultimately joined it. The aim of this pilot was to make public transport more accessible (Hartmann et al., 2015). The municipality was involved in this project, working together with a private party. After the pilot was launched, participants made more use of public transport and shared cars compared to before.

In 2016, Whim was introduced in Helsinki. Within two years, this service had more than 70,000 users. Within this pilot, people could subscribe themselves to the services. In Helsinki, the users can book and pay their journeys with public transport, bikes and shared cars. This is the level 2 form of integration. But it is also possible to subscribe to the services, making it an unlimited package of multimodal journeys. Whim works together with private parties such as taxi companies, supplemented by the public transport companies. This project became a global example for how to implement MaaS in cities (CityLab, 2018).

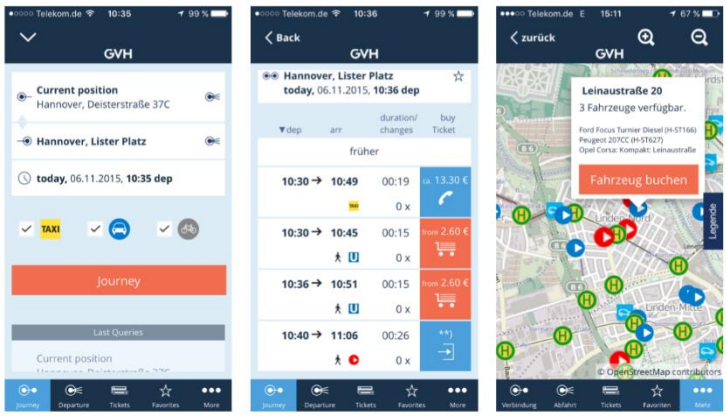

Figure 9. Example of a Mobility as a Service app, as used in Hannover. Source: Connective Cities (2019).

In Hannover, the pilot 'one stop mobility shop' was established. This pilot was established by a public transport company in the city. It is established by the public transport company of the city, to create more livability and fewer congestion within the city. The individual needs for the customer will be taken into account every time a journey is booked via the digital app, as shown in figure 9.

The last analyzed pilot is the SwissPass in Switzerland. This is a different pilot compared to the ones described above. This pass is usable in the whole country, and customers can use it on an extensive network of public transport lines. This project can be seen as an extensive form of MaaS, to reduce the amount of private cars in the country by making other modes of transport more accessible.

It becomes clear that most of the executed pilots nowadays took place in cities or urban environments. Only the SwissPass was also usable in rural areas. Next to this, the current public transport lines form the backbone of the services, whilst the first and last mile will be performed by private parties.

MaaS-pilot / project	**Amount of people in the pilot / project**	**Method of working**	**Stakeholders (public, private, commercial)**	**Level of integration (Sochor et al., 2017)**
UbiGo Gothenburg, Sweden (Karlsson et al., 2016)	83 Households in cities, urban environment	Use current transportation systems and offer them in a unified package	Commercial, negotiating with several transportation services	Level 3 – Subscription to the service
Smile Vienna, Austria (Smile, 2015)	More than 1,000 people	Offer multimodal journeys via an integrated app	Municipality of Vienna and the federal railways	Level 2 – Book and pay a journey
Whim Helsinki, Finland (Ramboll, 2019)	Around 70,000 customers nowadays	Book and pay a single, multimodal journey or subscribe to the services	Private taxi companies and public transport companies	Level 3 – Subscription to the service
One Stop Mobility Shop Hannover, Germany (Intelligent Transport, 2017)	Around 1,300 customers	An integrated app in which users can book and pay a journey (see figure 5)	Established by a public transport company	Level 2 – Book and pay a journey
SwissPass, Switzerland (Mobility, 2019)	Unknown	One pass which is working on all public transport lines in the country	Federal railways and public transport companies	Level 3 – Subscription to the service

Table 1. Overview of MaaS-pilots/projects around the world and their most important characteristics. Based on: Karlsson et al. (2016); Smile (2015); Ramboll (2019); Intelligent Transport (2017) and Mobility (2019).

4.3 – Sub-question 3: Current state of MaaS in the Netherlands

Figure 10. Locations of the seven researched national MaaS-pilots. Source: own work, 2019. Based on Connekt (2018).

Also in the Netherlands there were some MaaS-pilots (Connekt, 2018), as shown in figure 10 on the left. Especially the pilot in the provinces of Groningen and Drenthe will be of importance, because this is a part of the Northern Netherlands. As visible on the map in figure 10, some pilots cover one or more provinces, whilst others are only implemented in a certain region or city. The most important characteristics of these pilots are summarized in table 2.

The pilot in Groningen and Drenthe is established together with the already existing contract transport, available for people with physical limitations. With this interprovincial pilot, they want to make MaaS accessible for all inhabitants of the provinces. As in other pilots, the journeys will become available via an app. The pilot in the region of Twente is also established with the already existing contract transport. With MaaS, the barriers between this contract transport and regular transport will disappear. For this region, the intention is also to make MaaS accessible for all inhabitants in the near future.

The airport in Rotterdam established MaaS to facilitate journeys for international passengers and for their own employees, because they have to reach the airport on times that normal public transport is not active. It is namely established to improve the accessibility of the airport. Normal public transport lines will be the backbone of the service, but at some times of the day the MaaS-services will be fulfilled by other, private parties. The pilot in Amsterdam is also aimed at employees, mainly those of the companies at the Zuidas. The accessibility of this area decreased, and several public-private parties worked together to reach the aims of sustainability, accessibility and flexibility of transportation. Next to this, the municipality of Amsterdam wants to increase the livability of the city. While implementing MaaS, the amount of private cars might decrease, solving the problems of congestion and livability. The pilot in the city of Eindhoven is also aimed at the employees in the municipality, especially the employees from Brainport Eindhoven and the company ASML. The aims of the municipality are to be sustainable and CO_2-neutral in the year 2025, and by implementing MaaS they want to give sustainable journey options to the employees in their municipality.

In the province of Limburg, there are other reasons for implementing MaaS. Because of the fact that the province is located close to the borders of Belgium and Germany, a lot of international journeys are made here. The application here is aimed at facilitating the journeys between these countries. Besides, they want to remove the barriers of different modes of transport and make it easier for customers to choose a multimodal journey. It is aimed at reducing the amount of private cars and to create easier journeys between different (cross-border) regions. First of all, it is aimed to keep the capital city of the province accessible by letting partners of this association making use of it. Later on, it will become available for other inhabitants as well. This project is quite unique since this is the only current MaaS-pilot in the Netherlands nowadays that stimulates cross-border collaborations.

The last pilot analyzed here is the one in the new-built neighborhood Leidsche Rijn, located west of the city of Utrecht. In this neighborhood, the amount of cars is relatively high. Because of the fact

that the neighborhood will expand in the future, more and more congestion will appear, causing a decrease in the livability of the neighborhood. Here, MaaS can be a solution to increase the accessibility and livability of the neighborhood.

To explore the future possibilities for MaaS in the Netherlands, a taskforce has been established in which around forty public and private parties come together (Connekt, 2018). In this taskforce, they are aiming to develop MaaS with their combined knowledge about the concept. As a result of this, the implementation of MaaS in the Netherlands can speed up, while making it better and more accessible for a bigger target group.

MaaS-pilot / project	Aimed at (pilot group)	Stakeholder(s)
Groningen / Drenthe	First for people with physical limitations, later for all inhabitants	Contract transport
Rotterdam Airport	Employees and international visitors	Airport, public transport companies
Amsterdam Zuidas	Employees of the Zuidas	Companies at the Zuidas, public transport companies and the municipality of Amsterdam
City of Eindhoven	Employees of the municipality	Municipality of Eindhoven and Brainport Eindhoven together with the company ASML
Province of Limburg	Companies, later for all inhabitants of the province	Maastricht accessible association and partners
Twente region	First for people with physical limitations, later for all inhabitants	Contract transport
Neighborhood Leidsche Rijn, Utrecht	The new-built neighborhood with 80,000 inhabitants nowadays	Current public transport companies, municipality and province of Utrecht

Table 2. Overview of MaaS-pilots/projects in the Netherlands. Based on: Connekt (2018) and Ministerie van Infrastructuur en Waterstaat (2019).

4.4 – Sub-question 4: Development scenarios for the Northern Netherlands

According to Smith et al. (2018), MaaS can develop in three different ways. Following the analyzed and discussed MaaS-pilots, the public-private partnership development will be the most likely, also in the Northern Netherlands. Eckhardt et al. (2017) conclude this as well, since it can save costs for the public sector.

This has also been highlighted during the interview. In Groningen and Drenthe, contract transport is now the backbone of MaaS, but in the future it should become available for more inhabitants to improve the accessibility on the countryside. This can make the rural areas more accessible as well. This means that a private party, namely the contract transport provider in Groningen and Drenthe, works together with a public party (the public transport company) to carry out Mobility as a Service in these provinces.

4.5 – Main research question

The main research question, “How can Mobility as a Service (MaaS) be implemented as a replacement for the traditional car in rural areas in the Northern Netherlands?” can now be answered with the help of the sub-questions. It can be concluded from the first sub-question that the

car is nowadays the most used mode of transport in the research area. Because of the fact that public transport is not always nearby or economically viable on the countryside, MaaS can be a helpful tool for the first and last mile of a certain journey. Moreover, it makes it easier for people to move around and book and pay a journey in advance via a digital app. Current public transport lines will thus be the backbone of MaaS in those (rural) areas.

Public transport companies (public parties) can also work together with private parties (such as taxi companies), so that they can together create a mobility service. The first and last mile to and from a public transport stop is then executed by the private party, whilst the other part of the journey is executed by the public transport company itself.

5 – Conclusions

In this last section, some of the main conclusions and recommendations will be given. Next to this, some suggestions for further research are proposed. Finally, a reflection on how the process went is given.

5.1 – Main conclusions

It becomes clear from the accessibility maps that not all areas of the provinces of Friesland, Groningen and Drenthe are well-accessible by public transport nowadays. Here, MaaS can come in to fulfill the transportation needs in these areas. It is found that the current public transport lines should be used efficiently while implementing MaaS. The so-called first and last mile needs to be covered by other modes of transport. For the transport to and from a public transport stop, MaaS can be implemented. Users do not need to book and pay their different modes of transport separately, but via one, single interface. This makes it less likely that customers will take the car for their transportation needs. It will keep the rural areas accessible by public transport or by other modes of transport, apart from the car. This means that a certain amount of amenities can sustain on the countryside, despite of the fact that the population is declining there.

Next to this, it was found that public and private parties need to work together. They can together change the mobility in urban and rural environments. For example, companies (private parties) can promote sustainable modes of transport for their employees.

5.2 – Suggestions for further research

Further research about this topic might explore the outcomes of new MaaS-pilots in rural areas. It is important to accurately monitor and analyze these pilots to see which lessons from these pilots can be used in new, future projects. As a result of these investigations, it can become clear what the most common target group for MaaS is and what the causes for the development of MaaS might be. Next to that, exploratory research might be helpful to see how willing people are to use transport solutions such as MaaS. Before setting up a certain pilot, the benevolence and possible target group might become clear. A final implementation of MaaS can then more be aimed at a certain target group, so that the pilot can become more successful.

5.3 – Reflection on the process

The general theme of this thesis group (transitions in automobility: towards a post-car society) appealed me directly. But then it was the question on which specific theme I would focus in my research. I chose for public transport and smart transportation solutions, and tried to combine this into the new concept MaaS. At first, finding a good and defined research topic was difficult, but with some help and recommendations I started working relatively soon. I enjoyed working on this topic, since it is personally interesting for me as well, because I live in the research area. The interviews with the policy makers and those involved in the MaaS-pilot Groningen/Drenthe went well and gave some useful insights. After all, I am glad how the research process went. But there are some points of improvements as well, which I will think about when I am doing such a project again. First of all, finding a good scope is of importance from the beginning of the research. So, the next time I will define my research area and target group at the beginning. Next to that, trying to visualize the research questions into a conceptual model will be a helpful tool at the beginning of a research. Now, my definitive conceptual model came quite late. I will keep, among other things, these points of improvement in mind for the next time.

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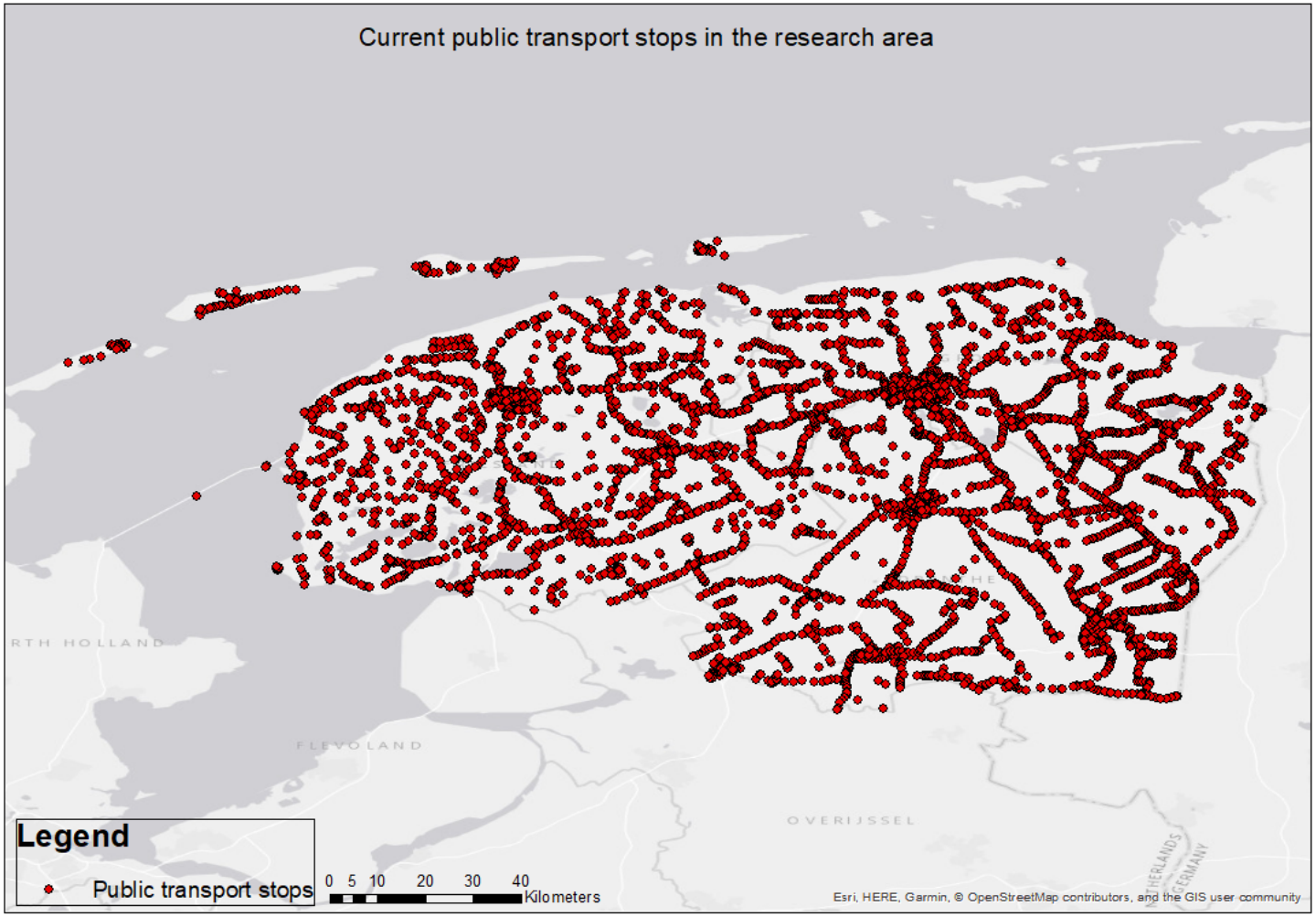
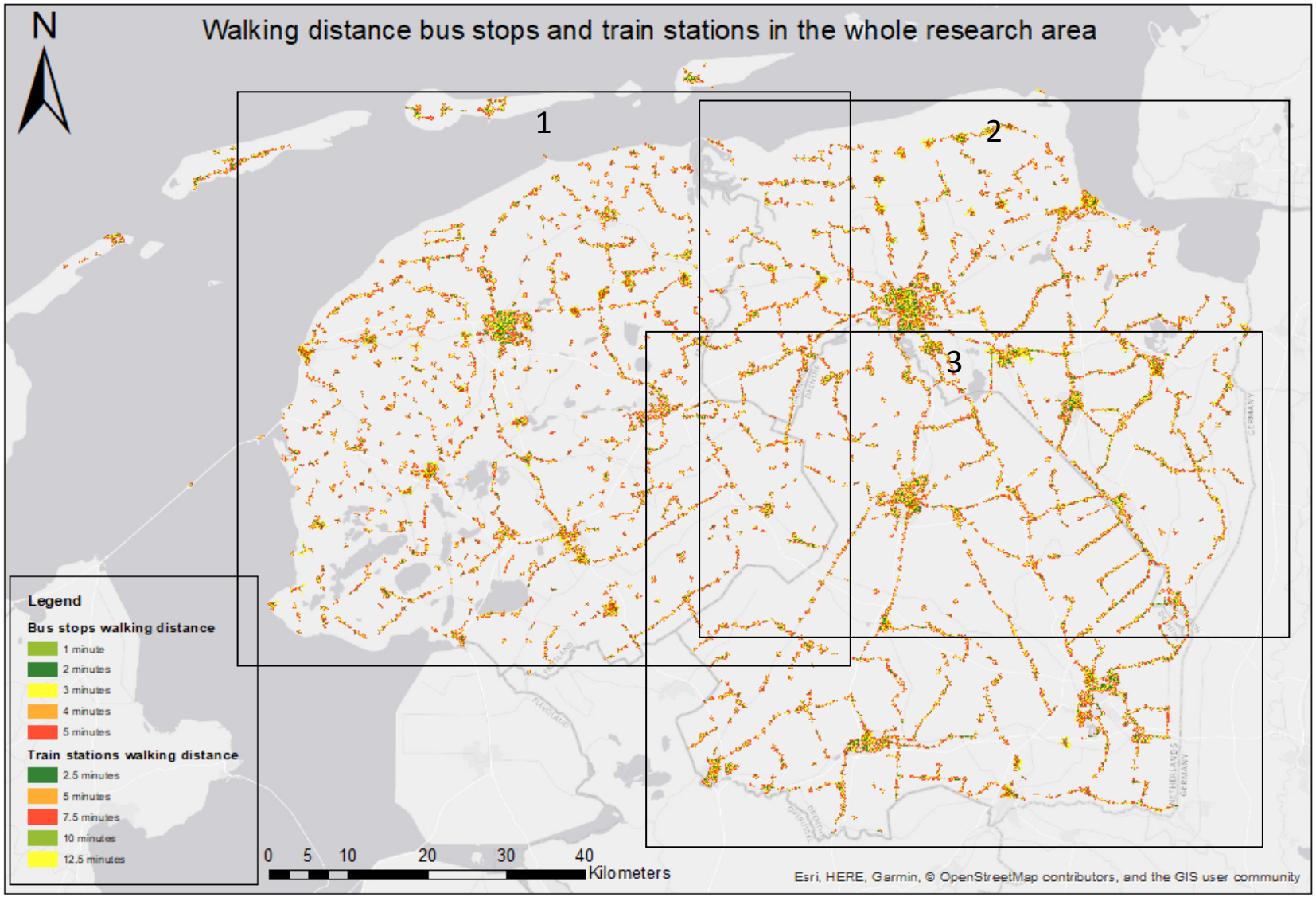
Appendices

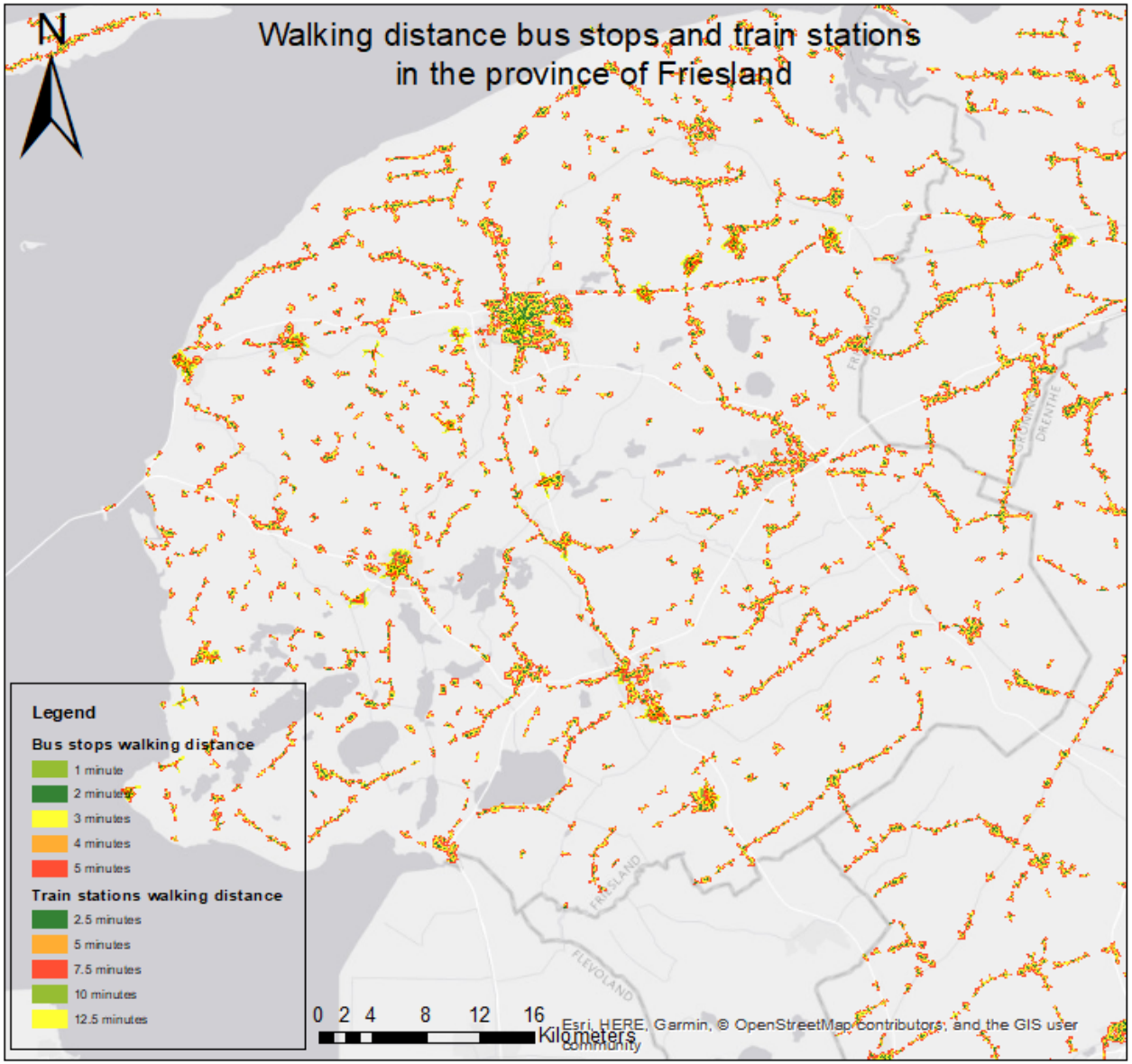
In the following section, the accessibility maps are shown. Next to that, the interview questions that were used for sub-question 4 are shown here.

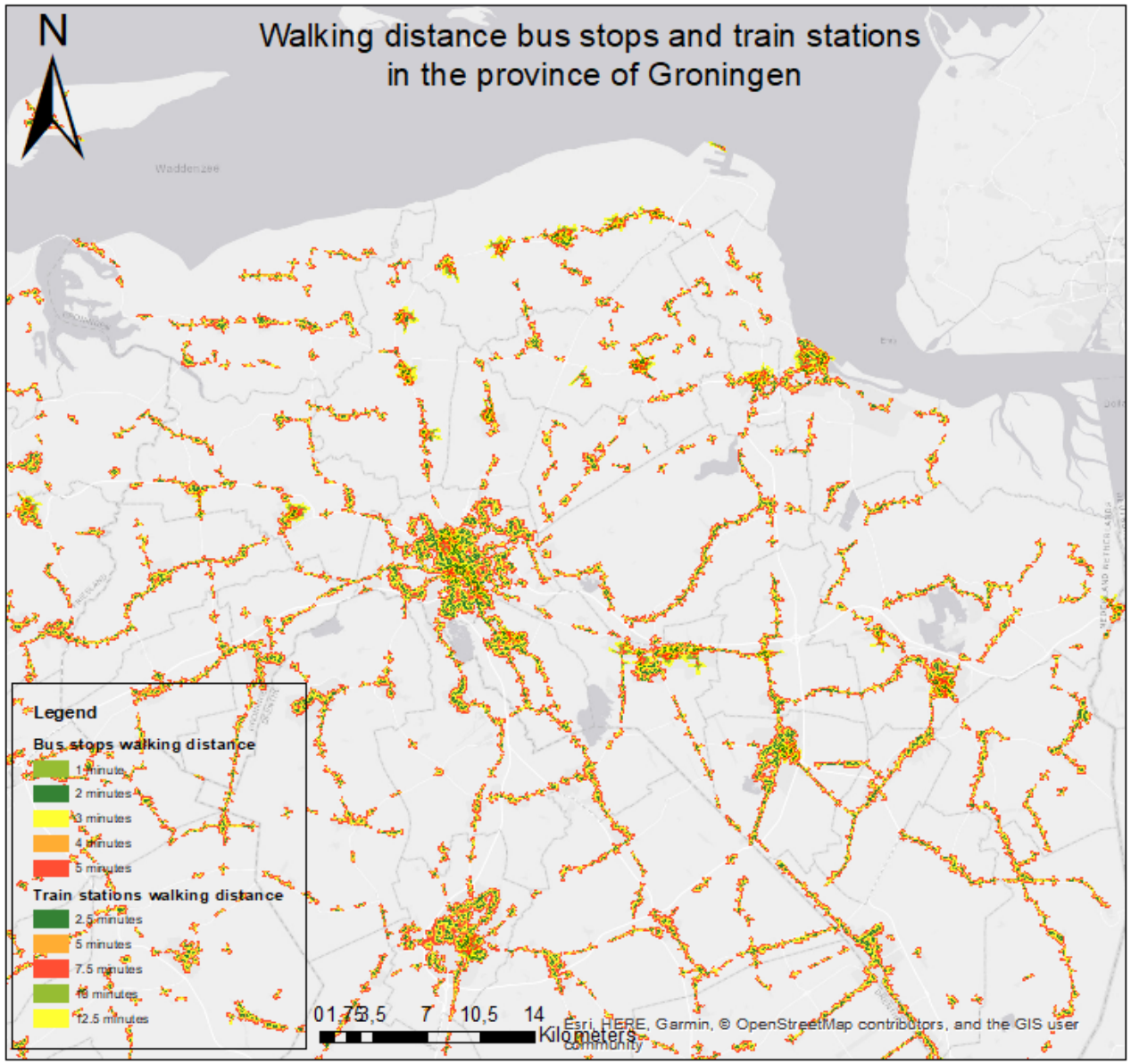
Appendix 1 – Public transport stops in the research area

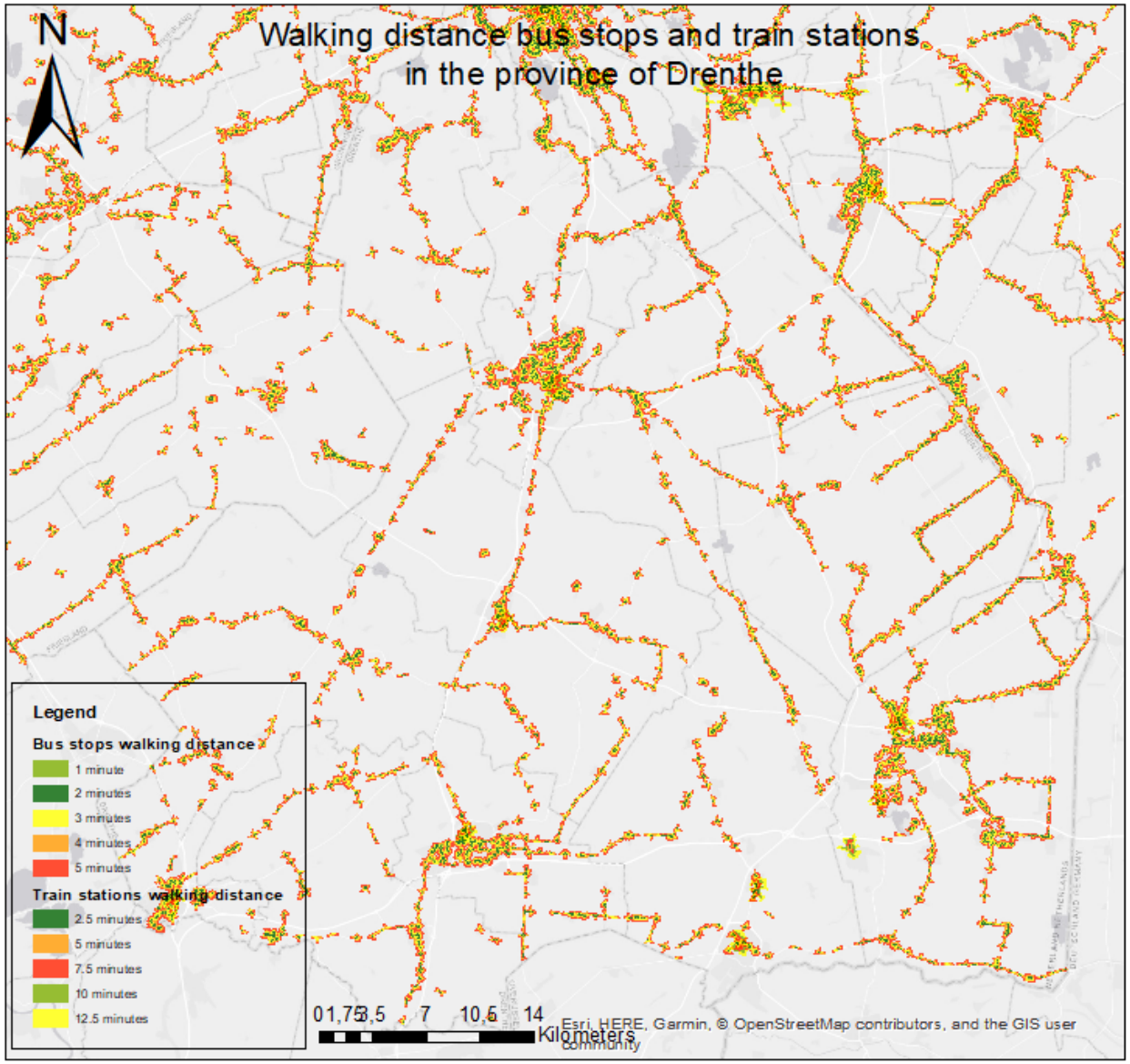


Appendix 2 – Accessibility walking distance bus stops and train stations

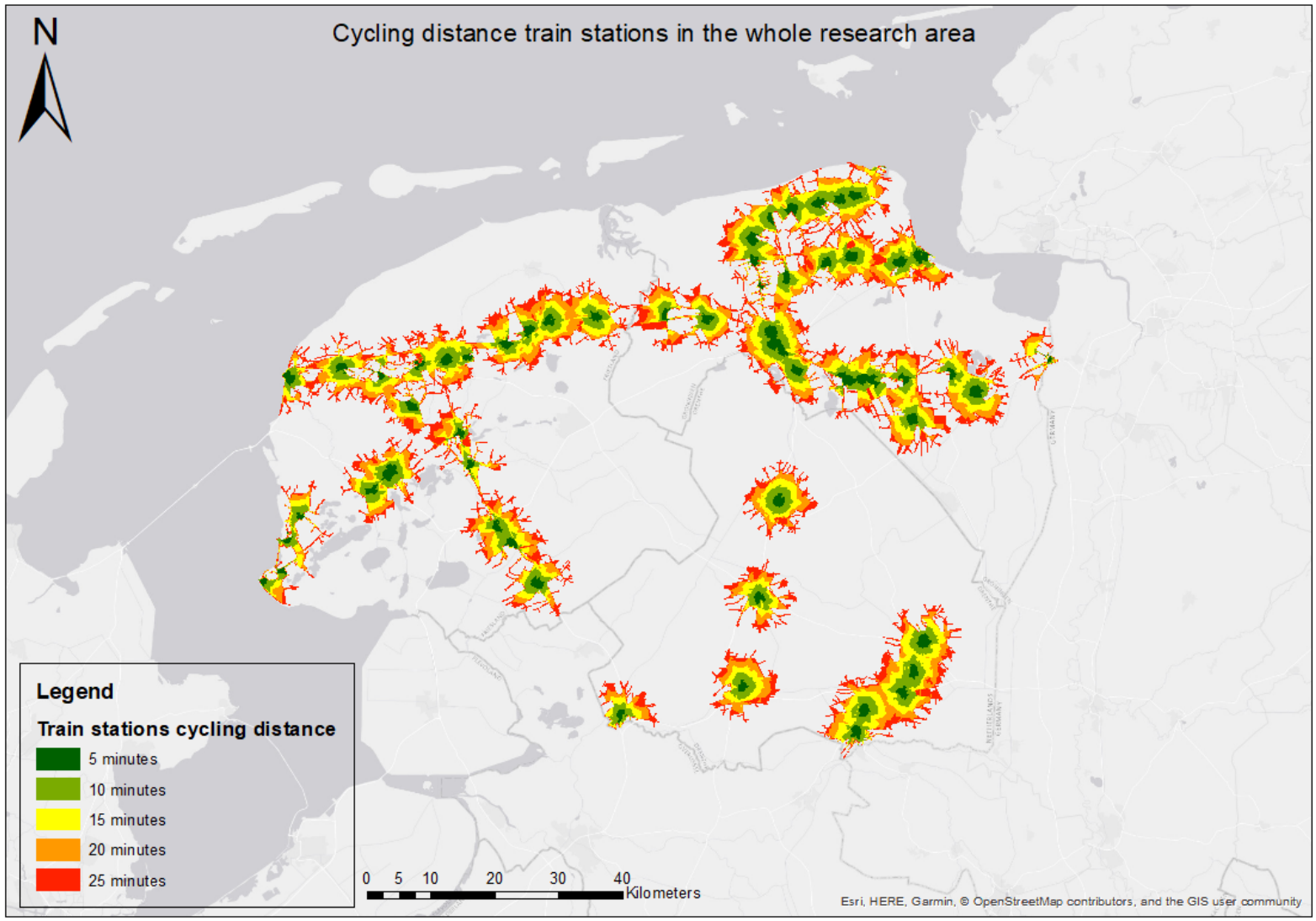



N
Walking distance bus stops and train stations
in the province of Friesland
Legend
Bus stops walking distance
1 minute
2 minutes
3 minutes
4 minutes
5 minutes
Train stations walking distance
2.5 minutes
5 minutes
7.5 minutes
10 minutes
12.5 minutes
0 2 4 8 12 16
Kilometers
Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community


N
Walking distance bus stops and train stations
in the province of Groningen
Legend
Bus stops walking distance
1 minute
2 minutes
3 minutes
4 minutes
5 minutes
Train stations walking distance
2.5 minutes
5 minutes
7.5 minutes
10 minutes
12.5 minutes
0 1,75 3,5 7 10,5 14
Kilometers
Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community


N
Walking distance bus stops and train stations
in the province of Drenthe
Legend
Bus stops walking distance
1 minute
2 minutes
3 minutes
4 minutes
5 minutes
Train stations walking distance
2.5 minutes
5 minutes
7.5 minutes
10 minutes
12.5 minutes
0 1,75 3,5 7 10,5 14
Kilometers
Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community

Appendix 3 – Accessibility cycling distance train stations



Appendix 4 – Interview guide, overview of used questions

The following interview questions were used as a guideline during this research:

- In which way is your province working towards the implementation of more sustainable modes of transport, such as car sharing?
- Is the province already working on (pilots of) Mobility as a Service (MaaS) and what are their preliminary findings from these pilots?
- In which way can Mobility as a Service (MaaS) be implemented in your province and why?
- In which way can the province contribute to the implementation of Mobility as a Service (MaaS)?